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Summary

Accessibility is often neglected in urban mobility projects, from the planning to the operational phase. Within the focus of this work - embarkation / disembarkation on urban buses – it´s noticeable that there is no adequate adaptation of vehicles, environments and services to people with disabilities and reduced mobility; or there is no full social integration of these passengers, which in turn could be achieved through the concept of Universal Design. Attention is drawn to the fact that accessibility, which is intrinsic to the daily life of cities, is only feasible through the continuous and joint action of its different actors, with a balance of interests of different types of users, entrepreneurs and public power.

Keywords: Accessibility; Public transportation by bus; Universal Design.

Introduction

In recent years, bus transportation systems have suffered successive decreases in the number of users, due to the decline in attractiveness and passenger loyalty caused by the low perception of system quality (Schein, 2003). Accessibility, being a quality factor of transport systems, is often neglected at the planning, implementation and operation stages, with solutions dissociated from a general and systemic view and with little discussion with users (Wright, 2001).

Another issue is that most projects are based on a hypothetical human standard, with little emphasis on physical and behavioral differences. In fact, it is known that diversity has always been the main mark of humanity. When it is well understood and celebrated, there is great social and cultural gain with the full acceptance of individual differences, including their limitations (Simões and Bispo, 2006).

Thus, with this work, the objective was to understand the complexity of accessibility, in the context of the embarkation and the transposition of borders in Brazilian urban buses, although there are several other issues involved. It is perceived that accessibility is an essential factor for a city to be really people-oriented, and therefore it must be understood as something systemic and weaved by its various actors. For this purpose, a literature review was carried out, covering books, articles, dissertations, theses, periodicals and legislation.

Accessibility and human limitations

With the adoption of the social model of considering people with disabilities within the concept of recognition and celebration of diversity, cited by Simões and Bispo (2006), the issue of accessibility has been widely discussed today. According to the Law 10.098, it is defined as:

> *[...] the possibility and scope for the safe and autonomous use of spaces, furniture, urban equipment, buildings, transport, information and communication, including their systems and technologies, as well as other services and facilities open to the public, for public or private use, both in urban and rural areas, by people with disabilities or with reduced mobility (Brazil, 2000, art. 2, our translation).*

The concept mentioned resolves that all people have the right to access any transportation system or urban equipment, regardless of their limitations, and it is the products and environments that must be prepared to attend them (Carvalho, 2015). However, the issue goes further: there needs to be a social action, with the involvement and responsibility of all society in adapting themselves, so that people with disabilities can fully participate in all areas of social life. Disability, therefore, is not the attribute of a particular person, but a complex set of conditions often resulting from the social environment itself (Simões and Bispo, 2006, WHO, 2001).

Within the international legislation on accessibility, it is important to highlight the United Nations Convention on the Rights of Persons with Disabilities, adopted in 2006 at the UN General Assembly, which aims to "protect and guarantee full and equal access to all human rights and fundamental freedoms for all persons with disabilities and to promote respect for their dignity " (ONU Brazil, 2016, our translation).

The convention was also internalized in Brazil, thus creating in 2009 the Decree No. 6949, considering the implementation and compliance with the Convention and its Optional Protocol, as fully contained in them. One of the highlights is the recognition of people with disabilities as important authors in the weaving of cities, and their potential to contribute to the common welfare and diversity of their communities, strengthening their sense of belonging to society, and promoting human, social and economic development (Dias et al., 2014).

In addition to reduced mobility of a permanent character, there are the temporary limitations that people are subject to at some time or stage of their lives. There is also the influence of certain day-to-day circumstances, individual conditions, and problems in the interaction with the physical environment that affect the conditions of mobility (Dischinger, Bins Ely and Piardi, 2012; Simões and Bispo, 2006; Wright, 2001).

In a public transportation system that provides quality access and services, the percentage of people who need specific adaptations to get around and carry out their day-to-day activities is reduced. Often such measures are indispensable and represent the most viable form. However, because they serve only a certain type of user, they run the risk of having a reduced opportunity to develop a interaction with products and their independence, and may be stigmatized or treated as incapable (Wright, 2001).

This happens, for example, in the questionable operation of some bus equipment, such as elevators and manual ramps, which are discussed in this paper. Thus, in the policies for the implementation of accessibility, there is a lack of concern for efficient social inclusion, including within the scope of legislation.

Universal Design

A design concept that covers the accessibility issues is the Universal Design (also called by some authors as design or universal project), a term that began to be used by the architect Ron Mace in 1985. In this conception, there is a concern in designing products or environments with characteristics that facilitate their use by the majority of people, including minorities, with the consideration of different anthropometric and sensorial characteristics, without the need for an adaptation or a specialized project, although in fact, it is not possible to serve the totality of users (Alvarenga, 2006; Carvalho, 2015; Dischinger; Bins Ely; Piardi, 2012; Iida, 2005).

Similar to this concept, there is also the term Inclusive Design, which according to Alvarenga (2006) has the same objective and meaning. They both assume that common social systems should be adapted to human diversity, including ethnicity, language, nationality, gender, sexual orientation, disability, amongst other attributes (Sassaki, 2009). In the public transportation, it becomes important to apply such concept, seeing as it is an equipment that allows the integration of people of the most varied profiles and capacities to the daily life and activities of a city, allowing them to play an active role in the local construction and development.

According to Iida (2005) and Simões and Bispo (2006), the projects developed in this concept of universality can have cost reductions with adaptations and special artifacts, and create conditions for the expansion of the target audience and with a better image. However, in the context of public transport, vehicular, operational and infrastructure-related costs are proven to be higher and thus the main cause of low interest both by operators and public authorities, and it may still be necessary to provide technical assistance to specific groups of people with disabilities as a complementary form (Carvalho, 2015; Pereira, 2008 and Wright, 2001).

According to Alvarenga (2006) and Simões and Bispo (2006), Universal Design, a concept that places users in the spotlight, requires their consultation and involvement in the development phases of the project. According to Simões and Bispo (2006) and Iida (2005), it is based on seven principles related to usability. They are:

• Have equitable use;

• Offer flexibility in use;

• Be simple and intuitive;

• Possess perceptible information to various human senses;

• Allow error tolerance;

• Provide low physical effort, ensuring maximum efficiency and comfort;

• Dimension the size, space and effort to the approximation for use.

Within the context of urban planning, this project concept has become an indispensable subject as it allows the identification of areas with inequalities in the provision of basic infrastructure, and because it is directly related to the quality of life since it involves greater equality of conditions, access, security and comfort for users, and consequently less prejudice, segregation and intolerance (Goto, 2000; Vasconcellos, 2000). However, there are some challenges in the transport system for the implementation of accessibility and social inclusion.

The first - and the main - is related to the reconciliation of individualities and diverse needs, both of priority groups and of others, even if their involvement is indirect. The same solution which would facilitate the accessibility of certain users, could hamper the access of others. Thus, without the recognition that people have different needs, and with an in-depth analysis of the various characteristics, capacities and limitations, the objective of offering accessibility conditions for all is compromised (Carvalho, 2003; Dischinger, 2000; Dischinger; Bins Ely; Piardi, 2012; Simões and Bispo, 2006).

The **second challenge** is to have a systemic approach to accessibility, assessing the interrelationships between built space and transportation. Therefore, the interactions of the vehicle with the medium must be considered; the structure of the shelter or terminal, with good access, usability, user protection; and urban infrastructure by foreseeing level changes and sidewalk signaling, since that planning public transportation also implies in complementary commuting on foot (Carvalho and Silva, 2003; Ferraz, 1998; Pinheiro, 2005; Wright, 2001).

The **third major challenge** is the dependence of government action to change the infrastructure of cities linked to accessibility, as well as the creation of laws, rules, regulation and supervision and the intermediation of issues and interests between users and operators (administrators of the fleet). There is still a lack of joint planning and better communication among the governments at the Municipal, State and Federal levels for the implementation and feasibility of such measures (Simões and Bispo, 2006; Lanzoni et al., 2011).

Legislation and regulation of accessibility on buses

Despite the political issue mentioned above, accessibility in the public transportation by bus in Brazil is already regulated. In 2004, the Decree No. 5296 was published, which stipulates conditions for accessibility, creation of norms and even deadlines for adjustments involving the fleet of urban road transport vehicles and the infrastructure of transportation services. Within the requirements, it was stated that the embarking/ disembarking of the users should be at ground level in at least one of the accesses of the vehicle (Brazil, 2004).

Because of this decree, some Brazilian norms were created, or had their action intensified, to regulate the accessibility of urban transport spaces and vehicles, such as:

• NBR 9050 (Accessibility to buildings, furniture, spaces and urban equipment).

• NBR 14022 (Accessibility in vehicles of urban characteristics for the collective transport of passengers);

• NBR 15570 (Transportation - Technical specifications for the production of urban vehicles for collective passenger transport);

• NBR 15646 (Accessibility - vehicular lift platform and vehicular access ramp for accessibility in vehicles with urban characteristics for public passenger transport - Performance, design, installation requirements (ABNT, 2004; 2005; 2008; 2009).

According to Wright (2001), even with the social advances brought by these norms, many of them fail to cater to the scope of all accessibility problems. Most of them focus on wheelchair issues, with less emphasis on other disabilities.

Concerning the physical accessibility of boarding in public urban transport vehicles, which is the focus of this research, the NBR 14022 standard foresees the adequacy of the environments, the vehicles, or both, through devices for border transposition, which can also be combined with automatic or manual ramps, vehicle lift platform, vertical vehicle suspension system and boarding and disembarkation platform (ABNT, 2009). Regarding vehicle suitability, three types of accessible vehicles are considered:

• Low-floor;

• High floor with access made by embarking / disembarking platform;

• Top-floor equipped with vehicular lift platform.

From this, it is the responsibility of the public power of each region to define the types of buses that will be used in cities, according to the transportation infrastructure and the road conditions. However, many city halls are not concerned with the issue of accessibility, preferring vehicles with a lift, although they are not the ones recommended by the norm (ABNT, 2009; Carvalho, 2015; Pereira, 2008).

Low-floor Bus

The Low-floor buses have the floor inside lowered in any of its sections (front, center, rear or total) (ABNT, 2009). The most common type is the so-called *Low-Entry*, with the lowering of the center to the front (Fig. 1). There is also the *Low-Floor*, where its entire extent is lowered (Fig. 2) (Carvalho, 2015; Pereira, 2008; Wright, 2001).

Such vehicles dispense with steps and lifts for the access of passengers, and may have automatic or manual ramps, in addition to the air suspension with the system called *kneeling*, which lowers the vehicle and allows a better leveling with the sidewalk during the stops. Even for a non-disabled user who is at the street level, he / she will have easy boarding, having to face only a small gap between the floor and the floor of the vehicle (B7R …, 2000, King, 1998, Wright, 2001).

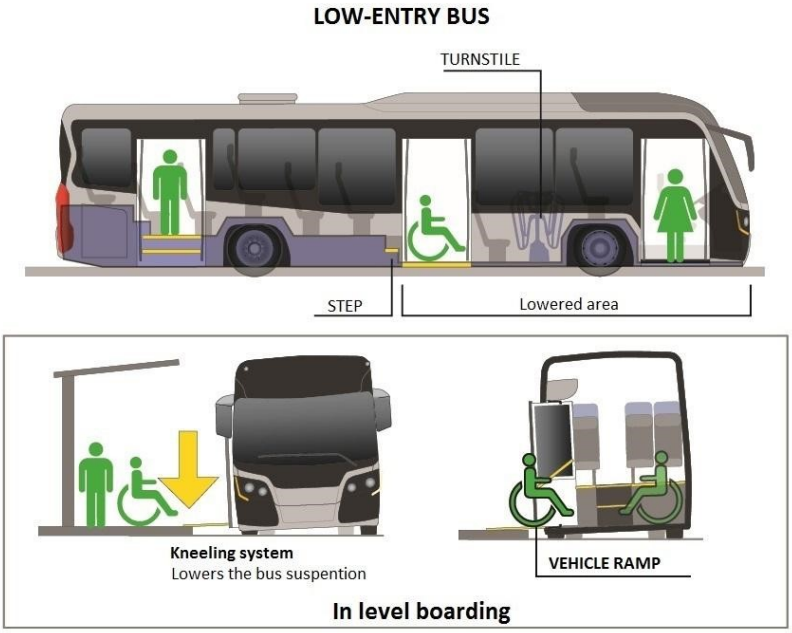

Fig. 1: The Low-entry boarding is performed in the lowered area, with height adjustment of the vehicle and with the possibility of aiding a ramp. Source: Raphael Souza, Róber Botelho, 2017.

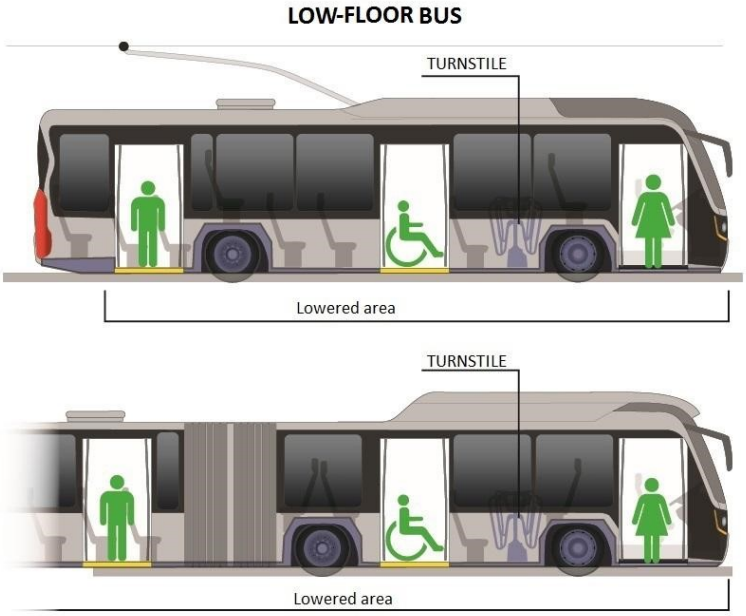

Fig 2: Low-Floor – The boarding is performed in level, similar to the Low-Entry, however, the lowered area covers the entire extension of the vehicle. In the figure are exemplified a trolleybus and an articulated bus in this configuration. Source: Raphael Souza, Róber Botelho, 2017.

To evaluate the characteristics of this type of bus, qualitative research was carried out involving users, entrepreneurs and collaborators. Kantor, Moscoe and Henke (2006) presents a survey conducted by the *MTA New York City Transit* (public transport company in New York), which aimed to listen to suggestions and check with some users their preferences and feelings of safety, comfort, and reliability of the low-floor buses, compared to those of the standard type. They used techniques such as focus groups and questionnaires involving both participants with no restrictions on mobility, elderly and parents of young children, as well as wheelchair users and visually impaired people. King (1998) also cites other research done in the cities of the United States, but also addressing the point of view of the operating companies. In Brazil, Freitas (2011) conducted interviews with passengers, drivers and collectors, at a time when the last low-floor buses were in operation in the city of Belo Horizonte, MG, being replaced by conventional buses.

Among the benefits to users, those surveys and other bibliographical references pointed to: easy access and friendly use; wider doors; reduction of boarding and disembarkation time; and attendance with more comfort both for people with disabilities, elderly and with mobility limitations, as well as for other users (Freitas 2011, Kantor, Moscoe, Henke, 2006, King, 1998, Schaller, Lowell and Stuart 1998). Among the negative points, were mentioned: the reduction of the supply of seats, when compared to high-floor vehicles of the same length; the presence of a step for access to the raised floor of the rear (in the Low-Entry); and little support to hold on, with the handrail in a raised position and few handles, which can reduce the safety of users (Freitas, 2011; King, 1998; Schaller, Lowell and Stuart 1998; Wrigth 2001)

From the operators' point of view, the low-floor operation eliminates the daily maintenance of the lift and for drivers the engine noise is reduced as it is not located in the front. However, its main disadvantage is related to costs. A new vehicle can be up to 40% more expensive when compared to the high-floor type with elevator, and because of its larger weight and more powerful engine, there is higher fuel consumption (Carvalho, 2015; Freitas, 2011; Pereira, 2008; Wright, 2001). Its maintenance is also considered more costly due to the complexity of the suspension (Pereira, 2008; Wright, 2001).

In relation to its implementation, it does not require major changes and planning in the cities and there is flexibility of routes, however it is a recommended vehicle to be used in roads with better paving conditions and pavements in good condition (Pereira, 2008; Wright, 2001).

According to Wright (2001), Universal Design is partially met by the characteristics of low-floor vehicles, because it allows a comfortable and independent boarding for both those with disabilities and some mobility limitations, and for those who do not have them. However, in order to make it truly viable, due to the infrastructure conditions of the cities and the higher costs, it is necessary to plan jointly between operators and public authorities, and it may be necessary for the latter to provide subsidies (Carvalho, 2015).

High-floor Bus with access made by boarding / disembarking platform

This type of bus, which includes the vehicles of the BRT (Bus Rapid Transit) system, consists of a high-floor bus with embarking and disembarking on platforms at the level of the bus floor (Fig. 3) (Kantor, Moscoe and Henke, 2006). Both platform spaces and vehicles are sized to suit all segments of people with reduced mobility (Carvalho, 2015; Wright, 2001).

The payment of the ticket is made in advance in terminals and transfer stations (Wright, 2001). With fast boarding / disembarkation and exclusive bus lanes, the operation becomes faster, with regularity of time and comfort for users, thus becoming an attractive transportation option (Kantor, Moscoe and Henke, 2006; Larica, 2003; Ministério Das Cidades, 2008).

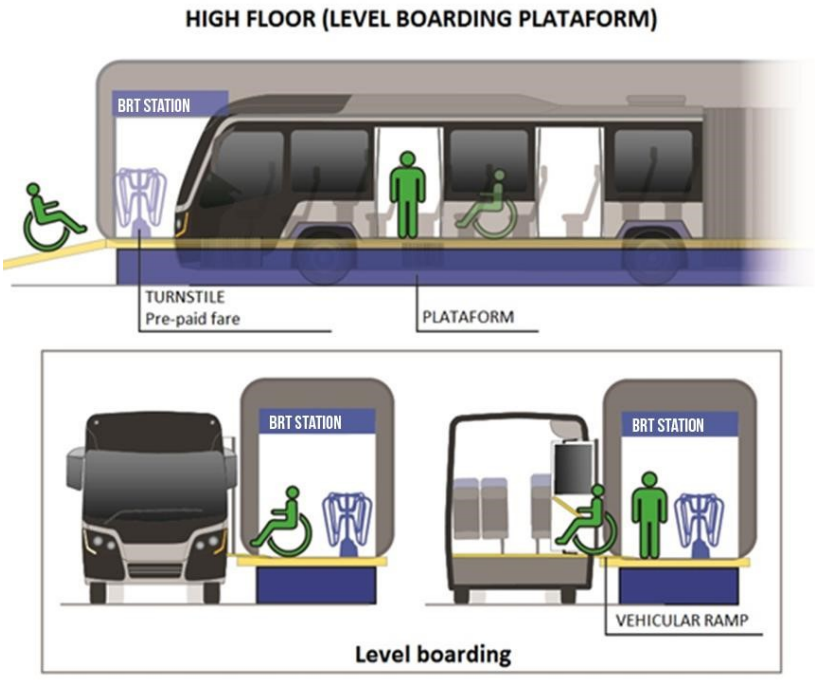

Fig. 3: Boarding of all users by the level platform with prepaid fee and ramp assistance. Source: Raphael Souza, Róber Botelho, 2017.

Some of these vehicles have automatic ramps, as in the cities of Curitiba and Quito, which are triggered soon after they are positioned near the stations. In this way, the embarkation / disembarkation of people with disabilities is guaranteed, without being required landing and maneuver precision on the part of the drivers to cover the spaces and differences between the bus and the platform (Wright, 2001; Chagas, 2014).

In other cities, such as Belo Horizonte, the projects relied on vehicles to accurately level the platforms, with a 2-cm variation only. However, during operation, it has been proven that there may be unevenness of more than 10 cm and in many cases drivers cannot position the vehicles at the ideal distance (Fig. 4). The buses only have a manual ramp that is activated only for the boarding of users with wheelchairs and when there is a gap, but (if the floor of the vehicle is at a lower level than the platform), it becomes inoperative (Reskalla, 2014; Câmara, 2014). The benefits associated with accessibility and social inclusion generated by this transportation are lost when ramps need to be activated by third parties, as there may be operational delays, as well as provoking the constraint of users, a situation similar to elevators, which will be addressed ahead (Chagas, 2014).

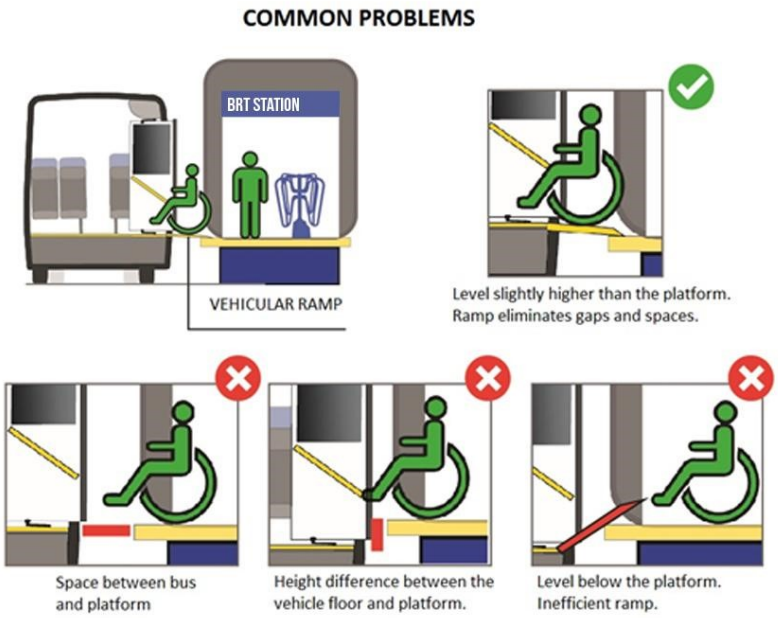

Fig. 4: Common operational problems in passenger boarding in BRT systems. (Source: Raphael Souza, Róber Botelho, 2017)

In addition to boarding issues, BRT systems in many cities are designed to improve the quality of urban mobility and the image of public transportation, with the aim of attracting and retaining users (Larica, 2003; Ministério das Cidades, 2008). Thus, it involves a more complex planning by the public power, with changes in infrastructure, including the construction of terminals, corridors and the adaptations of the environment, as well as the quality of services to the user, with more comfortable and safe places to wait the buses, real-time information and modal integration, including the possibility of transporting bicycles (Kantor; Moscoe; Henke, 2006; Pereira, 2008; Ministério das Cidades, 2008).

Being a modality with a user-centered project, it requires a greater involvement from the planning to the operation. Studies should be conducted in conjunction with the community, analyzing cultural preferences, the most appropriate public transport technology, and the deployment of user information, communication and marketing systems. In this way, the potential for transportation to become more comprehensive with greater equality in the conditions of access and social inclusion is really created, approaching to the concept of Universal Design.

High-floor bus equipped with vehicular lifting platform

This type of bus is the most common, due to both budgetary issues and the conditions of road infrastructure in cities. The vehicles can operate in irregular road systems, where it would be impossible for the low-floor type, and with the dispensation of the implantation of elevated platforms in the stopping points, and of a complex planning as in the BRT systems (NTU, 2008; Carvalho 2015).

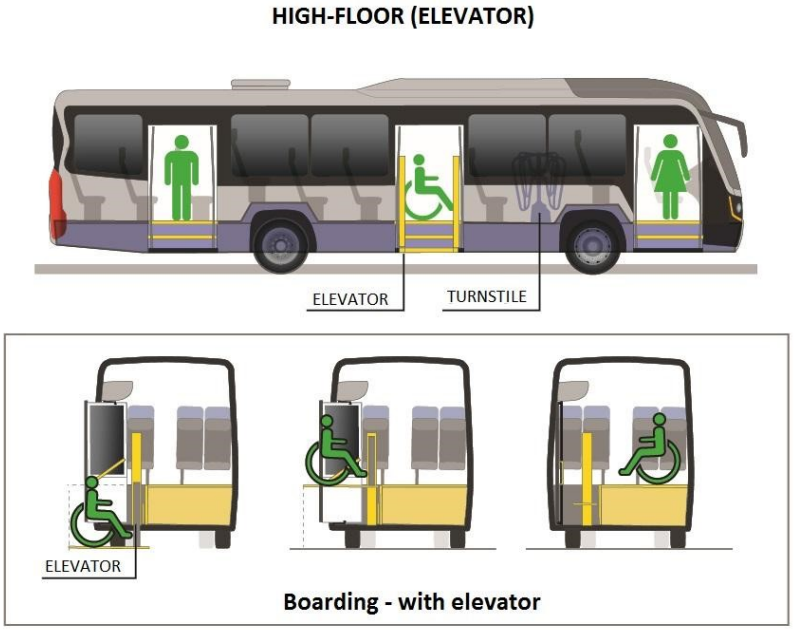

Fig. 5: Embarkation of disabled users through lift platform. Source: Raphael Souza, Róber Botelho, 2017.

Finally, the other advantage, pointed out by NTU (2008) and Pereira (2008), is the possibility of adapting old vehicles to become accessible, following the norm NBR 15646. However, it is not always possible and safe due to the structure of some chassis and bodies that do not foresee the additional unilateral weight and door openings, in addition to the risk of losing the vehicle warranty by its owner (Pereira, 2008).

In relation to attending people with reduced mobility, according to Carvalho (2015), Freitas (2011), Wright (2001), and the reports of Globo.com (2010) and Pereira (2008), who accompanied and interviewed users in the cities of Rio de Janeiro and São Paulo, the following problems can be highlighted:

• Dependence on operators to serve them, who do not always have the goodwill or training necessary to do so, in addition to the fact that some people do not like being helped;

• No attendance of drivers at boarding points when they notice them;

• Slow boarding and disembarkation, and the use of the elevator can take more than 10 minutes, creating constraints for the wheelchair and impatience in other passengers;

• Restriction of elevator service to only wheelchair users, and other groups with mobility limitations, such as elderly and pregnant people, will have to access the vehicle by stairs in an improperly way;

• Possibility of the equipment leaving the user vulnerable to risks;

• Requirement of daily maintenance and frequent occurrence of operational problems of the equipment, which compromise the reliability of the system.

Therefore, this type of bus, even expected by Brazilian legislation, does not guarantee accessibility, as it compromises safety and autonomy, and does not promote social inclusion.

Conclusion

In this study, it was verified that in order for accessibility to be implemented in public transportation in an efficient and integrative way, urban planning must be done in a systemic way, placing users at the center, consulting and involving the community, but in a viable way to others two groups involved: the operators and the public power. In addition, there must be an interweaving of issues related to the transformations of urban spaces and equipment, with the balance of different perspectives, such as technological, political-administrative and behavioral.

Although the focus of this article has been on boarding and the question of transposing physical boundaries, there are a large number of issues related to accessibility, mobility and social inclusion that must be constantly considered and reviewed, such as those relating to cognitive processes and orientation and displacement, and the factors of attraction and reliability of the public transport system.

The accessibility, when well planned and implemented, improves the quality of transportation and the lives of people with disabilities and reduced mobility, as well as of foreigners, illiterates and other passengers, by allowing the whole population to enjoy the spaces and activities of the of cities. The transportation system becomes more attractive and equitable, offering more

confidence, security and comfort to the population, favoring a greater balance and benefits in the social, environmental and economic spheres.

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