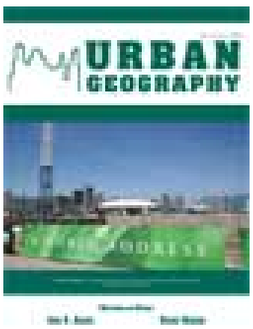

Urban Geography

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rurb20

Charting the design and implementation of the smart city: the case of citizen-centric bikeshare in Hamilton, Ontario

Robert Bradshaw & Rob Kitchin

To cite this article: Robert Bradshaw & Rob Kitchin (2021): Charting the design and implementation of the smart city: the case of citizen-centric bikeshare in Hamilton, Ontario, Urban Geography, DOI: 10.1080/02723638.2021.1878439

To link to this article: https://doi.org/10.1080/02723638.2021.1878439

Published online: 25 Jan 2021.

URBAN GEOGRAPHY
https://doi.org/10.1080/02723638.2021.1878439

Routledge
Taylor & Francis Group

Charting the design and implementation of the smart city: the case of citizen-centric bikeshare in Hamilton, Ontario

Robert Bradshaw and Rob Kitchin

Department of Geography, Maynooth University Social Sciences Institute, National University of Ireland Maynooth, County Kildare, Ireland

ABSTRACT

Previous scholarship on the smart city has expressed concern at the top-down, technocratic nature of smart technologies and the lack of meaningful citizen participation in their development. In this paper, we utilize instrumentalization theory to trace the initiation, design and deployment of a specific smart city initiative: bikeshare in Hamilton, Ontario. Smart bikeshare is increasingly seen as complicit in processes of social stratification, serving a predominately white, middle-class demographic and particular locales. Our case study reveals the potential of reflexive design praxes to reconfigure bikeshare as a platform for both instrumental and social value. In particular, we highlight how collaborative, open and inclusive forms of urban governance can enroll a broad range of civic actors to create a scheme that embodies diverse but complimentary goals and ideologies. We conclude that instrumentalization theory provides a conceptual means to open up the "black box" of urban design to critical interrogation, and to identify how to enact participatory design and citizen-centric smart urbanism.

ARTICLE HISTORY
Received 24 March 2020
Accepted 15 January 2021

KEYWORDS
Bikeshare; smart city; citizenship; participatory design; instrumentalization theory

Introduction

Smart technologies and the policy initiatives supporting them are increasingly being promoted as a means to enable cities to achieve greater efficiency, control, sustainability, innovation and economic performance (Hollands, 2008; Karvonen et al., 2018; Townsend, 2013). Over the past two decades, cities have been experimenting with a raft of new smart technologies (e.g., intelligent transport systems, urban control rooms, smart grids, sensor networks, building management systems, and urban informatics) in order to manage city services and infrastructures and to govern urban life (Kitchin, 2014). Similarly, businesses have been developing new smart products and business models (e.g., real-time apps, sharing and gig economy, new work processes) designed to enhance urban living and conducting commerce in the city. The drive to make cities smart has not, however, been smooth.

In general terms, the smart city has been critiqued for its top-down, technocratic, instrumental nature that predominately serves the interest of states and business rather than citizens (Datta, 2015; Kitchin, 2014; Sadowski, 2020). This critique is despite the

CONTACT Robert Bradshaw Rob Kitchin rob.kitchin@mu.ie Maynooth University Social Sciences Institute, National University of Ireland Maynooth, County Kildare, Ireland

promises of promoters that smart urbanism would not only deliver instrumental and financial rewards through improved service management, competitive advantage and net job creation, but also empower citizens by enabling the co-production of infrastructure, public services and strategic development (Townsend, 2013). Instead of the city being framed as a platform which empowers participatory and cooperative processes (Barns, 2020; McLaren & Agyeman, 2015), the city has largely been cast as a site where citizens perform non-participatory, consumer or tokenist roles (Cardullo & Kitchin, 2019; Cowley et al., 2018; Taylor et al., 2016). Here, the smart city is envisaged as citizen-centric in so much as the technologies enact forms of stewardship (delivering on behalf of citizens) and civic paternalism (deciding what is best for citizens), rather than citizens being meaningfully involved in the vision and development of the smart city (Morozov & Bria, 2018; Shelton & Lodato, 2019). In other words, the design of smart technologies largely operates in hegemonic ways by translating the interests of powerful state and corporate actors into specifications which create neoliberal modes of citizenship and governmentality characterized by passivity, obedience, consumerism and nudge (Feenberg, 2010; Haklay, 2013; Hannig, 2016; Kitchin et al., 2019).

Implicit in this narrative is the assumption that smart technologies are inherently value-free and benign, and are used for progressive and egalitarian ends (Kitchin, 2014). Such technological neutrality can be seen as a strategic attempt by vested interests to depoliticize the design and deployment of smart technologies and position them beyond the scope of political action (Haklay, 2013). From this perspective, articulations of democracy and citizen participation in the smart city have been largely rhetorical, mobilized to add legitimacy to technical praxes concerned with supporting private interests and entrepreneurial modes of governance (Cardullo & Kitchin, 2019; Perng, 2019). This has also been referred to asengagement theater or "co-optation" where institutional actors create, then strategically undermine, collaborative relationships to ensure certain outcomes (Teli et al., 2020). Such action has tended to produce technologies which are functional in nature, but which are resistant to social influence and the interests, concerns and needs of people and communities (Feenberg, 2010, 2017; Hollands, 2008). Even in cases of more citizen-engaged endeavors, such as hackathons, the evidence is that such events are framed and co-opted within neoliberal and corporatist agendas (Perng, 2019).

Yet, despite the pervasiveness of structural and ideological constraints conditioning technology production, citizen-centric design and social innovation may still prevail when supported by rationalizations and reflexive practices concerned with the reintegration of functionality with progressive social values (Le Dantec, 2016; Feenberg, 2010; Kitchin, 2019; De Lange & de Waal, 2013). In this paper, we explore this potential through an investigation of the deployment of one form of smart technology – public bikeshare that is often cast as a form of smart mobility given its reliance of networked digital technologies to function. Using a critical perspective derived from constructivist technology studies – instrumentalization theory as developed by Andrew Feenberg (1999, 2005, 2010, 2017)) – we argue that the design and configuration of these schemes can be re-imagined in order to exploit their potential to deliver on agendas which transcend narrow definitions of efficiency and functionality and which involve meaningful citizen participation. Through strategic initiatives and integrative practices, schemes offer the potential of assimilating intrinsic (technical) and extrinsic (social)

variables, emerging from different elements of society, into a single artifact which translates discursive demands into their functional equivalent. We explore this contention through an examination of the visioning and implementation of SobiHamilton, a public smart bikeshare scheme recently implemented in Hamilton, Canada, drawing from a set of 24 interviews and documentary sources. This case study complemented a similar study of the implementation of Dublin Bikes, Ireland, which followed a traditional, top-down procurement model and had no citizen engagement (Bradshaw, 2018).

Importantly, as well as casting light on citizen engagement in the smart city, our approach provides a theoretical means to open up the "black box" of scheme design to critical interrogation. To date, much of the smart city literature details in relatively broad terms the framings, narratives and technologies being deployed across the globe. Case studies tend to focus on the suite of programmes and schemes within a city and their consequences (Coletta et al., 2018; Karvonen et al., 2018; Marvin et al., 2016), or on the role of a particular technology in disrupting phenomena such as governance, governmentality, an industry or market (e.g., intelligent transport systems and traffic control, or sharing platforms such as Airbnb or Uber challenging regulations and the hospitality and taxi sector). Much less work has sought to trace the initiation, design, development and deployment of specific smart city technologies and the complex amalgam of politics and praxes that shaped their unfolding beyond a handful of studies. Using instrumentalization theory, we trace the contextual history of SobiHamilton, highlighting how the scheme unfolded in contingent and relational ways that sought to co-opt citizen views rather than tracking a purely top-down, teleological path. As such, we make a contribution not only to debates in critical urban geography, but also to previous scholarship in critical design (see for example, Le Dantec & DiSalvo, 2013; Kitchin et al., 2016; Liegl et al., 2016; Perng, 2019; Schliwa, 2019).

Smart bikeshare

Smart bikeshare programmes are a form of transportation sharing in which bikes are made available for use, usually on a short-term basis, from strategically positioned stations distributed throughout an urban environment. Typically, schemes are engineered to support point-to-point-based trips. Though the concept originated in the 1960s, its proliferation is generally associated with the emergence of viable technical formats in the late 1990s. The first generation of system design, which deployed initially in Europe in 1965, was largely unmanaged and the lack of effective tracking and user authentication left bicycle fleets vulnerable to theft and abuse (Midgley, 2009). Second generation approaches, pioneered by Copenhagen in 1995, proved somewhat more successful, using a coin deposit system for access (DeMaio, 2009). Schemes, however, proved prohibitively expensive to run due primarily to the effects of theft and the lack of automation. Third-generation designs utilize an architecture of hardwired, networked stations, along with tracking systems and smart access technologies to provide operators with high levels of security and control (Fishman et al., 2013). Though introduced in 1998, third-generation systems were somewhat limited until 2005 when Lyon launched its scheme with a fleet of 1500 bikes (Bührmann, 2008). The emergence of IoT (Internet of Things) technologies has led to a transition to fourth-generation schemes which include stationless operating models, high levels of integration with other transport

modes, and the use of collaborative technologies to encourage improved communication with riders (Bradshaw, 2018).

In addition to its pragmatic value, smart bikeshare has also been proposed as a way of promoting social equity and inclusion (Buck, 2012). In recent years, there has been significant research interest in the subject of transport disadvantage which has revealed the economic, social and educational constraints experienced by those unable to fulfil their mobility needs (Clark and Curl 2016). Part of the promise of smart bikeshare is its potential role in mitigating this disadvantage by providing communities with an affordable and accessible form of mobility (O'Brien et al., 2014; Shaheen, Martin et al., 2013). This emancipatory aspect of publicly owned bikeshare schemes positions them as an object of political discourse and associates them generally with the renaissance in cycling which can be understood, at least in part, as a form of oppositional culture challenging the orthodoxy of motorized transportation (Horton, 2006). Smart bikeshare is also aligned ideologically with new and emerging models of collective urban consumption which are less commercial and more collaborative, and underpinned by notions of urban citizenship (McLaren & Agyeman, 2015). Consequently, and in addition to its functional capabilities, smart bikeshare has become emblematic of both environmental and social justice and its adoption is increasingly positioned as a rite of passage for cities wishing to position themselves as ethically informed, citizen-centric and progressive (Fishman et al., 2013; McLaren & Agyeman, 2015). Despite the rhetoric of inclusivity and equity, however, several studies have begun to problematize the politics underpinning the configuration and implementation of many systems (Fishman et al., 2013; Hannig, 2016). In a manner reflective of broader smart technology critiques, smart bikeshare is increasingly seen as complicit in processes of discrimination and social stratification (Duarte, 2016; Hannig, 2016). For the most part, smart bikeshare serves a predominantly white, middle-class demographic (LDA Consulting 2014; Fishman et al., 2013; McNeil et al., 2017). Furthermore, these characteristics tend to be consistent across geographies and cultures (LDA Consulting 2014; Buck & Buehler, 2013; Hoe & Kaloustian, 2014; Shaheen, Martin et al., 2013).

In response, several cities have attempted to systematically remove financial and structural barriers to improve the reach of smart bikesharing for underserved populations (Buck, 2012). Despite modest success, however, vulnerable groups still tend to be underrepresented. Hannig (2016) proposes that, while mitigating barriers has merit, the measures deployed are often based on limited data and developed in isolation, without the participation and engagement of communities. Accordingly, there is a risk of the personal values of planners and operators prevailing over the needs and wishes of citizens. There is an emerging consensus; therefore, that the most equitable programmes are those which invest time and effort in developing partnerships between decision-makers and communities (NACTO, 2013). These partnerships have the potential to foster camaraderie, consensus building and mutuality and produce design solutions which are cognizant of a diversity of stakeholders and interests. These themes can be profitably examined, we posit, through the lens of instrumentalization theory, which acknowledges that technologies are the result of social processes, and focuses on the ways in which design and implementation are embedded within broader sets of values, practices and taken for granted assumptions.

Instrumentalization theory and bikeshare

Instrumentalization theory, as developed by Andrew Feenberg (1999, 2005, 2010, 2017)), combines ideas from the philosophy of technology with the insights of constructivist approaches and the empirical case study approach of STS. The theory acknowledges the tendency in modern societies toward efficiency and control, yet retains the possibility that design may also incorporate socially specific values and so develop in ways which can incorporate multiple epistemologies. It understands the tension between technocratic and democratic rationalizations of technology design and deployment in terms of two analytically distinct modes of production that Feenberg (2005) terms "primary" and "secondary" instrumentalization. Within primary production, technologies are conceived in technical not moral or political ways. In order to understand them, primary instrumentalization involves processes of decontextualization and reduction, in which the functional aspects of technology are seen in isolation of their environments and simplified in order to make them manipulable by technical reason. This produces technologies which are vulnerable to state and corporate projects of control and result in designs that reinforce Weberian notions of social rationalization (Kirkpatrick, 2013). Through the hierarchical and largely autonomous nature of modern organizations, the subjects of technical action are protected from the consequences of their actions, which encourages a separation of the technical and social spheres. Primary instrumentalization, therefore, embodies the technocratic orientation of many smart technologies and associated forms of top-down governance.

Unlike essentialist critics of technology, however, such as Heidegger (1977) and Borgmann (1984) who ontologize such characteristics, Feenberg proposes the possibility of a secondary mode of production that offers the potential of counteracting the reifying effects of primary instrumentalization. Secondary instrumentalization is the process of recontextualizing a new artifact or system to fit with its natural, technical and social environments. When supported by the appropriate normative and ethical mediations, this process of integration or *systemization* provides an opportunity to insert meanings and values into the design and implementation process. Through remediating strategies and democratic interventions, technology can be reconfigured to perform in ways that are sympathetic to social values. Reflexive secondary instrumentalization is exemplified by design approaches which merge multiple functions and technical attributes thereby conserving a wide range of influences and contexts in a single technology. In this way, its specifications can be accommodated to the requirements of its environment leading to innovation that is both technically and normatively progressive. Simondon (1958) describes this process as "concretization", while Feenberg uses the metaphor of the palimpsest (a parchment comprising diverse layers) to capture the potential heterogeneity of the actors and inputs shaping the design process.

To support secondary instrumentalization, Feenberg (2017) articulates forms of democratic intervention which differ both quantitatively and qualitatively from traditional political representation. Technical politics arise from "participant interests"; issues of concern unifying particular individuals in relation to particular technical assemblages. Such interests comprise the diversity of impacts that shape quality of life issues for citizens. Once motivated by issues of concern to coalesce around a technical issue and affect change then agency can be enacted through three distinct but complimentary

approaches: innovative dialogue and participatory design; creative appropriations; and forms of micropolitics.

Innovative dialogue and participatory design offer the potential of both creative and inclusive solutions to the conflict between lay and professional actors. The participatory design community uses the concept of "agonistic" engagements between a variety of stakeholders to capture the notion of disparate and sometimes conflicting interests, coming together to democratize innovation and produce technologies which incorporate the goals and values of multiple interests (Björgvinsson et al., 2012; Le Dantec & DiSalvo, 2013; Perng, 2019). In addition to technical artifacts and systems, this process may also deliver a principle, an idea, a social movement or an intervention (Björgvinsson et al., 2012).

Participatory design typically comprises processes of engagement through which lay actors, civil institutions, and networks of scientific and technical expertise become involved in various forums in order to create solutions, guide policy makers and encourage public debate (Joss & Bellucci, 2002). Bijker (2013) proposes such arrangements can lead to "pluriform" or hybridized forms of governance which act to align social and institutional practices and goals, while Böschen (2013) refers to the process as creating *meta-expertise* – combining instrumental reason with lay epistemologies to produce layered, creative solutions. This also resonates with the concept of "institutioning" (Teli et al., 2020) which frames institutions as dynamic sites through which reciprocity and transformation may occur. From the perspective of supporting civic and governmental actors, these processes meet two important political objectives. Firstly, they strengthen civil society by encouraging citizens to participate in the resolution of issues impacting their lives. Secondly, they enable forms of government which promote openness, transparency and adaptability. To avoid the risk of such practices being reduced to a consultative process for the legitimization of policy initiatives and development plans, engagement needs to take place in an environment of trust, willingness and mutual respect (Bianco 2016; Perng, 2019). Feenberg (2017) also notes that technologies produced iteratively through ongoing forms of engagement are likely to be inherently more sustainable and democratic.

Creative appropriation is a form of innovation where individuals participating in a technical network can reinvent an artifact or system by appropriating it to new purposes and investing it with new meanings (Feenberg, 2010). Haklay (2013) describes this practice as a form of hacking which may operate at multiple levels of sophistication depending on the technical skills of the actor. Hacking can be seen in the exploitation of Web 2.0 technologies to produce customized content such as mash-ups (web integrations using APIs and web services, etc.), community or collaborative maps, or a variety of user-generated content such virtual communities or citizen journalism (Stillman & Johanson, 2007). With regards to smart bikeshare, affordances such as Web 2.0, mapping technologies (GIS), advanced tracking (GPS), granular spatio-temporal data and dockless architectures (which obviate the need for hardwired networked infrastructure), offer a rich and heterogeneous technical environment within which various forms experimentation and appropriation may be explored.

In addition to participatory design and creative appropriations, recontextualizing strategies may also incorporate others forms of micropolitics, such as advocacy, activism and resistance (Feenberg, 2017). The power of social movements, for example, can play a

prominent role in challenging orthodoxy leading to more responsive and conciliatory governance cultures. Ecological actors have been successful in effecting social and political reform leading to new laws, regulations and technical codes (Feenberg, 1999). These codes have translated social concern for the environment into new technical solutions which include renewable energy generation, green computing, sustainable transportation and so on (Watson et al., 2010). Such innovation challenges the thesis that environmental values compromise efficiency and profit and positions them as concerns around which financial and other interests can operate.

Within the context of smart bikeshare, activism and micro-political maneuvering may leverage the design and implementation of systems to effect, or at least be a component part of, systemic social change (Lydon et al., 2011). System deployment, for example, has been noted as a potential form of tactical urbanism in that it can be used in the development of social capital between citizens and the building of organizational capacity between public-private institutions, nonprofits, and their constituents (Lydon et al., 2011; Wesley et al., 2016). Given that smart bikeshare is naturally aligned with a range of progressive agendas (cycling infrastructure, active transportation, open streets, health, and sustainable practices, for example), the possibility exists to use its implementation as a catalyst for building alliances and networks of influence which extend far beyond its boundaries (Callon et al., 2009). Used purposefully, smart bikeshare can become a part of a hybrid forum where conflicting interests can create *knowledge controversies* that can be resolved through various forms of democratic interventions – dialogue, experimentation, tactical resistance, collaborative design and so on. These processes, which may enroll a multiplicity of actors (e.g., urban planners, the public, traffic engineers, political representatives and other communities of interest), offer the potential of producing technical and social infrastructure which strengthens civil society (Wesley et al., 2016). Davidson (2013) emphasizes the technical aspect of this process, describing it as "a play on the physical and political landscape, manifested as a design intervention".

Importantly, from the perspective of the paper, forms of initiative may also operate within and across institutional settings when vocationally motivated actors wish to guide technical innovation in enlightened ways. Organizational leaders may champion particular initiatives or subordinates may operate in concert to subvert conservative regimes. Institutional technologists, for example, despite operating in hierarchical, rule-bound structures, may draw on ethical, political and philosophical principles to question the foundational assumptions of their own professions. Karwat et al. (2015), discussing the emergence of the "activist engineer" note that:

> Activist engineers understand how the notions of apoliticism and ahistoricity result in the current engineering practice of offering only technological progress as a solution to any future problem. [...] Employing praxis, activist engineers transform contemporary engineering practice as they are empowered to act on the political and value claims of their work. They thus reframe problems such as climate change and sustainability as socio-ecological problems that cannot be exclusively addressed as technological problems. (Karwat et al., 2015, pp. 237-238)

This can lead to a more reflexive design culture that shifts the priority from profit and liability to long-term resilience. In the transportation sector, this is evident in the efforts of engineers and planners who use their strategic positions in technical networks to

collaborate with citizens and other stakeholders in the production of more sustainable development such as pedestrianized streets, cycle infrastructure, bikeshare, more integrated public transit systems and so on. Again, this demonstrates how counter-hegemony may adapt governmental structures from within to form new socio-political arrangements in the pursuit of progressive infrastructuring (Marres, 2012; Perng, 2019).

In sum, modes of secondary instrumentalization which mobilize these various forms of agency, offer cities the potential to enrich and contextualize instrumental reasoning and the partial, realist epistemologies which support it. By encouraging a more nuanced and relational understanding of cities as places of diversity and complexity, democratic interventions may lead to technologies which are more social, inclusive and emancipatory (Foth et al., 2007).

We now draw on a case study of SobiHamilton to explore the ways in which these strategies and practices were leveraged to produce a system that incorporates a multiplicity of elements within the city. Our analysis is rooted in empirical fieldwork conducted in Hamilton, Ontario in the summer of 2016. The research was part of a larger project comparing bikeshare in two cities, and also a larger programme of research on smart cities that involved a number of linked projects. The case has been updated in the interim to allow us to report not only on the initial set up and configuration of the scheme, but also to include relevant post-implementation developments.

To develop a holistic understanding of system creation, implementation and use, 24 interviewees, comprising system designers and operators, scheme users (riders), advocacy groups, civil servants, politicians, journalists, and industry experts, were enrolled in the study.[1] Documentary sources included company and government reports, strategy and policy documentation, organizational websites, procurement and contract documents, patents, formal studies, academic papers, and newspaper and website articles. These sources supplemented and guided the interview process, and provided additional material to which critical analysis was applied. The data was analyzed using a thematic coding process informed by instrumentalization theory and by a complementary process of critical hermeneutics derived from the work of Ricœur (1981). The data was read and re-read using this lens to allow multiple data sources to be evaluated as a holistic whole rather than be biased by individual or partial accounts. Though critical theory and critical hermeneutics are not necessarily synonymous given that Ricoeur's work does not decide apriori which dialectics will be most significant, it is widely accepted that there is a high degree of congruence between the two positions (Horton, 2006; Myers, 2016).

SobiHamilton bikeshare

Situated 30 miles south east of Toronto and with a population of 536,917 in the 2016 census (Stats Canada, n.d.), Hamilton is a post-industrial city which broadly conforms to the North American archetype of suburban affluence and city center poverty (Harris et al., 2015). Historically reliant on the manufacturing sector, globalization and the effects of various free trade agreements has led to a process of deindustrialization which has significantly impacted Hamilton's social geography. The steel industry, once the backbone of the economy, has all but collapsed while other large employers have either closed or downsized due to automation. The overall effect of this restructuring has been a rise in neighborhood segregation, with many employed in the city's growing knowledge and

service economy tending to migrate to the suburbs, expanding preexisting middle and upper-middle class tracts in the process (Harris et al., 2015). As a result, Hamilton's core and inner suburbs are now characterized by significant economic and social deprivation, with disproportionately high concentrations of state welfare dependents, low-income renters, refugees and immigrants living in these communities.

The opportunity to provide service improvements in the inner core came through funding from Metrolinx, the transportation department of the Ontario government, as part of a regional investment strategy designed to support an integrated approach to public transportation infrastructure. The initiative, known as "quick wins", came with the caveat that funding could only be spent on capital projects that were innovative, transit-related and had a short delivery time. Hamilton's transportation demand manager (TDM), Pete Topalovic, understood bikeshare not only in these terms, but also as a means of delivering on prior commitments made in the city's cycling master plan (City of Hamilton, 2009), which had been developed through extensive public consultation but had been continually deprioritized due to a lack of political cohesion.

> The master plan was developed over time and was intended to address a whole range of concerns here like personal mobility, road safety, and environmental sustainability etc., but, despite the support for it, you still get councillors willing to block it. Suburban councillors mostly who see cycling infrastructure in the city as negatively impacting their commuters. (interview, Environment Hamilton, Advocacy Organisation, 2016).

Given these sensitivities and the need for final project approval from city hall, Topalovic mobilized networks of professional expertise and lay experience to create a project designed to build support and consensus. Acting primarily in the role of "activist engineer" his efforts would produce new socio-technical practices and reconfigure both decision-making and innovation as a function of civil society.

Remediating strategies

In addition to being a transportation engineer, Topalovic is also professionally and personally invested in a number of related agendas. He teaches community-based sustainability at McMaster University and is an active participant in numerous environmental and civic groups. As such, he was strategically well positioned to identify and mobilize resources within the city sympathetic to the project. Colleagues at McMaster and Hamilton's other university, Mohawk, were invited to provide feasibility studies, conduct station location demographic analysis and provisionally identify a viable service area based on available funding for the city's prospective bikeshare scheme. A community planning organization conducted additional statistical analysis which refined the service area and ensured the proposed system was consistent with international best practice. In tandem, a local not-for-profit environmental organization assisted by conducting financial analysis and prepared a business case. In addition to local expertise, Topalovic also exploited his own professional network of intercity transportation officials, in particular those with neighboring Toronto and Minneapolis whose schemes were well established at the time. They provided insights on a range of operational issues such as hub density and bike distribution.

These efforts formed the basis of a report submitted to city hall which emphasized that, while capital costs would be met by the city, no additional funding would be sought to support the running of the scheme. Topalovic committed to ensuring that operational costs would be met by the vendor (yet to be chosen) for a period of 5 years during which they would be liable for any short fall between revenue generated and operating costs. Reassured that the city had been exposed to limited liability and satisfied that the project met the requirements of the province, the council agreed that the project could proceed to tender.

Once the preparatory phase had been completed, Topalovic understood intuitively that successfully embedding the scheme in the physical and cultural fabric of the city would also require the active participation and support of the community.

> Based on my own experience I think the truly successful projects are the ones that engage with the grassroots, but also ones that are top down. You need professional and technical expertise, so that part of the community was mobilized, but you also need to leverage the knowledge and experience on the ground. (interview, 2016).

While engagement was clearly motivated by the desire to address issues of representation, it should be noted here that, due largely to the funding constraints imposed by Metrolinx, citizens were being enrolled in the process of design and development after some key decisions had already been made. This was further emphasized by the fact that, by the time the engagement campaign launched in early 2014, the city had chosen Social Bicycles (SoBi) as the preferred vendor. SoBi is a fourth-generation architecture; that is, stationless, data rich, demand responsive, scalable and relatively affordable when compared to station-based or networked equivalents. While the design does not use hard-wired digital stations, it does incorporate the use of simple bike rack hubs which supports service predictability and management. To afford the scheme a degree of operational autonomy (and legitimacy), Topalovic and SoBi collaborated to create a not-for-profit organization – SobiHamilton – to implement the system. Together, these stakeholders developed a strategy designed to augment traditional modes of engagement and enhance political representation.

Citizen involvement in the initiative then was largely constrained within a process that was moving along a particular trajectory. The wider populace were not consulted as to whether a cycle scheme would be an appropriate city infrastructural investment, though the city's cycling master plan was rooted in the 2009 public consultation exercise. Moreover, the public were given limited scope to reshape and repurpose the technologies adopted for the scheme. By way of mitigation, however, citizens were to be consulted about the geographical extent and configuration of the network. To support this process, a steering committee comprising representatives from a variety of community and environmental groups was created to guide the project and discuss key issues including logistics, the engagement strategy, and how best to translate feedback into actionable strategies. The initial feasibility consultations undertaken by Topalovic, along with the steering committee and public consultation, however, was in sharp contrast to implementation of bikeshare schemes in other cities where they have been procured and rolled out with minimal public consultation (for example, see an account of Dublin's scheme in Bradshaw, 2018).

The keystone of SobiHamilton's strategy was to utilize "Social Cyclist", the digital engagement-based platform developed by SoBi to aid in launching their programs, along

with social and physical media. The platform provided an opportunity for meaningful participatory planning by encouraging citizens to vote and comment on provisional hub locations or make site recommendations based their own needs and experience. It also provided a forum for discussion and debate (see Figures 1 and 2). This dialogical aspect of the platform created a polyvocal space through which reciprocity could be fostered. The process was replicated through various social media platforms which, in addition to supporting participation, provided a further mechanism through which Topalovic could co-ordinate and socialize the project. Facebook and Twitter accounts carried posts on the project, while in tandem, several local media outlets disseminated newly released information (see Figures 3 and 4). These digital channels were augmented by physical maps with attached sticker sheets for annotating and suggesting hubs, which were used as a form of direct engagement to stimulate interest and encourage reciprocity (see Figure 5). The maps were placed at 11 highly trafficked areas in the city, such as City Hall, university campuses, and community centers. In total, 3000 people were engaged by the process and 500 proposed and voted on bike share hub locations (City of Hamilton, 2014).

As the project developed, Topalovic was also careful to leverage synergies with other organizations in Hamilton's advocacy landscape. The Sustainability Professional Network (SPN), for example, is an organization of environmental-civic groups and scholars which operates through education initiatives to raise awareness of sustainability in local communities.

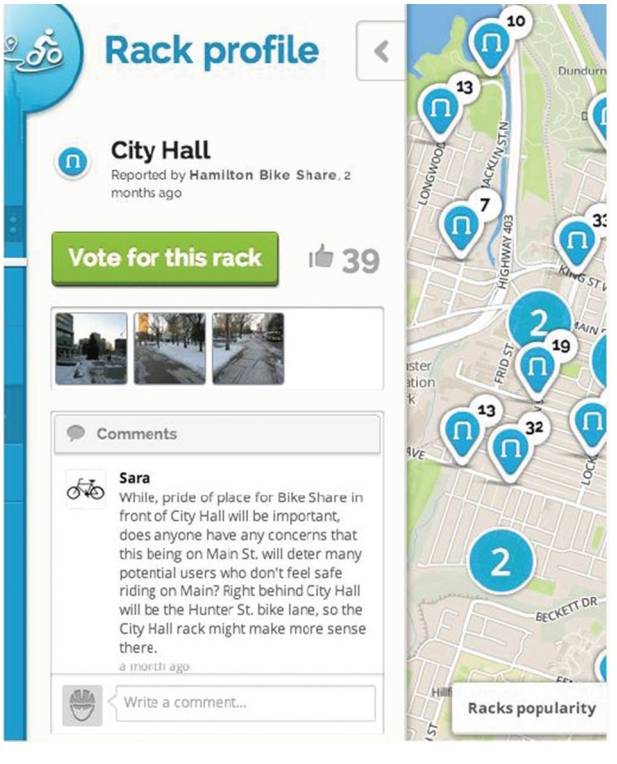

Figure 1. Commenting on social cyclist. Source: City of Hamilton, 2014

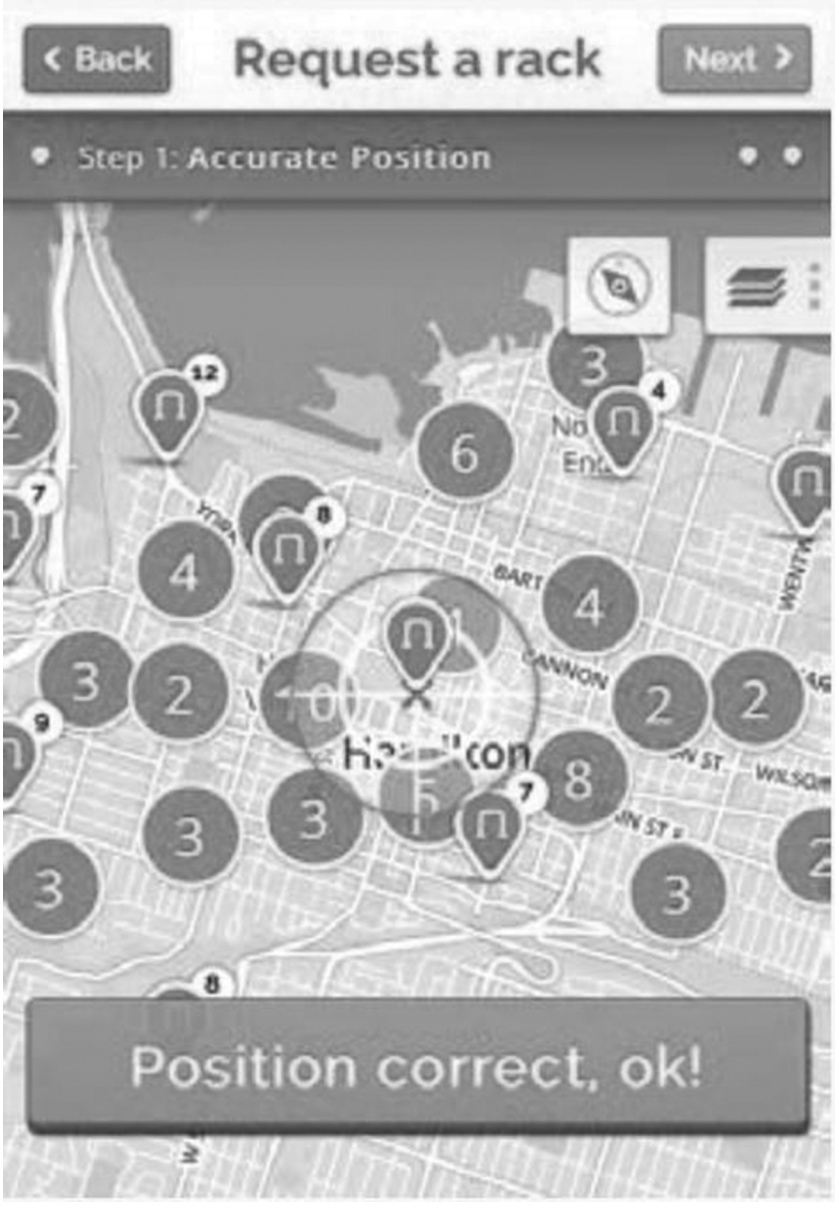

Figure 2. Voting for hubs. Source: City of Hamilton, 2014

> A lot of us in the SPN were also part of the bikeshare committee so we had an opportunity to encourage greater participation in the campaign. Hamilton is comprised of a network of related groups or clusters such as cycling, road safety, open streets, the built environment and so on and you'll see many of us working in more than cluster. We've managed to be quite effective that way, particularly in the last few years. (interview, SPN member, 2016)

The collaborative ethos continued post-implementation with citizens enrolled in experimental forms of design innovation. Once deployed, the generativity of the technology

Figure 3. Mobilizing support through twitter. Source: City of Hamilton, 2014

Figure 4. An example of collaborative network design. Source: City of Hamilton, 2014

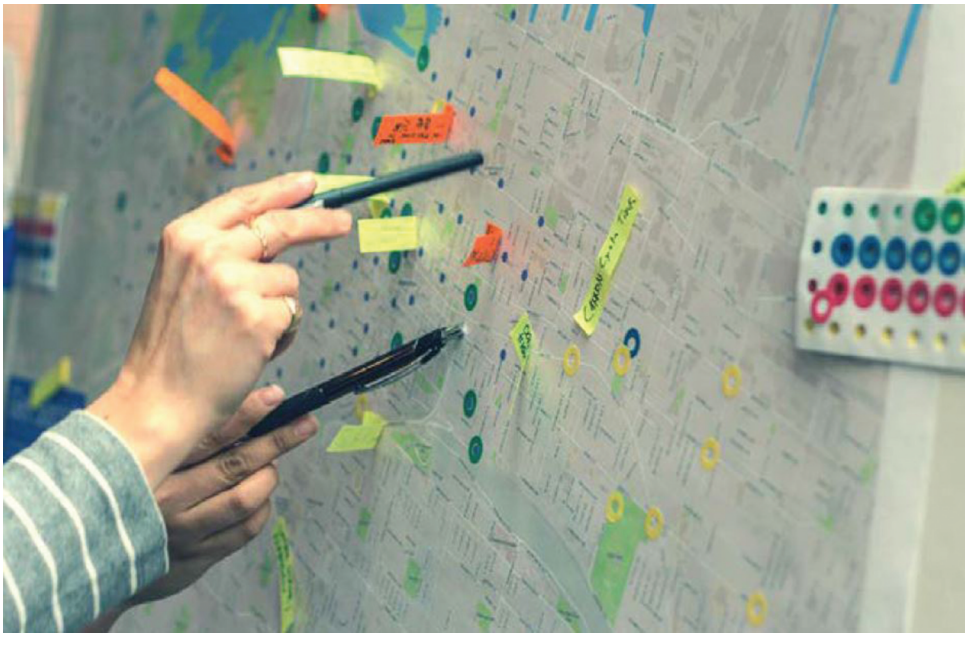

Figure 5. Physical map for selecting hub locations. Source: City of Hamilton, 2014

was exploited to allow unrestricted, organic traffic patterns to emerge as a way of customizing the network.

> "We had what we called desire lines. It's like you let people walk on the grass before you put the path in. So, we let people park the bikes wherever they wanted within the service area for 3 months without any controls and based on how the bikes were distributed – those desire lines – the network was adapted again." (interview, Topalovic 2016)

The final network – the product of local planning and design expertise, experiential learning from other cities, networks of advocacy and direct citizen engagement –

comprised 800 bikes and 101 hubs distributed across in inner city (see Figure 6). From the perspective of equity, 80% of the hubs are located in technically deprived areas, that is, municipal "code red" zones characterized by significant disadvantage (this is the polar opposite to Dublin where there are few stations in deprived neighborhoods). These locations are also home to many of the city's larger employers (i.e., universities, hospitals, service industries and so on). This mixed demographic is reflected in the scheme's ridership which shows a relatively even distribution of income across its membership (CivicPlan, 2018). Equitable access is also the rationale behind much of the design and process innovation taking place in other areas of the scheme. The "Everyone Rides Initiative" (ERI) for example, has funded tiered pricing with reduced fees for students and the low paid, and also provides free membership to the most marginalized groups through various social organizations. These equity programmes have been made possible through a combination of local fundraising and grant allocations.

Ongoing innovation

Technical innovation, largely in the form of new data products, digital tools and system integrations, has also been an emergent property of the relationships underpinning the project. SobiHamilton, in collaboration with the vendor, has developed the "General Bikeshare Feed Specification" (GBFS) which makes Hamilton's data feeds freely available via a uniform format so that map and transportation-based apps such as Google Maps can incorporate them into their platforms. The GBFS was subsequently adopted as an industry standard by the North American Bike Share Association and is currently being rolled out across cities in the US. The use of geo-fencing as a technique to encourage

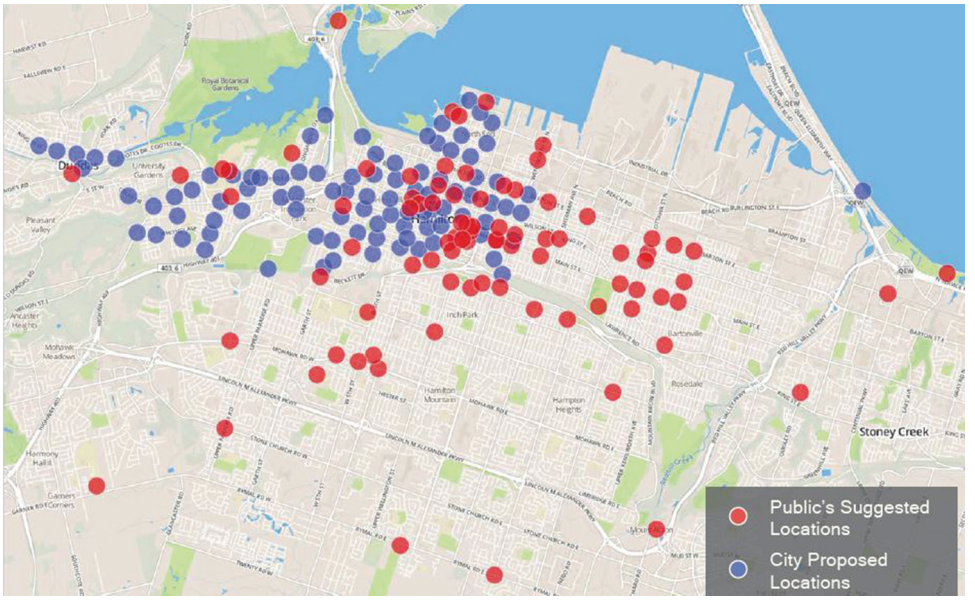

Figure 6. Distribution of SobiHamilton infrastructure. Source: City of Hamilton, 2014 (Note: Density to the south and east of the city were increased in 2018 with the introduction of 13 new stations and 75 bicycles. This was funded through the Everyone Rides Initiative)

cooperative system rebalancing is another example of a local innovation which is scaling across the industry. GPS-based geo-fences are essentially used to zone the service area based on fleet distribution density and riders are encouraged through a credit system to redistribute bikes based on service requirements. The concept was also devised by local expertise at SobiHamilton and is already working in SoBi's systems in Boise, Santa Monica and Portland.

System data has also been an important catalyst for activity across a range of related social and technical areas. Topalovic has worked closely with Hamilton's public health department to understand how route trace data might be used to inform public policy and health education initiatives. The data is also supporting the analysis of usage patterns which, in addition to informing transit planning and network design, is being used by communities to advocate for better cycling infrastructure. In 2016, residents groups were able to demonstrate that the Cannon Street area of the city – a well-known accident hotspot – was being heavily trafficked by system riders. This information was used by residents groups as a form of evidence-based activism to pressure City Hall into funding the first segregated bike lane in the province.

> We got people banging on doors and helping constituents to understand the position their councillors had taken on road safety in the past and how that position might impact on them. We encouraged them to write letters, send emails or pick up the phone, so it's essentially political campaigning. And it worked! (Interview, Local Resident's Association 2016)

Discussion

In contrast to the prevailing critique that smart city programmes and deployments are predominately top-down and technocratic in nature, SobiHamilton demonstrates that an alternative approach to smart city initiatives, one rooted in secondary instrumentalization, is possible. One might reasonably argue that Hamilton's approach is sub-optimal from a purely bottom-up perspective; however, the project demonstrates a key aspect of instrumentalization theory i.e. the value of institutional agency in reconfiguring governance cultures to make them more conciliatory, ethically informed and citizen centric. Remediating strategies and reflexive design practices were central to the democratization achieved throughout the life cycle of Hamilton's project. Topalovic used collegiality and experimentation to make the project a reality, but crucially enrolled the public in this endeavor. In effect, he acted to synthesize and direct various sources of agency, at both local and supra local scales in a purposeful way and created the conditions for a normative reconfiguration of governance practices.

> Despite the opportune funding from the province, somebody had to take the leadership role, somebody with an understanding of the city had to put it all together and present it as a package and he [Topalovic] took a big political risk as a staffer in doing that. This is not a city with a history of rewarding progressive thinking. No good deed goes unpunished in this town, right. (Interview, Raise the Hammer, advocacy group, 2016)

Under his influence, the production of knowledge, expertise and technology became a collaborative endeavor which operated through universities, civic organizations, bureaucrats, technologists, environmental groups, community advocates and citizens. This

embodies the notion of "agonistic" relationships (Bjögvinsson et al., 2012), i.e. the concept that diverse and sometimes conflicting interests can, through negotiation, consensus building and experimentation, create progressive networks of technical and human infrastructure. It also exemplifies the concept of organizational subordinate operating to subvert conservative regimes, making them amenable to cultural and structural reconfiguration. Perng (2019), for example, notes that this form of initiative can operate to challenge government as a center of control and reposition "the government" as a locus of innovation into the context of everyday life. The particular forms of governance developed through this project essentially synthesize the formal aspects of government, which provide structure, rules and resource allocation (hard infrastructure), with consensus, relationship-building, and mutual learning (soft infrastructure). As evidenced in this case, these forms and practices are likely to cultivate social, intellectual and political capital to promote co-ordination and knowledge flow among the various social relations constituting technical praxis.

While the success of SobiHamilton is clearly related to the integrative practices supporting it, it is also true that the nature of the infrastructure was instrumental in augmenting these efforts. Participatory governance, due to structural, economic or other contexts, may struggle to deliver positive outcomes for disenfranchised communities; however, the inherent flexibility of SoBi's architecture has supported the capacity of both hard and soft infrastructures to reshape patterns of decision-making and resource distribution. It achieved this by encouraging a culture of experimentation, disruption and dialogue. Significantly, this openness to possibility was achieved organically and in the absence of an overarching or highly articulated smart city narrative. "Smart", in the context of this project emerged as signifying a set of understandings and practices concerned with pragmatically addressing real urban problems and encouraging changes to mobility practices which are sustainable – socially, environmentally and economically. This aligns Hamilton with the smart city as envisioned by Hollands (2008) which calls for ICTs to enhance democratic public debate about the kind of spaces citizens wish to live in. It also positions the scheme as an example of how the smart city may disconnect from a purely competitive, profit-motivated agenda.

From a technological or design perspective, the scheme was conceived, designed and implemented with systematization or embeddedness as its overriding characteristics. Its configuration reflects the multiplicity of people, organizations and rationales that coalesced around its development to produce a platform with both functional and sociocultural value. The various layers of development and adaptation that the SoBi's initial design concept experienced as it passed through Hamilton's political and cultural landscape (secondary instrumentalization) conspicuously reflect the interests of a city engaging with the process of social change. The socially sanctioned patterns of network distribution, the goals and objectives which system data serve, even the alignment occurring at an industry level to produce common standards and specifications all represent the translation of discursive demands into system specifications. This eclecticism has made the process of integrating the scheme with its environment all the more effective.

Ontologically then, SobiHamilton is as much a platform for citizen engagement, collaborative design, and devolved forms of governance as it is a piece of transit infrastructure; epistemologically, it is the product of both lay experience and professional

networks of expertise. The successful assimilation of a variety of technical capabilities and affordances, which have their genesis in such a diverse set of demands, has created a technology that embodies a rich system of meanings and relations that reflect many ways of being and knowing. The choice of not-for-profit as an implementation strategy was key to this process. It is, at least in part, beyond the reach of political interference and carries genetic material from Topalovic, SoBi and progressive elements within the city. In practice, it represents a design space which circumvents many of the barriers which might otherwise have constrained it. Feng and Feenberg (2008), for example, note that while designers appear like powerful actors in reality they do not operate in a vacuum but instead must accommodate the requirements of a multitude of power relations. The creation of a not-for-profit, in effect, resulted in a center of innovation through which Topalovic and others, were free to use dialogue and appropriations at various levels of sophistication to refine many areas of the system.

The scheme also challenges the thesis that optimum design or efficiency is compromised by externalities like sustainability or democracy. Just as the distinction between technical efficiencies and external values is contingent on past negotiations and conflicts, it may be that the technical code created in Hamilton will form part of the canon which guides future development in other cities and across other projects. However, producing the level of contextualization achieved in Hamilton will require more than simply adopting a technology or architecture. The uniqueness of place, with all of its contingency and relationality, means a successful technology must emerge organically, at least in part, from the experiences and needs of those who appropriate it.

> There's no one optimal technical solution, there can't be. There are far too many factors that are not necessarily compatible across geographies. There are local laws and regulations. Even funding might be dependent on things like pollution and air quality mitigation which are factors that are not even across different cities and different systems. Then there are the demographics of your population and who you're targeting, the topography of the city, whether or not the weather supports the use of solar technologies, what kind of data are you interested in generating, what kind of cycling infrastructure is available to the scheme, and on and on and on. (Interview, NABSA, 2016)

This level of complexity may explain why some cities either choose to implement off the shelf solutions or allow the technical code to be controlled by corporate or bureaucratic interests which are motivated by profit, self-serving notions of efficiency or administrative convenience. These arrangements tend to produce technologies which have been isolated from social constraints and typically serve privileged interests. In other words, they exemplify primary instrumentalization.

Conclusion

Our purpose in this paper was two-fold. First, to utilize instrumentalization theory to provide a detailed analysis of the genesis and design of a smart city endeavor, charting how SobiHamilton was realized through a set of related praxes and politics. Second, to examine how the values of equality, democratization and citizenship can be embodied – to a greater or lesser degree depending on process followed – in the design and implementation of the smart city. Leveraging instrumentalization theory's ethical and normative lens, the realization of SobiHamilton makes it is clear that despite the

pervasiveness of a neoliberal orthodoxy, citizen-centric schemes are possible within a climate of reflexivity and cooperation. While the scheme retained some top-down orientation, being driven by an activist engineer in the employ of the state and a group of stakeholder organizations, the ethos and ambition of the initiative was rooted in civic paternalism and participation and a desire to enhance equity and participation, and it did involve extensive public consultation that shaped the scheme's implementation – a process which is still ongoing. The design approach in Hamilton positioned the scheme within a supportive framework of dynamic pricing structures, citizen-centric operations, and collaborative decision-making, which have reduced friction and encouraged meaningful integration with the city's cultural and technical spheres.

SobiHamilton's willingness to continually adapt to social and technical imperatives was made possible by an epistemic regime, operating at various spatial scales, which coalesced around progressive notions of success and the common good. In this sense, it represents an important corroboration of the emerging consensus within the bikeshare literature which, while acknowledging the role of technical innovation in addressing issues of equity, emphasizes the need for consensus building as integral to the development of sustainable and socially responsive programmes (Hannig, 2016; McLaren & Agyeman, 2015). While SoBi's design architecture may offer practitioners a useful archetype or staring point from which to conceive solutions, the remediating strategies seen in the city may also be mobilized to adapt legacy configurations. Washington and Boston, for example, have both recently deployed similar collaborative processes and tools to retrofit traditional station-based infrastructures with mobile, solar-based technologies, making them more demand responsive and accessible (Bradshaw, 2018). It has also made them more amenable to ongoing adaptation. Even when technical innovation is not integral to the process, programme development can still act as a form of social cohesion by motivating communities to take a proactive role in shaping their environments. Kansas City, which continues to use a station-based, 3rd generation architecture, made the creation of their programme a "barn raising" exercise which enrolled more than a 100 community volunteers to assemble the bikes and get the system up and running (Bradshaw, 2018).

What Hamilton and these additional examples emphasize is the socio-technical nature of system production and the potential of secondary instrumentalization to produce modes of design which embrace reasoning as a wider activity than seen in much of the industry to-date. As such, while certain technologies and architectures have inherent in them an additional capacity to encourage a climate of experimentation, the outcomes for citizens are far more likely to be dependent on the willingness of decision-makers to engage meaningfully with a diversity of interests and realize such interests using the technical means at their disposal. Therefore, the resocialization of technology through processes of secondary instrumentalization is not necessarily conditional on a set of historic technical conditions. Rather, it requires a critical sensitivity to circumstances and opportunities which may make systems more just and legitimate.

In sum, our analysis has highlighted the role of ideology in shaping the delivery and operation of systems and the potential of design to both respond to and foster more open and participatory design. Realizing this potential will depend on the imaginative capacity of key actors to re-conceptualize and restructure the ground rules and assumptions operating to create systems. Where collective reasoning can be made to prevail, then

schemes can be infused with meanings and values which transcend mere functionality or institutional self-interest. This was demonstrated by SobiHamilton's capacity to operate not only in the technical realm as an example of innovative mobility infrastructure, but also to function through other, more normative, modalities. Ontologically then, Hamilton reaffirms Feenberg's notion that technology is best seen not as a thing, but as a "site of contestation" where the dialectic between primary and secondary instrumentalization plays out (1999: 145). Of course, it should be noted that SobiHamilton itself may not be immune to the effects of external pressure as it develops to maturity. It remains to be seen, for example, how it responds practically and ideologically to new economic, political and operational challenges (e.g., pressure from private capital, political or cultural resistance to expansion, increased complexity in the transit environment or the threat of competition from other operators and transport options). Can Hamilton retain its core values of participation and equity or will these pressures drive adaptations that essentially empty the scheme of its valuative content? Only time will tell.

Note

(1) The research received the appropriate permissions from Maynooth University's ethics review committee and participants identified in the study gave prior informed consent.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the H2020 European Research Council [ERC-2012-AdG-323636-SOFTCITY].

ORCID

Robert Bradshaw http://orcid.org/0000-0002-8025-8663
Rob Kitchin http://orcid.org/0000-0003-4458-7299

References

Barns, S. (2020). *Platform urbanism: Negotiating platform ecosystems in connected cities*. Springer Singapore.

Bianco, L. (2016). Participatory engagement in urban design process: The case of an urban settlement in Malta. *Spatium*, *35*(35), 71–78. https://doi.org/10.2298/SPAT1635071B

Bijker, W. (2013). "Technology assessment: The state of play towards a hybrid and pluriform process of governance of science and technology." *Proceedings from the PACITA 2013 Conference Prague*, 22-36. Technology Centre ASCR.

Björgvinsson, E., Ehn, P., & Hillgren, P-A. (2012). Design things and design thinking: Contemporary participatory design challenges. *Design Issues*, *28*(3), 101–116. https://doi.org/10.1162/DESI_a_00165

Borgmann, A. (1984). *Technology and the character of contemporary life: A philosophical inquiry*. University of Chicago Press.

Böschen, S. (2013) "Opening the black box: Scientific, expertise and democratic culture." *Proceedings from the PACITA 2013 Conference Prague*, 37-38. Technology Centre ASCR, 2014..
Bradshaw, R. (2018). Instrumentalization in the bikeshare sector. PhD Thesis. Maynooth University. http://mural.maynoothuniversity.ie/10509/1/Instrumentalization%20in%20the%20Public%20Smart%20Bikeshare%20Sector_Robert%20Bradshaw_Thesis.pdf.
Buck, D. (2012). Encouraging equitable access to public bikesharing systems. Thesis, VirginiaTech Alexandria Centre School of Public and International Affairs. https://www.gracq.org/sites/default/files/etudeaccessvls2012.pdf. - Accessed September 1st, 2018.
Buck, D., & Buehler, R. (2013). "Bike lanes and other determinants of capital bikeshare trips." Paper #12-3539. *Presented at 91st Annual Meeting of the Transportation Research Board*, Washington, D.C., 2012.
Bührmann, S. (2008). Bicycles as public-individual transport – European developments. Meetbike Conference, Dresden 2008. Rupprecht Consult. https://www.gtkp.com/assets/uploads/20091127-150125-6592-Meetbike_article_Buehrmann_040408.pdf.
Callon, M., Lascoumes, P., & Barthe, Y. (2009). *Acting in an uncertain world: An essay in technical democracy*. MIT press.
Cardullo, P., & Kitchin, R. (2019). Being a 'citizen' in the smart city: Up and down the scaffold of smart citizen participation in Dublin, Ireland. *GeoJournal*, *84*(1), 1–13. https://doi.org/10.1007/s10708-018-9845-8
City of Hamilton. (2009) Hamilton's cycling masterplan: Shifting gears 2009. City of Hamilton, Ontario. https://www.hamilton.ca/city-planning/master-plans-class-eas/hamiltons-cycling-master-plan.
City of Hamilton. (2014) Hamilton bike share public Engagement report. City of Hamilton, Ontario. https://hamilton.socialbicycles.com/assets/pdf/Social_Cyclist_Bike_Share_Report.pdf
CivicPlan. (2018) SobiHamilton member survey 2018 2018. CivicPlan. https://civicplan.ca/sobi-hamilton-membership-survey/
Clark, J., & Curl, A. (2016). Bicycle and Car Share Schemes as Inclusive Modes of Travel? A Socio-Spatial Analysis in Glasgow, UK. *Social Inclusion*, *4*(3), 83–99. https://doi.org/10.17645/si.v4i3.510
Coletta, C., Evans, L., Heaphy, L., & Kitchin, R. (eds). (2018). *Creating Smart Cities*. Routledge.
Cowley, R., Joss, S., & Dayot, Y. (2018). The smart city and its publics: Insights from across six UK cities. *Urban Research & Practice*, *11*(1), 53–77. https://doi.org/10.1080/17535069.2017.1293150
Datta, A. (2015). A 100 Smart Cities, a 100 Utopias. *Dialogues in Human Geography*, *5*(1), 49–53. https://doi.org/10.1177/2043820614565750
Davidson, M. M. (2013). *Tactical urbanism, public policy reform, and 'innovation spotting' by government: from park(ing) day to San Francisco's Parklet program*. Master's, City Planning, MIT.
de Lange, M., & de Waal, M. (2013). Owning the city: New media and citizen engagement in urban design. *First Monday*, *18*(11). available at: http://firstmonday.org/ojs/index.php/fm/article/view/4954 (accessed 10.5210/fm.v18i11.4954
DeMaio, P. (2009). Bike-sharing: history, impacts, models of provision, and future. *Journal of Public Transportation*, *12*(4), 4. https://doi.org/10.5038/2375-0901.12.4.3
Duarte, F. (2016). Disassembling bike-sharing systems: Surveillance, advertising, and the social inequalities of a global technological Assemblage. *Journal of Urban Technology*, *23*(2), 103–115. https://doi.org/10.1080/10630732.2015.1102421
Feenberg, A. (1999). *Questioning Technology*. Routledge.
Feenberg, A. (2005). Critical theory of technology: An overview. *Tailoring Biotechnologies*, *1*(1), 47–64. https://www.researchgate.net/publication/261709929_critical_theory_of_technology_an_overview
Feenberg, A. (2010). *Between reason and experience. Essays in technology and modernity*. MIT Press.
Feenberg, A. (2017). Replies On: Democratic interventions. *Thesis Eleven*, *138*(1), 99–108. https://doi.org/10.1177/0725513616689389
Feng, P., & Feenberg, A. (2008). Thinking about design: Critical theory of technology and the design process. In P. E. Vermaas, *Philosophy and design*. Springer.
Fishman, E., Washington, S., & Haworth, N. (2013). Bike Share: A Synthesis of the Literature. *Transport Reviews: A Transnational Transdisciplinary Journal*, *33*(2), 148–165. https://doi.org/10.1080/01441647.2013.775612

Foth, M., Odendaal, N., & Hearn, G. (2007, Oct 15-16). The view from everywhere: towards an epistemology for urbanites. In D. Remenyi (Ed.), *Proceedings of the 4th International Conference on Intellectual Capital, Knowledge Management and Organisational Learning (ICICKM)* (pp. 127–133). Cape Town, South Africa. Academic Conferences Limited, UK.

Haklay, M. (2013). Neogeography and the delusion of democratisation. *Environment & Planning A*, *45*(1), 55–69. https://doi.org/10.1068/a45184

Hannig, J. (2016). Community Disengagement: The greatest barrier to equitable bike. In *Bicycle Justice and Urban Transformation share*, 203-216. Routledge.

Harris, R, Dunn, J., & Wakefield, S. (2015). "A city on the cusp: Neighbourhood change in Hamilton since 1970." Research Paper 236. Cities Centre, University of Toronto. http://neighbourhoodchange.ca/documents/2015/04/neighbourhood-change-in-hamilton-since-1970.pdf

Heidegger, M. (1977). *The question concerning technology and other essays*. Garland Press.

Hoe, N., & Kaloustian, T. (2014). "Bike sharing in low income communities: An ANALYSIS OF FOCUS GROUPS FINDINGS." The Institute for Survey Research, Temple University, https://b.3cdn.net/bikes/fc16c31cbff25139a1_3cm6bfs04.pdf. Accessed August 22nd, 2018.

Hollands, R. (2008). Will the real smart city please stand up? *City*, *12*(3), 3. https://doi.org/10.1080/13604810802479126

Horton, D. (2006). "Social Movements and the Bicycle." *Conference paper, Alternative Futures and Popular Pprotest at Manchester Metropolitan University, UK, in April 2006*. https://thinkingaboutcycling.files.wordpress.com/2009/11/social-movements-and-the-bicycle.pdf. Accessed November 4th, 2018.

Joss, S., & Bellucci, S. (2002). *Participatory Technology Assessment: European Perspectives*. University of Westminster: Centre for the Study of Democracy.

Karvonen, A., Cugurullo, F., & Caprotti, F. (2018). *Inside Smart Cities: Place, Politics and Urban Innovation*. Routledge.

Karwat, D, Eagle, W., Wooldridge, M., & Princen, T. (2015). Activist Engineering: Changing Engineering Practice By Deploying Praxis. *Science and Engineering Ethics*, *21*(1), 227–239. https://doi.org/10.1007/s11948-014-9525-0

Kirkpatrick, G. (2013). Formal Bias and Normative Critique of Technology Design. *Techné: Research in Philosophy and Technology*, *17*(1), 25–46. https://doi.org/10.5840/techne20131713

Kitchin, R. (2014). *The Data Revolution: Big Data, Open Data, Data Infrastructures & Their Consequences*. Sage.

Kitchin, R., Cardullo, P., & Di Feliciantonio, C. (2019). Citizenship, Social Justice and the Right to the Smart City. In P. Cardullo, C. Di Feliciantonio, & R. Kitchin (Eds.), *The Right to the Smart City* 1–24. Emerald Publishing Limited.

Kitchin, R. (2019). Towards a genuinely humanizing smart urbanism. In P. Cardullo, C. Di Feliciantonio, & R. Kitchin (Eds.), *The Right to the Smart City*193–204. Emerald Publishing Limited

Kitchin, R., Maalsen, S., & McArdle, G. (2016). The praxis and politics of building urban dashboards. *Geoforum*, *77*, 93–101. https://doi.org/10.1016/j.geoforum.2016.10.006

LDA Consulting. (2014). *"2013 Capital Bikeshare Member Survey Report*. LDA Consulting" . https://d21xlh2maitm24.cloudfront.net/wdc/cabi-2012surveyreport-execsum-5-15-13-revtitle.pdf?mtime=20161206135941 – Accessed September 6th, 2018.

Le Dantec, C. A. (2016). *Designing Publics*. MIT Press.

Le Dantec, CA, & DiSalvo, C. (2013). Infrastructuring and the formation of publics in participatory design. *Social Studies of Science*, *43*(2), 241–264. https://doi.org/10.1177/0306312712471581

Liegl, M, Boden, A, Büscher, M, Oliphant, R., & Kerasidou, X. (2016). Designing for ethical innovation: A case study on ELSI co-design in emergency. *International Journal of Human-computer Studies*, *95*, 80–95. https://doi.org/10.1016/j.ijhcs.2016.04.003

Lydon, M., Bartman, D., Woudstra, R., & Khawarzad, A. (2011). *Tactical Urbanism*. The Street Plans Collaborative.

Marres, N. (2012). *Material Participation: Technology, the Environment and Everyday Publics*. Palgrave Macmillan.

Marvin, S., Luque-Ayala, A., & McFarlane, C. (eds.). (2016). *Smart urbanism: utopian vision or false dawn?* Routledge.

McLaren, D, & Agyeman, J. (2015). *Sharing cities: A case for truly smart and sustainable cities*. MIT Press.
McNeil, N., Dill, J., MacArthur, J., Broach, J., & Howland, S. (2017). Breaking barriers to bike share: Insights from residents of traditionally underserved neighbourhood. Transportation Research and Education Center., Portland State University.
Midgley, P. (2009). The role of smart bike-sharing systems in urban mobility. *Journeys*, *2*(2), 23–32. https://www.academia.edu/26059926/Role_of_Bike_Sharing_in_City.
Morozov, E., & Bria, F. (2018). *Rethinking smart cities: Democratizing urban technology*. Rosa Luxemberg Stiftung. http://www.rosalux-nyc.org/rethinking-the-smart-city/
Myers, M. (2016). Hermeneutics in Organisation Studies. In Raza Mir & Hugh Willmott (Eds.), *The Routledge Companion to philosophy in organization studies* (pp. 113–124). Michelle Greenwood.
NACTO (2013). "Can monthly passes improve bike share equity?." National Association of City Transport Officials. https://nacto.org/wp-content/uploads/2015/09/NACTO_Can-Monthly-Passes-Improve-Bike-Share-Equity.pdf.pdf - Accessed September 6th, 2018.
O'Brien, O., Cheshire, J., & Batty, M. (2014). Mining Bicycle Sharing Data for Generating Insights into Sustainable Transport Systems. *Journal of Transport Geography*, *34*, 262–273. https://doi.org/10.1016/j.jtrangeo.2013.06.007
Perng, S-Y. (2019). Practices and politics of collaborative urban infrastructuring: Traffic light box artworks in Dublin streets. In Claudio Coletta, Leighton Evans, Liam Heaphy, & Rob Kitchin (Eds.), *Creating smart cities* (pp. 155–169). Routledge.
Ricœur, P. (1981). *Hermeneutics and the Human Sciences*. Cambridge University Press.
Sadowski, J. (2020). *Too smart: how digital capitalism is extracting data, controlling our lives, and taking over the world*. MIT Press.
Schliwa, G. (2019). Smart cities by design? Interrogating design thinking for citizen participation. In P. Cardullo, C. Di Feliciantonio, & R. Kitchin (Eds.), *The right to the smart city* (pp. 151–164). Emerald Publishing Limited.
Shaheen, S., Martin, E., & Cohen, A. (2013). Public bikesharing and modal shift behavior: A comparative study of early bikesharing systems in North America. *International Journal of Transportation*, *1*(1), 35–54. https://doi.org/10.14257/ijt.2013.1.1.03
Shelton, T., & Lodato, T. (2019). Actually existing smart citizens: Expertise and (non)participation in the making of the smart city. *City*, *23*(1), 35–52. https://doi.org/10.1080/13604813.2019.1575115
Simondon, G. (1958). *Du Mode d'Existence des Objets Techniques*. Aubier.
Stats Canada. (n.d). Census Profile, 2016 Census: Hamilton, city, Ontario. Statistics Canada. https://www12.statcan.gc.ca/census-recensement/index-eng.cfm
Stillman, L., & Johanson, G. (2007). *Constructing and sharing memory: Community Informatics, identity and empowerment*. Cambridge Scholars Publishing.
Taylor, L., Richter, C., Jameson, S., & Perez Del Pulgar, C. (2016). *Customers, users or citizens? Inclusion, spatial data and governance in the smart city* available at: https://pure.uvt.nl/portal/files/12342457/Customers_users_or_citizens_Taylor_Richter_Jameson_Perez_de_Pulgar_2016.pdf (last accessed 16 August 2016. University of Amsterdam.
Teli, M., Foth, M., Sciannamblo, M., Anastasiu, C.I., Lyle, P. (2020) Tales of institutioning and commoning: participatory design processes with a strategic and tactical perspective *PDC '20: Proceedings of the 16th participatory design conference 2020 - Participation(s) otherwise - volume 1*, *ACM International Conference Proceeding Series*, 159–171. Manizales, Columbia.
Townsend, A. (2013). *Smart Cities: Big data, civic hackers, and the quest for a new utopia*. W.W. Norton & Co.
Watson, R., Boudreau, M-C., Seth, Li, S., & Levin, J. (2010). Telematics at UPS: En route to energy informatics. *MIS Quarterly Executive*, *9*(1). doi: 10.1201/b10330-2
Wesley, M., Duvall, A., & Main, D. (2016). Large-scale tactical urbanism: The denver bike share system. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, *9*(2), 135–147. https://doi.org/10.1080/17549175.2015.1029510