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Professional paper

INCLUSIVE SMART CITY

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Abstract

Popular phrase „Smart Cities“ is in use for some time and it has different meanings: City which is environment friendly or „green“, sustainable city which employs technical solutions. The usual approach to smart cities is technical.

Smart city should allow every citizen to use all offered services, public and private, in the most convenient way. People with disabilities are part of the city and they have to use completely the advantages of access to the products, urban equipment, services and information. People with disabilities are sometimes denied better interaction with the city because very important information and instructions aren't accessible.

Inclusive Smart City suggests to broaden the vision of smart city so that people with disabilities could be considered as users and potential users of urban technologies.

The aim of the work is, based on analysis of studies available, to show the concept of inclusive smart city and the way to improve the accessibility of transport and managing life of disabled in urban spaces.

Keywords: inclusi, offered services, urban spaces, smart city

Introduction

Modern means of communication create an assumption for a more decentralized urban development, but also for thinking about how the mechanical growth of a city in one moment can create obstacles to its further development. In the past, cities were built near fresh water and on high ground, as it were, for safety. Today, only an inclusive city can provide security.

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Inclusive design of cities today has exactly the opposite goal, to make cities accessible to people of different abilities and different needs (Ivanic, 2008).

Living in the 21st century has become unthinkable without traffic and all its benefits. What is more, it is not possible to achieve further development of society without traffic as an existential function of living space due to the savings in time when traveling longer distances.

In recent times, the extent of barriers to mobility in the environment and in transport services has been recognized. Until these barriers are removed, a significant part of the population will continue to be disadvantaged, that is, unable to travel as they wish and consequently limited in the extent to which they can participate in society.

The number of people whose mobility is limited in this way is very significant. A study conducted by Eurostat on the employment of people with disabilities in Europe estimates that among people of working age (16 to 64 years), 44.6 million, i.e. one in six (15.7%) has a long-term health problem or disability.

A February 2005 communication from the European Commission to the European Parliament and Council cited an earlier document (Towards a barrier-free Europe for people with disabilities, 2000) which estimated that around 10% of the European population had reduced mobility. Two studies, one in Germany and the other in France, estimate that at any given time between 20% and 30% of people who travel have mobility difficulties for one reason (disability) or another (temporary impairment).

It's also important to remember that it's not just physical disabilities that can cause problems for people when they travel. Sensory impairments, that is, the inability to see or hear, can cause difficulties, as well as intellectual disabilities, mental health issues and communication difficulties.

Whatever definition of reduced mobility or disability is used, it is clear that a very large number of people are affected by barriers to movement.

The concept of an inclusive smart city

The popular phrase "smart cities" has been around for some time, and includes a variety of overlapping meanings associated with the term:

- an environmentally friendly city or "green" city,
- a sustainable city,
- a city that implements innovative technical solutions.

The subject of smart cities is most often approached from a technical perspective.

When the United Nations Development Program (UNDP) says "smart cities", it refers to the use of new technologies to contribute to the provision of inclusive, sustainable urban development, taking into account people, the economy and the environment.

The essential goal of the Smart City ("Smart City - SC") is to ensure that all citizens have the right and benefit from the adopted innovations and have a voice in deciding which SC strategies to adopt and how to do it (Batty et al., 2012; Rebernik et al., 2019).



To be inclusive, smart city development policy must take into account the specific needs of *women, the elderly and persons with special needs*, and must provide comprehensive solutions.

Access to the telecommunications infrastructure is also an important factor, that is, more than 52% of the global population still does not have access to the Internet, and in every region of the world, the number of men using the Internet exceeds the number of women using it. New technologies, if used strategically, could contribute to reducing inequalities, exclusion or discrimination of marginalized groups.

Inclusive Smart City (*ISC*) is a set of ubiquitous and digital urban assistive technologies, enabling those citizens to move independently and perform their daily activities autonomously, resulting in a better user experience in urban spaces.

ISC solutions use technology to provide people with disabilities with: additional forms of interaction with cities, as well as additional alternatives to support people with disabilities to effectively perform their activities in urban spaces. *ISC* is an integrated effort to balance environmental deficiencies in communication and interaction with people with disabilities (Soares, 2018).

ISC initiatives primarily seek to strengthen the social aspects of smart cities, for these initiatives are capable of enabling the inclusion of a wider range of citizens as users of innovative urban technologies and services.

Examining the results of the study, the features that cities would provide to improve the experience of people with disabilities in urban space are:

- 1) To adapt information and digital services available in urban spaces, making them suitable for different formats;
- 2) To adapt urban technologies and mobility solutions according to the abilities of different people;
- 3) To upgrade traditional assistive technologies with new functions;
- 4) To support navigation/exploration of the urban landscape;
- 5) Identification and description of objects and location;
- 6) Help people with disabilities to find city facilities and devices;
- 7) Anticipate unexpected events and/or dangerous situations;
- 8) Facilitate finding people who are willing to help;
- 9) Provide effective channels of communication to enable interaction between persons with disabilities and local authorities/public agents.

The concept of disability

People with disabilities are the largest minority group in the world. Currently, about 10% of the world's population, or approximately 650 million people, live with a disability (World, D., 2020). According to the United Nations Convention on the Rights of Persons



with Disabilities (UN CRPD), persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which, in interaction with various barriers, may hinder their full and effective participation in society on an equal basis with others.

People with disabilities (PWD) are one of the vulnerable sections of society that can benefit from the advantages brought by SC technology (Townsend, 2013), especially because they face different problems related to urban space (De Oliveira Neto & Kofuji, 2016). Access to public spaces is such an important issue that promoting the development of information and communication technology (ICT) services for people with disabilities is one of the topics that make up the Smart Cities Research Agenda proposed by the United Nations University (Estevez, Lopes, & Janowski, 2016).

An inclusive smart city uses digital assistive technology in urban spaces to improve the experience people with disabilities have in these spaces, extending the benefits envisioned by SC initiatives to a significant number of citizens.

The adoption of the UN Convention on the Rights of Persons with Disabilities recognizes persons with disabilities as holders of the right to participate fully and equally in all aspects of society. This implies that inclusion is not only an obligation of states, but an enforceable human right for all people.⁸⁷

According to the UN CRPD and the disability rights movement and for the development of disability policy, the four groups of impairments listed in the UN CRPD (physical, mental, intellectual and sensory, which include visual and hearing impairments) will be used as a framework for analyzing the interaction between impairments and barriers.

According to statistics, the most common disability in the world is mobility impairment or physical disability. Over 3.6 million people in the world use wheelchairs because of a disability. There are about 30.6 million people with mobility impairments in the world.

Another large part of the community of people with disabilities (about 12 million) are individuals who need help with everyday tasks. In addition, there are over 8.1 million who are partially or totally visually impaired. Fewer people face hearing difficulties because they are totally or partially deaf. Statistics also revealed that about 2.4 million people in the world have Alzheimer's disease, senility or dementia (World, D., 2020).

Physical impairment

Physical impairments and disabilities are most often associated with people who use wheelchairs, crutches or other mobility aids. However, people with mobility impairments are much larger and include people of short or tall stature, people with artificial or missing limbs or people with physical disabilities.

⁸⁷ United Nation Convention on the Rights of People with Disability (UN CRPD) (2006). Available online from: <https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html>



People with physical disabilities can face various obstacles when using public transport. Platform infrastructure, such as gaps and/or non-level access between platforms, is pointed out as a common barrier for those with physical impairments, as wheelchairs cannot access the vehicle. People with low stamina or chronic pain may need seats or rest areas to take a break from long walks in the station. Other obstacles in the built environment include uneven floors, steps or gaps, making it difficult for people to move around the station or get in and out of a transport vehicle.

Also, transport users may encounter communication barriers due to an inaccessibly built environment (e.g. information boards or counters that are too high to reach).

Lack of effective communication with the staff, especially bus drivers, can also be a problem. In Velho's (2016) study, many people with disabilities mentioned that drivers simply did not stop for them to board the bus. Others noted instances where drivers did not open the ramp to get off, despite pressing the "Request Stop" button. This proves that communication problems are also a potential barrier, which increases the stress felt by wheelchair users when planning and executing their public transport journeys.

Short boarding times can be a barrier as people with physical impairments may need more time to board or move around the transport vehicle. Moreover, even if the station itself is very accessible, some people with mobility impairments may need an assistant to accompany them through the station or help with their luggage.

Inaccuracy or lack of information provided before and during the trip can also be an organizational obstacle. It has been proven that wheelchair users often experience dissatisfaction, frustration, anger and other negative emotions when dealing with facilities (e.g. stations) that are stated to be accessible but are not in practice. This finding emphasizes the importance of reliable sources of accessibility information.

Visual impairments

"Visual impairment" is a general term that describes a wide range of visual functions, from low vision to total blindness. Visual impairment is usually defined in two terms - total blindness and partial vision. Total blindness is a complete lack of light perception and form perception. However, low vision refers to irreversible vision loss that interferes with daily activities. Some people are "deaf-blind", which means that they have severe vision impairments, or severe vision and hearing impairments (World, D., 2020).

Since people who are blind or deaf-blind cannot drive, they often rely on public transportation as a form of travel. The use of public transport usually relies on visual cues that are inaccessible to people who are blind, partially sighted or deaf-blind. People who are blind or deaf-blind must rely on advance planning, training, and assistance from transit drivers and other transportation users. A study by Azenkot et al. has identified that the main challenges faced by visually impaired and deaf-blind people are locating stops and getting off the bus at the correct stop.

Path guidance with tactile markers of contrasting colors for accessible routes to transport facilities and within transport facilities, especially clear indication of the position of



bus or train stations, platforms, entrances and vehicles is necessary to improve transport accessibility for visually impaired people (Sze, N. N., & Christensen, K.M., 2017).

It is vital for people with disabilities to have all of this travel-related in an accessible format, especially as audio. Moreover, it is very important that clear and large signage, audio information for the arrival of public transport vehicles and timetables in large letters legible for the visually impaired are available.

The entire transportation system should be organized in such a way that visually impaired people can move easily and safely, which means that all facilities (including ATMs, toilets, etc.) should be accessible to these passengers as well. Also, if the person needs assistance (e.g. to be guided through the station), it should be provided during all aspects of the journey.

Many individuals who have very low vision or who are completely blind use a cane or a guide dog. These travel aids also serve to indicate that a person has severe vision loss. The details of traveling with service animals or other issues related to visual disabilities remain a bit vague and have a lot to do with attitude.

Hearing impairment

This type of disability means that the person has difficulty hearing, is partially or completely deaf. The causes and degrees of deafness vary in the deaf and hard of hearing community, as do sign languages and other means of communication and attitudes toward deaf people.

The barriers faced by deaf and hard-of hearing people are related to the fact that the transport and station environment is not adapted to allow accessible information and communication. Furthermore intercoms do not always allow video communication to enable visual communication in sign language. Similarly, fire and security alarms and evacuation procedures do not always include visual signals (e.g. flashing lights) to alert deaf and hard of hearing people (EUD., 2014). Also, sudden sounds, such as the sound of the station announcement, cause hearing aids discomfort and do not help in station navigation (Caldwell J., 2018).

Common skills for people who are deaf or hard of hearing include using sign language, interpreters, live or video services, providing information in visual formats, speech-to-text technologies, subtitling, assistive listening devices, volume control phones, signaling devices (e.g. a flashing light that alerts individuals to a knock on the door or a ringing phone), captioned videos and the like.

Digital solutions and mobile applications for smartphones (e.g. GoBraille, Braille-based applications that provide information about buses and bus stops or Google Transcribe) can also be useful for deaf or deaf-blind people, and support values of independence (Azenkot, S. , et al., 2011).

Communication problems represent the main barrier for people with hearing impairment, which happens due to unpreparedness and lack of knowledge about how to communicate with hearing impaired people (Souza, M. F. N. S., et al., 2017).



Written communication remains a popular format for communicating with people who are deaf or hard of hearing. SMS notification of all information in written formats on station screens or in travel applications can be very useful, for it allows users to monitor the status of their mode of transport in real time or receive specific route notifications.

For some deaf people, their disability may not be visible. This can make it more difficult to access help services. And here it is important to note that all people have the right to all the forms of assistance they need, regardless of the degree of disability.

Attitudinal changes can be shaped by positive experiences with deaf people, which break down negative stereotypes. New communication skills can also be developed through educational workshops, courses and staff training activities on communication.

Mental health issues

People with mental health issues (e.g. depression, bipolar disorder or schizophrenia) may be overwhelmed by anxiety, claustrophobia or feelings of panic. Usually, such types of damage are less visible to other people, and this can cause some barriers and problems for these travelers during the journey.

According to Mackett (2016), one of the main problems of people with mental health issues is overcrowding of buses or stations. Additionally, trips that required changes in transportation were particularly stressful for mentally impaired people, as their anxiety increased. In many cases, travel planning is essential for this group of travelers, which is why available pre-trip information or inclusive travel guides could be very helpful in removing these barriers.

Digital technologies could be one of the solutions to improve accessibility. Mobile phone applications can alert caregivers if a user leaves the planned route, which can be useful for people with dementia or similar conditions.

Sometimes public transport staff may feel insecure about their interaction and communication with passengers with psychosocial disabilities. There are main 'rules' for communicating with people with mental health issues, such as being respectful and listening patiently, especially if passengers are scared or upset.

Penfold et al. found that the self-confidence of such a person is a key factor, and there are three key aspects of successful transport of people with mental health issues, which can be incorporated into organizational transport structures:

- 1) Routine and planning: knowledge of routes and ability to plan trips is important;
- 2) Safety and control: Whitley and Prince conducted a two-year qualitative study and found that people with mental health issues suffer disproportionately from fear of crime, especially women and older people.
- 3) Accessibility and finances: the high travel cost can be a problem for some people with mental health issues: only 41% of them had a preferential bus ticket. (Mackett, R., 2016).



To make transport accessible for people with mental health problems, all three aspects need to be taken into account. Despite the fact that their disability is often not visible, people with mental health problems are also entitled to all forms of help and support while travelling.

Intellectual disabilities

Broadly speaking, intellectual disabilities are conditions that interfere with the acquisition, storage, organization, and use of skills and knowledge. It can be identified by deficits in academic functioning and in the processing of memory, auditory, visual and linguistic information. They may have difficulty understanding information and/or following instructions. However, people with this type of disability can learn and they can do many things, it just might take them more time and effort than others. As with other disabilities, people with intellectual disabilities are far from being a homogenous group.

Problems with perception and understanding make it difficult to cope with changes and new journeys. As one study found, nearly 50% of people with intellectual disabilities were concerned about transferring between different transportation systems during their trip, for fear of getting lost or confused (Wasfi, R. A., et al., 2006). Changing regular routes and times can cause problems for people with intellectual disabilities. Another obstacle is difficulty in understanding regulations and procedures during travel, e.g. for preferential travel passes.

In order to remove such barriers, it is first necessary to improve the local environment. An accessible environment involves using sound design principles to provide short, direct routes with, for example, adequate lighting and avoiding complicated pavement patterns, and clear signage during special transportation services such as dial-a-ride, that provide door-to-door journeys, can reduce the number of decisions that must be made for such travelers (Mackett, R., 2016).

Another potential solution could be travel training for such travelers. This type of training includes classroom exercises and trips with a coach on a one-to-one basis to provide experience and confidence for unaccompanied travel.

A study conducted in the US found that 46% of people with intellectual disabilities indicated that they faced problems in reading timetables, while 49% indicated that they faced problems in understanding timetables. This is why it is very important for all travel information, such as timetables, routes and stops, to be provided in a simple and easy-to-read format. (Autism Europe, 2020).

Crowded and complex spaces can be a big obstacle for people with intellectual disabilities. For this reason, experienced people should be involved in the design of new stations to ensure a clear and legible station design.

The behavior of other passengers can cause concern for people with intellectual disabilities, including smoking, playing loud music, bullying and large groups of children shouting and making noise on buses. The attitudes of other passengers were identified as a



factor that discouraged people with intellectual disabilities from traveling and using public transport (Mackett, R., 2017).

Improving the accessibility of transport and finding a way for people with disabilities in urban areas

Technology is at the center of great changes. SC solutions promise to use outstanding technological concepts to improve the quality of life of citizens and this has already been achieved in the case of the invaluable use of digital maps for navigation in large cities.

In order to provide a better experience for people with disabilities in urban areas, a two-step approach was adopted:

1. Identifying the problems and obstacles that people with disabilities face when they move to the city, the strategies they use to solve these problems, as well as understanding how state authorities deal with the requests of people with disabilities;
2. Proposing a set of theoretical and technological tools to support public agents, entrepreneurs, developers and designers to conceive and implement digitally accessible urban solutions.

In order to offer a better urban experience to people with disabilities, first of all, one must look at the bad and good situations that people with disabilities go through in their daily routine. Second of all, public officials and professionals involved in such endeavors must have a set of resources to help them in the initial steps, avoiding wasting time, and to guide them in designing digitally accessible urban solutions, which can improve the quality of the final products.

Respondents were asked to give more details about what would help them solve problems they might have in public spaces. Respondents' proposals were grouped into five main categories of credible solutions, ordered by the number of proposals in each category:

1. **Technology:** improvements in GPS-based applications and mobile networks, especially providing alternative routes, providing information about sidewalks, paths and predicting obstacles and barriers on the route, more detailed navigation maps, audio information about buses and subways, and new navigation technologies that would work even offline;
2. **Information resources:** having real-time information to find solutions to their problems in public spaces. They listed the need for information: what is happening on the route, such as obstacles and barriers and whether there is availability of accessible facilities, signage of facilities, such as bakeries, drugstores, bars/restaurants, etc.
3. **Government actions:** some of the respondents recognize that some actions to solve their problems should be managed by government authorities, for example: improve the quality of public transport services and adapt them to accessibility requirements

4. **Human assistance:** human assistance is also an important factor in helping people with disabilities. The respondents pointed out that the human attitude towards persons with disabilities and the change of their attitude should be the subject of workshops, discussions and lectures for ordinary citizens in order to change their sometimes bad behavior towards persons with disabilities.

5. **Personal attitude:** the respondents admitted that part of the solution to possible problems that may arise depends on their behavior, personal mood and ability to prepare in advance.

The ISC vision allows adding some functionality to the initial SC concept, which can increase the efficiency of urban technology to improve the quality of life of more citizens. As Figure 1 shows, the accessibility layer provided by the ISC vision is the interface between a diverse group of citizens and SC services, which are increasingly described as absolutely necessary tools for living and interacting productively in modern urban environments.



Figure 1: The ISC Vision

In this context, *ISC* means equipping the city to offer new alternatives and innovative solutions that could improve the experience of people with disabilities in urban spaces. Some practical examples are devices used by users with disabilities, providing appropriate and adapted information to people with disabilities.

ISC initiatives are aimed at citizens, i.e. the focus of these initiatives is the person and his/her abilities, and not disabilities. This explains the need to provide accessible information, integrating it into digital services already available in urban spaces in different formats, such as audio, animation, plain text, or image, among others.



ISC requirements

There is the following list of ISC requirements:

Management requirements:

1. Promoting cooperation between citizens, government, entrepreneurs and researchers:
2. Implementation of laws, regulations and standards related to urban digital assistive technologies:
3. Encouraging digitization and adaptation of urban information and services, as well as their connection with urban objects and interesting places in the urban environment:
4. Developing communication channels to stimulate the participation of people with disabilities in the process of creating policies and local self-government decisions;

Technological infrastructure requirements:

1. Availability of facilities:
2. Content in multiple formats
3. User experience:
4. Heterogeneity and interoperability:
5. Scalability and flexibility:
6. Open data
7. Availability:
8. Protection of privacy and security:

These requirements can help authorities and experts to understand the problems related to digital accessibility in urban spaces and anticipate problems in the process of developing ISC technological solutions. Considering this list of requirements as a benchmark when developing a specific ISC vision can alert authorities and experts to the importance of recognizing the diversity of citizens.

ISC solutions

According to the vision of ISC, and in accordance with the idea of smart objects, objects that exist in urban spaces can be equipped with computing resources, processing and memory, which make them recognizable. These physical objects are connected to a digital counterpart, which is a virtual representation of the physical object.

It is important to note that in ISC, each virtual object has two basic characteristics: attributes and services. Attributes characterize the physical object of another and determine the state, appearance, or other qualities of that object. On the other hand, services refer to the functionality provided by an object, for example, the activities it can perform or operations that can be performed with a specific purpose. As Figure 2 shows, an inclusive smart object is defined as a combination of a physical object, its virtual counterpart with attributes and services, and the value of each attribute in various formats, such as audio, text, and animation.

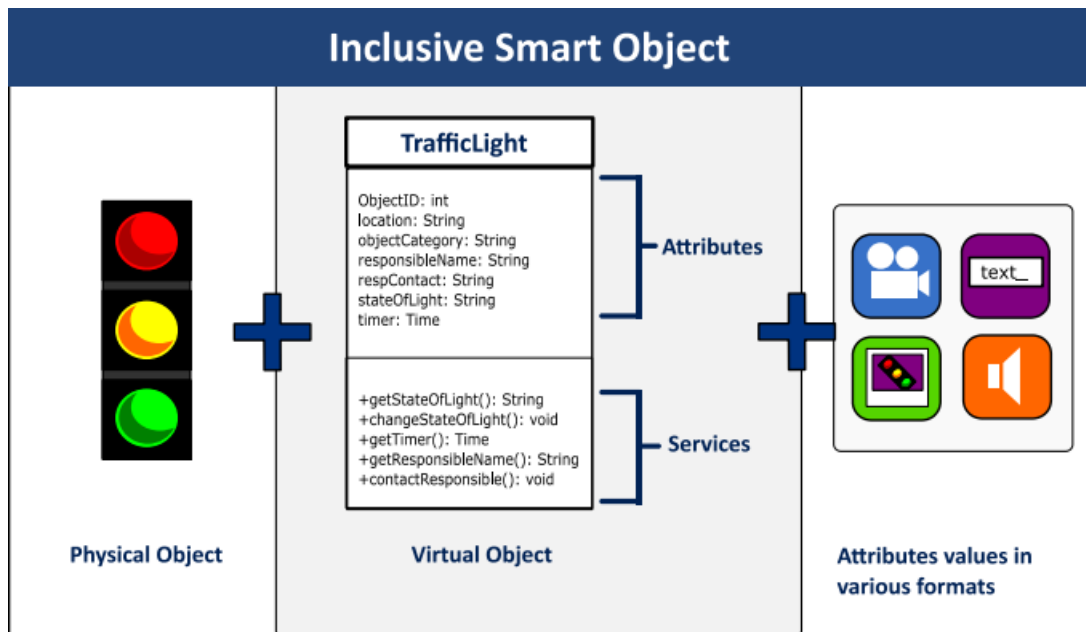


Figure 2: Inclusive smart object

Virtual object attributes are modeled as:

1) General attributes – a set of basic attributes that each inclusive thing must provide to users and

2) Specific attributes – a flexible set of attributes that depends on the domain and scope of the application, and on the semantics of the object.

Specifically, the general attributes are:

- ObjectID: link between physical object and virtual object;
- Class: defines an object as a member of a category of objects;
- Location: physical location of the object;
- Description: descriptive presentation of the object, external and internal characterization, its operation, restrictions on use and other information;
- Responsible person: responsible for facility availability;
- Responsible e-mail: e-mail address of the responsible object;
- Responsible phone: phone number of the responsible facility;
- Status: identifies the operational status of the facility - available, under maintenance, paused, unavailable;
- Display: describes the message displayed on the object;
- Message: general information, warnings or other types of messages that can be delivered to users near the facility;
- User reviews: comments or reviews of other users regarding the facility or the use of the facility.



To show how users and smart objects behave and interact with each other in ISC, an ISC conceptual model is introduced, in which users, especially people with disabilities, use interactive devices to actively or passively interact with inclusive smart objects located in the environment (Figure 3).

In ISC, as users move around cities, they can interact with inclusive smart objects that are observable or accessible in urban spaces. Users and inclusive smart objects can exchange information by setting up an interactive dialog that can be initiated by a user who needs help or assistance in performing a specific activity, such as finding out where the nearest toilet is and how to get to it, or notifying subway station staff that he/she is at the entrance to the station and that he/she needs instructions to get to the train platform.

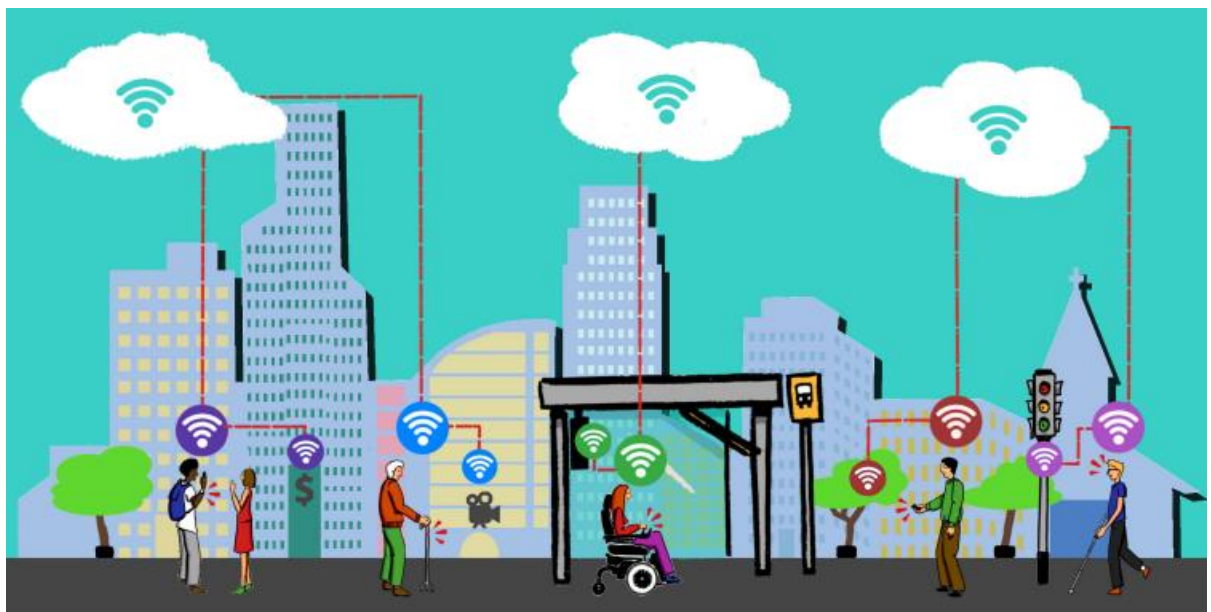


Figure 3: Elements of the ISC conceptual model

What is more, based on the identification of users and their location, ISC can proactively alert users to information and services available to them where they are or even, for example, broadcast an emergency message. It is important to anticipate the needs of people with disabilities and make their routine in urban spaces more productive and easier, but it is also valuable to give them control over the dialogue with the urban environment, as shown in Figure 4.

Inclusive smart objects can act as additional urban landmarks and sources of information and services for people with disabilities. In the context of ISC, traffic lights can inform the user next to them what color is currently displayed (green, yellow or red), the name of the street the user is on, how long they have to cross the street, or yet, how long the signal will be closed to cars and remain open for non-motorized users to cross the street. In addition, a person could activate a traffic light using some digital service, inform that they are near it and they want to cross the street, simulating what is already done in some places by activating the traffic light button, which results in the interruption of car traffic and allows the person to safely cross the street. What is more, for example, if a person accidentally falls or

experiences some other type of incident, they can digitally reactivate the traffic light, preventing it from opening for cars and avoiding those cars from going towards the injured person. In the specific case, the person can still request the traffic light to call the nearest ambulance.



Figure 4: Elements of the ISC conceptual model

ISC architecture

After the requirements and the conceptual model have indicated the main challenges of ISC, the following aspects should be included in order to adequately solve the accessibility of cities:

- Enabling interaction between inclusive smart objects and people with disabilities in urban areas;
- Adaptation of information available in urban areas, making it accessible and visible to persons with disabilities;
- Enabling people with disabilities to demand that inclusive smart objects perform tasks and services in urban spaces;



- Enabling people with disabilities to find help from others when in public places;
- Including the participation of citizens in the development of the city and government.

The ISC architecture consists of four parts that contain infrastructure components and provide services:

- 1) Infrastructure for information management;
- 2) Infrastructure for collecting information and requests for services;
- 3) Infrastructure of inclusive smart objects and
- 4) Cloud infrastructure.

The ISC architecture enables synergy between people with disabilities, and inclusive smart objects, so that people with disabilities can access information and services related to urban places and locations (where inclusive smart objects are located) and comment on data for inclusive smart objects, participating in the dynamics of the development of the city. The following approach is also proposed for the transformation of regular urban space into an inclusive smart space:

- 1) Define the area where users will be able to receive user-friendly content;
- 2) Define the level of detail to be provided from the selected area. For example, on an avenue, only the main description of the building can be given, or in each building, all floors and interior rooms can also be detailed for users;
- 3) Select existing acceptable inclusive smart facilities in the selected area;
- 4) Physically identify objects with tags or sensors and connect to network infrastructures when necessary;
- 5) For each object:
 - a) Define information/services;
 - b) Add information/services to the object model;
 - c) Test connectivity.

Conclusion

A smart city should enable every citizen to use all the services it offers, both public and private, in a way that best suits their needs. People with disabilities are part of the city and must take full advantage of access to products, urban equipment, services and information. People with disabilities are somewhat denied a better interaction with the city, because important information and instructions are not available to them. In this regard, the city can be a source of opportunities for the use of innovative technologies, with the aim of improving the urban experience for people with disabilities.

In essence, the inclusive smart city proposes to expand the vision of the smart city to consider people with disabilities as users and potential users of urban technologies.

To be inclusive, smart city development policy must take into account the specific needs of women, the elderly and persons with special needs, and must provide



comprehensive solutions. The existence of mobile apps that help drivers find disabled parking spaces doesn't mean much if parking lots and other facilities are not equipped with ramps and other solid infrastructure to facilitate mobility. New technologies, if used strategically, could contribute to reducing inequalities, exclusion or discrimination of marginalized groups.

People with disabilities still rely on the help of others in obtaining information, which most of the time is already available in public spaces, but is not adapted to the needs and capabilities of every citizen. People with disabilities refuse to accept the precarious situation of accessibility in the cities where they live. However, despite all the difficulties, they are open to learning and using technologies that will help them cope with urban problems and remain persistent using a set of strategies to overcome the obstacles that urban spaces impose on them.

Digital technologies could be one of the solutions to improve accessibility. Mobile phone applications can provide real-time information during walking and bus journeys, which could be beneficial for some people with mental health issues.

ISC solutions can continuously check what people with disabilities are doing and what they will do in order to warn them of obstacles that users might face on their way, or warn them of dangerous situations.

ISC architecture

After the requirements and the conceptual model have indicated the main challenges of ISC, the following aspects should be included in order to adequately address the accessibility of cities:

- Enabling interaction between inclusive smart objects and people with disabilities in urban environments;
- Adapting the information available in urban areas, making it accessible and visible to people with disabilities;
- Enabling people with disabilities to request inclusive smart objects to perform tasks and services in urban spaces;
- Enabling people with disabilities to find help from others when in public places;
- Including the participation of citizens in the development of the city and government.

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6) Defining the area where users will be able to receive user-friendly content;

7) Defining the level of detail to be provided from a selected area. For example, on an avenue, only the main description of the building can be given, or in each building, all floors and interior rooms can also be detailed for users;

8) Selecting existing acceptable inclusive smart facilities in the selected area;

9) Physically identifying objects with tags or sensors, and connecting to network infrastructures when necessary;

10) For each object:

a) Define information/services;

b) Add information/services to the object model;

c) Test connectivity.

Conclusion

A smart city should enable every citizen to use all the services it offers, both public and private, in a way that best suits their needs. People with disabilities are part of the city and must take full advantage of access to products, urban equipment, services and information.

People with disabilities are somewhat denied a better interaction with the city, because important information and instructions are not available to them. In this regard, the city can be a source of opportunities for the use of innovative technologies, with the aim of improving the urban experience for people with disabilities.

In essence, the inclusive smart city proposes to expand the vision of the smart city to consider people with disabilities as users and potential users of urban technologies.



The development policy of a smart city, in order to be inclusive, must take into account the specific needs of women, the elderly and persons with special needs, and must provide comprehensive solutions. The existence of mobile applications that help drivers find disabled parking spaces does not mean much if parking lots and other facilities are not equipped with ramps and other solid infrastructure to facilitate mobility. New technologies, if used strategically, could contribute to reducing inequalities, exclusion or discrimination of marginalized groups.

People with disabilities still rely on the help of others in obtaining information, which most of the time is already available in public spaces, but is not adapted to the needs and capabilities of every citizen. People with disabilities refuse to accept the precarious situation of accessibility in the cities where they live. However, despite all the difficulties, they are open to learning and using technologies that will help them cope with urban problems and remain persistent using a set of strategies to overcome the obstacles that urban spaces impose on them.

Digital technologies could be one of the solutions to improve accessibility. Mobile phone apps can provide real-time information during walking and bus journeys, which could be beneficial for some people with mental health issues.

ISC solutions can continuously check what people with disabilities are doing and what they will do in order to warn them of obstacles that users might face on their way, or warn them of dangerous situations.

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