Sustainable Cities and Society 74 (2021) 103148

Contents lists available at ScienceDirect

Sustainable Cities and Society

journal homepage: www.elsevier.com/locate/scs

Is your smart city inclusive? Evaluating proposals from the U.S. Department of Transportation's Smart City Challenge

Chihuangji (Herbert) Wang [a], Edward Steinfeld [b,c], Jordana L. Maisel [a,c], Bumjoon Kang [d,*]

[a] Department of Urban and Regional Planning, School of Architecture and Planning, University at Buffalo, The State University of New York, Buffalo, NY 14214, United States
[b] Department of Architecture, School of Architecture and Planning, University at Buffalo, The State University of New York, Buffalo, NY 14214, United States
[c] Center for Inclusive Design and Environmental Access, School of Architecture and Planning, University at Buffalo, The State University of New York, Buffalo, NY 14214, United States
[d] College of Architecture, Myongji University, 116 Myongji-ro, Cheoin-gu, Yongin-si, Gyeonggi-do 17058, South Korea

ARTICLE INFO

Keywords:
Inclusive Smart City (ISC)
Persons with disabilities
Underrepresented groups

ABSTRACT

The concept of "Smart City" has been proposed by governments, the business community, advocacy groups, and research institutions as a means to solve common urban problems and improve the quality of life for citizens. Although a Smart City has the potential to change our cities for the better, it also may unintentionally reinforce existing inequalities. In particular, without appropriate strategies that support inclusion, persons with disabilities and seniors may experience social and digital exclusion in communities. This study explored current progress toward building an "Inclusive Smart City (ISC)" through the *2015 U.S. DOT Smart City Challenge*. It examined the range and frequency of inclusive strategies that were proposed by cities in their applications and the differences between successful and unsuccessful proposals. After reviewing and analyzing documentation from both rounds, we conclude: (1) insufficient attention was given to these underrepresented population groups in the proposals; (2) more ISC strategies are needed to address these groups' needs and guarantee their rights; (3) government policies to support ISCs are needed to insure that the implementation of Smart City ideas addresses the needs of these groups; and, (4) universal design practices could be used to address the needs of many underrepresented populations.

Introduction

The concept of "Smart City (SC)" has been proposed and adopted by various city planners and policymakers as a means to enable efficient transportation systems, sustainable mixed land uses, and high-quality urban services, in an effort to improve citizens' quality of life. An essential goal of SC should be to ensure that *all* citizens have the right to benefit from the innovations adopted, and have a voice in deciding what SC strategies to adopt and how to do it (Batty et al., 2012; Rebernik et al., 2019). Hollands (2008) argued that a real SC would actually have to tackle risks with technology, devolve power, and inequalities. Without an inclusionary approach, it is likely that current inequalities in many spheres of life will be perpetuated, and those who are likely to benefit the most will continue to lose out.

In the United States, the Americans with Disabilities Act of 1990 (ADA) adopts standards that specify minimum accessibility requirements for people with disabilities for public environments, including buildings and street infrastructure, transportation, and services. The Vocational Rehabilitation Act of 1973 (Section 504) and Section 508 of the Telecommunications Act of 1996 (Telecommunications Act) further effectively requires that telecommunications equipment and services are accessible. These regulations were adopted well before the concept of SC was on the radar of government agencies. However, many information technology-based services are not directly addressed by the current regulations for those acts. For example, between 2011 and 2017, at least 142 local governments in the U.S. were sued for website accessibility issues (e.g., accessibility for blind or low-vision users) (Nichols, 2017). It should be noted that cities and transit agencies already have had difficulty complying with these regulations when implementing SC initiatives.

Some SC initiatives, in fact, neglect the needs of groups who stand to benefit most from innovative technologies, such as older adults or

* Corresponding author.
E-mail address: bumjoon@mju.ac.kr (B. Kang).

https://doi.org/10.1016/j.scs.2021.103148
Received 25 January 2021; Received in revised form 26 June 2021; Accepted 30 June 2021
Available online 9 July 2021

people with disabilities (de Oliveira Neto & Kofuji, 2016). New York City, for instance, installed smart kiosks, which were not fully accessible to people with disabilities (Woyke, 2019). Another major controversy arose a few years ago as Transportation Network Companies (TNCs) emerged. TNCs, like Uber and Lyft, maintained that they were not covered by the federal regulations for accessibility to public accommodations since their drivers were contract employees and the companies did not own the cars (Equal Rights Center (ERC) 2017). These examples are precursors of a broader range of conflicts over access that are likely to emerge as SC initiatives are implemented. Thus, we need to raise awareness and develop strategies to practice inclusion as SC initiatives are conceived and executed. Otherwise, disregard of groups like frail older adults, wheelchair users, and people who are blind or visually-impaired, could result in unexpected social and digital exclusion.

Unfortunately, Inclusive Smart City (ISC) surprisingly turns out to be under-investigated among both academia and industrial communities. An ISC should follow a citizen-centric approach (Kamel Boulos et al., 2015) and put the welfare of citizens first (Joss et al., 2017; Maxwell, 2018) to cultivate social and ethical plurality, flexibility, creativity, and open-mindedness in SC development process (Nam & Pardo, 2011). The goal of this case study was to assess whether inclusion is being appropriately addressed in recent SC plans. To the best of our knowledge, this study is among the first efforts in evaluating inclusion in implementing SC initiatives worldwide, which will contribute to the existing literature and provide practical guidance on evaluating SC proposals in the future.

This study evaluated the documentation from the *Smart City Challenge* (hereafter called "SC Challenge"), initiated by the U.S. Department of Transportation (US DOT) in 2015. We firstly evaluated all 78 first-round applications of the SC Challenge and categorized applicant cities into three levels of ISC based on the levels of awareness of challenges for the underrepresented populations. Next, we reviewed the details of all proposed ISC strategies from both rounds and summarized them from three dimensions: the groups of beneficiaries, challenge types, and implementation formats. Lastly, we reviewed the ongoing or proposed projects from Columbus, OH, the winning city of the SC Challenge. This study is an important introspection, we believe, as it expands the discussion of ISC in urban planning. It is also our hope that this study enables urban scholars and practitioners to rethink the nature of real SC and to promote inclusion when establishing SC in the future.

The remainder of the article is structured as follows. The next section is a literature review, in which we reviewed existing studies related to inclusiveness and smart city development. Section 3 introduces the background of the SC Challenge. Section 4 presented the methodologies of five analyses we conducted; section 5 discusses the results. The final section concludes our study and develops a set of recommendations for future SC competitions and for any municipality seeking to implement ISC initiatives.

Literature Review

Inclusion

All citizens, especially those underrepresented groups who are at the risk of poor physical, psychological, and/or social health, should have equal access to the urban services and infrastructure (Sasaki, 2010). An inclusive city aims to "create a safe, livable environment with affordable and equitable access to urban services, social services, and livelihood opportunities for all the city residents" (Singru & Lindfield, 2016, p. 4). There have been extensive studies that explore the equitable housing policy (Hu et al., 2020), social inequalities in street walkability (Su et al., 2017; Su et al., 2019), social desegregation (Cretan et al., 2020), and equity in transit (Kaplan et al., 2014; Li et al., 2019). However, 'accessibility' is still considered merely as an architectural measurement for physically and visually impaired people, while the need for accessible information, communication and services, and the needs of hard of hearing or cognitively impaired people are usually ignored (Rebernik et al., 2017; Rebernik et al., 2019). To ensure the respect of human dignity and equality, social inclusion should be emphasized when it relates to city planning and management.

A policy of social inclusion should allow for all members of society to participate economically, socially, and culturally in their communities, while bringing an end to the social discrimination as its priority (Sasaki, 2010). Current regulations fail to fully guarantee equality in user experience, social participation, and civic engagement. Universal design (UD) extends well beyond the scope of current accessibility regulations in a more aspirational way. Steinfeld and Maisel (2012, p. 29) defined universal design as "a process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation." They also proposed eight goals of UD (*body fit, comfort, awareness, understanding, wellness, social integration, personalization, appropriateness*) to frame what it meant to operationalize inclusion. The United Nations Economic and Social Commission for Asia and the Pacific also suggests that "universal design-based accessibility must be at the heart of governments' approach to expand service provision and build new infrastructure for Smart Cities" (Zahedi & Reyes, 2018).

Meanwhile, scholars have also identified concerns and challenges that need awareness when ensuring social inclusion. For example, Cretan et al. (2020) stated that efforts towards desegregation and integration of disadvantaged populations should be given carefully, otherwise it may lead to stigma against the marginal people. The corruption of government and political elite may also prevent building an inclusive city or promoting social justice (Creţan & O'Brien, 2020). Other scholars found that by the sense of place attachment that is shaped by social relations and features of the neighborhoods can characterize some segregated neighborhoods (Málovics et al., 2019), which may influence citizens' mobility choices and impede social inclusion (Belanche et al., 2016).

In the context of SC, Neirotti et al. (2014) classified 'social inclusion' as one of the soft domains that SC should invest and its main objective should reduce barriers in participation and improve the quality of life, especially for the older adults and people with disabilities. There has been evidence that smart technologies benefit socially excluded groups, such as people with disabilities, wheelchair users, or individuals with visual impairments (Morris et al., 2014; Maxwell, 2018; Boni et al., 2019; Nicula et al., 2020). The adoption of UD principles to both the physical environment and technologies is the most effective way to ensure that the entire population will benefit from SC initiatives (Steinfeld & Maisel, 2012).

Smart City Development

Although the SC concept has been discussed widely, there is no one-size-fits-all definition of SC (Hollands, 2008; Nam & Pardo, 2011). Previous research defines SC by emphasizing information and communication technologies (ICT) as the main way to foster urban development. One popular definition describes SC as urban areas connecting physical, social, business, and ICT infrastructure to uplift the intelligence of the city (Harrison et al., 2010). At one extreme, a SC can be as simple as an application of information technology to improve traditional infrastructure (Chambers & Elfrink, 2014). At the other, it could mean the wholesale rethinking of urban life from the ground up using advanced ICT (Bakıcı et al., 2013). No matter how to define SC, the utmost goal of SCs is to enhance the quality of life of urban citizens and operational efficacy of urban services (Zanella et al., 2014; Belanche et al., 2016; Silva et al., 2018).

SC initiatives have developed worldwide and gained great interests within research and industrial communities for the past decade (Anejionu et al., 2019; Rebernik et al., 2019). It is commonly recognized that the deployment of new technologies and infrastructure in SC, combined with the generation of big data, will fundamentally transform how and where people live, work, and play in future cities. A survey in 2018

predicted that cities' budgets and interests in SC projects would increase intensely (The United States Conference of Mayors, & IHS Markit 2018). Another web portal consolidating global SC calls reported over 100 SC proposals per month, including policy development or specific projects such as smart parking management system (Bee Smart City, 2021). However, current SC is mostly likely to be designed in a way to fit the needs of active and fully abled people, while the needs from marginalized population are often ignored (Rebernik et al., 2019). Therefore, it is critical for the cities to evaluate the SC proposals to ensure that they adequately address public interests (Caragliu & Del Bo, 2016), especially needs of the underrepresented populations.

Scholars also recognized some concerns regarding building a sustainable SC, such as the issue of digital divide is unignorable. Boulos et al. (2015) suggest that it is necessary and effective to mitigate a digital divide by offering digital inclusion workshop or training programs, such as "digital community ambassadors" or technical outreach to help older adults and other marginalized population to get familiar with technologies. Also, the transparency of government information and actions, as a tool to reduce corruption, is essential to a SC (De Guimarães et al., 2020).

An "Inclusive Smart City (ISC)", as defined by de Oliveira Neto (2018), is a SC to support the access and use of urban technologies by all citizens (including people with disabilities and seniors/older adults). He presented a comprehensive review of ISC in terms of definitions, theory, tools, and practices. More importantly, he identified two requirements any ISC initiative must have and satisfy: governance and technological infrastructure. Governance requirements, from a macro perspective, are visions and objectives concerning demands from underrepresented populations, while technological infrastructure requirements denote characteristics that can facilitate their accessibility, protect privacy, and ensure friendly user experiences.

It should be noted that ISC is currently under-explored in both academia and industrial communities and only a few scholars or agencies use inclusiveness as a standard to evaluate SC. In academia, Nicula et al. (2020) considered social inclusion of marginal communities when evaluating whether Alba Iulia is a true SC. Rebernik et al. (2019) developed a 4-dimensional model to fit needs of inclusive city planning and design. Their model incorporated four dimensions on the basis of the "people-place-technology" framework: a) human, b) spatial (including governmental aspects), c) technological and d) relational.

Among the practical community, San Francisco County Transportation Authority used inclusiveness as a guiding principle, but this was limited to only evaluating emerging smart mobility services (San Francisco County Transportation Authority 2018). The Smart Cities for All (SC4A) initiative, proposed Global Initiative for Inclusive Information and Communication Technologies (G3ict)[1] and World ENABLED[1], was launched in 2016 to define the state of ICT accessibility in Smart Cities worldwide. SC4A provides four tools to help city planners ensure SC technology initiatives benefit all citizens, intending to increase the awareness about inclusion when in the planning, deployment, and functioning of SC (de Oliveira Neto, 2018). However, to date, there is no large-scale evaluation of SC on its level of inclusion has been attempted yet. To fill this gap, this study aims to use documentation from the SC Challenge to evaluate whether inclusion has been addressed by applicant cities.

Background of the SC Challenge

In 2015, the SC Challenge was launched by U.S. DOT to develop SC models for technology-aided transportation systems that are applicable to other U.S. cities. The SC Challenge was a competition that selected one mid-size city (population between 200,000 and 850,000) to receive a USD 50 million grant to establish a city-wide intelligent transportation system. It was the first nation-wide, city-level-grant explicitly focused on Smart Cities. The Notice of Funding Opportunities (NOFO), titled "*Beyond Traffic: Smart City Challenge*", explicitly addressed inclusion issues (e.g., mobility of people with disabilities or seniors) (U.S. Department of Transportation, 2015).

The SC Challenge provides a unique opportunity to evaluate SC proposals and is an appropriate vehicle for our study for several reasons. First, it was the first nation-wide project after the 2015 White House Initiative on SC (Office of the Press Secretary, 2015). Second, it called for SC ideas and solutions from more than 80 mid-size cities in the U.S. using a standard format, making all the applicants, and their proposals comparable. Third, as an exemplary and highly promoted competition, its influence on future municipal or state projects was likely to be remarkably considerable. For example, the South Korean central government called for a nation-wide Smart City project in 2019 based on the SC Challenge model (Department of Urban Economics, 2019).

Even though the SC Challenge provides an unprecedent research opportunity, it has been rarely used for evaluation study that compares and evaluates multiple, comparable SC plans. So far, we could find only one study that utilized SC Challenge documentation to evaluate public interest among applicants (Beck, 2017). This study will reveal SC issues utilizing the 2015 SC Challenge from the perspective of inclusiveness.

Methodology

Five analyses were conducted in this study. First, we quantitatively measured the frequency of keywords and applied Latent Dirichlet Allocation (LDA) to detect topics in the first-round documents. Second, we categorized 78 applicant cities into three levels of ISC, based on the extent of their awareness of inclusiveness and quality of actionable strategies to benefit underrepresented populations. Third, ISC strategies were extracted from proposals in both rounds. Fourth, ISC strategies were then quantitatively summarized from three aspects: beneficiary group, type of challenges, and implementation formats. Lastly, the ongoing or proposed projects in the winning application, Columbus, OH, were examined.

The first was a quantitative content analysis using *ATLIS.ti* software (Friese, 2019) to measure the frequency of keywords mentioned in 78 proposal documents from the first round of the competition. Keywords included words or short phrases that referred to underrepresented groups who are at the risk of poor physical, psychological, and/or social health in the context of ISC. Five keyword categories were "disability", "seniors", "wheelchair users", "visually impaired", and "inclusiveness/ inclusion/ inclusivity". They were selected to describe each proposal's overall awareness of inclusiveness on target populations. Relevant words or phrases are grouped by categories. For example, "senior(s)", "older adults", and "the elderly" all counted towards the category of seniors. Additionally, we also compared the frequency of the keywords between selected cities (seven finalists in the second round) and non-selected cities (the remaining 71 cities).

We also applied an LDA model, using the "topicmodels" package in R (Hornik & Grün, 2011), to detect if there exist any topics related to keywords or "inclusion" in the first-round documentation. LDA is an unsupervised machine learning technique that explores latent topics and associated word groups in a large collection of documents. We combined all 78 proposals into one document and LDA primarily utilizes a "bag of words" model the document as a vector of word counts (Haghighi et al., 2018). The core idea behind LDA is that such a document is treated as a mixture of topics and each topic is then characterized by a probability distribution over a number of words (Blei et al., 2003). For parameterized models such as LDA, the number of topics, K, is the most important parameter to define. In order to pick up the optimal K, we used the package 'ldatuning' in R (Nikita & Nikita, 2016).

Second, we categorized applicant cities based on whether the applicants were aware of challenges for these underrepresented populations, and whether proposals showed relevant actions. We grouped applicant cities into three categories based on their proposals: (1) "no-awareness" ISC, (2) "awareness-yet-no-action" ISC, and (2) "awareness-and-action" ISC. The "no-awareness" category (ISC Level 0) refers to

applicant cities that did not mention any keywords related to people with disabilities, seniors, wheelchair users, or individuals with visual impairments, nor propose any strategy regarding mobility, accessibility, or other aspects to address their needs. The "awareness-yet-no-action" category (ISC Level 1) refers to applicant cities that identified challenges related to these groups, expressed concerns towards them, or included them in the visions or objectives, but did not propose any actual strategies or plans to tackle the identified challenges or issues. The "awareness-and-action" category (ISC Level 2) refers to applicant cities that not only conveyed an awareness of issues, challenges, or needs for these groups, but also proposed or intended to implement at least one strategy to meet their needs and deliver a new service or services that would address them.

Third, we conducted a qualitative analysis examining ISC strategies in each proposal. We defined an *ISC strategy* as a project, plan, physical or visual product, or a new innovative service specifically proposed to benefit people with disabilities (including wheelchair users and visually-impaired people) or seniors. For example, a healthcare transportation service using electric autonomous vehicles (AVs) to transport wheelchair users, proposed by New Orleans, LA is counted as one ISC strategy (New Orleans, 2016). ISC strategies were summarized from cities in the "awareness-and-action" category (ISC Level 2) in the first round and the seven finalists in the second round. This analysis was intended to characterize the challenges mentioned and summarize the overall trends of ISC strategies.

Fourth, all ISC strategies were examined and summarized along three dimensions: the groups of beneficiaries, challenge types, and implementation formats. The City and County of Denver, for instance, proposed to address accessibility issues for low-income, disabled, and elderly people by establishing smart corridors with AVs to provide reliable Mobility on Demand (MoD) transportation service (The City and County of Denver 2016). We also compared the second-round plans of the seven finalists with what they proposed in the first round.

Finally, we examined the ongoing or proposed projects in the winning application, Columbus, OH. As of July 2019, Columbus announced nine US DOT grant-funded projects and five Paul G. Allen Philanthropies grant-funded priorities on a website (https://smart.columbus.gov/projects/) that reports progress toward building Smart Columbus. These funded-projects were just the start, and some projects were recently planned or designed but not yet implemented; therefore, only their introductions, descriptions, or webinars were reviewed; we completed a similar qualitative analysis as those above using the same keywords to identify the challenges, strategies, beneficiaries, challenge types, and implementation formats in the proposed projects.

Results

Keyword Frequency and Topic Modelling

During the first round of the SC Challenge, there were 78 proposals from 85 cities, including four jointly submitted proposals. Table 1 shows the keyword frequency results, selected from 10 cities with the highest total number of keywords. Tampa, FL, and Scottsdale, AZ stated "disability" and "seniors" highly frequently, yet they were not selected as one of the seven finalists. Common keyword categories were "seniors" (82 times) and "disability" (70 times).

Table 2 shows keyword category frequencies among selected cities (seven finalists) and those not selected for the second round (71 cities). On average, the selected cities stated the keywords slightly more than the non-selected cities (12.8 vs. 11.6). However, the selected cities stated "inclusiveness" (4.1 vs. 1.2) and "visually impaired" (2.0 vs. 0.3) more than the non-selected cities. It is noteworthy that Tampa, FL and Scottsdale, AZ did not mention "inclusiveness" at all in their proposals, although they mentioned "disability" and "seniors" many times. None of the selected cities mentioned "wheelchair user" or related terms at all in their proposals. Kansas, MO mentioned "visually impaired" or relevant terms 11 times because it proposed a detailed project for visually-impaired people, a navigation assistance App development with beacon sensors on buses and other transit systems (City of Kansas City, 2016).

Based on the metrics results, we finally set K as 4 when modelling topics among first-round documentation. Figure 1 showed the 40 most probable terms from four topics according to the term-topic-probability vector. Not surprisingly, the most likely terms that are relevant to the SC Challenges, such as 'smart', 'city', and 'transportation', have been well captured in topic 1. However, terms related to our keywords are not commonly addressed in the rest of four topics. The only term, 'blind', is identified as a term in topic 4, but with a low term-topic-probability. The results indicate that, compared with topics like smart city, data, transportation, and challenges, the discussion about disability or inclusion is rare or non-existent.

Inclusive Smart City Categories

We categorized 12 applicants (14 cities) as Level 0 ("no-awareness") ISCs, 18 applicants (18 cities) as Level 1 ISCs ("awareness-yet-no-action"), and 48 applicants (53 cities) as Level 2 ISCs ("awareness-and-action"), as shown in Table 3. As a Level 1 ISC example, Charlotte, NC, only provided a vision to create inclusive neighborhoods but did not show any actual or feasible strategies or projects (City of Charlotte, 2016). It is notable that more than half of the first-round proposals had one or more actionable strategies, which was requested by the SC Challenge. Among those cities (Level 2 ISCs) with the high awareness of inclusiveness, Tampa, FL, proposed the most ISC strategies, totaling eight projects or plans (City of Tampa, 2016).

Only 61.5% (n=48) of applicant cities in the first round were classified as Level 2 ISC. The seven finalist cities were all categorized as Level 2 ISCs since they proposed at least one ISC strategy in the first round, and they even proposed more ISC strategies, totaling 19, in the second round. Columbus, OH, the final winner, submitted five ISC

Table 1
Top ten cities with keywords frequency.

	Rank & City	Disability	Seniors	Wheelchair user	Visually impaired	Inclusiveness	Total
1	Tampa, FL	11	25	0	1	0	37
2	Scottsdale, AZ	9	24	1	0	0	34
3	**Kansas City, MO**	5	0	0	11	7	23
4	Nashville, TN	8	7	3	0	5	23
5	Oklahoma City, OK	5	8	0	0	5	18
6	Fremont, CA	6	6	4	2	0	18
7	Richmond, VA	10	2	1	3	1	17
8	Reno, NV	7	5	0	0	3	15
9	Minneapolis & St Paul, MN	7	5	0	3	0	15
10	**Portland, OR**	2	0	0	1	10	13
Total	*70*	*82*	*9*	*21*	*31*	*213*	

Note: Finalist applicant cities are **bold.**

Table 2
Comparison of keywords frequency between selected and non-selected cities.

	City, State	Disability	Seniors	Wheelchair users	Visually impaired	Inclusiveness	Total
Finalist cities							
(N = 7)	Austin, TX	3	5	0	2	0	10
	Columbus, OH	2	0	0	0	2	4
	Denver, CO	3	0	0	0	0	3
	Kansas City, MO	5	0	0	11	7	23
	Pittsburgh, PA	4	1	0	0	2	7
	Portland, OR	2	0	0	1	10	13
	San Francisco, CA	1	1	0	0	8	10
	Mean	*2.9*	*1.0*	*0.0*	*2.0*	*4.1*	*12.8*
Non-selected cities (N = 71)	*Mean*	*2.9*	*2.0*	*0.4*	*0.3*	*1.2*	*11.6*

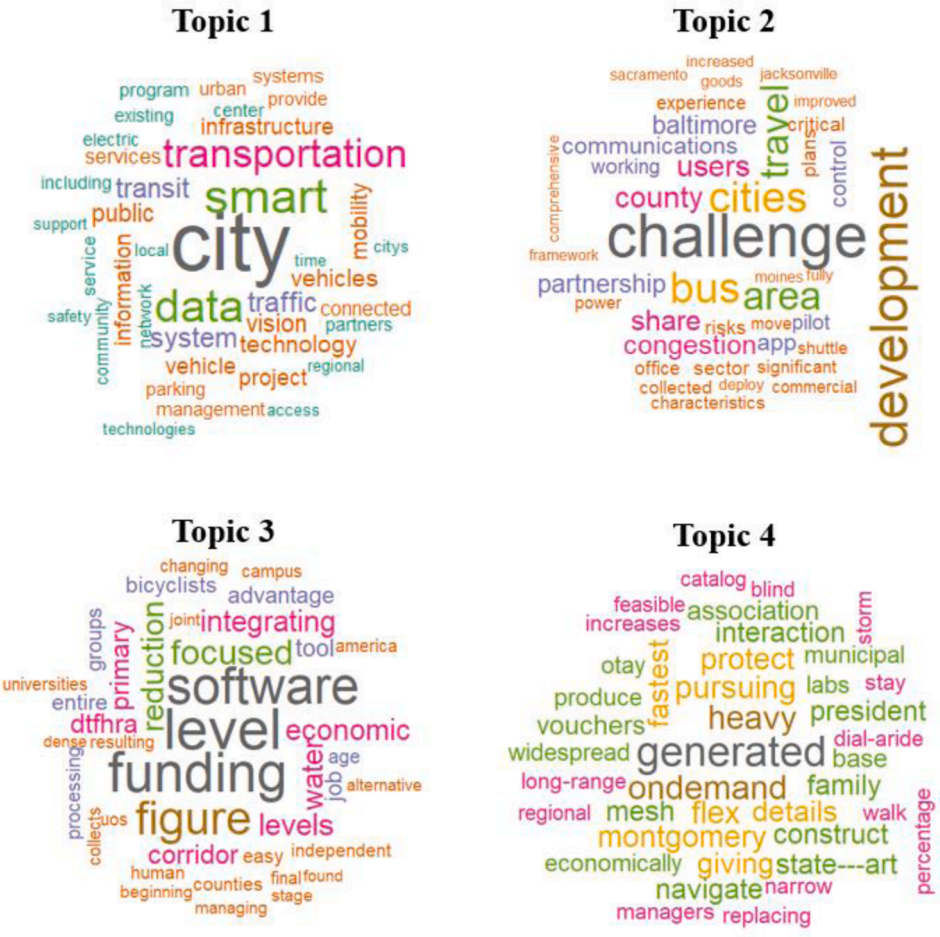

Fig. 1. Top 30 popular terms in each topic.

strategies, the most among seven finalists, in the second round.

ISC Strategies

There were 95 ISC strategies identified from 48 proposals in the first round. The first-round NOFO announced 12 vision elements, to which applicants were required to respond, and specifically requested applicants to enhance overall mobility for all travelers, including older Americans and people with disabilities, under two vision elements: Vision Element #5: User-Focused Mobility Services and Choices and Vision Element #9: Connected, Involved Citizens (U.S. Department of Transportation, 2015). About 65% (n=62) of the strategies focused on smart and integrated transportation system development to respond to Vision Element #5: User-Focused Mobility Services. Moreover, Vision Element #1, Urban Automation, was also addressed by 15 ISC strategies from 14 applicants. Most cities proposed AVs under this vision element to improve mobility for all citizens.

According to the published report by US DOT, 44 applicant cities proposed to test AVs or shared AVs to help travelers connect to their destinations more easily and faster (U.S. Department of Transportation, 2016); however, we only found 15 ISC strategies that mentioned that AVs either offer service to underrepresented populations, such as wheelchair users or people with disabilities, or have to be designed to be ADA compliant and accessible by people with disabilities. The findings suggest that inclusiveness was not a significant area of concern for applicants, even though it was requested.

In the second round, there were 19 ISC strategies from seven finalists. Table 4 shows the number of proposed ISC strategies from seven finalists in both rounds. Not surprisingly, most cities proposed more ISC strategies in the second round, except Denver, CO and Kansas City, MO. On

Table 3
Categorization of ISC of 2015 Smart City Challenge.

Category	City, State
"No-awareness" Level 0 ISC (N = 12)	Akron, OH; Birmingham, AL; Chula Vista, CA; Columbus, GA; Detroit, MI; Lincoln, NE; Newport News, VA; Oceanside, CA; Orlando, FL; St. Louis, MO; Tulsa, OK; Yonkers/New Rochelle/Mt. Vernon, NY
"Awareness-yet-no-action" Level 1 ISC (N = 18)	Canton, OH; Charlotte, NC; Cleveland, OH; Jacksonville, FL; Las Vegas, NV; Long Beach, CA; Louisville, KY; Lubbock, TX; Madison, WI; Memphis, TN; Miami, FL; Moreno Valley, CA; Newark, NJ; Sacramento, CA; Scottsdale, AZ; Spokane, WA; St. Petersburg, FL; Toledo, OH
"Awareness-and-action" Level 2 ISC (N = 48)	Albany/Schenectady/Troy/Saratoga Springs, NY; Albuquerque, NM; Anchorage, AK; Atlanta, GA; **Austin, TX**; Baltimore, MD; Baton Rouge, LA; Boston, MA; Brookhaven, GA; Buffalo, NY; Chattanooga, TN; **Columbus, OH; Denver, CO**; Des Moines, IA; Fremont, CA; Fresno, CA; Greensboro, NC; Greenville, SC; Indianapolis, IN; Jersey City, NJ; **Kansas City, MO**; Minneapolis/St. Paul, MN; Montgomery, AL; Nashville, TN; New Haven, CT; New Orleans, LA; Norfolk, VA; Oakland, CA; Oklahoma City, OK; Omaha, NE; **Pittsburgh, PA**; Port Huron/Marysville, MI; **Portland, OR**; Providence, RI; Raleigh, NC; Reno, NV; Richmond, VA; Riverside, CA; Rochester, NY; **San Francisco, CA**; San Jose, CA; Seattle, WA; Shreveport, LA; Tallahassee, FL; Tampa, FL; Tucson, AZ; Virginia Beach, VA; Washington, DC

* Seven finalists shown in bold

Table 4
Comparison of ISC strategies from seven finalists in both rounds.

City	State	# of ISC strategies (the first round)	# of ISC strategies (the second round)
Austin	TX	2	3
Columbus	OH	1	5
Denver	CO	2	1
Kansas City	MO	4	2
Pittsburgh	PA	1	2
Portland	OR	1	4
San Francisco	CA	1	2
Total		12	19
Mean		1.7	2.7

average, seven finalists proposed one more ISC strategy in the second round than what they proposed in the first round. For example, Portland, OR proposed only one strategy, providing technology-based solutions to improve paratransit services, in the first round, but expanded to four ISC strategies, including applications, low-speed AVs, partnership with entrepreneurs, and hackathons, in the second round, to emphasize and meet the needs of low-income, minority, immigrant, youth, elderly, and disabled residents (Portland Bureau of Transportation, 2016).

Beneficiary Group: Who Will Benefit from ISC Strategies?

Table 5 summarizes four different beneficiary groups of ISC strategies in both rounds separately: people with disabilities, seniors, wheelchair users, and people with visual impairments. Two points need clarification: (1) the grouping is not mutually exclusive since we categorize each ISC strategy based on the terms and words applicants used in their proposals, and (2) one ISC strategy can benefit multiple groups of beneficiaries at the same time. For example, New Haven, CT proposed to deploy ITS strategies/technologies to support better accessibility to disadvantaged citizens, including the elderly, and the driverless population (City of New Haven, 2016); therefore, this strategy was counted to benefit three beneficiary groups: seniors, people with disabilities, and wheelchair-users.

In the first round, 55% of ISC strategies were targeted to help

Table 5
Target groups identified from proposed ISC strategies.

# of proposed ISC strategies	Target group	PwD	Seniors	Wheelchair-users	Visually impaired
First round (N = 95)	# of ISC strategies per applicant city (n = 78)	0.9	0.7	0.2	0.3
	% of ISC strategies	73%	55%	16%	24%
Second round (N = 19)	# of ISC strategies per applicant city (n = 7)	2.3	0.6	0.7	0.4
	% of ISC strategies	84%	21%	26%	16%

Note: PwD = People with Disabilities

"seniors," but only 22% in the second round targeted this group. The number of ISC strategies benefiting people with disabilities, in general, increased from 0.9 to 2.3 per applicant city, which indicated more attention was given to this group by the seven finalists in the second round. Moreover, there were more strategies for "wheelchair users" and fewer for individuals with visual impairments in the second round. It is noteworthy that Columbus, OH was the only applicant city that addressed the issues of inclusive mobility for people with cognitive disabilities in the first-round proposals (The City of Columbus, 2016).

Challenge Type: What Challenges were Acknowledged?

In Table 6, we categorized ISC strategies from both rounds into four challenge categories: limited mobility/accessibility, safety issues, digital exclusiveness and lack of information, and lack of data for decision-making.

Since the overall goal of the SC Challenge was to increase mobility for all citizens (U.S. Department of Transportation, 2015), the category of 'limited mobility/accessibility' challenges was largely identified by most applicant cities in both rounds. About 87% and 79% of ISC strategies from both rounds, respectively, were proposed to solve accessibility issues and improve mobility for all citizens. Some cities described their challenges as both limited mobility and insufficient accessibility. For example, the "first-mile/last-mile (FMLM)" challenge was identified by three applicants, Denver, CO, Minneapolis/St. Paul, MN, and Atlanta, GA (City of Atlanta, 2016; City of Minneapolis, 2016; The City and County of Denver, 2016).

Challenges related to 'Safety issues' were given more consideration in the first round and mainly included street design (City of Kansas City, 2016; The City of Fremont, 2016), wayfinding issues for sight and hearing-impaired citizens (City of Austin, 2016; Tucson, 2016), and safety for pedestrians, bicyclists, and people in wheelchairs in crosswalks or on the roadside (City of Tampa, 2016; Oklahoma City, 2016; The City of Fremont, 2016). Challenges related to the 'digital exclusiveness and lack of information' category focused on socially and digitally excluded populations; for instance, lacking access to technologies, specific devices and digital skills, which limited their ability to benefit from real-time traffic information and information about their surroundings. Many cities are facing this challenge when planning new technologies or innovations; it made up 39% and 47% of ISC strategies from the first- and second-round applications, respectively. It was noteworthy that Rochester, NY was the only applicant city, among 78 first-round proposals, that specifically identified inaccessible websites or applications for blind and visually-impaired citizens or seniors, and proposed to insure that all web-based site or applications be screen-reader friendly (City of Rochester, 2016). This is one of the easiest strategies to implement.

The last category, 'lack of data for decision-making', was mainly addressed from leadership and planner perspectives. This challenge category was rarely identified by applicants in both rounds (i.e., only

Table 6
Challenge type of ISC strategies.

	Challenge type	Limited mobility and accessibility	Safety issues	Digital exclusiveness and lack of information	Lack of data for decision-making
First round (N = 95)	# of ISC strategies per applicant city (n = 78)	1.06	0.60	0.47	0.04
	% of ISC strategies	87%	49%	39%	3%
Second round (N = 19)	# of ISC strategies per applicant city (n = 7)	2.14	0.29	1.29	0.57
	% of ISC strategies	79%	11%	47%	21%

Table 7
Format of proposed ISC strategies.

	ISC strategy format	App	Transit option/ service	Technology-based environment improvement	Data, informatics, and outreaches	No specific format
First round (N = 95)	# of ISC strategies per applicant city (n = 78)	0.21	0.41	0.29	0.21	0.14
	% of ISC strategies	17%	34%	24%	17%	12%
Second round (N = 19)	# of ISC strategies per applicant city (n = 7)	1.00	0.71	0.43	0.71	0.14
	% of ISC strategies	37%	26%	16%	26%	5%

three applicant cities in the first round and four in the second round). As an example, Omaha, NE explicitly pointed out the challenge of how to harness and better operate and manage the transportation system in real-time using existing big data (City of Omaha, 2016).

Implementation Formats: How ISC Projects were Proposed?

After determining ISC strategies and corresponding challenges, we classified the implementation formats of ISC strategies into five categories in Table 7: (1) Applications (apps); (2), Transportation option/ service; (3) Technology-based environment improvement; (4) Data informatics and outreach; and, (5) No specific format.

Application-based ISC strategies are cost-effective and specialized applications for underrepresented populations. Thirteen applicant cities from the first round proposed to deploy 16 different apps for multiple purposes, such as reporting traffic accidents (Pittsburgh, 2016), improving MoD services for the seniors and people with disabilities (City of Montgomery 2016), improving safety and providing wayfinding service for bicycles and pedestrians with visual impairments (City of Minneapolis, 2016), and customizing paratransit service through apps (Portland Bureau of Transportation, 2016). In the second round, apps were also the most prevalent ISC strategy; five finalist cities proposed seven apps to help visually-impaired people identify appropriate buses and routes with real-time information (City of Austin, 2016; City of Kansas City, 2016; City of Richmond, 2016).

There were 17 ISC strategies proposed related to the development of electric vehicles or connected/autonomous vehicles (CAV) as a new transportation option to increase the mobility and accessibility of the target populations in the first round, making this the most common strategy (34%; n=32). Improving existing paratransit for people with disabilities was another strategy frequently proposed (11 applicant cities, including Reno, NV, and Washington, DC). A third group of solutions proposed public-private partnerships or collaborations with TNCs, such as Uber and Lyft; Washington D.C. (District Department of Transportation, 2016) and Nashville, TN (Metropolitan Government of Nashville and Davidson County, 2016) made proposals of this type.

Technology-based environment improvement strategies focused on infrastructure investment, physical hardware improvement, or streetscape renovation. Six cities from the first round proposed "smart corridor" projects in either downtown or Central Business Districts of their cities. Infrastructure investments included the deployment of sensors at bus stops to stop Bus Rapid Transit (BRT) vehicles, beacons to warn pedestrians (Oklahoma City, 2016), newly-designed and ADA-compliant BRT stations and parking facilities (Metro Atlanta Buford Highway Corridor Municipalities, 2016), and indoor wayfinding systems in an airport to help the elderly and persons with disabilities (City of Tampa, 2016). Des Moines, IA and Tallahassee, FL identified strategies to address the issues of parking for people with disabilities (City of Tallahassee., 2016, Des Moines Area Metropolitan Planning Organization, 2016).

Data informatics and outreach strategies focused on improving the use of existing data to address "digital exclusiveness and lack of information". Omaha, NE proposed local campaigns to reach all citizens and collect their opinions about inclusion in their first-round proposal (City of Omaha, 2016).

ISC Strategies with 'no specific format' only accounted for a small portion of all proposed ISC strategies (i.e., 11 ISC strategies in the first round and one from the second round). In these cases, applicants did not explain the strategies or used vague languages to describe them.

Final Winner: Columbus, OH

Columbus, OH was ultimately awarded the funding from US DOT. Since the detailed selection criterion were not public, it remains unclear whether the ISC strategies in the applicant's proposal played a significant role in their selection. Although Columbus, OH did not propose many ISC strategies in the first-round application, it proposed five different ISC strategies to benefit people with cognitive impairments, people with visual impairments, seniors, and wheelchair-users in the second round. After they received the award, Columbus published 9 follow-up projects, of which two were relevant for the target populations. One of the projects Columbus proposed was titled "Mobility Assistance for People with Cognitive Disabilities". To help this group travel more independently on fixed-route bus service, an outside agency or call center would monitor trips and provide interventions when necessary (Smart Columbus. 2021). In March 2018, Columbus evaluated various commercial applications and identified the best technology to implement this service. Thus, this initiative not only prioritized the needs of people with cognitive disabilities, but also produced criteria for purchasing the desired system, maybe the first U.S. example of a mechanism for implementing ISC strategies. Columbus also proposed a "Multi-Modal Trip Planning Application" project to provide personalized trip itineraries, known as trip optimization services, to travelers with disabilities.

Conclusions and Recommendations

The keyword content analysis and topic modelling analysis were used to assess overall awareness of inclusivity in SC plans. In general, insufficient attention has been given to underrepresented populations when planning and implementing SC initiatives. The analyses demonstrated that there were no substantial differences between the selected cities and non-selected cities in the frequency of mentioning inclusivity during the first round. We classified 61.5% (n=48) of applicant cities in the first round as Level 2 ISC but, given the explicit criteria in the NOFA, we had expected that all applicants would propose specific ISC strategies, not just express awareness of the issues. It was, however, encouraging to find that all seven finalists were categorized as Level 2 ISC ("awareness-and-action") in the first round, and the final winner, Columbus, OH, not only considered ISC strategies in their planning but also expanded the number of such strategies after the competition.

The content analysis of ISC strategies, currently being considered by applicant cities, provided a comprehensive understanding of the anticipated benefits to underrepresented populations. Apps were the most preferred type of ISC strategies proposed, which is consistent with lessons learned and published by US DOT (U.S. Department of Transportation, 2016). A majority of the ISC strategies (about 65%) focused on developing smart and integrated transportation systems to create user-focused mobility services. As demonstrated by de Oliveira Neto and Kofuji (2016), when building the digital layer of the urban environment (applications, ICT services and electronic services), these services should be oriented to all diversity of citizens. Adopting ISC strategies can conveniently connect citizens and improve access to both innovative technologies and informative knowledge. We found that over 70% of ISC strategies were proposed to benefit people with disabilities in general, especially those strategies proposed by the seven finalists. Few applicant cities proposed ISC strategies to address the specific needs of wheelchair users, individuals with visual impairments and other specific functional limitations. But their needs should be the fundamental aspects of a SC and barriers, not only physical but also digital, should be eliminated, so a real SC can be called an ISC (de Oliveira Neto & Kofuji, 2016).

This is the first study to examine the inclusiveness of the 2015 U.S. DOT SC Challenge. The analyses revealed that inclusiveness was not a high priority when designing Smart Cities. Thus, we developed the following recommendations to help DOT put more emphasis on inclusion and to help local communities develop improved ISC policies, plans, and projects in the future:

- The SC community as a whole should expand the understanding of underrepresented populations. There are many other marginalized groups, for instance people with temporary disabilities, communication disorders, pregnant women, children, and those who do not speak the local language all have limitations in human performance. Social limitations that often lead to underrepresentation in planning initiatives include low income, refugee status, and membership in the LGBTQ+ community. During two rounds of application, only the winner, Columbus, OH, mentioned people with cognitive disabilities and proposed an app as an ISC strategy for inclusion in the SC plan. Lee et al. (2020) also claimed that current studies often fail to define the full set of target populations for ISC strategies. Therefore, it is critical that planners and policymakers broaden their vision of inclusiveness and find ways to engage segments of the population whose needs are often ignored.
- SC development plans should adopt universal design as a means to guide and evaluate ISC proposals. Universal design addresses the diversity of human populations and recognizes that everyone has limitations in one way or another. This concept has also been recommended previously when implementing SC initiatives and building an ISC (de Oliveira Neto & Kofuji, 2016). Only Rochester, NY, and San Francisco, CA, among 78 first-round proposals, specifically stated that universal design principals would guide the design of CAVs (San Francisco Municipal Transportation Agency, 2015) and should be used throughout any transportation plan (City of Rochester, 2016). It appears that few urban planners and policymakers know about this concept and how it pertains to SC initiatives. The Goals of Universal Design, briefly described earlier, provide a framework for evaluating SC strategies.
- We encourage SC policymakers and practitioners to use inclusiveness as a *primary* factor in evaluating SC proposals. Caragliu and Del Bo (2016) argue that there is yet no recognized framework for SC policy evaluations. The first-round NOFO only explicitly required applicants to consider people with disabilities and seniors under two out of 12 vision elements (U.S. Department of Transportation, 2015). Since the detailed selection criterion were not publicly available, it is unclear whether inclusion was an essential factor in their selection. But the focus of SC proposal evaluations should be on citizen needs, especially those of underrepresented populations. The fact that specialized apps were the most preferred format for implementation, for instance, suggests that mainstream apps are not providing sufficient access and usability to address the needs of many groups. It is therefore recommended that future SC competitions should demand that inclusive strategies be contained within proposals and provide resources to help cities understand the difference between regulatory compliance and universal design.
- The creation of infrastructure for outreach and communication to underrepresented groups should be an essential component of ISC initiatives. We found that only a small portion of ISC strategies considered outreach and public engagement, and those applicants did not specifically target underrepresented populations. Cities should engage with underrepresented communities to discover their needs and priorities, which may vary significantly from one municipality to the other. In a recent Smart City Challenge announced by Infrastructure Canada, the Canadian federal department responsible for public infrastructure, it was explicitly requested that "meaningful engagement" should be undertaken to broaden and enhance potential public impact to build a more inclusive SC (Goodman et al., 2020). At the same time, local authorities need to find appropriate channels to inform underrepresented populations about SC initiatives and engage these groups in planning processes, or their needs will likely remain poorly addressed. It is vital to develop ways to facilitate outreach and communication with these populations to identify what they truly need and their priorities, in order to understand how to help them appropriately (de Oliveira Neto, 2018).
- Policies and regulations on accessibility need to be reconsidered in light of the SC paradigm. Neirotti et al. (2014) demonstrated that policymakers and city planners should take vulnerability and social inclusion into consideration in their approaches to build smarter and more inclusive cities. Some cities may adopt new technologies without considering the implications for certain individuals with disabilities (Matthews, 2019). Among all the proposed strategies, only Oakland, CA gave attention to developing a policy on the deployment of AVs to ensure that people with disabilities would not be discriminated against as they come on line. It is noteworthy that the East Bay region is home to several disability rights advocacy organizations who are engaged in policy development on this topic. This may have raised awareness of this issue in the city's proposal development process.
- Cities need to go beyond awareness to identify action strategies in order to demonstrate a commitment to inclusive practices. It is encouraging that about 85% of applicant cities in the first round had some levels of awareness on inclusivity (Level 1 and Level 2 ISCs). But from this study, we cannot tell if the expression of awareness in the proposals was merely paying lip service to the NOFA priorities or reflected real commitment. There are always differences between visions or images of a SC and the implementation of SC initiatives or strategies (Fernandez-Anez et al., 2018) (AlAwadhi & Scholl, 2013). What truly matters is that actual implementation of ISC strategies

utilize a ''bottom-up'' approach, identifying the real needs through engagement with underrepresented populations and evaluating whether those needs are being fulfilled (Neirotti et al., 2014; Kominos, 2016).

We acknowledge that there were limitations to this research. First, we only considered a limited set of groups of underrepresented groups in our study. Second, the content of available materials was restricted due to the competition rules. Due to the 30-page application limit in the first round and 80 pages in the second round, it is possible that applicants may not have enough space to explain their plans towards building an ISC. We only considered applications from the SC Challenge and explored the follow-up progress of Columbus, OH, without expanding the analyses to other applicant cities. It is possible that many of the other cities in the competition implemented some of their ISC proposals with other funding sources. Using more extensive source material and SC plans from multiple sources would be helpful in future research of this type.

Declaration of Competing Interest

The authors report no declarations of interest.

Funding

The contents of this paper were developed under a grant from the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR grant number 90RE5011-01-00). NIDILRR is a Center within the Administration for Community Living (ACL), Department of Health and Human Services (HHS). This study was also supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (No. 2020R1C1C1013021).

References

AlAwadhi, S., & Scholl, H. J. (2013). *Aspirations and realizations: The smart city of Seattle.* Paper presented at the 2013 46th Hawaii international conference on system sciences.

Anejionu, O. C., Thakuriah, P. V., McHugh, A., Sun, Y., McArthur, D., Mason, P., & Walpole, R. (2019). Spatial urban data system: A cloud-enabled big data infrastructure for social and economic urban analytics. *Future Generation Computer Systems, 98*, 456–473.

Bakıcı, T., Almirall, E., & Wareham, J. (2013). A smart city initiative: the case of Barcelona. *Journal of the knowledge economy, 4*(2), 135–148.

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., & Portugali, Y. (2012). Smart cities of the future. *The European Physical Journal Special Topics, 214*(1), 481–518.

Beck, K. (2017). Smart Security? Evaluating Security Resiliency in the US Department of Transportation's Smart City Challenge. *Transportation Research Record, 2604*(1), 37–43.

Bee Smart City. (2021). *SMART CITY TENDERS-Access the Latest Smart City Tenders from Around the World*. Retrieved from https://hub.beesmart.city/services/smart-city-tenders.

Belanche, D., Casaló, L. V., & Orús, C. (2016). City attachment and use of urban services: Benefits for smart cities. *Cities, 50*, 75–81. https://doi.org/10.1016/j.cities.2015.08.016

Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *Journal of machine Learning research, 3*, 993–1022. Jan.

Boni, A., López-Fogués, A., Fernández-Baldor, Á., Millan, G., & Belda-Miquel, S. (2019). Initiatives towards a participatory smart city. The role of digital grassroots innovations. *Journal of Global Ethics, 15*(2), 168–182.

Boulos, M. N. K., Tsouros, A. D., & Holopainen, A. (2015). *'Social, innovative and smart cities are happy and resilient': insights from the WHO EURO 2014 International Healthy Cities Conference. In.* Springer.

Caragliu, A., & Del Bo, C. F (2016). Do smart cities invest in smarter policies? Learning from the past, planning for the future. *Social Science Computer Review, 34*(6), 657–672.

Chambers, o., & Elfrink, W. (2014). *The Future of Cities: The Internet of Everything will Change How We Live*. Retrieved from https://www.foreignaffairs.com/articles/2014-10-31/future-cities?utm_campaign=reg_conf_email&utm_medium=newsletters&utm_source=fa_registration.

City of Atlanta.. (2016). *Atlanta reimagined: Creating community, collaboration and access through Transportation Innovation in Atlanta*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/GA%20Atlanta.pdf.

City of Austin.. (2016). *Live from Austin, Texas: Vision for a 21st Century Mobility System-Beyond Traffic: The Smart City Challenge*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/Austin%20Vision%20Narrative.pdf.

City of Charlotte.. (2016). *BEYOND TRAFFIC SMART CITY CHALLENGE*. Acess, Choice, Opportunity. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/NC%20Charlotte.pdf.

City of Kansas City. (2016). *Beyond Traffic: The Vision for the Kansas City Smart City Challenge*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/Kansas%20City%20Vision%20Narrative.pdf.

City of Minneapolis.. (2016). *Minneapolis/Saint Paul Smart City*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/MN%20Minneapolis%20St%20Paul.pdf.

City of Montgomery. (2016). *Montgomery Area Transit System; Mobile Studio, I.,; Auburn University. MONTGOMERY, ALABAMA: CONNECTING MGM with E-TRANSIT*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/AL%20Montgomery.pdf.

City of New Haven.. (2016). *"Beyond Traffic: The Smart City Challenge"*. Part1: Vision Narrative. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/CT%20NewHaven.pdf.

City of Omaha.. (2016). *OMAHA: We Don't Coast, We Build a Smart City*. Retrieved from https://www.transportation.gov/smartcity/visionstatements/omaha-ne.

City of Richmond.. (2016). *BEYOND TRAFFIC: THE SMART CITY CHALLENGE GRANT APPLICATION One Bold City: A Healthy Mobility Approach*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/VA%20Richmond.pdf.

City of Rochester.. (2016). *BEYOND TRAFFIC: THE SMART CITY CHALLENGE*. ROC FORWARD.

City of Tallahassee.. (2016). *Changing How We Commute through Access and Innovation-City of Tallahassee Smart City Challenge Application*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/FL%20Tallahassee.pdf.

City of Tampa.. (2016). *Beyond Traffic: The Smart Tampa Vision*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/FL%20Tampa.pdf.

Cretan, R., Málovics, G., & Berki, B. M. (2020). On the perpetuation and contestation of racial stigma: urban Roma in a disadvantaged neighbourhood of Szeged. *Geographica Pannonica, 4*, 24.

Creţan, R., & O'Brien, T (2020). Corruption and conflagration:(in) justice and protest in Bucharest after the Colectiv fire. *Urban Geography, 41*(3), 368–388.

De Guimarães, J. C. F., Severo, E. A., Felix Júnior, L. A., Da Costa, W. P. L. B., & Salmoria, F. T. (2020). Governance and quality of life in smart cities: Towards sustainable development goals. *Journal of Cleaner Production, 253*, Article 119926. https://doi.org/10.1016/j.jclepro.2019.119926

de Oliveira Neto, J.o. S. (2018). *Inclusive Smart Cities: theory and tools to improve the experience of people with disabilities in urban spaces*. Université Paris-Saclay.

de Oliveira Neto, J. S., & Kofuji, S. T. (2016). *Inclusive smart city: an exploratory study. Paper presented at the International Conference on Universal Access in Human-Computer Interaction*.

Department of Urban Economics. (2019). *M. o. L., Infrastructure and Transport, South Korea*. Challenge to Smart City with Private Partnership. Retrieved from http://www.korea.kr/briefing/pressReleaseView.do?newsId=156313135.

Des Moines Area Metropolitan Planning Organization. (2016). *The City of Des Moines, & Des Moines Area Regional Transit Authority*. Preferred Sustainability Status City: Des Moines- Model Smart City Proposal.

District Department of Transportation.. (2016). *Smart DC: Making the District a Smart City*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/DC_0.pdf.

Equal Rights Center (ERC). (2017). *EQUAL RIGHTS CENTER FILES LAWSUIT AGAINST UBER FOR PROVIDING SERVICES THAT ARE INACCESSIBLE TO WHEELCHAIR RIDERS*. Retrieved from https://equalrightscenter.org/press-releases/equal-rights-center-files-lawsuit-uber-providing-services-inaccessible-wheelchair-riders/.

Fernandez-Anez, V., Fernández-Güell, J. M., & Giffinger, R. (2018). Smart City implementation and discourses: An integrated conceptual model. *The case of Vienna. Cities, 78*, 4–16.

Friese, S. (2019). *Qualitative data analysis with ATLAS. ti*. SAGE Publications Limited.

Goodman, N., Zwick, A., Spicer, Z., & Carlsen, N. (2020). Public engagement in smart city development: Lessons from communities in Canada's Smart City Challenge. *The Canadian Geographer/Le Géographe canadien, 64*(3), 416–432.

Haghighi, N. N., Liu, X. C., Wei, R., Li, W., & Shao, H. (2018). Using Twitter data for transit performance assessment: a framework for evaluating transit riders' opinions about quality of service. *Public Transport, 10*(2), 363–377.

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., & Williams, P. (2010). Foundations for Smarter Cities. *IBM Journal of Research and Development, 54*(4), 1–16. https://doi.org/10.1147/JRD.2010.2048257

Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City, 12*(3), 303–320.

Hornik, K., & Grün, B. (2011). topicmodels: An R package for fitting topic models. *Journal of statistical software, 40*(13), 1–30.

Hu, L., He, S., Luo, Y., Su, S., Xin, J., & Weng, M. (2020). A social-media-based approach to assessing the effectiveness of equitable housing policy in mitigating education accessibility induced social inequalities in Shanghai, China. *Land Use Policy, 94*, Article 104513.

Joss, S., Cook, M., & Dayot, Y. (2017). Smart cities: Towards a new citizenship regime? A discourse analysis of the British smart city standard. *Journal of Urban Technology, 24*(4), 29–49.

Kamel Boulos, M. N., Tsouros, A. D., & Holopainen, A. (2015). 'Social, innovative and smart cities are happy and resilient': insights from the WHO EURO 2014 International Healthy Cities Conference. *International Journal of Health Geographics, 14*(1), 3. https://doi.org/10.1186/1476-072x-14-3

Kaplan, S., Popoks, D., Prato, C. G., & Ceder, A. A. (2014). Using connectivity for measuring equity in transit provision. *Journal of Transport Geography, 37*, 82–92.
Komninos, N. (2016). Smart environments and smart growth: connecting innovation strategies and digital growth strategies. *International Journal of Knowledge-Based Development, 7*(3), 240–263.
Lee, J. Y., Woods, O., & Kong, L. (2020). Towards more inclusive smart cities: Reconciling the divergent realities of data and discourse at the margins. *Geography Compass, 14*(9), e12504.
Li, Z., Han, Z., Xin, J., Luo, X., Su, S., & Weng, M. (2019). Transit oriented development among metro station areas in Shanghai, China: Variations, typology, optimization and implications for land use planning. *Land Use Policy, 82*, 269–282.
Málovics, G., Creţan, R., Méreiné Berki, B., & Tóth, J. (2019). Urban Roma, segregation and place attachment in Szeged, Hungary. *Area, 51*(1), 72–83.
Matthews, K. (2019). *The Connection Between Smart City Infrastructure and Accessibility*. Retrieved from http://smartcityhub.com/collaborative-city/connection-smart-city-infrastructure-accessibility/.
Maxwell, L. (2018). *HOW TO ENSURE THAT YOUR SMART CITY STRATEGY IS INCLUSIVE Smart City Strategy: Facilitating successful urban transformation*. Retrieved from https://hub.beesmart.city/strategy/en/how-to-ensure-that-your-smart-city-strategy-is-inclusive.
Metro Atlanta Buford Highway Corridor Municipalities. (2016). *2016 USDOT SMART CITIES CHALLENGE: LINDY: History, made here*.
Metropolitan Government of Nashville and Davidson County. (2016). *"Nashville Connected: Music City's Smart Transportation Vision"*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/TN%20Nashville.pdf.
Morris, M. E., Adair, B., Ozanne, E., Kurowski, W., Miller, K. J., Pearce, A. J., & Said, C. M. (2014). Smart technologies to enhance social connectedness in older people who live at home. *Australasian Journal on Ageing, 33*(3), 142–152.
Nam, T., & Pardo, T. A. (2011). *Conceptualizing smart city with dimensions of technology, people, and institutions*. Paper presented at the Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times.
Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., & Scorrano, F. (2014). Current trends in Smart City initiatives: Some stylised facts. *Cities, 38*, 25–36.
New Orleans, L. (2016). *A new New Orleans: A Model for Innovative and Equitable Mobility*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/LA%20New%20Orleans.pdf.
Nichols, J. (2017). *Accessibility Lawsuits Target Local Government Websites in Georgia*. Retrieved from https://www.adpharos.com/2017/12/12/ada-lawsuits-target-websites-in-georgia/.
Nicula, A.-S., Boţan, C. N., Gligor, V., & Cociş, E.-A. (2020). Celebrating the Great Union through Smart Digital Solutions: Lessons from Alba Iulia. Romania. *Journal of Urban History*, Article 0096144220940713
Nikita, M., & Nikita, M. M. (2016). *Package 'ldatuning*. In.
Office of the Press Secretary, T. W. H. (2015). *FACT SHEET: Administration Announces New "Smart Cities" Initiative to Help Communities Tackle Local Challenges and Improve City Services*. Retrieved from https://obamawhitehouse.archives.gov/the-press-office/2015/09/14/fact-sheet-administration-announces-new-smart-cities-initiative-help.
Oklahoma City. (2016). *"Beyond Traffic: The Smart City Challenge": Smart Oklahoma City*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/OK%20Oklahoma%20City.pdf.
Pittsburgh, T. C.o. (2016). *Into the Future: Smart PGH*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/Pittsburgh-SCC-Technical-Application.pdf.
Portland Bureau of Transportation. (2016). *Beyond Traffic: The Smart City Challenge: Ubiquitous Mobility for Portland*. USDOT. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/Portland-SCC-Technical-Application.pdf.
Rebernik, N., Marušić, B. G., Bahillo, A., & Osaba, E. (2019). A 4-dimensional model and combined methodological approach to inclusive urban planning and design for all. *Sustainable Cities and Society, 44*, 195–214.
Rebernik, N., Osaba, E., Bahillo, A., & Montero, D. (2017). *A Vision of a Smart City Addressing the Needs of Disabled Citizens*. Paper presented at the Proceedings Accessibility 4.0, Conference PaperMalaga 27th.
San Francisco County Transportation Authority. (2018). *Emerging Mobility Evaluation Report- Evaluating Emerging Mobility Services and Technologies in San Francisco*. Retrieved from https://archive.sfcta.org/sites/default/files/Emerging%20Mobility%20Evaluation%20Report%2004242018.pdf.
San Francisco Municipal Transportation Agency. (2015). Meeting the Smart City Challenge.
Sasaki, M. (2010). Urban regeneration through cultural creativity and social inclusion: Rethinking creative city theory through a Japanese case study. *Cities, 27*, S3–S9.
Silva, B. N., Khan, M., & Han, K. (2018). Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. *Sustainable Cities and Society, 38*, 697–713.
Singru, R. N., & Lindfield, M. R. (2016). *Enabling Inclusive Cities: Tool Kit for Inclusive Urban Development*. In. Retrieved fromhttps://doi.org/10.22617/TIM157428 doi: 10.22617/TIM157428.
Smart Columbus.. (2021). *Providing Mobility Assistance to People With Cognitive Disabilities*. Retrieved from https://smart.columbus.gov/playbook-assets/mobility-assistance-for-people-with-cognitive-disabilities/providing-mobility-assistance-to-people-with-cognitive-disabilities#playbook-resources.
Steinfeld, E., & Maisel, J. (2012). *Universal design: Creating inclusive environments*. John Wiley & Sons.
Su, S., Pi, J., Xie, H., Cai, Z., & Weng, M. (2017). Community deprivation, walkability, and public health: Highlighting the social inequalities in land use planning for health promotion. *Land Use Policy, 67*, 315–326.
Su, S., Zhou, H., Xu, M., Ru, H., Wang, W., & Weng, M. (2019). Auditing street walkability and associated social inequalities for planning implications. *Journal of Transport Geography, 74*, 62–76.
The City and County of Denver. (2016). *BEYOND TRAFFIC: DENVER, THE SMART CITY CHALLENGE*. Retrieved from.
The City of Columbus. (2016). *BEYOND TRAFFIC: The Smart City Challenge, PHASE 2*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/Columbus-SCC-Technical-Application.pdf.
The City of Fremont. (2016). *Beyond Traffic: Smart City Challenge: The Fremont Smart City Challenge proposal*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/CA%20Fremont.pdf.
The United States Conference of Mayors, & IHS Markit. (2018). *US City Decision Maker Survey – A Collaborative project run by IHS Markit and the US Conference of Mayors US Smart Cities - 2018*. Retrieved from http://www.usmayors.org/wp-content/uploads/2018/06/2018-Smart-Cities-Report.pdf.
Tucson,T. C. o.. (2016). *Tucson Smart City Demonstration Proposal Part 1: Vision Narrative*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/AZ%20Tucson.pdf.
U.S. Department of Transportation.. (2015). *Beyond Traffic: The Smart City Challenge Notice of Funding Opportunity*. Retrieved from https://cms.dot.gov/sites/dot.gov/.../NOFO-BeyondTraffic-SmartCityChallenge.docx.
U.S. Department of Transportation.. (2016). *Smart City Challenge Lessons Learned*. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/Smart%20City%20Challenge%20Lessons%20Learned.pdf.
Woyke, E. (2019). *Smart cities could be lousy to live in if you have a disability*. Retrieved from https://www.technologyreview.com/s/612712/smart-cities-coule-be-lousy-if-you-have-a-disability/.
Zahedi, K., & Reyes, M. S. C. (2018). *Asean smart cities – do not forget the disabled*. Retrieved from https://www.unescap.org/op-ed/asean-smart-cities-do-not-forget-disabled.
Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). Internet of Things for Smart Cities. *IEEE Internet of Things Journal, 1*(1), 22–32. https://doi.org/10.1109/JIOT.2014.2306328