Inclusive Smart City: An Exploratory Study

João Soares de Oliveira Neto[1(✉)] and Sergio Takeo Kofuji[2]

[1] Department of Technological and Exact Sciences (CETEC),
University of Recôncavo da Bahia (UFRB),
Av. Rui Barbosa, 710, Cruz das Almas, BA zip 44380-000, Brazil
jneto@ufrb.edu.br
[2] LSI - School of Engineering/Escola Politécnica, University of São Paulo,
Av. Prof. Luciano Gualberto, 380 – Butantã,
São Paulo, SP zip 05508-010, Brazil
kofuji@usp.br

Abstract. Smart City Projects are getting more and more attention from the academy, industry and government in a global scale. We investigate some problems People with Disabilities (PwD) face in the urban space; we also observed some improvements that assistive technology should have in order to assure autonomy and independency to each and every citizen. We walked along 1 km in the downtown area of São Paulo taking pictures and recorded a range of difficulties that impaired persons, elderly people, pregnant women and so forth can have while trying to orient themselves in metropolises. The results of this observation are the principles of a broader view of Smart Cities: Inclusive Smart Cities.

Keywords: Inclusive smart cities · Accessibility · Assistive technology · Smart cities · People with disabilities

1 Introduction

Technology has been strongly perceived as a key element in the daily life of contemporary cities. In recent years, municipalities have invested in Information and Communication Technologies (ICT) solutions in order to increase the efficiency and productivity of several local services/systems – such as transport, communication, water, business, city governance and others [1]. The offer of such services has transformed the way people interact with each other, with institutions and with the public space – namely, the city.

After the rise of several Smart City initiatives in different parts of the globe [2–5], the central point of this kind of initiatives has progressively changed to considering the role that citizens must play in a Smart City. Even considering this new approach, it is rare to find academic research and industry products that deal with accessibility issues, as is the employment of Information and Communication Technologies (ICT) to help persons with disabilities in the urban space. To be considered "smart", a city must reinforce the participations of everyone recognizing the diversity of citizens, struggle against the segregation of minorities, and try, as much as possible, to eliminate, not only physical but also digital, barriers. That is what we call Inclusive Smart City.

M. Antona and C. Stephanidis (Eds.): UAHCI 2016, Part II, LNCS 9738, pp. 456–465, 2016.
DOI: 10.1007/978-3-319-40244-4_44

This is an exploratory study on the challenges that people with disabilities face when they need to interact with the urban space and on how universal access and technology and can help them to move safely through and to better explore the city. Our main objectives are: (i) observing the urban space looking for opportunities make the urban space decipherable to PwD; (ii) looking at already installed assistive technology tools in the urban space trying to find opportunities to maximize their usability; and (iii) formulating some of the seminal principles of Inclusive Smart Cities.

This paper is organized as follows. First, we briefly discuss definitions and main features of Smart City projects. Then, we point out some aspects of accessibility in the urban space and the importance of assuring independence and autonomy to every citizen living in cities. Section 4 describes the methodology of our study and presents some relevant pictures and notes taken during the observation of the selected neighborhood. The findings are presented in Sect. 5 as well as some of the seminal principles of the Inclusive Smart City approach. Finally, Sect. 6 presents our conclusions.

2 Smart Cities

Finding a universal definition for the term "Smart City" is not a trivial task. This is a widely multidisciplinary subject. Therefore, different fields will conceive different definitions based on each different point-of-view and focusing in one or more particular aspects. [6] states that "Smart City" is not a static concept. It is rather a process – no end point -, a series of steps that will make the city more livable, resilient and ready to deal with new challenges. However, [6] underlines some aspects, which are strongly information-driven, which can better delineate some elements that Smart City projects should consider:

- A modern digital infrastructure to provide access to useful data enabling citizens to access the information they need, when and where they need it;
- Service delivery must be citizen-centered, meaning that citizens' needs must be in the forefront. City-administrators must collaborate with each other and share the information management in order to provide a coherent service and a consolidated view of data that, most of time, is spread over a multiplicity of silos;
- An intelligent physical infrastructure (computers, sensors and other Internet of Things components) to collect and to transport data supplying services and enabling those services to perform their tasks;
- An openness to learn from others and to experiment with new approaches and new business models; and
- Transparency of outcomes/performance to feedback citizens/ enterprises with data collected from the city and to enable citizens to compare and to challenge performance.

For the purpose of better management and control, urban systems are grouped in layers: natural environment (resources, environment, topography); infrastructure (utilities, buildings, roads); resources (minerals, oil, air); services (building services, transport, water, power); and social systems (people, policy, culture, commerce) [7]. Instrumenting cities with sensors and actuators allows citizens and city-administrators

to access real time information on air quality conditions, traffic jams, natural disasters and emergency situations, health campaigns, job opportunities and so on.

However, the gain acquired with better transactions between citizens and local governments, as well as a better relationship between citizens and (public and non-public) service providers are not – or, at least, should not be – the major outcomes of Smart Cities projects [8, 9]. Since the context of Smart City projects is the city as a whole, such projects can mitigate the segregation of citizens regarding information access once the users of Smart City initiatives form, by definition, the wide variety of citizens living in the city.

3 Accessibility and the Urban Spaces

One of the key issues of contemporary societies, accessibility has brought together national and international organisms, governments and social movements around the needs of persons with disabilities. Concisely, the design (or redesign) of products, devices, services and environments [10] means a wide range of advantages to PwD: the ability to access - products, places, information, systems and so on – that were only previously accessible to people without disabilities. Assistive technology is mostly developed making use of Universal Design principles, in order to guarantee access to the widest possible range of abilities. Designing taking into account accessibility principles is designing for everyone.

The United Nations emphasize in their *Convention on the Rights of Persons with Disabilities* that accessibility has to "enable persons with disabilities to live independently and participate fully in all aspects of life, States Parties shall take appropriate measures to ensure to persons with disabilities access, on an equal basis with others, to the physical environment, to transportation, to information and communications, including information and communication technologies and systems, and to other facilities and services open or provided to the public, both in urban and in rural areas" [11]. This right to access concerns the physical layer (building, roads, and other indoor and outdoor facilities), such as to the digital layer (information, communications and other services, including electronic services and emergency services).

Cities continue to be one of the greatest obstacles for PwD: wheelchair users must deal with potholes; impaired–hearing persons must count mostly on their vision to compensate for the lack of sound; people with limited walking abilities have to move over sidewalks with changes in level; visually impaired have do deal with the lack of appropriate signs regarding places and objects. Specific laws and governmental regulations have treated part of these problems associated to the physical infrastructure of the urban space. In Brazil, for instance, number of municipalities have made it mandatory to adapt sidewalks equipping them with tactile floor indicators; buildings must be readapted with ramps, curb ramps and elevators – even old buildings are motivated to be retrofitted; parking lots must be reserved for elderly people and PwD; public spaces restrooms must fit PwD needs; buses must provide platform lifts, etc. As expected, those changes take time, but there have been advances and progress.

When the focus moves to the digital layer of the urban tissue (applications, systems, ICT services and electronic services), there is still a particular absence of digital

services oriented to all diversity of citizens living in a city (including PwD, elderly persons, children, pregnant women, foreign people that do not speak the local language etc.). When discussing Smart City initiatives, accessibility and assistive technology, we rarely find options of services. Most applications in this field (route tracers, maps, emergency systems, sharing economy apps, ride-sharing programs, point of interest maps, bus tracker apps, smart parking and others) are not at all capable to interact properly in a non-excluding manner. Public administrators have more and more provided free Wi-Fi zones in squares and public buildings, but unfortunately, most PwD are not able to fully benefit from this service.

As most of our activities are becoming digital, providing digital services in an inclusive manner is to allow every citizen to occupy a place in a digital society and in a moving democracy era, potentially assuring the mitigation of the digital divide caused by the lack of full access to both urban physical and digital layers.

4 Methodology

This is a qualitative and exploratory research once the problem cannot be completely envisaged; it has not been clearly defined and has to be "discovered" [12]. One of the purposes of our research is to gain familiarity with the relationship between accessibility, urban spaces and Smart Cities, as background. Also, the exploratory approach helped us to gain experience in the difficulties faced by PwD in their daily routine when moving along streets, avenues, buildings, squares and other urban equipment. As the research subject is still new – namely, how Smart City initiatives could be inclusive – the exploratory research allowed us to learn while theories are still being formulated.

With 11.8 millions inhabitants, São Paulo – Fig. 1(a) - is a representative example of a contemporary megalopolis. We have chosen a 1-km route in São Paulo downtown

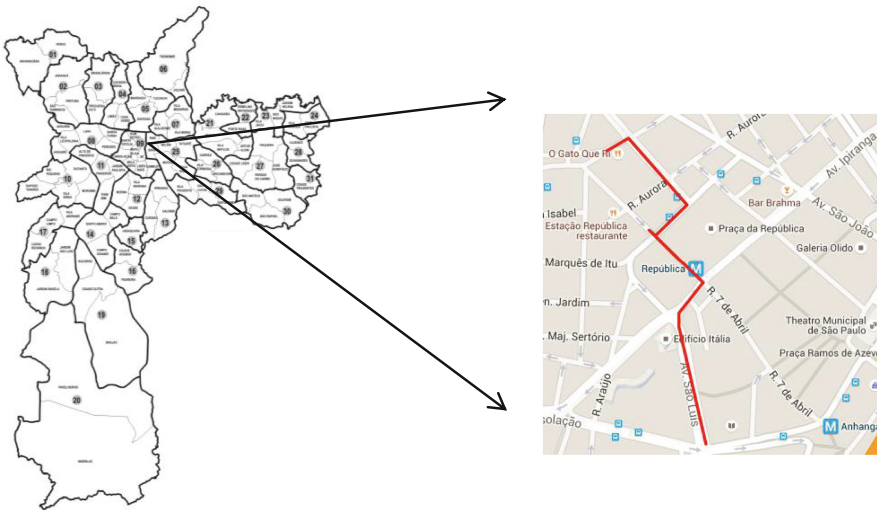

Fig. 1. Map of São Paulo and studied area in São Paulo downtown

Fig. 2. Overlapped information layers Urban landscape is made by layers of sensorial information (sight and hearing most of the time). These layers are overlapped in perspective.

depicted in Fig. 1(b) in order to explore (i) what kind of information is signed in a very confused area of a huge city, (ii) what kind of assistive technologies are found in the urban space, and (iii) opportunities for employing technology to adapt the urban digital layer so that the urban space can be more inclusive.

While walking, we have taken some pictures of obstacles and potential opportunities for developing assistive technology in the urban space; we also have written down some descriptive notes. The result of this documentation process can be seen in the following Figs. 2, 3, 4, 5, 6, 7, 8 and 9.

Fig. 3. Some very important information is not accessible to every citizen Extremely important information shown in the city is mostly textual. PwD, blind people, elderly persons and foreign people can not access this information at all or may have great difficulty in discovering what places and objects in the city are – as is the case of the information shown at bus stops.

Fig. 4. Low floor and tactile floor indicator Low floor and tactile floor indicator can be very useful for people with reduced mobility/wheelchair users and visually impaired people. Yet, as shown in Fig. 4, sometimes they float on the sideway: no signs show how to reach them – especially to blind people.

Fig. 5. Touristic places Low floor and tactile floor indicator can be very useful for people with reduced mobility/wheelchair users and visually impaired people. Yet, as shown in Fig. 4, sometimes they float on the sideway: no signs show how to reach them – especially to blind people.

5 Towards the Inclusive Smart City

The data collected and shown in Sect. 4 reinforces the hypothesis that cities still do not make very important information accessible – and that, in many cases, can be vital – to guide citizens in the urban space. Some aspects observed in the area selected determine that the urban space is a still more complex system concerning PwD needs. On the other hand, these aspects establish that cities are a source of research opportunities regarding the improvement of assistive technology already installed and/or the development of new products and services driven to PwD to allow them to fully use the urban space.

Fig. 6. Emergency situation warnings There are some places even the goodsighted are not able to find. Or places that deserve special attention such as touristic and historical places. These places have to be made reachable by PwD, too. Some well-known alert mechanisms concerning dangerous situations are mostly not accessible to PwD: warning sounds at the exit of underground parking can be misjudged due to street noises; textual messages addressed to escalator users cannot be accessed by impaired persons ("Keep left free" – in Fig. 6).

Hence, we propose an approach to deal with the observed lack of accessibility in the urban space and with improving the tools already offered to PwD in cities: the Inclusive Smart City. Inclusive Smart City is a new citizen-centered approach that combines pervasive technologies (hardware and software) and the Universal Design methodology in order to: (i) provide mechanisms that allow people with disabilities to interact with the urban space and to access geolocalized information and services; (ii) use ICT to mitigate the segregation of people with disabilities, creating innovative solutions or adapting some of those already in use but not available to everyone.

The urban space is a rich source of visual, audio and spatial data. People with disabilities have to face the obstacle of not perceiving one (or several) of these channels of information. A blind person, for instance, does not perceive what is drawn in a traffic sign a few meters away. If he/she does not know the place, he/she will probably not find where the public bathroom is (even though the place shows the appropriate sign). Thus, **the main feature of the Inclusive Smart City is the ability of identifying places and objects (or things) and making this information digitally available**. Once this information is available, it can be sent to devices that receive the information and personalize this information according to the disability of the user.

Fig. 7. Business opportunities Entrepreneurs are missing commercial transactions with PwD once holiday sales, renting and selling signs, as well as advertisement messages do not reach a significant part of the population that has valuable income. Another accessibility barrier is the identification of business and stores: PwD are simply unable to identify stores they are in front of, or to be "flaneurs"/wanderers in the streets and shopping malls.

Fig. 8. Urban common facilities Urban facilities – such as bus stops, taxi stations, police stations, hospital, restrooms – that are spread all over the city are not easily found by PwD. Most of these places are identified by signs and even by text written on the road.

Fig. 9. Subway station In large cities, the subway is a very important transport modality. The larger the subway station, the more confusing direction identification is. Finding information is a very hard task even for non-PwD., PwD usually depend on volunteers and subway personnel to help them to move inside these complex "universes".

6 Conclusions

A Smart City should enable every citizen to use all the services offered, public as well as private, in the way best suited to his or her needs. PwD are part of the city and have to take advantage to full access to products, urban equipment, services and information. They need independency, autonomy and safety. Based on the experiment held in a 1-km area of São Paulo downtown, we propose the Inclusive Smart City approach: a broader information digitalization, the use of Internet of Things, Pervasive Computing, Wearable Computing, Cloud Computing and other technologies to enhance the role of assistive technology already available in cities. We believe that the Inclusive Smart City approach can help PwD to explore neighborhoods and to know things and places by themselves.

References

1. IBM: "A vision of smarter cities," 23 Jun 2009. http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?infotype=PM&subtype=XB&appname=GBSE_GB_TI_USEN&htmlfid=GBE03227USEN&attachment=GBE03227USEN.PDF. Accessed 24 Feb 2016
2. Gea, T., Paradells, J., Lamarca, M., Roldán, D.: Smart cities as an application of internet of things: experiences and lessons learnt in barcelona: In: 2013 Seventh International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), pp. 552–557 (2013)
3. Mohammed, F., Idries, A., Mohamed, N., Al-Jaroodi, J., Jawhar, I.: Opportunities and challenges of using UAVs for dubai smart city. In: 2014 6th International Conference on New Technologies, Mobility and Security (NTMS), pp. 1–4 (2014)
4. Fortes, M.Z., Ferreira, V.H., Sotelo, G.G., Cabral, A., Correia, W.F., Pacheco, O.L.C.: Deployment of smart metering in the B #x00FA;zios City. In: Transmission Distribution Conference and Exposition - Latin America (PES T D-LA), 2014 IEEE PES, pp. 1–6 (2014)
5. Pla-Castells, M., Martinez-Durá, J.J., Samper-Zapater, J.J., Cirilo-Gimeno, R.V.: Use of ICT in smart cities. A practical case applied to traffic management in the city of Valencia. In: Smart Cities Symposium Prague (SCSP), pp. 1–4 (2015)
6. UK: Smart cities: background paper - Publications - GOV.UK. https://www.gov.uk/government/publications/smart-cities-background-paper. Accessed 24 Feb 2016
7. Harrison, C., Donnelly, I.A.: A theory of smart cities. In: Proceedings of the 55th Annual Meeting of the ISSS - 2011 Hull UK, vol. 55, no. 1, September 2011
8. Oliveira, Á., Campolargo, M., Martins, M.: Human smart cities: a human-centric model aiming at the wellbeing and quality of life of citizens. In: eChallenges e-2014, 2014 Conference, pp. 1–8 (2014)
9. Hollands, R.G.: Will the real smart city please stand up? City **12**(3), 303–320 (2008)
10. "Accessibility," Wikipedia, the free encyclopedia, 05 December 2015
11. United Nations: Convention on the rights of persons with disabilities. http://www.un.org/disabilities/convention/conventionfull.shtml. Accessed 25 February 2016
12. HCI Models: Theories, and Frameworks: Toward a Multidisciplinary Science, 1st edn. Morgan Kaufmann, Amsterdam; Boston (2003)