

1 Article

## 2 ‘Smart’ Tools for Socially-sustainable Transport

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7

8 **Abstract:** In the smart city, information and communications technologies (ICTs) are proposed as  
9 solutions to urban challenges, including sustainability concerns. While sustainability commonly  
10 refers to economic and environmental dimensions, the concept also contains a social component.  
11 Our study asked how smartphone applications (apps) address social sustainability challenges in  
12 urban transport, if at all. We focused on transport disadvantages experienced due to low income,  
13 physical disability, and language barriers. A review of 60 apps showed that transport apps respond  
14 to these equity and inclusion issues in two ways: (a) by employing universal design in general-use  
15 apps; including cost-conscious features; and providing language options (b) by specifically  
16 developing smartphone apps for persons with disabilities. The article discusses the study by  
17 positioning it in the literature of smart cities as well as socially sustainable transport.

18 **Keywords:** Smart transport tools; ‘smart’ and sustainable; social-sustainability

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### 20 1. Introduction

21 One of the primary concerns for urban areas in the 21st century is sustainability in using  
22 resources and in maintaining environmentally-conscious approaches to urban development. While  
23 not explicitly under the umbrella of sustainability, cities attempt to address issues of equity and  
24 inclusion as well. In the advent of the smart city<sup>1</sup> and its potential in solving urban problems,  
25 specifically in encouraging efficiencies in urban infrastructure and services, cities have been  
26 increasingly incorporating ‘smart’ technologies in their quest for sustainability. The important  
27 junction of smart technologies and sustainability has not been missed in the academic literature where  
28 the current debate explores the relationship between information and communications technologies  
29 and the concept of sustainability [1,2].

30 In his seminal work on smart cities, Townsend [3] highlighted that the application of information  
31 technologies has proliferated urban transportation systems more than other urban planning  
32 subfields. The use of smart city technologies in transportation systems includes smartphone  
33 applications (app) for various purposes ranging from real-time transit information, measurement of  
34 carbon dioxide emission, information about low-cost travel options, navigation information for  
35 people with accessibility needs, and many more.

36 In the academic debate, smart cities are criticized for their focus on the economic and  
37 environmental dimensions of sustainability while disregarding social dimensions e.g. [4]. In addition,  
38 our review of literature, indicated that in the academic discourse, the joint mention of smart city and  
39 social sustainability (equity) was not significant. This can partly be explained through the evolution  
40 of sustainability from an environmental concern and its historic focus on the economy and  
41 environment. To gain a better understanding of the reality outside the academic literature regarding

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<sup>1</sup> “Places where information technology is combined with infrastructure, architecture and everyday objects, and even our bodies to address social, economic, and environmental problems” (Townsend, 2013, p.9).

42 the application of smart technologies to social sustainability, we conducted a survey of 60 smartphone  
43 transport apps to assess the features they offer in light of equity and inclusion. We share the findings  
44 in this paper.

45 The paper first provides a background on sustainability and sustainable planning based on the  
46 definition in the 1987 *Brundtland Report*, highlighting the lack of clarity in the definition and in the  
47 meaning of social sustainability. The next section examines urban sustainability and transport equity  
48 and inclusion by delving into what constitutes sustainable transport and the impact of transport in  
49 shaping communities. Planners and citizens alike are looking to smart technologies as one of the tools  
50 for solving urban challenges. The concept of smart technologies is introduced following that and it  
51 focuses on what role they play, if any, in socially-sustainable transport. The findings from academic  
52 literature on their role is contrasted with the findings of our study, which we discuss in depth  
53 including the method of investigation and data collection used.

54 The overarching goal of the study is to contribute to research work at the intersection of socially-  
55 sustainable transport and technology. One of the objectives of the paper is to bring forth issues of  
56 social sustainability in the 'smart' discourse. In discussing the social aspect of sustainability in relation  
57 to an emerging technology, this paper will contribute to breaking the historical persistence of the  
58 focus of sustainability on the environment and economy only. The paper will also raise questions of  
59 equity and inclusion in urban transport and paint a realistic picture of the potential and limitations  
60 of smart technologies in contributing to these issues.

## 61 2. Sustainability and Sustainable Planning

62 Discourse on the topic of sustainability often references the vagueness of the concept and  
63 includes the frequently cited definition of the term put forth in 1987 by the *Brundtland Report*, entitled  
64 Our Common Future [5]. According to the report, "sustainable development is development that  
65 meets the needs of the present without compromising the ability of future generations to meet their  
66 own needs" [6] (p. 291). It is widely accepted in the literature about sustainability that the "needs"  
67 mentioned in the report are threefold: economic, ecological, and social [7,8] while [9] list four "needs":  
68 cultural, political, ecological, and economic. Social is a broad concept that includes both culture and  
69 politics; as such, the discussion in this paper will reference to the three needs, commonly referred as  
70 the 3Es (economy, environment, and equity).

71 The definition in the *Brundtland Report* has been adopted across various fields. It is especially  
72 relevant in urban planning; as [5] said, "Sustainability and planning have much in common." (P. 507).  
73 Sustainability has three aspects, namely economic, environmental, and social; so does urban planning  
74 according to [10, 11]. Moreover, planning and sustainable development are both future-oriented  
75 practices. Planning is inherently a sustainable practice in that it is a balancing act of competing needs,  
76 including that of future generations, which sustainable development stands to protect. Sustainable  
77 policies should include the preservation, maintenance and strengthening of all communities and their  
78 overall quality of life through a variety of community services and infrastructures. The three Es of  
79 sustainability are prosperous economy, quality environment, and social equity. The ethical principle  
80 of equity, particularly intergenerational equity, is central to the concept of sustainability.

81 The definition of sustainability in the *Brundtland Report*, despite creating the basis of most  
82 discussions on sustainability, is vague, an attribute that has made it open to various interpretations.  
83 We concur with [9] that there is a lack of precision in understanding exactly what sustainability is.  
84 This is problematic because misunderstanding the concept may lead to using ineffectual and incorrect  
85 methods which in turn may result in an inability to achieve the desired outcome. Unfortunately, the  
86 lack of precision also extended into the varying degree of attention the three "needs" receive, with  
87 the environment being at the top of the list. Partly this has to do with the evolving concept of  
88 sustainability in public policy. [5] said it originated and extended from environmental sciences.  
89 Similarly, [7] pointed out that the precedent to the *Brundtland Report* in sustainability research was  
90 the 1972 United Nations Conference on the Human Environment. In that conference, the organization  
91 decided that it was important to protect the environment for the well-being and economic prosperity  
92 of human beings. It sounded a warning alarm that the world had come to a juncture where

93 environmental consequences of human actions could not be ignored anymore. It also laid out  
94 principles, action plan for implementation, recommendations, financial arrangements, and a  
95 multitude of miscellaneous resolutions to protect the environment. Partly as a result, the environment  
96 receives considerably more attention in the sustainability discourse. While such is the case, [12] said  
97 economic and social dimensions of sustainability are acknowledged but there is neither consensus  
98 nor clarity regarding the meaning of social sustainability. [13] agree with the lack of clarity in the  
99 meaning.

100 When the concept of sustainability is examined in the context of cities, the same emphasis on the  
101 economy and environment is observed. [7] said "Most of the definitions [of urban sustainability] are  
102 derivations from those of sustainability" (p. 1178). Similarly to sustainability, the concept of  
103 sustainable cities evolved from concerns that are mostly environmental [14] and from an interest to  
104 reduce the effects of climate change and urbanization [15]. While cities address equity and inclusion  
105 concerns through various avenues, (a) they do not address them as the social dimensions of  
106 sustainability or (b) they do not receive the same degree of attention as the economy and  
107 environment.

108 Consistent in various perspectives on cities is that they play a part in creating sustainability [8,  
109 7, 9, 16, 17, 18]. Ensuring urban sustainability (which is the focus of our paper) then becomes of utmost  
110 importance. According to the European Environment Agency, one of the five goals that creates urban  
111 sustainability is "ensuring equal access to resources and services" [19]. This entails the provision of  
112 services and infrastructures to all members of the community, ensuring a level of affordability and  
113 access to service and removing barriers to service.

### 114 3. Social Sustainability in Urban Transport

115 While economic growth remains essential, development must not only meet present concerns  
116 for growth, it must do so in a context that includes the long term safeguarding of social and  
117 environmental resources. Sustainability policies should include the preservation, maintenance and  
118 strengthening of all communities and their overall quality of life through a variety of services and  
119 infrastructures. This will require significant changes in planning, lifestyles, population growth, and  
120 especially in technology. Overall, the concept of social sustainability can be defined according to two  
121 points:

- 122 • **Intergenerational equity:** the success of cities of the future will largely depend upon the legacy  
123 on current cities on resources and the environment. Capital assets passed on to the next  
124 generation must be at least of equal value.
- 125 • **Social equity:** implies a fair and equitable distribution of resources among the current  
126 generation. In terms of the built environment, the metropolitan area should provide a place of  
127 equal opportunity and not be an agent of segregation.

128 Plans for urban sustainability generally address transportation, housing, and employment and  
129 their effects on air quality, energy use, economic prosperity, and social equity. Recommended policies  
130 often include transit-oriented development; mixed-use developments; urban infill; brownfields  
131 redevelopment; more public transit use; active transportation; and better transportation information.  
132 This paper specifically examines social sustainability in transportation systems as they have far-  
133 reaching effects in social and economic opportunities, i.e. employment and prosperity, health and  
134 wellbeing, education, and access to information.

135 Transportation mobility is a hallmark of full membership in American society. The basic concept  
136 behind "sustainable transport" is to make transportation, land use, and resource decisions in a  
137 manner that does not preclude transportation options for current or future generations or any  
138 segment of populations. This is an initiative that broadens the scope of transportation decisions so  
139 that economic, environmental quality, and social equity considerations are balanced in the short and  
140 long term [20]. At the national policy level, the concept of sustainability including its applicability to  
141 communities, transportation, and the environment is quickly emerging as a key issue. As mentioned,  
142 sustainability is a frequently used concept whose exact meaning is not well established. An oft-quoted  
143 definition cited previously reads: "a sustainable condition for this planet is one in which there is

144 stability for both social and physical systems, achieved through meeting the needs of the present  
145 without compromising the ability of future generations to meet their own needs" [6] (p.41). However,  
146 this definition is difficult to express in objective terms, and there is no consensus on the specific  
147 policies that flow from it. Nevertheless, many advocates have determined that promoting a  
148 sustainable environment and sustainable communities is a key objective. Though its definition may  
149 vary from place to place, a sustainable transport system is one that:

- 150 • Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant  
151 economy
- 152 • Is inclusive and provides options for persons of various abilities, financial as well as linguistic  
153 capabilities
- 154 • Saves in travel costs
- 155 • Ensures opportunities for meaningful public involvement in the transportation planning  
156 process, particularly for those communities that most directly feel the impact of projects or  
157 funding choices
- 158 • Distributes the benefits and burdens from transportation projects equally across all income levels  
159 and communities
- 160 • Provide high quality services—emphasizing access to economic opportunity and basic  
161 mobility—to all communities, but with an emphasis on transit-dependent populations
- 162 • Equally prioritize efforts both to revitalize poor and minority communities and to expand  
163 transportation infrastructure

164 Across the country, community-based organizations and low-income and minority residents that  
165 seek to improve their communities are recognizing the significant role played by transportation in  
166 shaping local opportunities. Efforts to challenge inequitable transport policies have become  
167 increasingly sophisticated to encompass a broad range of related social impacts. In the advent of the  
168 smart city, urban planners, governments, and citizens consider 'smart' solutions promising for solving  
169 urban challenges, including urban transport. Among these include incorporating ICTs to expand and  
170 increase participation in the planning process [21].

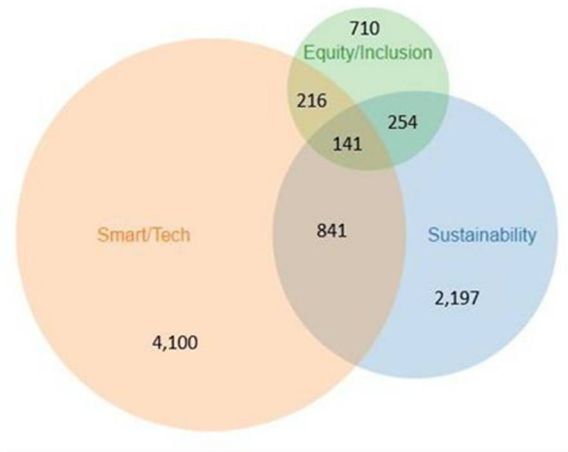
171 Rapid changes in technology and changing patterns in travel behavior are having significant  
172 impacts on urban transportation mobility. Because the ease of movement within and between urban  
173 places is a critical element of social, economic, and environmental vitality, the evolution of complex  
174 systems for moving people, goods, and information is the focus of considerable global attention.  
175 Modal options in the future will be different from those we experience today, perhaps in unexpected  
176 ways. Cities will seek to implement "intelligent", "smart", and "sustainable" practices as they plan  
177 for and analyze the mobility needs of their populations. In the process, these practices will shape and  
178 reshape urban landscapes. History has shown that each era of transportation innovation has also  
179 coincided with cultural shifts. An interesting question is how or whether culture prompts  
180 technological change, especially relative to the "smart city" movement.

#### 181 **4. Smart and Sustainable**

182 According to [3], the intent of smart cities, which he defines "as places where information  
183 technology is combined with infrastructure, architecture and everyday objects, and even our bodies"  
184 (p.9) is to solve problems of the economy, environment, and those of social nature. In that, the author  
185 implied that the purpose of smart cities is inherently to attain sustainability by addressing its three  
186 dimensions. A slightly different sentiment is reflected by [4] who highlights that the 'smart' concept  
187 merely encourages sustainable practices in the three dimensions of sustainability. However, the  
188 author argued that regardless of the technological affordances to advance sustainable practices in all  
189 dimensions, socially sustainable considerations are not optimized by the smart city. Similarly, [22]  
190 state that one of the challenges smart cities face is in developing technologies that work in the interest  
191 of fairness and equity. This reflects that the introduction of 'smart' in sustainability has followed the  
192 historical focus on the environment and economy.

193 The integration of ICTs and sustainability is gaining traction as a topic of discussion in the  
194 academic debate [2]. We found in our study that there is still less focus in the academic debate for

195 smart solutions that create social sustainability. We examined approximately 90 sources on topics of  
 196 smart cities and technology, sustainability, and equity and inclusion. There are certainly substantial  
 197 bodies of literature on sustainability, social equity, and smart cities. We focused on recent sources  
 198 that would be more likely to draw together these themes or at least include each as components of  
 199 contemporary urban discourse. A keyword search of the selected documents resulted in 4,100  
 200 mentions of “smart” or “technology”; 2,197 mentions of “sustainability”; and 710 mentions of  
 201 “equity” or “inclusion”. This allowed us to get a general sense of topics being discussed by each, but  
 202 we did not examine each of these 7,007 keyword mentions for context. The keyword search did allow  
 203 us to identify documents that potentially included the three topics of interest (see Figure 1 – Venn  
 204 diagram of topics/keywords).



205

206 **Figure 1.** Document analysis and keyword co-mentions (note: numbers show frequency of  
 207 (co)mentions)

208 The keyword scan resulted in 20 documents that along with sustainability and smart cities (or  
 209 technology) also mentioned equity or inclusion. As shown in Figure 1, there were a small number of  
 210 mentions of equity or inclusion related to smart cities or sustainability. It is interesting to note in these  
 211 cases how equity was being connected to sustainability and also to technological aspects of cities (i.e.,  
 212 smart cities). There are many perspectives, applications, and implications of the concept of equity.  
 213 Among those included equity as part of the planning process, as inputs and also as outcomes. Several  
 214 authors acknowledged that social exclusion and inequity are critical problems to be addressed (e.g.,  
 215 Newton, 2012). Technologies as part of “smart cities,” are sometimes seen as having the potential to  
 216 increase citizen engagement (Allwinkle and Cruickshank 2011, Angelidou 2014) and having the  
 217 potential to increase citizen engagement (Angelidou 2014, Redman 2014, Basiri et al 2016). These  
 218 notions are common among planners who see information and communications technologies as  
 219 removing barriers from government and public interaction and information exchange.

220 Overall, the joint mentions of sustainability, technology, and equity fell into six general  
 221 categories. These include citizen engagement, citizen involvement in governance and planning  
 222 process, digital divide/digital inclusion, detecting inequality and disadvantage, human and social  
 223 capital, and general critiques about the ineffectiveness of technology in addressing social inequity.  
 224 There is a notable void in the literature that explores the junction of technology and social  
 225 sustainability.

## 226 5. ‘Smart’ Beyond the 2Es?

227 The academic literature suggests that smart city technologies have not explored the social aspect  
 228 of sustainability to address urban challenges as discussed previously. To compare that with the  
 229 reality outside of it, we designed a study to examine the application of information and  
 230 communications technology (‘smart’ tools) in addressing a social dimension of sustainability in  
 231 transport. In our Section 3 we provide a list of what constitutes sustainable transport. For the purpose  
 232 of the study, we focus on three issues in the list: affordability, access to transport for people of varying

233 body abilities and language proficiency. We selected smartphone apps as the smart mobility tool of  
234 choice for this study as they have become ubiquitous in various aspects of urban living, with a high  
235 presence in transport-related functions.

236 Smartphone apps are “software programs for mobile device operating systems ...” (Ahmad,  
237 Brauer-Rieke, & Newland, 2012, p.1). The use of smartphone apps for daily urban living is growing  
238 rapidly. In 2015, out of the 77% Americans who owned smartphones, 68% of them used apps, with  
239 38% using 20 or more apps and 7% using 50 or more apps (Olmstead & Atkinson, 2015). The app  
240 technology notably enables the shared economy through platforms such as Uber, Airbnb; providing  
241 social connectivity - Facebook, Twitter; assisting navigation and travel - Waze, Google Maps; and  
242 providing essential assistive information for visually impaired persons - BlindWays, BlindSquare;  
243 and so on. The industry is also growing fast. According to the University of Alabama at Birmingham  
244 (2017), by 2017 the app market will be a \$77 billion industry worldwide, with more than 268 billion  
245 app downloads. It is also estimated to have employed 1.729 million by December 2016 (Mandel, 2017).  
246 In the study, we asked: What role do ICTs play, if at all, in making urban transport socially  
247 sustainable, i.e. equitable and inclusive in relation to cost, disability, and language barriers? To  
248 investigate the state-of-the-art, we examined 60 smartphone transport apps.

## 249 6. Data Collection and Research Method

250 We collected data by replicating Google searches that people conduct to look for apps, and used  
251 the following keywords: transport apps, ridesharing apps, ridesharing services, carpooling apps,  
252 transport apps for people with disability, transport app for the visually impaired, transport apps for  
253 wheelchair users, transport app for low-income earners. Using terms such as transport apps,  
254 ridesharing apps, ridesharing services, carpooling apps, resulted in enough apps for our collection  
255 on the first pages of each Google search. However, when using terms like transport apps for people  
256 with disability, transport app for the visually impaired, transport apps for wheelchair users, transport  
257 app for low-income earners, we included the first, second, and third pages of the Google search  
258 results.

259 Our initial search resulted in a list of approximately 90 apps. We looked for these apps in the  
260 Apple Store and Google Play (initially depending on which one appeared first, but mostly on Apple  
261 for consistency and information on language options). Further exploration indicated that some of  
262 them were not available and did not have official websites, for example RideScout, Hopstop, and  
263 Way2ride. For some apps, we found media accounts that reported they no longer exist. With other  
264 apps, we identified that they were not exclusively for transport purposes but have a component of it.  
265 These include Looptivity and GoKid. We excluded AccessMap, Ridershare, and Kangaride as they  
266 are not smartphone apps but web-based platforms. This processes reduced the number of apps in our  
267 list to 60.

268 A content analysis was conducted on the descriptions of apps found on their respective official  
269 download pages from the Apple store, Google Play, and official websites. This research method was  
270 used for the following reasons: convenience to access websites at any time, accuracy of information  
271 regarding the apps' features, and efficiency in time used to gather data. We identified sample size (60  
272 apps) to be a limitation of our data. The limitation in our research method is that we did not verify  
273 the functionality of the apps' features with users to compare with the official descriptions of the apps.  
274 In addition, in focusing on the official website descriptions of apps, the study might have missed app  
275 features not described there. The next phase of research will include interviews with app developers,  
276 app users, cities, and transport agencies to gather more data.

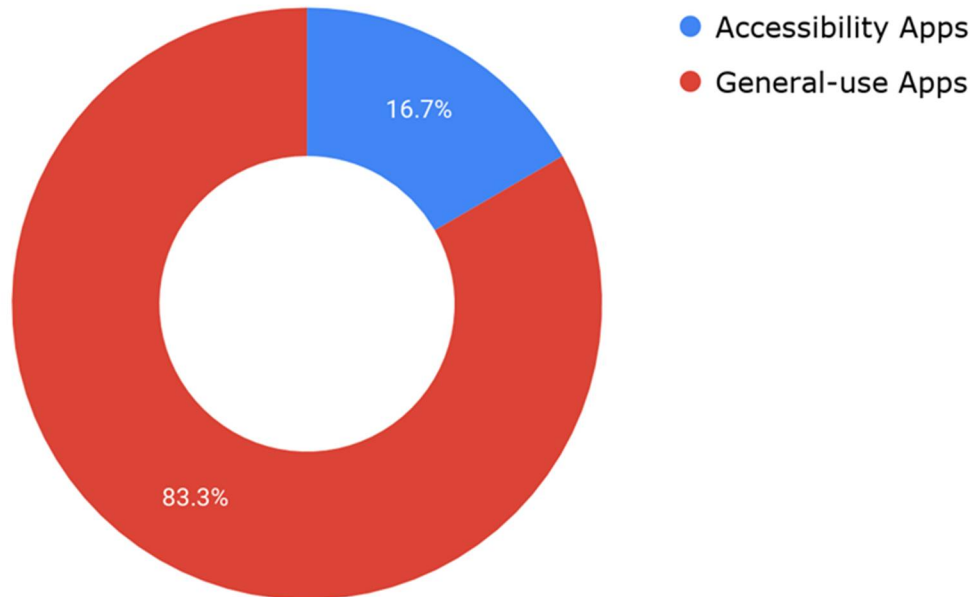
277 The data used for this study constitutes a list of apps for public transport, car sharing, carpooling,  
278 cycling, and walking. Most of the apps examined were for short, urban travel while a few of them  
279 were for longer-distance. Apps that have some component of travel such as Looptivity, Cozi, Carpool  
280 Party, and Carpooler were excluded in order to maintain consistency of the type of apps and the  
281 features for which they were assessed.

282 Our research question asked how smart tools respond to social sustainability concerns resulting  
283 from low-income and physical and financial barriers. To assess the apps for inclusivity and

284 equitability, we looked for references of cost, wheelchair accessibility, accessibility to vision  
285 impairment, and availability of language options in the description of the apps. Terms used included  
286 save money, wheelchair accessible, share cost, accessibility feature for blind users, split cost, and so  
287 on.

## 288 7. Findings and Discussion

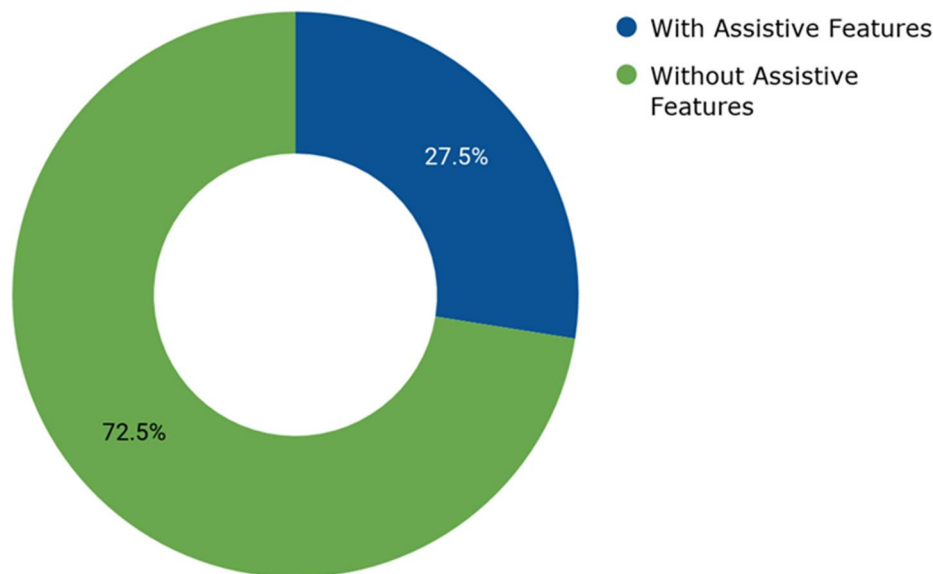
289 Based on the approach described above, our analysis produced the following findings.



290

291 **Figure 2:** Out of the 60 apps reviewed, 16.7% of them were accessibility apps and 83.3% of were  
292 general-use

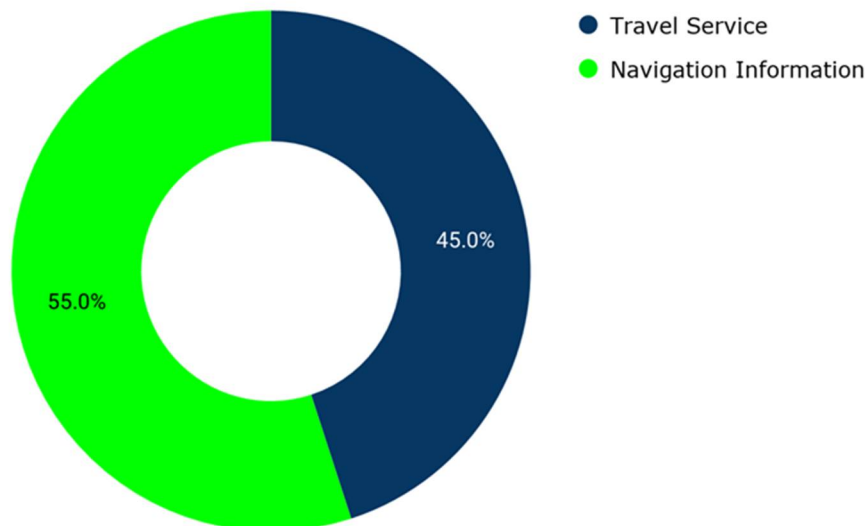
293 Google searches using generic terms like “transport apps” listed more on the first search page of  
294 results than using specific terms like “transport apps for the visually impaired”. This indicates the  
295 proportion of apps for general use compared to those that encourage social sustainability in transport.  
296 This was not unexpected considering the fact that populations with transport disadvantage due to  
297 limited physical ability and language barriers are a minority and represent a smaller market for app  
298 developers. In the US, nearly 20% of the population have some form of disability (US Census Bureau,  
299 2012).



300

301 **Figure 3:** Percentage of general-use apps with and without assistive features

302 The apps we examined fall into two different categories in terms of the type of function they  
 303 provide. In the first category the apps aggregate travel-related information to assist with navigation.  
 304 Examples in this category include Google Maps, Bus Checker, Waze, and BlindSquare. The second  
 305 category of apps enables travel service through car rental (e.g. Car2Go) or ridesharing services (e.g.  
 306 Uber, Carma, Curb). Figure 4: Type of provision in all apps



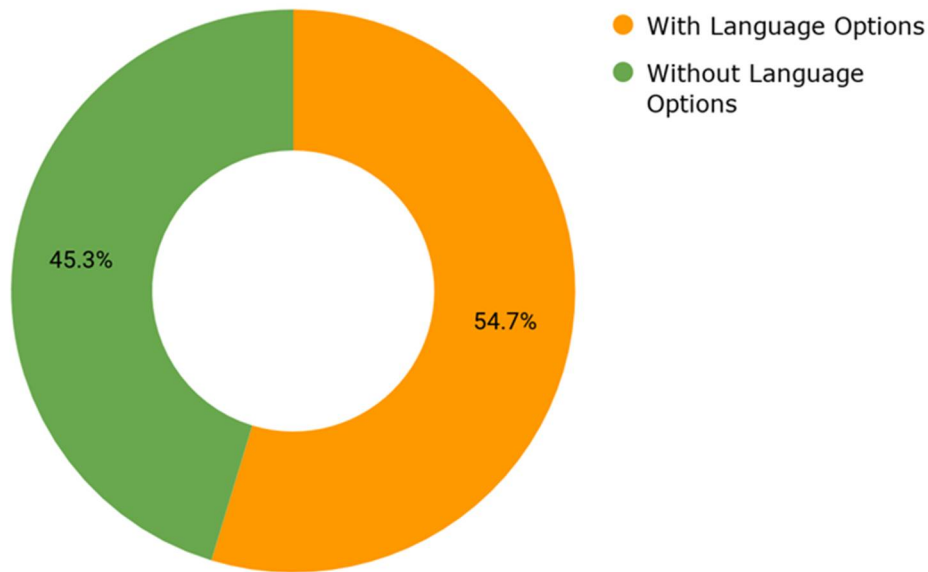
307

308 **Figure 4:** Type of provision in all apps

309 Another finding is that apps serve two different users: the general public and those that require  
 310 special needs. The former group makes up most of the listed apps in our data and the later constitutes  
 311 a quarter of the list. Out of the 60 apps examined, 18% of them were developed specifically for  
 312 accessibility needs - for persons with limited mobility or visual impairment. Out of the 53 general-  
 313 use apps, 21% included information about wheelchair accessibility or voice options for navigation.  
 314 Language option was offered by 62%, varying from two to over fifteen language options and  
 315 seventeen percent (17%) mentioned cost-conscious features. In other words, the apps responded to  
 316 social sustainability in transport in two ways: (a) by employing universal design in general-use apps,



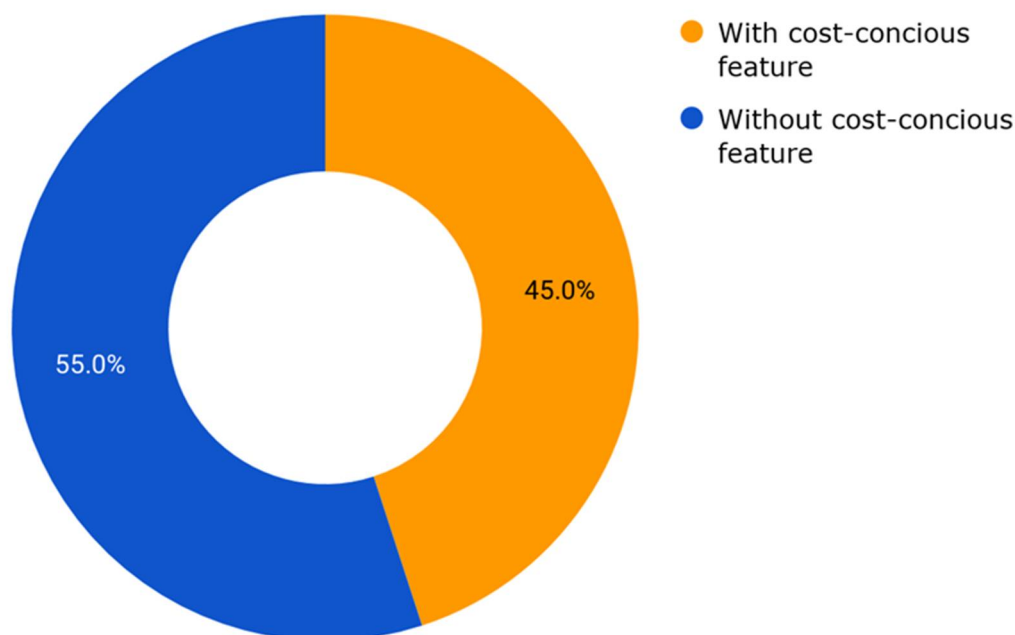
317 including cost-conscious features, and providing language options (b) by specifically developing  
 318 smartphone apps for persons with disabilities.



319

320 **Figure 5:** Language option in all 60 apps

321 Our finding that some of the most used general-use apps such as Waze, Uber, Google Maps are  
 322 incorporating accessibility features indicates two things. That accessibility is a consideration for  
 323 smartphone app developers and that ICTs can be used for socially sustainable practice in transport.  
 324 Apps such as Waze are used by millions in many countries around the world and as such provide  
 325 service in various languages. As a result, their language options address potential barriers in  
 326 communities that are linguistically diverse. Some of the apps provide features that enable cost-  
 327 sharing or cost-splitting indicating the technology's ability to respond to transport disadvantages that  
 328 result from financial barriers.

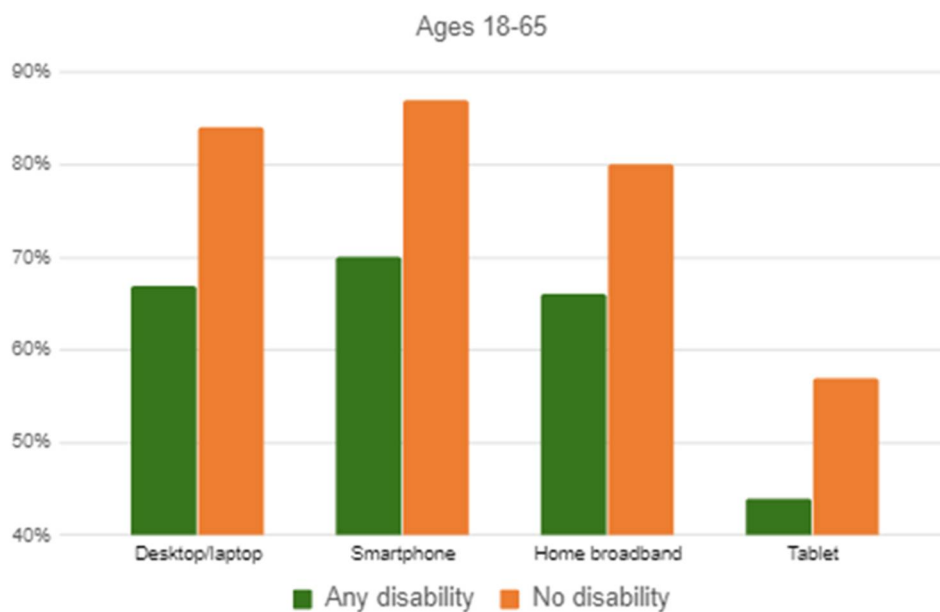


329

330 **Figure 6:** Apps with and without cost-conscious features

## 331 8. Smart Tools, a Panacea?

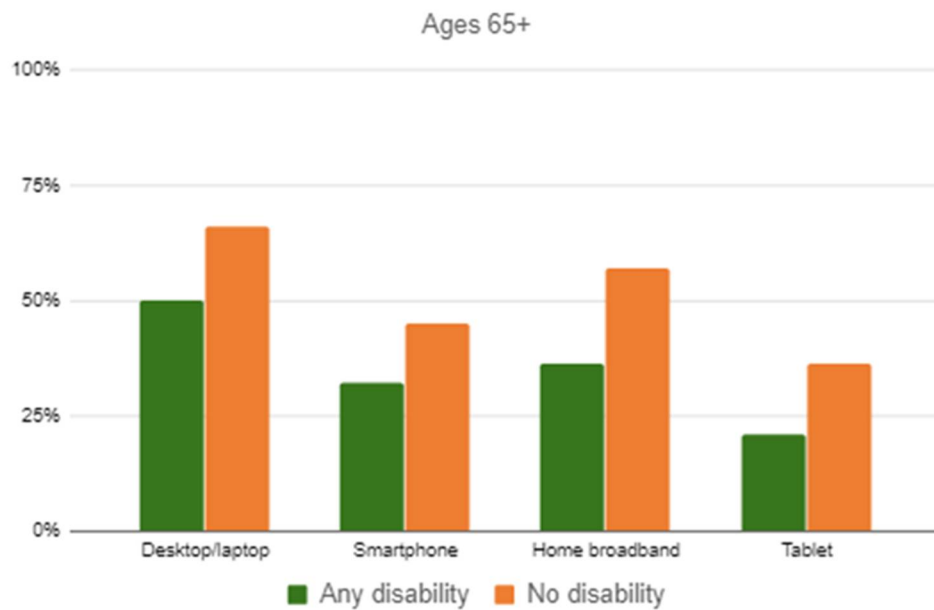
332 In a report entitled, *Technological Innovations in Transportation for People with Disabilities*, the  
 333 Federal Highway Administration (FHA) stated, “Technological advancements could help to  
 334 empower people with disabilities by addressing their mobility needs, but the benefits of such  
 335 advancement have not yet reached this segment of the traveling public” (FHA, 2011). The same  
 336 demographic that can benefit from the technology have barriers to accessing it. Smart technologies  
 337 have the ability to remedy digital divide but they might create other forms of polarization (Batty,  
 338 2012). A Pew report published recently highlighted the pronounced difference in smartphone  
 339 ownership based on education, age, and income (Anderson, 2017). (See figure 7,8, and 9 below  
 340 adopted from Anderson, 2017, Anderson & Perrin, 2017 (a); Anderson & Perrin, 2017 (b)).



341

342 **Figure 7:** Technology usage and body ability for ages under 65

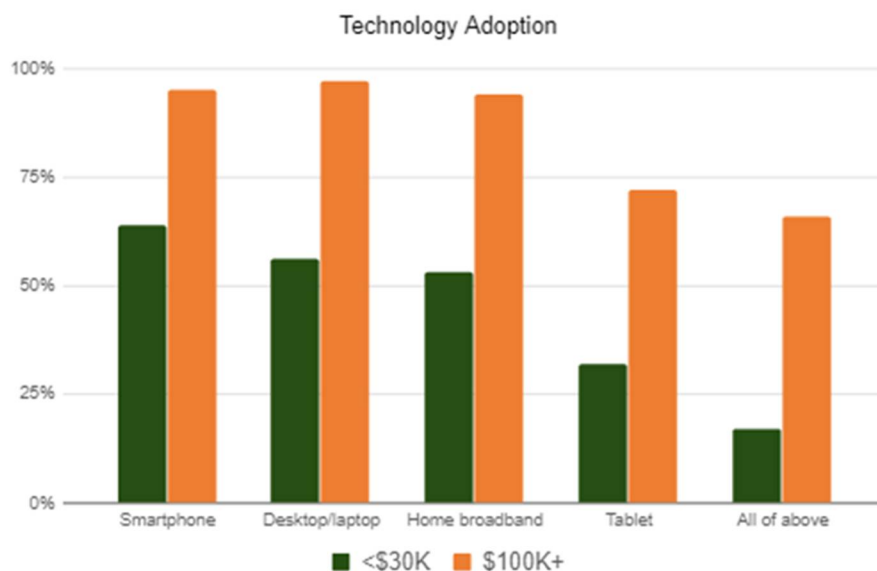
343 Figures 7 and 8 illustrate the consistent gap in technology adoption between those with  
 344 disabilities and those without. As might be expected, the 18 to 65 age group has adopted technologies  
 345 like computers, broadband, laptops, and tablets more rapidly than has the 65+ age group. It is  
 346 interesting to note that between these age groups, the adoption gap by disability status is fairly similar  
 347 averaging 15-16 percentage points. Also as expected, there is a significant adoption gap by income  
 348 level (see Figure 7). For the technologies shown, the gap is between 30 and 40 percentage points, with  
 349 an overall difference of almost 50 percentage points. A digital divide clearly present and looks to  
 350 particularly disadvantage those with disabilities.



351

352 **Figure 8:** Technology usage and body ability for ages under 65

353 As shown in the above statistics, seniors, persons with disability, and low-income earners have  
 354 a lower rate of adopting technology in general and smartphones in particular than their peers in other  
 355 demographics. Developing technologies that consider equity and quality of life equally is challenging  
 356 for those who create them (Batty, 2012). The challenge faced by users can be due to inequity in access  
 357 to technology or a technology that address equity issues.



358

359 **Figure 8:** Technology usage and body ability for ages under 65

360 The objective of our study was to gain a better understanding of the application of smart tools  
 361 for the purpose of socially-sustainable transport. While our list of apps was not exhaustive, the  
 362 findings of our study indicate that smart technology has the potential to address equity and inclusion  
 363 issues and play a role in creating social sustainability in urban transport. However, this is not to imply  
 364 that technology is a panacea for equity issues; rather it is one of the tools that can be used to address

365 them. In addition, regardless of the technological capabilities, socio-economic factors affect  
366 technology use. As discussed previously access to emerging technologies affects the same  
367 demographics whose transport disadvantage could be alleviated using advancement in ICTs. To fully  
368 optimize the technology's potential, these socio-economic factors need to be addressed. In other  
369 words, it is important to recognize that the ability of smart city technologies to play a part in  
370 contributing to sustainability is dependent on other socio economic factors. Batty (2012) said, "New  
371 technologies have a tendency to polarize and divide at many levels and we need to explore how new  
372 forms of regulation at the level of urban and transport planning, and economic and community  
373 development can be improved using future and emerging technologies"(p. 481). One way, he said,  
374 this can be accomplished is by balancing efficiency and equity.

## 375 **9. Further Research**

376 In this study, we examined equity and inclusion issues by focusing on cost, physical, and  
377 language barriers. We recognize that transport exclusion occurs as a result of other factors such as  
378 various forms of disabilities, race, gender (safety issues for women), level of literacy (specifically, in  
379 immigrant communities from countries with high illiteracy level), localities, and neighborhoods. The  
380 next phase of our study will exclusively focus on disability and explore the issue in depth. We will  
381 pay attention to development of new apps and assess their applicability to persons with disabilities.  
382 The Americans with Disabilities Act plays a role in accessible transit; our study will examine its role  
383 in regulating transport apps in general and those associated with travel service such as Uber, Lyft,  
384 Via, and others in particular. As one of the emerging information and communications technologies,  
385 transport apps have a communications aspect. Our study will examine the role of the Federal  
386 Communications Commission in relation to their regulation.

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