Transportation and Smart City Imaginaries: A Critical Analysis of Proposals for the USDOT Smart City Challenge

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Abstract:

Scholarly attention to the development of "smart cities" around the globe has been focused on the nature of these cities, as well as visions of the futures that these developments would provide for individuals, communities and institutions (Gabrys, 2014; Hollands, 2015; Zook, 2017). Much of the research about these information-intensive projects has been focused on the description of these cities in terms of their primary socio-economic goals and on the influential roles in their development being played by globally active information technology firms (Kitchin, 2014; Wiig, 2015; Rossi, 2016). An important, but under-explored focus of this research has been an examination of how local and regional governments have envisioned these projects (Chourabi et al, 2012; Kitchin et al, 2015). This paper responds to that challenge through an analysis of proposals submitted by 70 American cities to the U.S. Department of Transportation's (USDOT) Smart City Challenge.

The analysis begins with an identification of the kinds of descriptive frames that have been relied upon by the applicants to justify their selection as finalists and ultimately winners of this competition. While there are many different frames and points of emphasis that a participant city might choose, we selected a subset identified within the critical literature as being focused on the likely impact of these projects on the underclass (Li et.al, 2018; Vanolo, 2014). Among those frames, we emphasize those focused on population subgroups defined by age, race and minority status, as well as their identification as disabled, disadvantaged or underserved.

Because this literature also stresses the importance of decisions regarding the use of transaction-generated information, as well as that derived from the analysis of social media (Fuchs, 2015), the association of these frames with references to privacy and trust are also included. In an attempt to identify the socioeconomic and political factors that both predict and explain the special character of these proposals, we examine the correlations between references to the terms that serve as anchors of our analytical frames, and measures of the racial and economic status of these cities, or regions in which they are located. Structural measures, such as the proportion of African Americans, levels of poverty and economic distress, and the extent of racial and economic inequality within these areas emerged as the best predictors of the frames being used within these proposals.

These proposals necessarily reflect the policy agendas of the USDOT, including those

related to civil rights and environmental justice, so a comparative analysis of the changes made in the initial frames used by the seven finalists is developed. We conclude with recommendations for the kinds of research and analysis that should be pursued to extend our understanding of the factors that shape these designs for the future of cities and the well-being of those who will make their homes within them.

Introduction

Planning for the development of technologically enabled urban spaces under the banner of "smart city initiatives" has become a global phenomenon attracting the interest of scholars from a wide range of academic disciplines and departments. Some of this interest is economic and strategic, as universities are becoming actively engaged in the planning and implementation of these development projects, often as members of public-private partnerships (P3s). Although there have been a number of important regional initiatives, such as those begun within the European Union, the Smart City Challenge organized by the United States Department of Transportation (USDOT) provided a unique opportunity to examine how the smart city imaginaries developed among a large number of mid-sized American cities would incorporate concerns about information technology and its impact on inequality within "smart" urban spaces.

Because these smart city projects have been identified, in part, on the basis of their reliance upon the utilization of information and communication technologies (ICT), with special regard for the computational and analytical dependency on massive amounts of data generated and captured by sensors and transactional devices, this article begins with a short summary of how technological "revolutions" in the past have relied upon various socio-technical paradigms and particular kinds of epistemologies. That said, given the great variety of dimensions along which success or failure among these initiatives might be assessed, this paper has minimized its focus on technological systems, focusing instead on the visions or imaginings of the kinds of cities that might be developed by virtue of attention to transportation as a primary facilitator of economic developments appropriately sensitive to the distributional consequences of design and management.

This review comprises a descriptive and often critical assessment of smart city initiatives in the United States, attending primarily to their scope and the nature of central actors in their

development. Based on a content analysis of 70 initial proposals and seven technical proposals produced by the finalists, this paper identifies several challenges regarding the role played by USDOT, especially in the face of an ideologically altered federal policy environment, as well as what we might expect with regard to the consequences for the future of inequality within smart cities across the United States.

Long waves and socio-technical paradigms

Contributions to the development of economic theories regarding the long wave cycles of rapid expansion in economic growth followed by periods of slower growth have generally been attributed to elaborations made by Joseph Schumpeter to the initial contributions of Nikolai Kondratiev. Although these analyses of business cycles and their relationship to technological innovation have gone through their own cycles, interest, and abandonment by mainstream economists, Paschal Preston (2001) devotes considerable attention to the "neo-Schumpeterians" and their efforts to explain the upswings and downswings in capitalist economies in relation to new technologies that brought about growth through the "creative destruction."

Carlota Perez (2009) suggested that these developments were not strictly technological, but also reflected the impact of financial innovations that supported the rapid adoption and diffusion of these technological resources throughout the economy. Perez (2013) later added a call for an increased role for the government in managing the integration of financial and technological innovations in support of economic expansion. She maintained that the state should "be an enabler of a shift in the balance of power from finance to production, and to change the focus from the stock market indices to the expansion of the real economy and to the increase in social wellbeing" (p. 13).

In part, Perez's views (2010) reflect those of Preston (2001) who points out the limitations of long wave theories in that they tended to emphasize the role of technological developments while ignoring the equally important "socio-technical paradigm," which emphasizes the social, political, and institutional forces influencing the development of norms that shape practices in both consumption and production. Depending on one's emphasis on the technological, economic, or socio-institutional relationships governing changes within societies,

there is a variety of temporal divisions used to mark significant transitions from one revolutionary phase to another. Kondratiev Long Waves, which vary between 40 and 60-year cycles, are generally thought to have entered a fifth cycle around 1971. Still other periodizations emphasize industrial production, and how "cyber-physical systems" are expected to usher in the Fourth Industrial Revolution (Schwab, 2016). This fourth revolution is a digital revolution marked by a merging of new technologies, blurring the lines between physical, digital, and biological dimensions of everyday life. At the core of these changes is the transformation of systems of production, management, and governance of populations, specifically in terms of an algorithmic ordering of the world (Campolo, et al, 2017): how life is codified into rules and databases which are then used to "render aspects of everyday life programmable" (Kitchin, 2011, p. 945).

However, unlike most of the investigations into the socio-economic impact of technological innovations that have focused on industrial settings and relationships, our emphasis is on those outcomes that are likely to occur within the context of urban centers actively seeking to be defined as "smart cities" (Hollands, 2015). Although Manuel Castells (1991) sought to focus our attention on the role of information technology in the transformation of cities, his emphasis on the "space of flows" and the networks that enabled its development, led him to minimize the importance of the "social contexts associated with the places of their location" (p. 170). Much has changed since Castells' writing, and, as we will suggest, it is the impact that use of locally generated data is expected to have on the quality of life of residents, and visitors within distinct neighborhoods in many urban centers around the globe that has captured our attention and has become the focus of this initial investigation.

The emergence of "smart cities"

Over the last decade, urban developments have been reimagined as smart spaces that can integrate a range of networked systems, sensors, and analytical resources to govern and manage a city's functions. These cities have been envisioned as spaces that possess the computational power to monitor, gain knowledge on, and adapt to both the physical architectures that comprise these spaces as well as the people who inhabit them (Batty, Axhausen, Giannotti, et al., 2012). In part, because of its status as an emergent phenomenon, the term "smart city" is difficult to pin

down. There is not one comprehensive definition that can be applied across all the contexts in which the term is being invoked (Hollands, 2008) which, as some argue, is strategically appealing in that the promise of smart cities can often be reformulated to suit the shifting focuses of both public and private actors (Kriv, 2018). Most of the available definitions emphasize the many aspects of this spatio-temporal imaginary that must ultimately be computationally enhanced, or made "smart," including the economy, its governance, mobility, environment, as well as the lives of those within (Nam and Pardo, 2011). For many, the ability of these aspects of smartness to be measured and evaluated in support of comparative rankings of these urban centers represents both a benefit and a risk to their development in the future (Giffinger and Gudrun, 2010).

Nearly all of those definitions make reference to the generation and use of transaction-generated-information (TGI). The vast amounts of data that will be extracted from smart city devices are expected to contribute to the management of a city's environmental, financial, health care, recreational, social, and transportation systems. A smart city is not only massively inter-connected through smart sensors and devices, it also interconnects an expansive network of actors and institutions, including governments, businesses, schools, hospitals, homes, citizens, and other residents.

Successful management of cities with the assistance of algorithms and artificial intelligence depends to a considerable extent on the knowledge and ability of those managers to gather, store, access and transform massive amounts of data generated by transactions, as well as by periodic and continuous measurement of operational systems and the status of their environments, into practical intelligence about the past, present and future operation of these systems. Decisions about which features of these complex systems need to be measured, and which particular measures, or metrics, are the best of the many possible to be used become increasingly difficult as more and more participants make claims on the sorts of data and intelligence they believe they will need (Zook, 2017).

The challenges that Hollands and others see on the horizon reflect some of the difficulties associated with the responsibility to balance community needs with those of business and local governments, especially when the leaders of local governments are driven by an economic imperative to "attract capital, particularly knowledge and informational capital to their city" (Hollands, 2008, p. 311). This understandable desire to derive the benefits of investments and

expenditures by well-resourced firms leads city managers to enter into deals, including heavily subsidized public-private-partnerships (P3s) that can easily backfire, or evaporate, because "information technology capital may flow elsewhere depending upon what advantages are available to aid further capital accumulation" (Hollands, 2008, p. 314).

The extent to which key developments and transformations of these urban environments are being shaped by corporate interests is yet another source of concern (Rossi, 2016). Observers have pointed out that governing these spaces with coded devices and infrastructures that rely on dynamic data might result in technocratic and/or corporatization of governance, subjecting urban life to a top-down plan (Greenfield, 2013) as well as difficult issues of surveillance (Kitchin, 2014). Further, the manner in which surveillance, profiling and discrimination, enabled by the commodification of TGI, seems likely to "lead to highly controlling and unequal societies in which rights to privacy, confidentiality, freedom of expression and life chances are restricted" (Kitchin, Lauriault and McArdle, 2016, p. 20) demands our attention.

Of particular importance in the case of smart cities, and the variety of services that are provided by governments, or are delivered by commercial firms that are subject to governmental regulation, are the responses of the public to the nature, quality and availability of those services. Increasingly, in part because data derived from social media is relatively easy to collect and analyze in real time, it has become a reliable source of information for urban analysis (Zook, 2017). It is also suggested that the analysis of social media may even aid the monitoring of voter sentiments (Ghosh and Scott, 2018, p. 24) and potentially the manipulation of these sentiments (González, 2017). The widespread critical response to claims made about the use of data regarding the political orientations of Facebook users and their friends (Cohen, 2018) underscores the potential impacts of such use. However, it is the use of social media data by governmental agencies, especially police departments, that "raises concerns that local governments might stray towards an Orwellian big brother state in which citizens are tracked and recorded" (Zook, 2017, p. 9). Similar concerns are expressed regarding the problems that arise when the places in which particular people live become marked on color-coded maps reflecting assessments of these areas as centers of risk, and concentrations of racialized problem populations (Jefferson, 2018).

Our analysis of the proposals submitted to the U.S. Department of Transportation's (USDOT) Smart City Challenge represents our attempt to identify similarities and differences

among cities seeking to be counted among the socially and economically attractive locales on the basis of the nature of the public-private-partnerships they include within their operational core structures, and the extent to which they reflect an appropriate level of concern regarding the nature of the privacy and surveillance risks (Crawford and Schultz, 2014; Acquisti, Taylor and Wagman, 2016; Privacy International, 2017) that they are likely to impose on actual or potential users of their transportation systems. An assessment of the extent to which distributional concerns are emphasized in these proposals in general, as well as with regard to the seven technical proposals that the USDOT requested of finalists in the competition, leads to our conclusions about the maldistributed values and risks that may emerge as results of this initiative.

The USDOT Smart City Challenge

The U.S. Department of Transportation (USDOT) created a research-based initiative that was intended to mobilize the nation's technologically oriented leaders to consider how information and transportation-specific developments could be applied to improve the performance of urban transportation systems with regard to congestion, safety, and environmental impacts in ways that would support economic vitality while expanding quality service to underserved communities.

This initiative, named "Beyond Traffic 2045: The Smart City Challenge", initially committed up to $40 million as support for the winning city's project. The department extended its commitment by an additional $65 million in grants to four of the seven finalists in the competition. A partnership with technology innovator and philanthropist, Paul Allen, through his multidimensional corporate enterprise, Vulcan Inc., seems likely to have influenced the orientation of competitive proposals to reflect the corporate approach, which "is to discover and develop smart, data-driven solutions and create inspiring experiences that help tackle some of the world's toughest challenges" (Vulcan Inc., 2018). Additional grants to cities from corporations and philanthropic organizations expanded the resource pool by more than $500 million (USDOT, 2017).

A significant aspect of these rapidly developing urban transportation projects is the central role being played by public-private-partnerships (P3s), especially those that link

universities with corporate and government institutions (Kenney, 1986; Gabrys, 2014). An important consideration in the evaluation of these partnerships is that these partners often have quite different goals, orientations, and levels of transparency and accountability to the public as they are being brought together in novel governance arrangements (Vanolo, 2014; Kitchin, 2015; Dameri, 2016).

In Dameri's (2016) examination of the role of universities within the set of key players helping to define smart cities, she noted the dramatic rise in scientific papers published between 1997 when there were very few, and 2011 when the number reached 110, rising to 731 in 2014. Although this literature reflects something of a multidisciplinary approach to understanding the smart city phenomenon, computer science and engineering dominated the flow of publications, with social science articles representing a rather small fraction, less than 15 percent of the papers Dameri reviewed (p. 24). Concerns about the social and political characteristics of smart cities have focused on the extent to which these projects have addressed the structural problems that link transportation with poverty, race, and economic and social inequality (Rio, 2016). Many of these concerns are associated with the altered role of the public in which citizens become sensors embedded in the environment, and/or sources of data, in addition to their roles as members of urban communities playing a part in the participatory governance that smart cities are thought to require (Mattern, 2016). In this capacity, smart technology can potentially be used to alter the behavior of individuals and groups instead of engaging them in dialogue: a form of governmentality through "environmental-behavioural control" (Kriv, 2018, p. 16).

In its own assessment of those initial proposals, USDOT noted that "more than 80 percent of applicants were concerned about ensuring the cybersecurity and resilience of their Smart City Infrastructure" (USDOT, 2016, p. 7). In her early assessment of the nature of these concerns Beck (2017) examined 32 of the initial applications to the Smart City Challenge paying close attention to how these projects appeared ready to respond to these issues. Although Beck relied on dominant framings of privacy risks in terms of harms to individuals (Zwitter, 2014) related to security breaches, she observed that most of the expressed concerns about security risks in the proposals were focused on mass security breaches, while "fewer cities addressed cyber-and physical security breaches that target individuals" (Beck, 2017, p 41). Very little attention was apparently being paid to the risks (Levy and Barocas, 2018) that individuals and members of communities and groups were likely to face from the mining and analysis of

data about transportation system users likely to be gathered by the project partners and shared with their clients and customers (Acquisti, Taylor and Wagman, 2016).

This project examines the role of transaction-generated-information (TGI) in the management of smart city transportation as envisioned by the 70 cities and urban areas that submitted proposals in response to the USDOT invitation.[1] Although these proposals focus on a considerable range of outcomes and goals (Slowik and Kamakaté, 2017), we have fixed our attention on aspects of these proposals that relate to the risks to privacy that arise from the likely use of social media content for the assessment of system users' orientations towards and assessments of a city's transportation systems.

Research strategy and results

A variety of approaches to the analysis of the frames, and areas of emphasis that characterized the approaches taken by the participant cities in this competition were used. Because the purpose of our analysis differed substantially from those used by communication scholars concerned with the role of the press in framing issues of public concern (Gandy, 2003; McCombs, 2004; D'Angelo and Kuypers, 2010; Manheim, 2011; Gandy, 2017), we initially sought to characterize the population of contestants in terms of their use of the words that appeared most often in the other proposals.

Utilizing NVivo software to characterize the proposals as a whole, an initial search was designed to identify the words that were used most often. The first approach identified words by frequency of use, and we noted that the terms of primary interest to us were not very popular among the competitors.[2] While "minority, "underserved" and "low-income" did not rank among the top one thousand, "privacy" came in at 609th. While "elderly" did not make the list, "senior" or seniors came in at 777. University was much more popular, coming in at 84th, with partnership coming in even further up the list at 78th.

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[1] Although 78 proposals were submitted to and were considered by USDOT, only 70 of those proposals were capable of automated processing by content analytic software that was incorporated into Adobe Acrobat Reader DC, or NVivo 11 Pro.

[2] NVivo's Word Frequency Query identified and listed words, and similar words by their count and weighted percentage, stopping at the 1000th word in the list.

In order to identify the competitors that used similar frames, an initial strategy made use of the overall Word Frequency Query resource to identify proposals in terms of their correlations with other proposals based on word use similarity. We have included a circular map of these proposals (sources) clustered on that basis, and call your attention to the fact that the majority of the source proposals were not closely associated with each other, and more critically, from our initial assumptions about the role played by frames in the positioning of the competitors, few of the Finalists in the competition were in the more similar clusters. Kansas City was most closely linked with other proposals, while Austin, Texas had five links, and San Francisco was only linked with its near neighbor, San Jose. None of the remaining finalists were parts of meaningfully similar clusters.

(***Insert Figure 1: Sources clustered by word similarity***)

Similarities and Differences among the Competitors

Because of our interest in the role of universities as key members in emergent P3s in smart cities, references to universities were noted along with references to our primary concerns related to the data mining of social media and other sources of risks to privacy. Assessments of the relevance of those references led to direct reading of those sentences and additional indicators of the context of those references within the proposals, such as those dealing specifically with data collection and use. Additional searches were made in order to develop assessments of the way inequality or disparities were discussed within these proposals, including their links to universities, social media and privacy risks.

University focus

References to "university" appeared quite frequently in these proposals with as many as the 44 sentences identified in the proposal from Minneapolis/St Paul, Minnesota, to as few as two identified in the proposal from Oakland, California. The proposal from Birmingham, Alabama had a large number of references to area universities, such as those referring to the University of Birmingham because of its car sharing program, as well as its expected

collaboration in developing and implementing a "comprehensive plan for assessing impacts of connected vehicles deployment on congestion, traffic safety, fuel consumption, air quality, and user satisfaction" (p. 13). The proposal from Boston also had a large number of references to universities, some of which reflected the special character of the benefits to be derived from university-based research, such as "concierge access to city resources and opportunities for on-street research, including randomized control trial infrastructure" (p. 7).

Of particular interest was the proposal from Canton, Ohio that emphasized its university-centered P3, but also took note of the challenges related to the sharing of risk that these non-profit centers might face. As the proposal noted, "While the Project would involve participation by universities (see Section 7.1), equipment and facilities would be deployed almost entirely off campus and without being owned or operated by a university, minimizing potential for institutional risks" (p. 19).

Despite making numerous references to "university" within its proposal, Tucson, AZ did not foreground its P3. Indeed, Tucson's proposal was among a small group of applicants that did not emphasize private or corporate partnerships, instead it simply indicated that "Private partnerships will be identified, and MOU's or contracts will be developed" (p. 1). Unlike the Tucson proposal, the proposal from Minneapolis emphasized the ability of private stakeholders to gain access to data about users. As the Minneapolis proposal noted, "The business model of SMART in our proposal is a public-private partnership which allows private stakeholders to opt in to this travel consumer-oriented data clearinghouse and gain access on travelers' trip demand and patterns" (pp. 26-27).

In addition, where Tucson based much of its data management strategies on its partnership with the University of Arizona, Kansas City cited the expertise of its corporate partner, Booz Allen, which reportedly had considerable experience with data management as a result of its multiple contracts with US government agencies and departments. Finally, along these lines, the proposal from Spokane, Washington focusing on its University District, noted that "The digital master plan, among many other outcomes, will produce a functional governance model for the management of the data resource which also addresses data privacy as well as cyber security issues from inception and for the long haul" (p. 9).

Social media focus

There were far fewer references to social media than there were to universities. As with the other primary terms of interest, our interest in social media includes the proposed use of information gathered from the mining of social media to facilitate comparisons between population segments, especially those defined by their residence or location in particular areas of the city. The greatest number of references to social media (10) was in the Tucson proposal. Some of these references related to the functional uses of communications within what the proposal refers to as "urban commons—physical and virtual spaces where everyday citizens consume collaboratively in an effort to live more sustainably" (p. 6).

Tucson's proposal includes several references to the use of social media to assess traveler satisfaction (p. 12), and gathering information about "what Tucsonans want, are lacking, are happy with" (p. 20). While measures of satisfaction could readily be used to make comparisons across population segments or their locations with regard to "travel delay," including comparisons within the areas identified as "commons" through analytical "geofencing" (p. 20), no such examples were included in the proposal.

Kansas City's seven references to social media differed from Tucson's in that most of the references to social media are comparatively general related to particular functions, such as the project's communications strategies to facilitate the delivery of feedback from transit users and engagement with citizens. Richmond, Virginia, on the other hand, emphasized their use of social media as devices for accessing information from consumers without relying on surveys (p. 17). Even though capturing measures of consumer satisfaction was identified as a central concern, there were no references to comparative assessments.

Sentiment detection was also included among the uses of information derived from analyses of social media in proposals from Rochester, New York and Oakland, California, but only Oakland's plans noted the potential for comparative assessments. While Oakland suggested that "if the City could gauge its work in terms of satisfaction of those most affected by the work, rather than relying solely on metrics such as 'potholes filled'…." (p. 19), the identification of common concerns is not the same as the identification of disparities between types of transportation system users.

Orientations toward privacy

Tucson's proposal discussed privacy concerns in the context of a table describing privacy risks and their levels, and also specified in general terms how the city would act to mitigate those risks. Noting that privacy represented medium-high risk, Tucson simply said that it would "develop policies and procedures to protect private individual information" (p. 13). Kansas City, on the other hand, noted that "Security and privacy are key to making an integrated and advanced ICT system operate efficiently and effectively" (p. 17). Boston's proposal also had quite a bit to say on the subject of privacy, indicating that they would "crowd-source" the development of new standards through collaboration with our public and private sector partners. To ensure that "data is research- and product-ready, we will implement APIs and the privacy & security policies necessary to ensure easy access and appropriate use" (p. 5). It is worth noting, however, that Boston's interests in this area seem to relate primarily to the potential for monetizing the data being generated and captured through their system (p. 27).

Rochester makes nearly as many references to privacy as Boston. Yet, their approach to privacy is somewhat unusual in framing its relationship to the interests of consumers: "empowerment of consumers with enhanced information to save energy, ensure privacy, and shrink bills; and improve grid security and resilience" (p. 15). Many of their privacy-related references emphasize the collaborative aspects of their partner's efforts to keep up with the challenges that privacy and security represent. Like Rochester, Norfolk, Virginia's proposal expressed great confidence in their ability to manage whatever problems related to privacy and security might arise. Their level of confidence seems unwarranted, however, given their recognition that activities demanding security will only increase. Despite this, Norfolk's proposal promised that a "security plan will also be extended to fully cover all smart services used by the City, taking into account all perimeter access points to ensure proper controls and privacy are maintained" (p. 19). While they recognize the expansion of challenges they will face, they seem a bit overconfident in their ability to manage them, perhaps by cordoning them off (p. 20).

New Orleans' proposal differed from Norfolk's in that it recognized that there was a considerable number of areas of concern with regard to privacy and security, especially as they relate to data access and governance. Without claiming that they are prepared to handle all challenges, New Orleans concludes:

> The sheer scope of data generated by a Smart City poses new challenges. Even anonymized data carries privacy implications, as highly specific conclusions can be drawn for historical location data over time. Balancing this risk with our commitment to open data for all, we will work with international data science experts to navigate this challenge as we develop our proposal (p. 29).

Inequality or equity versus disadvantage

It is well known that critical distinctions are drawn between equality and equity, especially in regard to distributional differences along racial and ethnic lines. These indicators are related but critically distinct from references to poverty and its extent, although the relationships between equality and equity take on a different character when they involve comparisons between neighborhoods in which levels of poverty and disadvantage vary (Chetty, Hendren, Jones et al., 2018). In recent years, scholarly and political attention has turned more explicitly toward measurement and comparisons of inequality within nations and around the globe, raising its salience as a basis for pursuing policy change (Hacker and Pierson, 2010). One would expect that proposals for improving an urban transportation system, given the importance of transportation for reliable, convenient and affordable access to schools, retail outlets, and employment opportunities, would include some consideration of the barriers and constraints that limit the access that members of disadvantaged groups have to these links to opportunity.

Proposals were reviewed in order to identify and then compare how these cities presented their assessments of the character of access within their various neighborhoods, as well as their strategies for addressing them with assistance from the Department. Despite the quite dramatic increase in mass media attention to the problem of inequality in the U.S. and around the globe, specific references to inequality were actually quite rare among these proposals. Out of 70 proposals, only 11 explicit references to inequality were found. Nearly all of those references were to income inequality. Only Portland's proposal mentioned racial inequality as a problem, while Oklahoma City rather proudly noted that "According to the Brookings Institute, we have one of the lowest rates of income inequality in the country" (p. 3).

An alternative strategy, somewhat less informative than relying on references to

Inequality, was chosen despite the considerable differences in the interpretation of equity as a status as well as a procedural indicator. Searching for the stem "equit" without regard to the different uses to which it might apply (equity, equitable, inequitable, etc.) a similar search of the proposals was made. A rather dramatic increase in usage of the stem was observed. Closer reading of the texts was required, and the variety of meanings made it difficult to derive its particular function within these proposals.

For example, Oakland's title page declared: "Oakland Smart + Equitable City," despite the fact that the proposal later notes that "Oakland was recently ranked as having the seventh-highest income inequality among cities in the nation" (p. 5). Most likely the optimistic title was a reference to what Oakland would become with support from the USDOT and reflected its "commitment to transportation equity" (p. 2). Oakland used the stem some 17 times, with the most frequently used term being equity (11), other uses being devoted to the fairness-oriented adjective, equitable.

New Orleans' proposal used the stem some 30 times, and like Oakland, the stem was in the title "A new New Orleans: A model for innovative and equitable mobility." Only four uses of the stem were a part of equity, and the rest were either equitable, or equitably. While Portland's proposal also made use of the same stem as New Orleans, only two of those uses were for equitable, or equitably. A rather striking difference was Portland's use of the negative assessment, inequities, with regard to the challenges its plan would have to address. The remainder were to equity as a noun, that still emphasized fair and impartial treatment.

A somewhat more readily interpretive alternative to inequality is disadvantage, a usage that implies a disparity, but is focused upon those who are suffering, rather than a mere difference between population segments. A search using a suitable stem "disadvan" identified numerous proposals making frequent use of the term. Out of the total of 65 references to the stem, nearly all made references to disadvantaged groups or individuals. Richmond, Virginia, for example, made 11 references, 10 of which were used as modifiers of reference groups: families, households, communities, neighborhoods and populations who were "transportation-disadvantaged." The proposal from New Orleans used the adjective six times with reference to job seekers, residents, neighborhoods, and noted the existence of inequality without the specific term by referring uniquely to non-disadvantaged neighborhoods.

Frames and the influence of structural forces

We next sought to identify the use of terms considered relevant to our concerns about the distribution of benefits and risks associated with the use of TGI. Our approach to the identification of frames began with the identification of words within our initial list that were correlated with each other. And finally, we evaluated the extent to which those terms were correlated with or predicted by a set of socio-economic measures in those cities, emphasizing those indicating the nature of racial and economic inequality, hardship and segregation.

Given the relative marginality of the terms we had identified as being important, we made use of simple correlations between those terms as they appeared in the proposals. At this initial level, no attempt was made to differentiate between the many ways in which a word or its stem might be used within a proposal. This meant that the stem "equit" could be used in a sentence, or it could be in the name of an organization of a partner. Additional strategies were used to evaluate the use of words in their context will follow from this initial analysis.

We used as a criterion measure of relevance to our analytical goals the fact that the word or stem was correlated with at least three other key terms, as well as with at least one of several socio-economic measures. Five terms and two indicators met those requirements. Behavior was an important term as it was significantly correlated with three core terms, and one socioeconomic indicator. Most of the significant correlations with other key terms were positive, meaning that proposals that made frequent references to behavior also made frequent references to low-income, seniors, and trust. However, we note that the correlation with the percent of the population identified as poor is negative, suggesting that a focus on behavior of the poor was less likely to be part of the strategies common to those cities, despite the significant positive correlation between the Gini measure of inequality, and the percentage poor.

(***Insert Table 1 Correlations between key terms and socioeconomic indicators***)

Trust was an important term, with significant correlations with seniors, privacy, and low-income, but it was not correlated with either of the socio-economic indicators, suggesting that trust was more of a central framing resource, rather than one associated with particular kinds of populations. References to data sharing were only associated with references to low-income. Privacy was correlated with only a single term, trust, but it was also correlated with the Gini

coefficient, indicating that in communities marked by higher levels of inequality, concerns about privacy were more likely to be expressed. We note that none of the population sectors associated with particular populations at risk were linked with references to privacy, although they were correlated with trust.

Because we assumed that the frames in the proposals identified by USDOT as the sponsor of the competition were those deemed to be representative of legitimate orientations toward the challenge as they defined it, we focused the balance of our analysis on the similarities and differences between the seven finalists, both in their initial narratives and in their subsequent technical proposals.

The Finalists

The USDOT (2017) selected seven cities as finalists in the competition: Austin, Columbus, Denver, Kansas City, Pittsburgh, Portland and San Francisco. These finalists received financial support and technical assistance to prepare technical proposals. Three of the seven finalists identified goals that reflected concerns about inequality, and they focused primarily on the disadvantaged or underserved. In its report on the lessons learned from the Smart City Challenge, USDOT (2017) divided the goals and strategies of the finalists into technological, social, and policy-oriented groups, with the concerns about inequality falling under the heading, "How we grow opportunity for all" (p. 14). They noted that historic racial and economic divides have been perpetuated by planning, infrastructure, and socioeconomic policies that have isolated neighborhoods, encouraged sprawl, enabled economic segregation, and overlooked pockets of poverty (p. 14).

The USDOT (2016, p. 3) announced its seven finalists as part of its report on "trends and priorities from Round 1." It did not emphasize differences between the applicants, instead it characterized the points of common emphasis among the proposals including the fact that "more than half of applicants wanted to implement an autonomous low-speed shuttle or podcar by 2019," as well as the fact that "almost half of applicants proposed shared-use mobility (rideshare, carshare, or bikeshare)." It did not report any proportions for the summary statement implicating surveillance, or data gathering and analytics: "new sensors will allow cities to monitor vehicle traffic, parking availability and even pedestrian and bicyclist counts to make better decisions."

It did, however, offer broad descriptions of the "unique challenges" to be addressed by three cities, one of which was Detroit that indirectly referenced inequality with regard to its being an area "almost totally reliant on personal auto ownership. As a result, many Detroiters lack affordable access to mobility" (USDOT, 2016, p. 5). When it pointed out "shared mobility challenges," it included comments from Seattle's proposal noting the impact of gentrification "resulting in low-income residents moving further from downtown to areas where access to high frequency public transportation is weaker" (USDOT, 2016, p. 6).

Austin's proposal emerged as the primary example of an appropriate response to those concerns. Austin's goal was to connect underserved communities to economic opportunity, and to thereby reduce the spread of poverty. The goal identified by Columbus was specifically to reduce infant mortality and narrow the health disparity gap, and its proposal called specific attention to the status of African-Americans, and the concentration of these deaths in poorer neighborhoods (p. 20). Portland's goal was less specific, and merely sought to ensure that all communities would have access to transportation and the ability to choose wisely among them.

With the exception of the poor showing by Columbus and Pittsburgh, which devoted only one reference to privacy, 139 other references to privacy were included in the other five technical proposals. San Francisco paid the most attention to privacy with 56 references, followed by Portland with 30, and Denver with 28. Kansas City made eight references while Austin made seven. San Francisco's proposal was unique in its commitment to apply "core privacy by design concepts to project implementation" beginning in the first year (pp. 33-34). The city's investment in the development and implementation of comprehensive privacy and security plans, oversight, and expert assistance was as impressive as the comparatively high number of references would suggest. That said, none of the articulations of privacy addressed the pertinent issue of government and corporate encroachment into urban lives, nor the processes of subjectification that the value of these kinds of privacy initiatives presuppose.

There were 120 references to words with "equit" as the stem in the finalist proposals. Kansas City's proposal had only one such reference, identifying a project stakeholder that would "make emerging technology equitable and accessible" (p. 68). Pittsburgh's proposal had only four such references, one of which referred to decision making processes regarding road maintenance and paving that would be made equitably. Denver's proposal only had three such references, one of which was about eliminating inequity in public education. Portland included

21 references incorporating the equit stem, two of which were related to existing problems of inequity. Three references were related to equitable access, distribution, or the enhancement of safety. Austin's proposal had 22 such references. Four were related to being more equitable as a goal, one was about growing inequity as a liability to be overcome, and the rest were primarily about equity as a challenge to be met.

Since the seven finalists were selected by the USDOT, we assumed that there were aspects of their proposals that made them stand out from the crowd beyond the degree to which they differed from most of the other applicants in terms of their use of words. We used several strategies to identify the similarities and differences between the finalists in their initial proposals, or narratives, and their later technical proposals.

Utilizing the 17 terms that we identified as being closely related to the various frames we identified for each of the finalists, we calculated the correlations between the narrative and technical proposals. The greater the correlation between the initial and final proposals, the less change there had been in their use of those terms. Columbus changed its proposal the most, as indicated by the negative correlation (-.10). Kansas City changed the least, as reflected in the high positive correlation between its proposals (.94). The other five finalists can be ranked from greater to lesser change: Pittsburgh (.21), San Francisco (.51), Portland (.60), Austin (.65), and Denver (.66).

We noted that with the terms we chose for comparisons, the overwhelming tendency in the revision of their proposals was to increase references to these particular terms. There was one somewhat surprising departure from that tendency, however, in that Portland's technical proposal actually reduced its use of terms based on the equity stem from 30 to 21 references. San Francisco's technical proposal had the bulk of the equit-stemmed references (69). The overwhelming majority of those references were to equity, used often as labels for the kinds of concerns about equity that a particular initiative would address, or as the names of groups or entities for whom assurances about, or achievement of equity through project activities was their responsibility. Equitable was used primarily as a description of the kinds of access that would be provided to residents. The only reference to inequities occurred early in the proposal, when the city noted that "Without innovation to meet housing and transportation inequities, the region risks its economic competitive advantage" (p.1).

The reference that emerged as a "term of art" among the finalists was the "underserved,"

with 82 such references among these seven technical documents. San Francisco, Pittsburgh, Columbus and Portland were the least likely to use the term, ranging from three to nine cases. The most frequent socio-spatial term that was modified in this way was community (39), followed by neighborhood, or area (9).

Utilizing NVivo's word similarity cluster analysis, we were able to display the changed relationships between these cities between the first and final drafts of their proposals. What is most striking about these charts is the rather dramatic shift in the relative positions of both Columbus and San Francisco, with San Francisco becoming quite similar to Kansas City, while Columbus moved substantially in the other direction toward Portland's framing of the challenges and opportunities they were committed to engage.

(***Insert Figure 2: Narrative and Technical shifts***)

Because we were interested in attempting to understand what kinds of influence there was which was reflected in the dramatic shifts made by Columbus and San Francisco, we made use of the Word Tree Mapping resource in NVivo to generate representative maps of the relationships between their usage of behavior, minority, equitable, public-private and privacy in the narrative and technical proposals from these two competitors. We have included one map that identifies the phrases or sentences utilizing references to behavior in the technical proposals from Columbus and San Francisco. We have highlighted a number of phrases within these clusters, noting their origins with yellow for Columbus and blue for San Francisco.

(**Insert Figure 3: References to Behavior by San Francisco and Columbus**)

The Columbus technical proposal only included only two references to behavior, and they were descriptive features of their use of communication strategies and data gathering, such as the first, linking sustainability, walking and art, and the second referring to gathering input about commuter behavior, including transit usage. We were struck by the emphasis in many of the references to behavior in the San Francisco technical proposal that focused on the modification of behavior, involving changing, shifting, reducing, encouraging, and even nudging, while also seeking to understand those behaviors. They also included, perhaps

hopefully, the desire to increase equity and safety.

And the winner is: Columbus, Ohio

After characterizing the proposal from Columbus as a "holistic vision for how technology can help all residents move better and access opportunity" the USDOT announced its selection of that city as the winner of the Smart City Challenge.

In developing our overall impression of the competition and its winning proposal, we felt it was important to note that the initial proposal from Columbus (2016a) included only 6 references to university and no references to privacy or social media. Most of its university references were to Ohio State University and its transportation research centers. The others merely made mention of other universities with expertise in areas relevant to the proposed project that would be partners or collaborators with the city. Searching through Technical Application from Columbus (2016b), we found a substantial increase in the number of university references (23), a moderate increase in the number of references to social media (14), but a pitiable increase in references to privacy (6). And, while there was only one reference to the mitigation of inequities in the initial proposal, "equit" did not appear at all in the final, technical proposal from Columbus.

Among the few references to privacy that appeared in the technical proposal from Columbus, we noted a curious distinction in the way that access to data will be provided for private, or corporate entities, as compared that to be provided to public agencies: "Access by private entities to the raw data will be made available in accordance with the City's privacy policy as managed by the Department of Technology" (p. 53). None of the references to privacy bear any relationship to the project's intended use of social media, as the proposal only recognized social media as distributional resource for the project's communications with its target audiences.

The fact that the Columbus project intends to make use of the Alphabet/Google Sidewalk Labs Flow platform to help encourage and facilitate "health visits to be made through transportation subsidies and the linking of the trip to a 'Smart Columbus' payment card/mobile application" (p. 32) suggests the need for a much more substantial emphasis on data privacy than this proposal suggests that Columbus is committed to or ready to provide (Sauter, 2018).

Commentary and conclusions

The greatest changes that Columbus made between its initial and final proposal were related to its references to universities and social media. With regard to references to disadvantaged people, communities or neighborhoods, Pittsburgh, Columbus and Portland made only two in their technical proposals, whereas Austin made five, and Denver and San Francisco both made six, leaving Kansas City as an outlier without a single reference to the disadvantaged. At the same time, it is worth noting that Columbus was among 11 of the nation's 100 largest metropolitan areas that were characterized as achieving "improved growth, prosperity, and inclusion" between 2010 and 2015 (Parilla, 2017, p. 28).

Among the six things that the USDOT indicated had been learned by the participants in the challenge, the smallest number of proposals were seen to have emphasized "How we grow opportunity" (USDOT, 2017, p. 5), so we assume that there was actually very little pressure being applied to increasing the attention that would be paid to such concerns. USDOT made only a single reference to privacy in its summary document, and its emphasis was on the extent to which the finalists had come to "understand that only by building a resilient, secure privacy-driven data platforms will the public feel confident sharing their data" (USDOT, 2017, p. 13).

It is again quite striking that the winning proposal from Columbus made the fewest references to privacy in its final proposal, and none of those six references were about the level of confidence that the public might feel about the nature of their data platforms. Despite the fact that the number of references to social media made by Columbus was among the highest made by the finalists, there is not much comfort to be drawn from the fact that social media was seen primarily as a promotional channel, rather than an instrument of surveillance or commercial exploitation. However, the extent to which these promotional messages will be precisely targeted to those market segments with the greatest commercial potential might reestablish those concerns (Páez, Trépanier and Morency, 2011).

There is also some comfort to be derived from the number of proposals, including those which received some financial support for their projects, that expressed concerns about and allocated resources for addressing the problems of inequality and disadvantage along with expressions of concerns about the challenges to opportunity that are characterized as privacy

risks. This is especially important in the context of rapidly developing insights about the importance of the heightened privacy risks that low-income internet users face because of their reliance upon their smartphones for most of their social media interactions (Madden, Gilman, Levy and Marwick, 2017).

The technical proposal from San Francisco not only made substantially more references to privacy than the others, but the discussion of its "privacy and security framework" included a "privacy risk model" that identified three primary privacy risks that included: unauthorized access or disclosure of private information, the re-identification of individuals where data were intended to be anonymous, and the "reduction in autonomy ... posed by sensor-based data collection methods" (p. 55). While our view is largely speculative, it seems likely that the financial and technical support that San Francisco received as a finalist expressing concern about privacy and surveillance led that city to become the first in the nation "to ban the use of facial recognition technology by the police and other city agencies" (Editorial Board, 2019).

Looking forward

Although it was possible to note, as we have, the kinds of changes that have been made in the way these competitors altered their proposals, we had no generalizable basis for inferring the nature of the influence exercised by the USDOT, or any of the corporations or foundations that provided both professional guidance and financial support, on the adjustments that were eventually made. In comparison with the difficulties we and others faced in attempting to characterize the nature of the institutional and organizational influences on the development of smart city proposals and initiatives, we still believe that it should be possible to explore the relationship between socio-economic and structural features of these cities and their discursive imaginaries.

Many of the proposals made reference to the status of various indicators, often in comparative terms, with rankings, or with regard to levels or rates of improvement in those measures. Treating the more frequently used references to aspects of inequality, privacy risks, public and private engagement in the design, management, and evaluation of smart city initiatives as dependent variables, comparative assessments of predictive or explanatory models would provide us with a valuable, if indirect indicator of those factors that seem to matter more or less across cities, states, regions and even nations as they plan for the future. Chin's (2017)

use of cluster analysis to assign 36 cities into four primary forms and eleven "micro-foundations" that facilitate comparisons between cities while identifying what she refers to as "solution sets" for planning interventions and investments in their futures (pp. 98-100) represents a promising approach along these lines. Among the attributes that she identified as critical inputs in the cluster analysis, it is encouraging to note that in addition to racial and ethnic status comparisons, she included measures related to poverty such as the supply of affordable housing, the impact of gentrification, and the levels of unemployment with census regions. Although we expect that it would be something of a challenge to gather comparable data from all these cities, it would be especially useful to be able to estimate the impact of political mobilization and activism on the part of underserved and racialized community members on the cities' plans for truly getting smart.

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Figures and Graphs

Figure 1: Sources clustered by word similarity

Table 1: Correlations between key terms and indicators

	Behavior	Data shr	Low-inc	Privacy	Seniors	Trust	Gini
Behavior							
Data-shr	.141						
Low-inc	.351**	.239*					
Privacy	.233	.108	.152				
Seniors	.390**	.041	.089	.011			
Trust	.445**	-.009	.245*	.269*	.290*		
Gini	.126	-.08	.111	.248*	.013	.024	
% Poor	-.238*	.119	.007	-.076	-.310**	-.172	.394**

*significant (.05), **significant (.01) 2-tailed

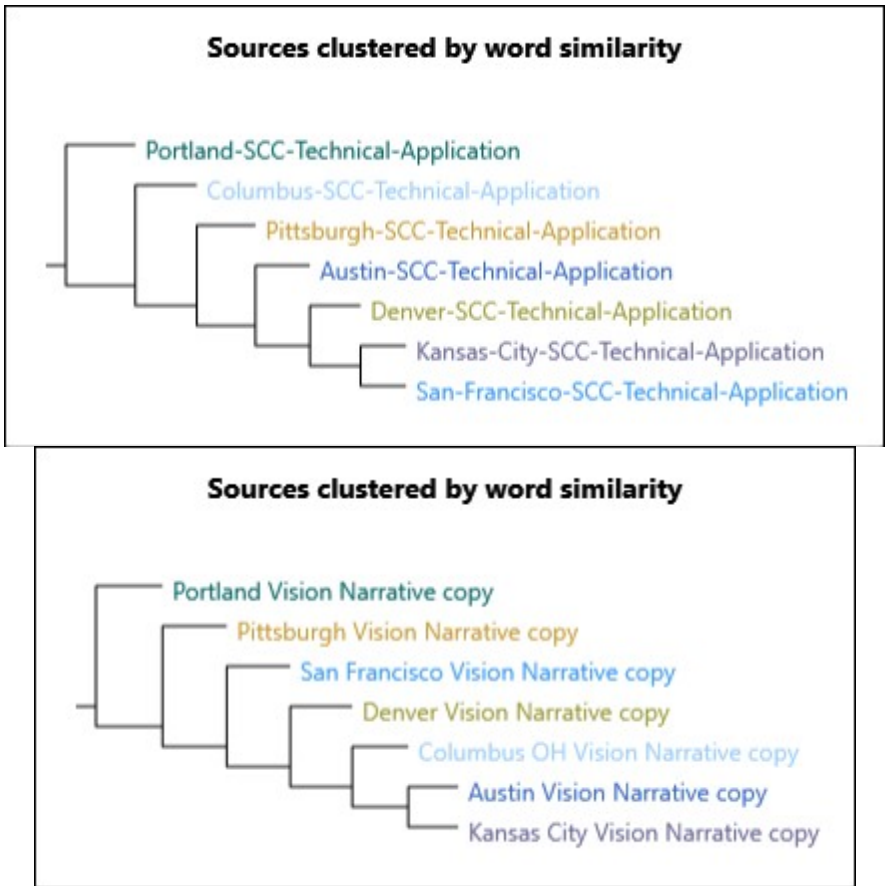

Figure 2: Narrative and Technical shifts

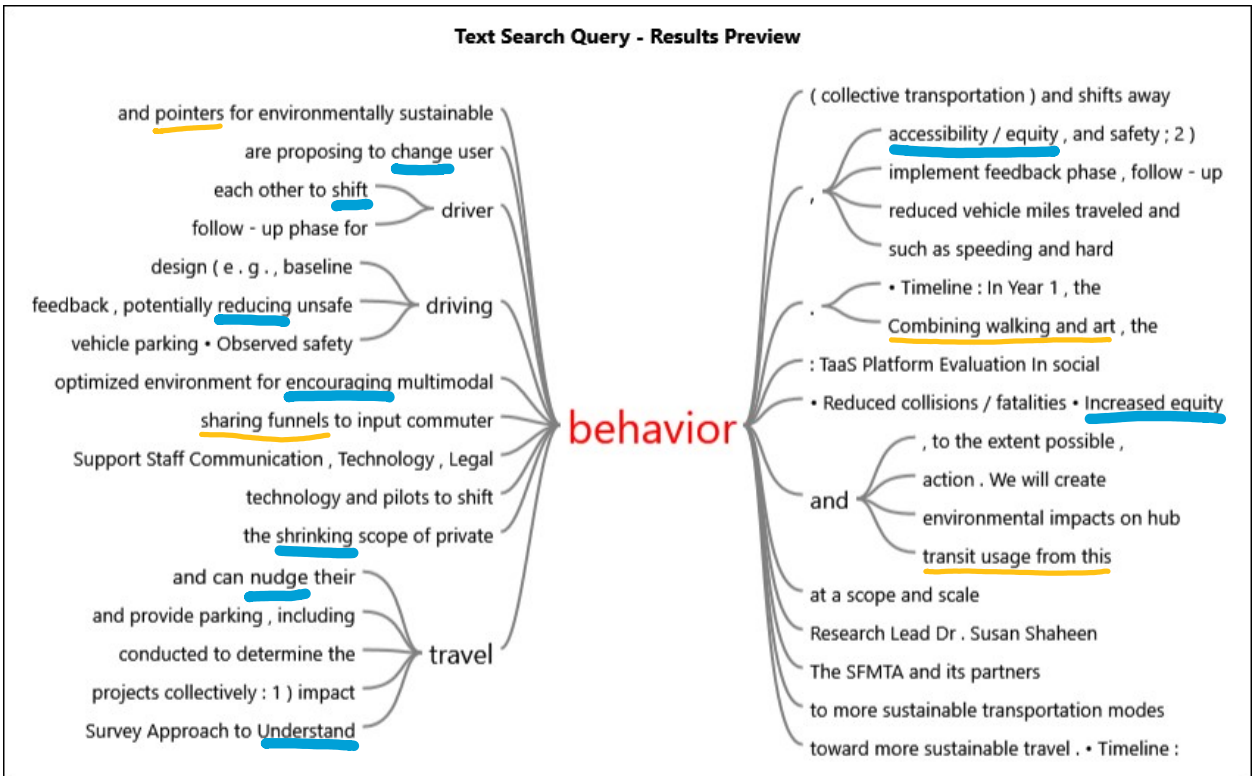

Figure 3: References to Behavior by San Francisco and Columbus