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Spatial orientation and accessibility in the Botanical Garden of Juiz de Fora, Minas Gerais (Brazil)

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SUMMARY

Ergonomic requirements have become pillars for the development of varied skills. They enable individuals to get oriented and to move in every environment. These requirements, together with other elements, must grant the quality of accessibility for the greatest number of people. Everyone should be able to move without the help of third parties, which means actual social inclusion. Accessibility is everyone's right and finding orientation means understanding where you are in space and time, therefore being able to define your own displacement. Given these points, this article presents an ergonomic analysis of the facilities of the Botanical Garden of the Federal University of Juiz de Fora: it preserves a large green area within the urbanization and it has a great haven for leisure and contemplation. The Botanical Garden is also a space that promotes educational experiences through cultural events, lectures, and courses for the city's population.

KEYWORDS: Accessibility. Spatial orientation. Public parks.

1 INTRODUCTION

The city presents itself as an element of interactions and interrelationships between social actors who appropriate the spaces/territories, creating integrated and interdependent relationships among themselves. In this regard, Elias (1994) points out that, although thought is fragmentary, areas of knowledge, such as history, sociology, and psychology, unite in defense of the theory of reticular phenomena, which the researcher conceptualizes as the tension existing in the individual/society relationship.

Individuals, according to their interdependence, are members/constituents of society, shaping it and shaping themselves when they relate to each other. According to Elias (1994), this individualization process is not the same in any society and at any historical time, as each society and each historical moment have their own specifications that also determine particular forms of configuration and interrelationship between individuals and society.

Under this logic, within the contemporary urban context, public parks play a fundamental role in the affirmation of identities. They change at the same time as they merge due to the introduction of new cultures and new concepts in the context of interactions. It is in this sense that the large green spaces of cities, such as parks and botanical gardens, present themselves as areas of great importance, not only ecologically, but also socially.

Ultimately, it is imperative that public green spaces are accessible to all. An accessible environment, free from architectural barriers, is an act of social inclusion, empathy, and, more than that, respect for diversity. On this approach, in a comprehensive way, the National School of Public Administration (ENAP) highlights that

> the walking conditions of cities are especially important for people with disabilities, the elderly, children, and pregnant women. In this way, the urban project can either welcome and invite people to socializing or exclude and segregate them, denying them the right to the city (ENAP, 2020, p. 6).

Thus, the accessible urban environment is a facilitating element for people with disabilities to enjoy life in society, independently. This means fully participating in all the possibilities offered by the spaces, with equal opportunities, both in physical aspects as well as in transportation, information and communication.

Regarding these premises, this article starts with the following question: how the Botanical Garden of Juiz de Fora (Minas Gerais, Brazil), linked to the Federal University of Juiz de Fora, has dealt with spatial orientation and accessibility and what are the strategies to overcome existing barriers while we aim for social inclusion? As we know, despite all the challenges, public spaces must seek to favor inclusion strategies, and consequently eliminate architectural and communicational barriers.

2 OBJECTIVES

Considering the question that motivated the research, the main objective of this article is to highlight some architectural and communicational barriers in the Botanical Garden of Juiz de Fora, Minas Gerais. The objective is also to present, in the light of physical ergonomics and with the help of the four components pointed out by Dischinger and Bins Ely (2006), suggestions for improvement that could contribute to accessibility studies, therefore possibly favoring social inclusion.

Finally, from this case study, we expect to contribute to a discussion on accessibility (architectural and urban) and spatial orientation (spatial signage system) in large public green areas, such as parks and botanical gardens.

3 METHODOLY

From a methodological point of view, this article is the result of a qualitative and exploratory research, which relies both on the collection of bibliographic plus documental data and on the in loco survey that was established on unsystematic and systematized observations.

Due to the pandemic, the bibliographic research began in 2020 but the field research only happened in July 2021, after the approval for this activity was granted by the consultative and deliberative bodies of the Botanical Garden. It is also significant to know that this research complied with all health safety protocols established by the Federal University of Juiz de Fora and by the Botanical Garden.

The on-site visit aimed to perceive the physical barriers that jeopardize the free access of people with disabilities in the public areas of the Botanical Garden. Signage systems were also analyzed, in an attempt to understand to what extent these items have contributed to the efficient use of space. For this purpose, we produced photographic and field diary records of the sights. The studied spaces comprised: the main entrance, access to decks for lookouts, access to the main house, and entrances to the trails.

So far, as presented in this article, the observations of the research were restricted as per the guidelines of circulation routes of the Botanical Garden. Indoor spaces were not surveyed, but there is a plan to examine them in a future step of the research.

At the end, the data were analyzed according to the four accessibility components of the built environment proposed by Dischinger and Bins Ely (2006), leading to suggestions for improvement.

It is also worth mentioning that the operationalization of the research has its roots in the ergonomic intervention methodology, developed by Moraes and Mont'Alvão (2002). The method is established on five major steps: Ergonomic Assessment, Ergonomic Diagnosis, Ergonomic Design; Evaluation/validation/ergonomic tests; and detailing and optimization.

The ergonomic assessment, the focus of the research, regards an exploratory stage, a moment of in loco observations in an unsystematic way, and, after data collection, it culminates in an ergonomic opinion about the significant issues. Therefore, the ergonomic problems were mapped using unsystematic and later systematized observations through taxonomy and categorization of the problems we took into consideration. That worked as preparation for the formulation of the problem, explanation of hypotheses and definition of variables. Then, the hierarchies of the ergonomic problems were observed. Later, the prioritization and predictions of these problems were elaborated. Finally, some preliminary suggestions for improvement were made, aiming to overcome the highlighted architectural and communicational barriers.

4 ACCESSIBILITY POLICIES AND PROJECTS IN THE BUILT ENVIRONMENT

In the scope of social relations, it is necessary to understand the importance of incorporating accessibility policies and projects in the built environment for the full exercise of citizenship and social inclusion. Public and private spaces are usually designed for able-bodied people. But if the plurality of individuals is disregarded, social segregation will automatically occur. On this matter, Cambiaghi (2007, p. 40) emphasizes that,

> generally speaking, today, we live in environments created by human beings for human beings. Thus, any interaction problem must also be seen as a result of the inadequacy of this environment to our needs and not exclusively as a mismatch of our capabilities to the environment.

In this perspective, the Convention on the Rights of People with Disabilities clarifies, on the ninth article, that it deals with "Accessibility":

> In order to enable people with disabilities to live independently and participate fully in all aspects of life, States Parties shall take appropriate measures to ensure people with disabilities have equal access to the physical environment, on an equal basis with others, transport, information and communication, including information and communication systems and technologies, as well as other services and facilities open to the public or for public use, both in urban and rural areas. These measures, which will include the identification and elimination of barriers and barriers to accessibility, will apply, among others, to: a. Buildings, highways, transportation, and other indoor and outdoor facilities, including schools, homes, medical facilities, and workplaces; B. Information, communications and other services, including electronic services and emergency services; (...). (BRASIL, 2007, p. 21.).

People with disabilities have gained visibility mainly due to the fact that the UN Convention on the Rights of People with Disabilities is superior to a constitutional amendment,

hence it is a constitutional norm. IN a plural and heterogeneous society, to which we all belong, it is urgent to acknowledge people with disabilities and provide each and every individual with the same opportunities and enjoyments.

In Brazil, Law number 13 146/2015 (the Statute of People with Disabilities) concerns people with disabilities and their right to fundamental freedom. They should be able to live an independent life and engage in society just like other people. We agree with Araujo and Maia (2015, p. 231) when they state that accessibility "is a necessary assumption for inclusion" and “the acceptance by society will only be possible if accessibility is implemented, enabling people with disabilities to enjoy all the rights given to them by the legal system”.

When talking about accessibility, we inevitably refer to Ergonomics. It is worth remembering that we find, in literature, several definitions for this field of knowledge and human action. However, all conceptualization (or definitions) have an agreement as described by Iida (2005, p. 2):

> the interdisciplinary character and the object of its study, which is the interaction between man and work, in the man-machine-environment system. Or, more precisely, the interfaces of this system, where information and energy are exchanged between man, machine and environment, resulting in the performance of work.

It is noteworthy that the term “work," in this context, has a broader meaning, not referring only to paid tasks that require the individual's interaction with machinery and equipment in the means of production for transforming materials.

> Ergonomics takes a broad view, encompassing planning and design activities, which take place before the work is carried out, and those of control and evaluation, which take place during and after the work. All this is necessary for the work to achieve the desired results. (...) ergonomics starts from man's knowledge to design the work, adjusting it to his abilities and limitations (IIDA, 2005, p. 2).

In this sense, operating ergonomics is, in fact, articulating multidisciplinary knowledge in order to positively transform products, environments or any type of system that presents interaction between the individual, the machine and the environment. The goal is to minimize fatigue, stress, avoid damage, prevent accidents and provide satisfaction and quality of life to the system user.

Within the scope of research in ergonomics, "Spatial accessibility" has been increasingly present in academic debate and has expanded beyond academia, reaching the general public that enjoys urban environments, especially public ones. Therefore, accessibility in the built environment brings an effective discourse on the “social inclusion/segregation” dichotomy, fostering the debate on the proposition of public policies regarding the elimination of physical and architectural barriers, which, to a large extent, end up by preventing the effective movement of people in built spaces.

> Physical barriers can be natural or constructed elements, which make it difficult or prevent the performance of desired activities independently. The presence of trees and poles on a narrow sidewalk reduces, for example, the circulation area for all pedestrians. It can even prevent the movement of a person in a wheelchair and thus becomes a barrier for that person. Excessive noise can be a barrier for a person who

> can hear poorly, and also for a blind person who needs to recognize the sounds of activities to know where they are (MONT'ALVÃO; VILLAROUCO, 2014, p. 43).

Under those circumstances, spatial orientation and way-finding become extremely relevant ergonomic requirements since communication is inherent to human nature and this phenomenon happens when we capture messages/information by listening, smelling, looking, reading, touching and tasting. After all, we perceive the world through various of the human senses. The act of signaling is the ability to give information to another in a specific place, with a specific objective. The signage system is part of the wide universe of visual information that, according to Gomes Filho (2010, p. 152), "give life and promote social relationships between people, identified in their numerous and diversified supports and substrates of visual communication".

Henceforth, when we focus on the urban environment, we will find spatial information about the city, centered on various types of visual appeal systems, such as the guidance and signage system (MORAES, 2002). Gomes Filho (2010, p. 172) defines an orientation system as "objects belonging to the scope of information and that make use of virtual signage in indoor and outdoor environments". Guidance systems are of vital importance, especially in spaces that concentrate large numbers of people, whether they are in transit in vehicles or on foot. Also, per the author,

> they are elements made up of signs, banners, boards, totems, displays, and others, which make it possible to inform people about how they should orient themselves on their route, road, and circulation in company spaces or in places where notices, messages and other types of provision of services outside its headquarters (GOMES FILHO, 2010, p. 208).

According to the informational elements described above, spatial orientation takes on a prominent place in research in various areas of knowledge, but always with regard to the guidance and signage systems. As a result, a strand, in the field of research in ergonomics in the built environment, is now outlined. Communication starts to consider human factors, including physiological aspects.

Following this reasoning, ergonomic requirements become crucial for the effectiveness of signage and the orientation of the built space. Therefore, new subjects of research are open, such as the concept of way-finding (RANGEL, 2016), which appears as a set of urban items that allow the individual to move in a given space in a safe and informed manner.

For an environment to be usable, ergonomic items in signage systems are imperative to enable spaces and make them inclusive, thus meeting the needs of a large part of the public who want to use them independently, without the need for adaptation, without modification or specialized solutions. Smithshuijzen (2007, p. 13) states that it is necessary for the individual to minimally understand the environment in which he is found, in order to feel safe. Thus, the signage, to a large extent, helps to guide the path.

In rapport to Villarouco and Andreto (2008, p. 527), "the aspects involved in adapting the environment must come from the users' feelings in their daily interaction with the environment". Another relevant factor, pointed out by Moraes and Frisoni (2001), to be considered in signage systems, is the usability of human-task-machine communication. For the

author, these are questions that go beyond human-computer interaction studies, and involve warnings, warnings on packaging, signage systems, among others.

Informational ergonomics is responsible for promoting viable spatial orientation. Fialho and Santos (1997) point out that elements such as visibility, readability, understanding, prioritization and coordination, consistency of symbolic components (alphanumeric characters and iconographic symbols) are widely used in the signage, security and guidance systems. Takeda and Xavier (2008) corroborate, stating that it is up to informational ergonomics, the application of specific techniques and assessments that allow the individual the quality of interaction between themselves and their work and between themselves and the space they use.

Despite all the attention and care, the task of designing spaces for everyone is a great challenge given its complexity. However, architects, urban planners, engineers and designers must dedicate themselves to the development of inclusive proposals per the principles of accessibility and ergonomics. In this sense, Dischinger and Bins Ely (2006) point out four components that help in the studies of accessibility of the built environment. They are: (1) guidance and information; (2) mobility; (3) usage; and (4) communication. The definitions of these components are presented in Chart 1.

Chart 1: Guiding components in accessibility studies

Components	Description
Guidance and Information	Fundamental elements for understanding environments. They allow the visitant to be able to situate themselves, and, at the same time, to relate to the space through the quality of the information that exists in a place. Good guidance and information allow locomotion, whether this information is visual, sound, architectural, etc. The use of resources such as informational signs and maps helps with orientation when the environment does not provide information at different points.
Mobility	Condition of mobility or free movement, horizontal or vertical, in circulation areas. Features that qualify this component as effective or not: • Regular and non-slip floors; • Handrails and landings on stairs and ramps; , etc.
Usage	Component that assesses the individual's interaction with the system. Through usage, it is possible to evaluate ergonomic items of usability for products and accessibility in a given spatial configuration. As an example, barrier-free spaces for wheelchairs approaching next to tables, washrooms, etc.
Communication	Ability to satisfactorily give information to the visitant through the quality of existing signage. Important requirements for the quality of this component: assistive technologies, signals, etc.

Source: Bins Ely and Dornelles (2006, p. 3).

The authors also emphasize that to achieve real spatial accessibility it is essential that each component mentioned above is fulfilled effectively. If one of the components fail, it can jeopardize all the others.

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5 RESULTS AND DISCUSSION: ACCESSIBILITY AND SPATIAL ORIENTATION IN THE BOTANICAL GARDEN OF JUIZ DE FORA

According to its website, the Botanical Garden of the Federal University of Juiz de Fora (2020) is a space for the preservation of a large remaining green area of the Atlantic Forest within the urbanization. The site itself (Mata do Krambeck [Krambeck Forest] - Figure 1) encompasses more than 500 plant species already identified in the Botanical Garden area, a stronghold of rare, native, and ornamental plants. It is a place of leisure, contemplation and shelter for existing fauna and beautiful springs. The Botanical Garden is also a space that promotes educational experiences through cultural events, lectures and courses for the city's population. According to Cruz, Braida and Colchete Filho (2020) and Colchete Filho, Pedroso and Braida (2014), the “Mata do Krambeck” environmental protection area covers an area of 291.9 hectares and constitutes one of the largest Atlantic forest remnants in an urban area in the state of Minas Gerais.

Figure 1 – Illustrative map of the Botanical Garden of Juiz de Fora/MG

Fonte: https://www.ufjf.br/jardimbotanico/visitacao/mapa/.

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After the in loco survey, the data were systematized in analytical and propositional frameworks. Due to the maximum number of pages in this article, we chose to consolidate the identified problems in single tables. They are grouped according to the components of the previous section. The tables also contain ergonomic opinions and suggestions for improvement (Charts 2, 3 and 4).

It is remarkable that most images have more than one component that restricts accessibility at the site, such as, for example, lack of signage and lack of ramps or handrails. However, just one of the components was prioritized so it is easier to exhibit the identified problem and the solution for each one of the analytical categories.

Chart 2: Ergonomic opinion: information and guidance

Accessibility Analysis Component: INFORMATION AND GUIDANCE	
	**Problems encountered:** Lack of signs informing the entrance to restrooms. **Suggestions for improvement:** Placing informational signs at the beginning of the walkway indicating the entrance to the restrooms.
	**Problems encountered:** At the arrival of the environmental education house, there is a bifurcation without signage, with no information on the destination of the path ahead. **Suggestions for improvement:** Placing informational signs throughout the garden's circulation route, especially at junctions and entrances to establishments.

Source: Authors' personal collection.

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Chart 3: Ergonomic opinion: mobility

Accessibility Analysis Component: MOBILITY	
	**Problems encountered:** Architectural barriers hindering access to the environmental education house. **Suggestions for improvement**: Leveling the entrance floor through ramps and non-slip floor. Inserting handrail for wheelchair access and people with reduced mobility. At the very least, an accessible route must be created.
	**Problems encountered:** Upon arrival at the Botanical Garden's main building, there is no access option for wheelchair users and people with reduced mobility. **Suggestions for improvement**: Improvement in access stairs and floor leveling, with placement of ramps (next to the stairs), placement of non-slip flooring and a handrail for wheelchair access and people with reduced mobility.

Source: Authors' personal collection.

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Chart 4: Ergonomic opinion: communication

Accessibility Analysis Component: COMMUNICATION	
	**Problems encountered:** Lack of warnings and warnings about danger of approaching and touching toxic plants. **Suggestions for improvement:** Placing warning signs about the danger of touching plants that are toxic to health, in addition to protective railings, mainly preventing children from approaching.
	**Problems encountered:** Lack of signage and warning at the entrance to the trail, which is located outside the main road, whose trail presents risk of accidents and the appearance of wild animals. **Suggestions for improvement:** Placing warning signs about the danger of entering, without prior knowledge of the existing conditions in the place.

Source: Authors' personal collection.

As one can see, different physical (architectural and urban) and communication barriers were identified in the Botanical Garden. They are mainly linked to a faulty signage system. These problems only represent a part of the issues we raised in this paper. And although the number of barriers is much higher, the above-mentioned examples reveal urgent demands for the space to be fully inclusive and to allow visitants to safely exercise their autonomy.

At last, we emphasize that, after the in loco observations, the Botanical Garden does not favor the inclusion of people with disabilities, since this population is not able to safely and independently move around through the pathways in the park. In addition, signage falls short of ergonomic safety and orientation requirements, putting children at risk.

6 CONCLUSION

Accessibility and spatial orientation are topics for an urgent discussion if we want to achieve a truly inclusive society. Therefore, ergonomic requirements in the built environment must go beyond the academic debate and reach different spheres of the social context. Eliminating physical and communicational barriers requires attentive thoughts and effective action, especially when it comes to public environments, such as parks, squares and, in this specific case, a botanical garden.

Specifically, in relation to the Botanical Garden of Juiz de Fora, it appears that there are still important demands for this space to include more people, guaranteeing them safety and autonomy. Some short and medium-term actions, with relatively low costs, may provide a better environment to the visitants. The solutions we suggest are of low complexity and only require attention from the managers of public spaces so that they can be easily implemented.

In conclusion, one can affirm that accessibility is a democratic issue. Accessibility promotes social inclusion and the full exercise of citizenship: only then the individuals can assert their identity. Given that, researches of this nature are deeply necessary as they analyze the quality of life through the interaction of the individual with the environment and consequently may promote the adoption of inclusive public policies. Finally, it is noteworthy that enhancing inclusion, accessibility, and guidance strategies is an exercise of empathy, which was we sought with the research and with this article.

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