Rethinking Public Transport Services for the Elderly Through a Transgenerational Design Approach

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Abstract. In discussing the city suitability to people's needs, generally a special attention has been given to people with special needs, e.g. the elderly. In this sense, most of the research about accessible cities has focused on the architectural design of public spaces, aiming at ensuring the access to urban places through the removal of architectural barriers. However, as technologies have been diffusing in many different city services, it also should be given attention to the constraints derived from this unavoidable change affecting the elderly life. The focus is on the potential of the technologies for improving the elderly city experience. In this paper the authors, starting from the principles of the transgenerational design, focus on how the technologies applied to the public transportation services could improve citizen experience and promote really inclusive mobility services.

Keywords: Transgenerational design · Public transport service · Elderly · Redesign · Technology adoption

1 Introduction

The connection between city development and technologies has been largely discussed in the scientific literature about the so-called smart city [1–3]. Beyond the definition of a theoretical framework of the city, technology has effectively permeated different sectors of the urban environment. In several cases, the implementation of interactive systems has been really enhancing the spaces and the services of public interest and has been producing information about citizens and city that can be usefully reused to improve their quality of life [4, 5].

The delivery of smart services and real time information can lead to a real breakthrough and improvement in the way people live and experience their cities, but most of the smart cities initiatives do not already properly consider the citizen's needs. However, in order to be really effective, city services have to take into account all the different kinds of needs and limitations that people may have, according to a human-centered approach. So, the use of the technologies should be consistent and suitable for the users experience and their physical and cognitive features. Nowadays many different technologies have been showing their potential benefits among different categories of

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adopters [6]. In such a complex and rapidly evolving context of various interactive systems, a particular attention should be given to older people, as they often need support in using technological systems and need more effort and time in becoming confident with the required know-how [7]. However, beyond their potential reluctance, older people actually are nearly forced to use different kind of technological systems, as they often are the only or the more advantageous mean for accessing certain services and information [7, 8]. So, the elderly needs have to be considered and evaluated in the design research about smart services.

The academic literature has been largely debating about the elderly user experience and level of acceptance and adoption of information technology within the home context, e.g. IT health systems, assisted living technology, ambient intelligence, sensors, etc. [9–12]. On the contrary, few studies have focused on the adoption and use by older people of technology situated in the open urban space. Moreover, the research on the needs and requirements of aged population outside the domestic context mainly has concerned the planning of physical public places [13, 14], and the role of the Public Administrations in taking into account the elderly needs (e.g. in planning the transport sector) [15, 16]. In this regard, Gilhooly et al. [17] analysed the difficulties of older people during their experience in public spaces (e.g. difficulty in carrying heavy loads, running late, behaviour of some passengers, etc.).

On this basis, the analysis and evaluation of the influence of technology on the older people urban experience has to be integrated.

So, in this paper, the authors will focus on the study of the interaction modes between older adults and some of the enhanced services offered by the smart city, in order to safeguard the inclusion of older adults, as long as, mainly in the industrialized countries, the population continues to age and the rate of the elderly on the total number of people is expected to increase [18]. In detail, in this paper, the authors intend to focus on the analysis of mobility services, as they are a relevant element of the cities that enables the use of other public spaces. Moreover, it is a sector extremely digitized and, at the same time, necessary to the life of citizens, elderly included [19, 20]. In this sense, the design of accessible and usable interactive systems relating to the transport services might prevent the social isolation of the elderly. So, in the next section, the authors present the work related to elderly needs in public transport services. In the third section they present the approach adopted in reflecting about a truly inclusive design of mobility services, while in the fourth section the different steps of the service journey, from the trip planning to the effective use of public transportation means, are described and then discussed in the fifth section. Finally, in the conclusion, the authors focus on the general principles to be considered in designing public transport services and on the future work.

2 Related Work

Many studies about public transport requirements for people with special needs mostly focus on the hindrances caused by the physical environment in accessing to different city services, as the presence of architectural barriers [21–23]. In this regard, most of the problems are caused by the lack of information about the physical barriers present

at the stations or along the way [24]. Regarding more in general the elderly needs, Bekiaris et al. [19] observed that it is very important to provide additional information, such as: coming buses with platforms to facilitate the access in the transport mean, presence of staircases on the path, information about reduced rates for pensioned or disabled people. On the contrary, little attention has been given to user sensory impairments, such as the difficulty to see and to listen acoustic notices on board and within the stations or at the bus shelter.

In general, by considering the presence of different kind of obstacles, the necessity of an inclusive design approach emerges. In this regard, Bogren et al. [25] highlight the importance of the active involvement of the elderly in designing solutions that favor the accessibility in the public transport. The accessible technology is a key component that has to be adequately considered into the service design process, as it greatly influences the user experience and sets different challenges in respect of the peculiar features of the involved subjects [20, 22]. In effect, older people are one of the main groups to which heavy cognitive efforts are required in the adoption of modern information technology [26]. So a good design of the interaction between the elderly and the digital devices should primarily understand some human aspects of the user experience: the devices daily routine, the problem-solving skills, the interaction preferences, etc. In this perspective, Subasi et al. [27] focus their attention on the many factors that positively influence the online tickets purchase experience of the older users. The elderly see benefits both in real life ticketing services and web ticketing services. The preference for the first interaction mode depends on the reluctance of the elderly at changing their habits, but clear benefits perceived into the experience of online ticketing might induce them to use also the second one. In detail, the online ticket purchase is perceived allowing timesaving and ease and convenient purchases. Regarding the whole user experience, the use of portable devices, especially PDA and smartphone, seems to positively influence the access to mobility information.

Due to the differences among older people needs and the variables among the technological interactive systems, the design of the elderly user experience in the public transports has been proving to be fragmentary, more focused on single aspects, as physical barriers, or on single step of the whole journey. Despite that, in using public transportation service, there are some needs in common among elderly and even very different social groups. For example, Grotenhuis et al. [28] show how there were for the elderly and younger people some common needs regarding various types of information (e.g. including interchanges with other means of transport, remaining travel time, etc.), although the elderly have more need of information than younger people, especially in the pre-trip, to save physical effort.

In conclusion, in order to achieve a comfortable experience for elderly in using the public transport services even a focus on the influence that technology may have on the whole journey is needed. Moreover, it should be oriented towards an integrated and inclusive service design approach.

3 The Role of Transgenerational Design in Rethinking Public Transport Service for the Elderly

In order to improve the citizen experience and promoting really inclusive mobility services, in this paper the authors have been inspired by the transgenerational design approach to re-think the public transport services. In detail, the transgenerational design aims to propose solutions suitable for everyone, regardless of age or ability, by designing products and environments according to the simultaneous accommodation of the requirements of the widest possible range of people who would use them, from the young to the older people, from the able bodied to the disabled people [29].

The transgenerational design has emerged in the 1980s as the result of the public's growing awareness of the increasing aging of population and of the arising of the disability rights movement. This approach was developed by Pirkl and Babic, starting from the idea that the accommodation to the widest spectrum of human needs is a pivotal responsibility of the designers [30]. In this sense, the transgenerational design aims to create or reimagine products, services, and places for ensuring safety, comfort, accessibility, and ease of use to the end user, allowing at the same time a convenience and a good design. All products and services should be designed to fit the changing sensory and physical needs, through designs that do not stigmatize, but rather maintain and reinforce everyone's dignity and self-respect. Indeed, one of the transgenerational design challenge is to emphasize beauty while actively avoiding the sterile and clinical solutions. So, in summary, the transgenerational design "accommodates rather than discriminates, sympathizes rather than stigmatizes, and innovates rather than replicates" [31].

Then, the authors of this paper refer to this approach because of its focus on the way humans actually use and live things, spaces, and services. In fact, this design process is value oriented [32], rather than aimed at merely adapting interactive systems to principles, standards, and dimensions. Furthermore, in this paper the transgenerational design approach has to be intended as inclusive of the traditional web accessibility and usability design principles [33]. In fact, these concepts complete the transgenerational approach in respect to the interactive systems, as technology is by now integrated in several types of service touchpoints. In this regard, in this paper the authors analyse how technological systems intervene into the different steps of public transportation services and affect the whole user service experience. The focus of the study is on the elderly, even if the authors try to maintain an inclusive point of view. In effect, although the World Health Organization suggests that "most developed world countries have accepted the chronological age of 65 years as a definition of "elderly" or older person" [34], this is a simplification. As Nielsen states [35], people do not change all their behaviours on their 65th birthday; instead the human aging process starts when people turn 20. Designing for elderly is challenging because there are several skills that decline with age: vision, dexterity and motor skills, memory and cognition, hearing. These conditions can occur either separately or jointly. Still, these problems, typical of the elderly, can also be experienced by other people as a permanent or temporary issue. Disabled people can be young and have one or more of these problems, tourists with luggage or parents with strollers can have mobility issues, sunny conditions can give rise to vision problems, and so on. In this

sense, the transgenerational approach results a valid solution to adequately meet the widest range of user needs and abilities.

4 Analysis of the Interactive Systems in the Public Transport Service User Journey

In analyzing the possible influences of technologies on the whole elderly user experience with the public transport service, the authors need to focus on one specific case, in order to refer to an effective touchpoints ecosystem. Because of practical needs, they choose the one of Rome. The resulting analysis should not lead to any value judgment about the specific provided service. It deals with the potential user journey related to the use of the public transport service, split into its main stages, each one characterized by specific functionalities and technologies: (1) planning of the trip; (2) ticket purchase; (3) access to real time information; (4) ticket validation; (5) ride.

1. *Trip Planning*. This first stage consists in getting information and data useful to plan the movements within the city. In Rome, the activities related to this phase are performed both through digital applications and non-digital tools. A lot of web and mobile applications belong to the first category. They provide users some basic parameters and features, useful to plan the trip between two different places of the city. Among the provided parameters: the choice of the starting address and the destination address (in order to identify the way to go), the choice among the most favorite means of transportation (e.g. only buses, bus and underground, etc.), the propensity for walking (e.g. high, medium, low), the time shift (e.g. setting the departure time or time of arrival), the possible integration with other means of transportation (car sharing, bike sharing, private means). The final user can access to these features both in the home environment (e.g. through a desktop application) and in the city environment (e.g. through a mobile application). Some of them are designed with an attention to the needs of specific users, in particular the visually impaired. Concerning the use of non-digital tools, different solutions are provided: the bus stop signage that show the route of the single transport line, the city geo-referenced map with the main transport lines, etc.
2. *Ticket Purchase*. This stage consists in getting the ticket good for a ride on the public transport services by paying a fee to purchase it. There are different sales channels, also depending on the ticket type (i.e. paper ticket, e-ticket, pass, and touristic ticket). In general, the interaction between the user and the ticket purchasing system can be set entirely offline (through physical channels) or online (through digital ones), or it can be set partly offline and partly online. In detail, the user can purchase all the ticket types at the carrier ticket offices or at the other authorized sales points and agencies (e.g. tourist agencies, news-stands, tobacco shops, etc.), by paying by cash or other accepted payment instruments (e.g. credit card). The latter can cause troubles especially for non-expert users. Automatic ticket vending machines are another physical sale channel that requires an in-person interaction. In this case difficulties may occur because of the poor and not standardized interface of the system and the lack of the assistance by a human operator. These machines are generally set at the

entrance of the subway, near the turnstiles, at the main bus terminals and at other strategic sites, that may be crowded and cluttered places, where the user may be in a hurry. Moreover, even in this case the user can use different payment instruments, e.g. credit card (contact or contactless) or cash. Conversely, the customer can purchase an e-ticket (a single ticket or a personal pass) through the smartphone by accessing to a mobile app for paying and obtaining a digital item that stores the ticket information, such as a QR Code or a code redeemable through NFC technology. The customer can also load e-tickets on a rechargeable card (passes or touristic cards). In this case, the tickets can be purchased online on the carrier website or at the carrier ticket office and loaded on the user's card, that can be required at one of the carrier ticket office or on the carrier website and then collected at the carrier ticket office or received by mail. The passes can be topped up also at the ATM or on the website of the affiliated bank or at one of the affiliated point of sale. The online purchase may require the user to do different steps: selecting the desired product, selecting the desired collection method, filling different personal information, paying (by using different payment instruments), receiving confirmation about the transaction, and inserting the required digits composing the personal code on the card. Eventually, the paper ticket can be purchased on buses and on other surface public transport means at the ticket issuing machines available on board.

3. *Access to real time information*. This stage consists in getting information and data for the journey that is going to begin. In the city of Rome, these activities are mainly performed through digital tools. The single transport means are monitored through satellite systems and the related data are used to give the final user real time information about the state of the public transport, accessible through web and mobile apps. The main information the user can access to are: the arrival time of the single transport mean by digitizing the number or the name of the bus stop, or the number of the bus line; the access to the favorite bus lines and stops (by add them to bookmarks); the access to real time general news, always related to the service status (e.g. crashes, strikes, etc.). The same real time data are also used for the digital bus stop signage that shows the list of the buses that are arriving and for each of them by how many minutes it arrives and the number of stops before it arrives. Some added tools for the real time information to the city users particularly focus on the possible delays and problems of the mobility of Rome, such as one Twitter account and an Instant Messaging service through the WhatsApp platform.
4. *Ticket Validation*. This stage consists in validating the ticket on the appropriate machine. There are different validation systems, depending on the ticket support type. In the city of Rome the validity of the ticket is essentially based on time (starting from the moment of ticket validation). In certain cases there are constrictions concerning the period of use, e.g. the current month. The validated ticket entitles the user to access to all the public transport services provided by the carrier and by the affiliated transport companies within all the city of Rome (i.e. bus, trolleybus, tram, railroad train, and subway train). The ticket has to be validated any time the user boards a public mean of transport, both to begin and continue the trip. In some metro stations ticket validation is also needed to open the exit turnstiles. In general, to validate paper tickets, the user has to insert them into the validator integrated into

the metro turnstiles or located on board on buses, trolleybus, and trams, or located at the train stations. The validator stamps the date and expiration time on it, making it valid for the use, and returns it to the customer. The user has to insert the ticket according to a precise pre-defined direction. To validate tickets and pass loaded on contactless smartcards the user has to tap it on one of the contactless smart card readers available on board of surface public transport means, at railroad train stations or integrated into the metro turnstiles. The area where to place the ticket is in general demarcated by different shapes and colors on the validator surface. A similar technology is adopted for the validation of e-ticket through the mobile app provided by the carrier, since it uses the NFC technology. However, to travel on the subway and validate the e-ticket by smartphone, the user has to access the mobile app provided by the carrier and select a purchased e-ticket to make the mobile app generating a QR Code. Then the user has to approach this code displayed on his/her smartphone to the optical reader placed on the subway turnstiles to validate the e-ticket. Otherwise, if the user owns a NFC-enabled smartphone, once generated the QR Code, he/she has to place the smartphone near to the reader integrated into the turnstile to validate the e-ticket. Lastly, to travel on the surface public transport means and validate the e-ticket by smartphone, before boarding the mean the user has to access the mobile app provided by the carrier and select a purchased e-ticket to make the mobile app valid for the time allowed by the purchased ticket, starting from that moment. In any case, the user may be asked by a ticket inspector of the carrier to show the validated ticket.

5. *Ride*. At this stage the user is on board. If the journey variables do not change, the user requires to know only a few more details, mostly: at which stop the vehicle currently is (to know when he/she has to get off), how long it will take to get to the destination, which connections are available. Instead, if anything changes, the user needs to recalculate the route and maybe choose other options. In both cases, these needs have already been discussed in the previous stages, i.e. "access to real time information" and "trip planning". However, there is a major difference regarding the environmental conditions: the user is no longer at home, or at least standing firmly on the ground; now he/she is on a vehicle, moving towards the destination. Decisions must be taken within seconds, and this makes some tools (e.g. paper maps, or slow loading websites) less efficient. To overcome these problem, at this stage other tools that let users access real time information are often available: led displays showing the next stop name, descriptive acoustic messages, screens that supply a set of useful tips. Generally, these tools are always non-interactive, but provide the user with effective and quick information.

5 Reformulating the Public Transport Service According to the Transgenerational Design Approach

In this section the authors reformulate the stages described in the previous paragraph, trying to give some indications that meet the needs of a larger part of city users. As in the previous section, the focus is not on the whole user experience, but only on the user

interaction with the ICT related to the service. In fact, the authors sustain that a wider number of people categories has been increasingly assimilating the idea that technologies may support several types of activities (including the use of the public transport services). Concerning the digital devices, both personal (e.g. smartphones and tablets) and non-personal ones (e.g. digital signage and interactive kiosks), it is important to consider during all the stages of the traveller's journey the accessibility issues related to the possible hearing, mobility, visual, and physical impairments and the usability requirements related to the interactive systems. In effect, a good design of the user interfaces of interactive systems gives the elderly a greater control of their daily activities, making them more active and consequently more willing to opt for new habits [23]. Following, the authors detail the discussed stages, indicating some specific elements that could be implemented or changed in order to improve the public transportation service, according to the transgenerational design approach.

1. *Trip Planning*. At this stage, the users need to know all the different travel options, by choosing the public transport means that most meet their desires. For this reason, the authors propose to improve the structure of the different applications helping the user to do the right choice. In the previous paragraph the authors showed the presence of different travel options (e.g. the propensity for walking, the time shift, the duration of the ride, etc.). Here, in addition, they propose the implementation of more options helping users to identify their better travel solution. A possible proposal is the possibility to choose a public transport means with specific characteristics (e.g. the presence of wheelchair ramps). Another fundamental aspect of the service is the personalization of the experience, as it helps the user to stay focused on his/her objective. In detail, the user, after the identification of the route to follow, should receive only the information he/she needs during his/her specific journey, omitting the data that are not useful for him/her. An example is the use of maps that only put in evidence the elements the user needs most, providing him/her a support for the orientation.
2. *Ticket Purchase*. For this stage the authors propose to consistently design the whole ticket purchase through the different channels. By this way the digital interaction (e.g. the graphical interfaces, the navigation path, etc.) and the physical one (e.g. the design of the automatic vending machines, etc.), should be rethought seamless by facilitating the transition from online and offline or avoiding it when useless. For this reason, the authors suggest that this process should be characterized by a clear explanation of the process steps and by a wealth of information. In doing that, also specific people categories, as elderly, that need more information during and after the purchasing process (e.g. price comparison, travel opportunities, final report, etc.) [27], are encouraged to use these services. Specific improvements are necessary for the automatic vending machines and the mobile app. On the one hand, the first should provide multi-sensory aids and feedbacks (e.g. acoustic messages and selective lighting) to facilitate the interaction for all the users, filling a gap both of abilities and competences. Moreover, the context of use of the vending machines should be chosen or specifically designed to avoid confusing and noisy situations, as well as crowded environments, in order to allow all the users to accomplish the ticket purchasing process with serenity and concentration. On the other hand, the interaction with the smartphone and the mobile app may probably require a familiarity with

these kinds of systems by the user, so it could be useful to provide at the first use an app walkthrough to explain functionalities or just some intuitive hints that appear during the use of the app. Regarding the ticket, there are some practical advantages to prefer the rechargeable card rather than the paper ticket, as the former is: robust, replaceable, easy to validate, reusable. Furthermore, the rechargeable card, as unique material support, enables the users to focus only on a single, recognizable item, avoiding confusion.

3. *Access to real time information*. During this stage it is important to reduce the gap of information that could bring, not only the user to make wrong choices, but also to be irritated, frustrated, and nervous, mainly while exploring little-known spaces. This element is particularly true for the elderly, who feel anxiety when they are in new places or in unfamiliar situations [22]. So, in these cases the user should not only be sure that the path he/she is following is the right one, but also that he/she is receiving real time information and services only related to the route he/she has to do. In fact, it could be useful that the system automatically changes on the basis of the stages of the journey. A push-oriented approach facilitates this kind of interaction between the user and the needed information; the use of personal devices (e.g. smartphone, tablet, etc.) allows for better personalizing the experience. An example: when the user is waiting for the bus, he/she can receive information, not only related to the time arrival, but also to the characteristics of the mean (e.g. crowding, spaces and services on board, presence of wheelchair ramps, etc.). At the same time, the use of digital screens on board could be very useful by giving people detailed information (e.g. time of arrival at the different stops).
4. *Ticket Validation*. The validation of the e-tickets, both through smartphones and contactless smart cards, requires the use of technological systems that may be less known by the elderly. However, even if paper tickets are more used, the possession of the e-tickets could be over time more useful for the elderly. This kind of ticket can be more immediate, making the validation process faster and efficient. In fact, it requires a lower cognitive effort concerning the needed position of the ticket for the validation operations, since the user has only to place the ticket near the contactless reader. Anyway, a good communication of these operations, for example by realizing tutorials, is necessary. Regarding that, if nowadays the elderly are more ready to validate e-tickets through a smart card (since it is a more immediate tool), they are probably less ready to validate them through the smartphone that could be more complex in the mode of operation. The authors sustain that to allow the elderly to familiarize with an e-ticket on the smartphone some elements are required, for example the possibility to visualize the ticket in a version that resembles the paper ticket. Letting the elderly familiarize with these technologies is important for the future adoption of digital services. Moreover, the reproduction of the behaviour of other people that already use these services can be really helpful. Finally, also the product design and the user interfaces of the validators are important elements to consider. For example, the "affordance" of the contactless validator is important, as the user needs to understand where to exactly place the ticket.
5. *Ride*. As stated above, the main problem at the ride stage is represented by the changing surrounding conditions. In fact, the vehicles are on the move and so the

users might easily miss their stop if not properly addressed. As the authors said, personal tools such as smartphones can help them, thanks to localization services and other additional features, but users should not exclusively rely on those, since they could stop working right in time of need, due to lack of data connection, low battery or overuse. For this reason, as stated, it is important that users can count on other tools, which have to be reliable, sharable, designed on purpose to satisfy user needs whenever occur. For example, acoustic messages could inform about the following stop with proper anticipation, so that users can have time enough to figure out it is the right stop, prepare and get off, even if they are inattentive, slow or squeezed in a crowded vehicle. On board screens are nowadays scarcely used to offer information and they end up being mainly advertising spaces. Instead, they could be used to provide real time information about the localization of the vehicle (so that the user can always know where he/she is) and about surrounding activities and points of interest.

6 Conclusion

In this paper the authors have dealt with the re-design of a public transport service according to the transgenerational design approach, focusing on technological issues. In fact, the increasing presence of innovative technologies, e.g. ICTs, in the public services leads to consider the effective access required to them by all the people categories. In general, the principles that orient the design of digital applications according to the transgenerational design approach are: minimizing the effort for each task, accommodating rather than discriminating, using multiple service solutions, personalizing the experience, designing a seamless experience, clearly explaining all the steps of the process, reducing the gaps of information. Furthermore, to facilitate the technology adoption also by the elderly a good communication that points out the advantages and the benefits of these solutions is needed. This is a key point to consider, since it really induces the change in the older adult's habits.

However, in order to allow a real inclusion it is necessary to redesign all the human experience, also improving the other elements of the public transport service (e.g. the spaces, the products, etc.) that may still present hindrances for the older part of the population. For example, an important element to take into account is the signage of the urban spaces, and especially that of the spaces related to the public transportation. In this paper the authors mostly focus on the influence of technologies on the whole experience, postponing this analysis to a large-scale design process with the users. In effect, in redesigning the overall human experience, it is necessary to understand the people needs, especially the elderly ones, really engaging them in the design process. So, in the future work the authors are going to apply the human-centered design methodologies in order to identify how people act in the urban environment and what solutions better meet their needs and desires.

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