PERCEIVING NEEDS FELT BY THE PORTUGUESE COMMUNITY WITH VISION IMPAIRMENT

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Abstract

In an increasingly globalizing society, where the audio-visual world plays a crucial role in the most diverse areas of human activity vision impairment is one of the deficiencies that most directly impact the life quality of individuals who bare it. This deficiency can be classified, according to the World Health Organization, into seven categories in accordance with the greater or the lesser visual acuity that people with this condition have. Among the factors that contribute to eye disease are aging, heredity, unhealthy lifestyles, and certain health conditions. Many eye diseases do not originate from one cause but from a multitude of them. However, advanced age is an unavoidable contributory factor. In Portugal, life expectancy has increased at an escalating pace which reflects in the growth of the elderly population and, consequently, in the growing number of cases of visual vision impairment.

Briefly, we may say that social inclusion makes the feeling of "well-being" universal, turning possible access, when desired, into opportunities for education, work, and health. Social integration implies access to prospects and conditions that guarantee the exercise of human rights.

With the aim of understanding the real needs of daily life felt by the Portuguese community with distance vision impairment, and for which solutions have not yet been found, a research study of a mixed nature was carried out. The results presented here are based on the analysis of the data collected from two questionnaires, one applied to institutions dedicated to this cause and the other one applied to adults with blindness or severe vision impairment according to WHO's distance classification, semi-structured interviews, and field notes. It should be highlighted the precious collaboration of the Portuguese Association of the Blind and Visually Impaired (ACAPO), dispersed throughout various parts of the country, with greater expression in the central zone and the Lisbon metropolitan area, without which it would not have been possible to apply this questionnaire. In this study, the participants revealed the need for auditory applications to the detriment of their representation in Braille. They have pointed out, that even though there are already a large number of auditory applications, sound perception is poor, falling far short of their expectations and needs. An example of this difficulty, strongly present in online authentication mechanisms, is reCAPTCHA. They also highlighted that despite having the ease to move around, either with a cane, guide dogs or without the need for auxiliary resources, they have enormous difficulty in orienting themselves. These difficulties can be overcome by improving the auditory perception of the available tools and/or creating new ones, which may be associated not only with online authentication mechanisms but also with precise direction indicators, increasing the autonomy of these individuals.

Keywords: Vision impairment, needs, mobile devices.

1   INTRODUCTION

Nowadays, there is a great determination to leave no one behind, regardless of the difficulties or conditions that someone may have. The term disability has been gradually modified, which made people increase their understanding of the needs of people with disabilities [1].

In line with the United Nations 2030 Agenda for Sustainable Development [2], which aims to improve the social, economic, and environmental components of the respective member countries, the research study described here falls within goal 3 (Ensure healthy lives and promote well-being for all at all age) and goal 10 (Reduce inequality within and among countries).

Blindness is one of the most common conditions among the elderly population [3]. If we combine this fact with the growth in life expectancy [4], we can predict that the number of people with this condition will also be increasing. This is a reality, not only in Portugal but worldwide.

According to the most recent estimates, as reported in [5], there are 43.3 million people blind worldwide representing a prevalence of 5.25 cases per 1,000 persons, and 295.3 million people moderate to severely visually impaired representing a prevalence of 35.8 cases per 1,000 persons. The International Agency for the Prevention of Blindness (IAPB) points to a doubling of these numbers, due to the aging of the population. Looking at the Portugal case, in 1970 the Portuguese lived, on average, 67 years, while in 2018 the standard was 81 years [6]. In addition, in 1970, the birth rate was 10.1% higher than the death rate, while in 2018, the death rate was 2.5% higher than the birth rate [7], [8].

Blindness can be distinguished by different degrees or categories [9]. For its identification, there are several tests available, among which stand out the Snellen and the Tumbling E [10]. The first test consists of sitting the patient at a specific distance from a board, covering only one eye. This board contains a set of letters distributed by rows and columns, in which the size of the letters decreases line by line. The objective is to read these letters aloud until there is no possibility of comprehension. The second test, the Random E test or Tumbling E Eye Test, consists of identifying directions, left, right, up, or down, in which the legs of the letter "E" are directed [11]. For visual acuity evaluation, the former is generally preferred and is expressed as a fraction, such as 20/x. Having 20/20 vision represents the ideal, and it means that 20 feet away from an object, visual acuity is normal. However, having 20/40 vision, for example, means you need to be 20 feet away from an object to perceive it, whereas a person with normal vision would be 40 feet apart.

According to the World Health Organization [12], there are seven categories, numbered 0, 1, 2, 3, 4, 5, and 9, referring to the visual acuity of people with vision impairment. The first category, category 0 – Mild or absent vision impairment – refers to individuals who see equal to or better than 20/70, that is, individuals who do not have vision problems or the problems are very reduced; category 1 – Moderate vision impairment – refers to people who see worse than 20/70 and equal to or better than 20/200, that is, they have a reasonable vision; category 2 – Severe vision impairment – refers to people who see worse than 20/200, and equal to or better than 20/400, that is, the person sees with great difficulty but is still not considered blind. Categories 1 and 2 belong to the classification of low vision, it should be noted that vision problems such as farsightedness, myopia, and astigmatism, depending on the degree, are included in these categories. There is still category 3 – Blindness – which refers to people who see worse than 20/400, and equal to or better than 20/1200, that is, they are the least intense degree of blindness; category 4 – Blindness – refers to people who see worse than 20/1200, that is, they have great difficulty seeing, but still can perceive light; category 5 – Blindness – refers to a degree of blindness, in which people no longer have light perception; and category 9 has undetermined or unspecified visual acuity. Note that in categories 3, and 4 the person in question can count fingers at least one meter away, which does not happen with category 5. The distinction of the blindness category is very useful, as capabilities are related to the identified degree [12].

Several causes originate blindness or low vision. According to the IAPB [13], the five most relevant are: (i) Refractive error - consists of an error in the refraction of light entering the eye, which causes difficulty in focusing images from the outside world, blurred vision is the main consequence of this disease that, in some cases, can lead to low vision. The best-known refractory errors are myopia, hyperopia, and astigmatism [14]; (ii) Cataract is the leading cause of blindness worldwide. It consists of the appearance of a cloudy area on the lens of the eye, which at first may not be noticeable, but over time makes the vision blurry, dim, or less colorful [15]; (iii) Macular degeneration, another major cause of blindness, consists of obscuring central vision. It occurs when there is damage to the macula - the part of the eye that controls the sharpness and vision direction. It may not cause total blindness, but it does make it difficult to perform some daily activities, such as identifying faces, reading, and driving [16]; (iv) Glaucoma refers to damage to the optic nerve, the nerve responsible for communication between the eye and the brain. It is usually caused by an accumulation of liquid in front of the eye, reflected in the compression of this nerve [17]; It is usually caused by an accumulation of fluid in the front of the eye, reflected in the compression of this nerve [14]; (iv) Diabetic Retinopathy, which is also one of the leading causes of vision loss worldwide, takes several years to threaten vision. Since diabetes arises due to a high concentration of sugar in the blood, this can damage the retina, thus originating this pathology [15].

According to the Association of the Blind and Visually Impaired of Portugal (ACAPO), the main causes of blindness, in Portugal, are refractive error, glaucoma, and diabetic retinopathy [16]. However, there is only confirmed information concerning glaucoma in the National Institute of Statistics (INE) dated 2005/2006 [17].

Illness that disrupts the patient's daily activities can be classified as chronic communicable diseases, (CDs) or non-communicable diseases (NCDs), the latter being described, by WHO, as a long-term trend due to a combination of genetic, physiological, environmental, and behavioral factors [18]. Blindness,

according to the IAPB, although it fulfills the scope to be considered as an NCD, for a long time already [19], the WHO has not yet considered it as such, which makes it impossible for people who suffer from low vision or blindness to access certain worldwide available resources. For example, the United Nations (UN) is strongly committed to finding new sources to finance the development of NCDs, establishing agreements with the Global Coordinating Mechanism for the Prevention and Control of NCDs (WHO GCM) [20], of which Portugal is a member [21]. In addition, since 2013, there has been an operational and multisectoral national policy, strategy, or action plan for NCDs that integrates several of these disorders and their risk factors [22].

Over the last few years, technology has been evolving at a galloping pace playing an increasingly important role in everyday life. The functions they provide are geared towards younger people, forgetting a significant fringe of society, which is increasingly notable, the elderly. These, in turn, contract diseases more frequently, such as those mentioned, and are excluded from this integration [23]. Therefore, when designing certain functions or devices, the necessary adaptations for people with disabilities, blind people included, must be taken into consideration, thus promoting social integration.

All these concerns directed the research study reported in this paper. In this sense, factors such as the age group, the origin of their disease, and their most significant needs, from both perspectives of institutions and patients, were identified.

The first stage consists of constructing a theoretical basis for developing applications that facilitate their daily life. This article reports an exploratory research study to obtain insights into the needs of these people and the age group for which these apps should be developed, aiming to improve their overall quality of life and integration into the community in which they live.

2   METHODOLOGY

The main objective of this research study is to identify the most pressing needs of people with visual impairment, considering several factors, such as age, locomotion, and location. The data reported in this paper are derived from a mixed-method exploratory study seeking to obtain more information on this subject, deepen the understanding of their needs, and outline a possible strategy to help them. The results presented here are based on two questionnaires and semi-structured interviews.

The first questionnaire was addressed to institutions and companies that work with or provide services to visually impaired people. The purpose of this approach was to identify the ages of the users to whom they provide services, the needs these institutions consider essential for their members, the most common means of transport, and their availability for the participation and dissemination of a second questionnaire.

For the circulation of the first questionnaire, the organizations that best suited the scope of the study were selected, including ACAPO delegations. The questionnaire, applied during May and June 2022 and disseminated by email and telephone, was sent to 39 institutions, of which only 22 (56%) responded.

From the questionnaire data analysis, described in detail in the next section, arose the need to clarify some aspects, such as the origin of the lost sight or the degree of incapacity, and the real needs of the target group. For this purpose, semi-structured interviews were carried out with members of the participant organizations performing secretarial and public service functions. We highlight the fact that 2 among 39 of these members are visually impaired. The collected information proved to be essential for the elaboration of a second questionnaire.

Following the qualitative analysis of these interviews, and joining the information collected from the first questionnaire, a second questionnaire was designed for the same target group. The collaboration of the previous entities was, once again, essential in the circulation process of the second questionnaire. We also emphasize that the new questionnaire was tested regarding the use of the electronic tool "Screen reader", which they use more frequently, ensuring its accessibility.

The primary objective of the second questionnaire was to ascertain whether the requirements and modes of locomotion recognized by the organizations align with those of their members. Additionally, it aimed to gather information on the age, origin, and severity of visual impairment of the participants, as well as to identify their priority needs that could improve their daily routines.

The analysis of the second questionnaire, comprising both closed and open-ended questions, and applied from December 2022 to March 2023 is of mixed nature. This questionnaire contains a section (the "Opinion" section) enabling the respondents to share their thoughts on the issues discussed.

Regarding the sample of this research, the participation rate was more significant, with 80 respondents giving their contribution, considering the anonymity of the answers and the confidentiality of the data.

In the following section, an analysis and discussion of the accumulated data will be presented, utilizing both quantitative and qualitative methodologies. The analysis will begin by assessing each questionnaire independently, and then the findings will be compared to evaluate the level of consensus between the two groups surveyed.

3 DATA ANALYSIS

This section is structured into four subsections to analyze in detail our findings. The first subsection provides an analysis of the collected data from the first questionnaire. The second subsection is focused on the analysis of the semi-structured interviews, the third is dedicated to the examination of data gathered from the second questionnaire, and the final presents a comparative and integrative analysis of all collected data throughout the study.

Regarding the first questionnaire, addressed to support organizations, the collected information was classified according to the following categories: age, NUTS II classifications of Portugal (Nomenclature of Territorial Units for Statistics) [24], use of Braille, method of transport more adopted and needs that these organizations identify as priorities.
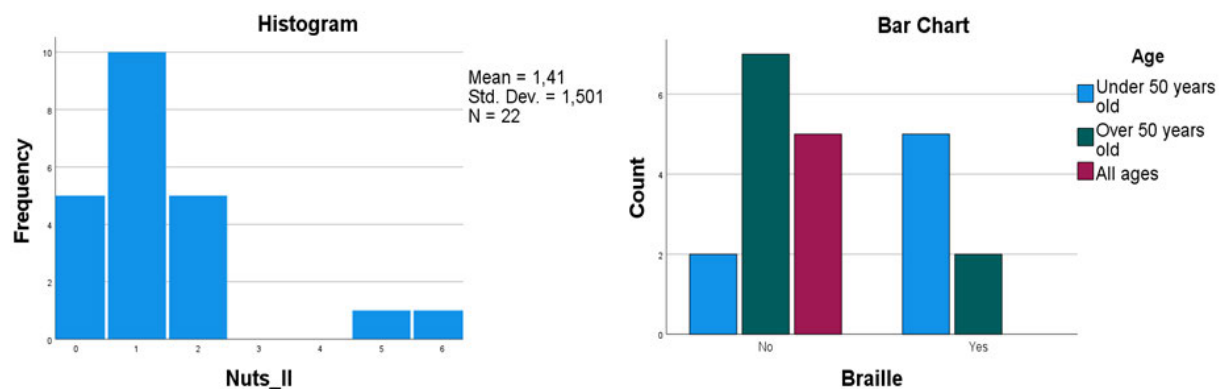

Figure 1. Territorial division, and Braille reading

For the first category, age, a division was established based on a specific value, considering the previous bibliographic review. Thus, the organizations were separated according to those who serve people aged 50 or over (40.9%), under 50 (31.8%), or all ages (27.3%).

For the territorial division, Portugal NUTS II classifications, the regions were coded according to the following numbers: 0 North, 1 Centre, 2 Lisbon Metropolitan Area, 3 Alentejo, 4 Algarve, 5 Madeira, and 6 Azores, see left-hand side of Figure 1. The Centre is strongly present, followed by the North and the Lisbon Metropolitan Area. We received responses from an organization in Madeira, another in the Azores, and none in the Algarve and Alentejo.

From the data analysis, it became evident the lack of braille usage by the institutions' associates, i.e., based on the opinion of the inquired organizations, most of the population with this condition does not know how to read braille. This issue can be evidenced based on cross-tabulation, where there is a principle of connection between age and the ability to read this language, in other words, there is a greater tendency to learn braille at ages below 50. This fact is evidenced by the information given by the graph where the majority of the inquired, consider their associates to know how to read Braille, operating mostly with individuals aged below 50 years, see right-hand side of Figure 1.

Regarding the method of locomotion, two categories can be distinguished: guide dog or cane, with a strong emphasis on the use of the latter as the preferred method (77.3%), see right-hand side of Figure 2.
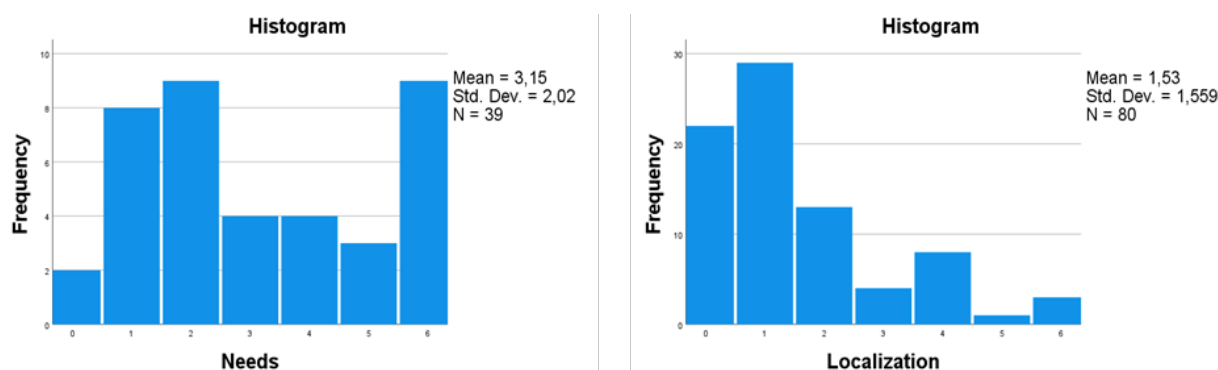
Figure 2. Distributions associated, respectively, with needs and locomotion methods categories.

In addition, and meeting the primary objective of this article, organizations were asked about their perception of their associates' most evident need, i.e., which area of the daily life of people with this condition should be changed first. Seven categories were distinguished: 0 Access to hospitals and health centers; 1 Access to public institutions and retailers; 2 Access to public transportation; 3 Access to supermarkets and hypermarkets; 4 Physical activity practice; 5 Leisure activities; and 6 Others, see left-hand side of Figure 2. Regarding the first, only 2 institutions identified it as one of the greatest needs of these people, followed by leisure activities, with mention by 3 organizations, access to supermarkets and hypermarkets, and physical activity with 4 institutions. The main two needs highlighted regard to access to public institutions and retailers (8), as well as access to public transportation (9). The Other category, on the other hand, presents several themes, dispersed among themselves, so these evaluations were not highlighted.

As seen in a previous section, semi-structured interviews were conducted during the dissemination of the first questionnaire. These had a significant impact on the orientation of the second questionnaire, as they helped to understand the primary needs of the group under analysis, as well as to clarify certain concepts and recognize their equipment.

The interviewees mentioned that the greatest difficulties were related to online authentications, such as reCAPTCHA systems and QR codes. These online authentications have become increasingly present in their daily lives and are sometimes essential to access important information.

It is also important to note that they mentioned that the cost of the electronic equipment they usually use, such as braille terminals and higher quality screen readers, is quite expensive. While government financial aid is available, it takes a significant amount of time, sometimes two to five years, to receive the necessary financial aid or equipment. Considering that there is a period of adaptation to new equipment and due to their disability, sometimes it takes longer to adapt, which reflects on their late independence, which ends up being demotivating.

The second questionnaire, aimed at blind and low-vision people, converged in some objectives with the previous questionnaire, in parameters, such as age, location based on the NUTS II Portugal classification, preferred locomotion method, and Braille use. After combining the data obtained from both the initial questionnaire and the semi-structured interviews, it was determined that certain questions about the origin and degree of disability, usage of electronic devices, online authentication methods, and QR codes were excluded from the second questionnaire.

Regarding the first category under analysis, age, there is a greater homogeneity present in the respondents, i.e., 48.8% are 50 or over years old, and 51.2% are younger. As for the location of the individuals, the classification was made as in the previous case, with emphasis again on the Center (37.0%) followed by the North (27.2%) and Área Metropolitana de Lisboa (16.0%). The archipelagos account for a 4.9% share. This time Algarve (9.9%) and Alentejo (4.9%) stood out compared to the previous case.

Respecting the method of locomotion, the options were broadened, these being Cane (50%), Guide Dog (10%), Help from another person (25%), and I do not use any locomotion aid (15%) see left-hand side of Figure 3. The use of Braille materialized a paradigm, given that 53.1% of those surveyed claimed to be aware of and make use of this tool. However, 58.3% of those questioned who said they could not read Braille stated that had no desire to learn this tool shortly.
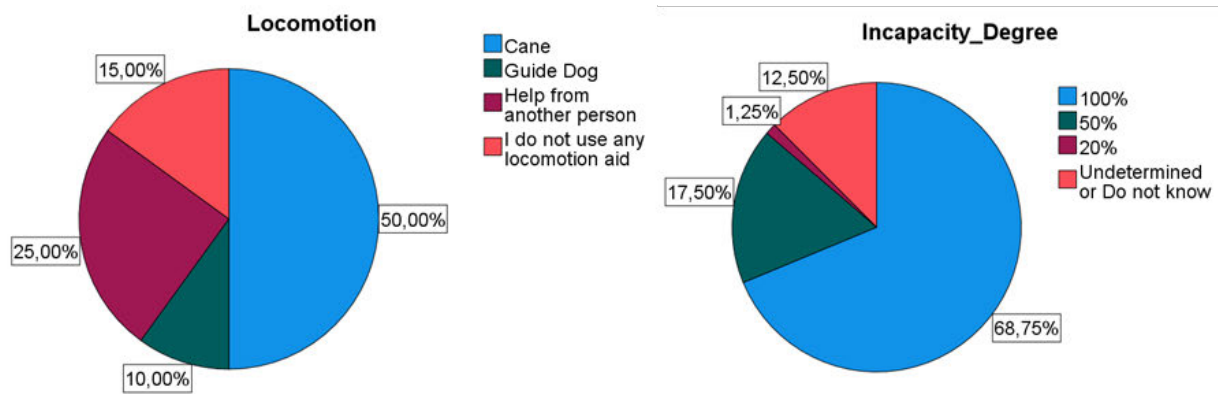
Figure 3. Distributions according to locomotion methods and degree of disability.

As stated previously, the degree of disability and origin of disability influences the development of tools and applications, as well as one's abilities. Thus, it was considered relevant to analyze the level of incapacity of the respondents. The most significant group (68.8%) have 100% disability, that is, they are completely blind, see right-hand side of Figure 3. This is followed by 50% sight vision with a presence of 17.5%, while only 12.9% are uncertain or have an undetermined degree of impairment. It should also be noted that consistent with the literature review, the majority (51.2%) have adventitious blindness, meaning it developed later in life.

Despite the limitations, the overwhelming majority (91.2%) claimed to use electronic equipment, such as smartphones and computers or laptops, however, it was found that they had difficulty with authentication mechanisms such as QR codes and, more specifically, with reCAPTCHA (83.6%). In open questions related to this subject, the respondents stated that "The voice should be clearer so that we can write what it says", and several assert that a possible solution for these cases would be voice humanization, and regulated speed, so that perceptibility may be greater. A second suggestion vehemently present is the standardization of the authentication methods, i.e., there should be only one checkbox indicating "I am not a robot". Although QR codes are not as impactful, "[...] the best alternative [...] would be for the [QR] code to always appear aligned in the centre of the screen, which would allow us to locate it more easily."

Considering the scope of the article, for the discovery of the main needs in the daily life of this community, the free-response questions proved to be extremely enriching. The issue of orientation stands out primarily, that is, the problem is not displacement, but orientation. It is relevant to keep in mind the fact that public roads are constantly changing, for example, the placement of new signs or advertisements, incorrect parking of vehicles, and public works, among others. This oscillation does not reflect safety for the blind to be able to move around alone. Similarly, pavement signage, such as crosswalk markings, or public transportation rugosities, is not standardized, i.e., it differs from place to place. Thus, there must be a formalization of sidewalk signals, as well as redoubled care when placing new elements on sidewalks.

Comparing the results of both questionnaires it can be seen that there is no clear agreement on the age of the target audience. This discrepancy may be influenced by the platform through which the questionnaire was performed. Taking into consideration that there is a greater tendency for younger age groups to use electronic equipment, this may justify why, in the second questionnaire, there were not many Over 50 years old responses like in the first one. Analogously, the use of Braille might be explained by this fact. There is a lesser tendency to learn a new language as age increases. Given that most answers were given by people under 50 years old, the responses related to braille knowledge increased. Regarding geographical location, the results of the questionnaires converge, except in the Alentejo and Algarve regions. This situation may reveal that there is not enough support for the population located in these areas. Regarding the main aim, the daily needs of the target group, there are similarities, however, the priority does not seem to be the same. The institutions identify as the main problems the access to institutions and public transport, as well as online authentication mechanisms, while the group identifies as the main concern the reCAPTCHA mechanisms, but even more markedly the orientation and safety on outings.

4 CONCLUSIONS

Considering the research carried out, as well as the results of the questionnaires and interviews, several pieces of information can be concluded. There is a geographical dispersion of the institutions supporting this group, although they are mainly present in the Centre, North, and the Lisbon Metropolitan Area, leaving areas such as Alentejo, where the population is significantly elder.

As regards the use of Braille, there is divergence among the groups of respondents, leading to no possible conclusion, or age-braille reading relation. While institutions state that most of their associates do not read Braille, the majority of the impaired vision community respondents claim to be able to do so. As far as these people's primary needs are concerned, they can be divided into three essential areas.

The first is related to the acquisition of electronic devices, where government support needs to be effective and timely. Among the needs reported, we observed the need for the detection of QR codes and authentication systems, such as reCAPTCHA, to be carried out more efficiently. As a possible solution, we highlight the centralization of the QR code on the screen or a perforated one. Regarding reCAPTCHA, we suggest a humanization of the adopted voices and regulated speed. A measure that, in their perspective, should not only be adopted for authentication systems but also for all screen readers and available applications. Still, regarding authentication methods, it is suggested that they be generalized, for example, using an "I am not a robot" checkbox.

The second area refers to orientation, i.e., the problem they identify is not moving between points, but rather the orientation and dangers they encounter along the way. Thus, we suggest the creation or adaptation of available applications, such as Google Maps, and a generalization in the identification of pavement markings, namely at crosswalks and access to public transport. There must also be redoubled care when placing traffic signs and advertisements, so as not to obstruct the pavements and offer danger to pedestrians with this condition.

The last area refers to employment, i.e., there is the need to create jobs adapted to their conditions. In this measure we suggest the culmination of the last two areas, that is the development of orienteering together with the creation of a job. Thus, we leave the suggestion of adapting voice-picking systems, as an idea to be developed in future projects.

ACKNOWLEDGEMENTS

REFERENCES

[1]   A. J. Hogan, "Social and medical models of disability and mental health: Evolution and renewal," *Canadian Medical Association Journal*, vol. 191, no. 1, pp. E16–E18, 2019. https://doi.org/10.1503/cmaj.181008.

[2]   United Nations, "Sustainable Development Goals," 2022. Retrieved from https://unric.org/en/united-nations-sustainable-development-goals/ (accessed Dec. 13, 2022).

[3]   J. Steinmetz, R. Bourne, P. Briant, "Causes of blindness and vision impairment in 2020 and trends over 30 years, and prevalence of avoidable blindness in relation to VISION 2020: The Right to Sight: An analysis for the Global Burden of Disease Study," *Lancet Glob Health*, vol. 9, no. 2, pp. e144–e160, 2021. https://doi.org/10.1016/S2214-109X(20)30489-7.

[4]   H. Wang, "Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950–2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019," *The Lancet*, vol. 396, no. 10258, pp. 1160–1203, 2020.

[5]   A. G. Fernandes, M. Alves, R. A. e. Nascimento, N. Y. Valdrighi, R. C. de Almeida, and C. T. Nakano, "Visual impairment and blindness in the Xingu Indigenous Park – Brazil," *International Journal for Equity in Health*, vol. 20, no. 1, 2021. https://doi.org/10.1186/s12939-021-01536-w.

[6]   INE and PORDATA, "Esperança de vida à nascença: total e por sexo," PORDATA, 2022. Retrieved from https://www.pordata.pt/en/portugal/life+expectancy+at+birth+total+and+by+sex+(base+three+years+from +2001+onwards)-418 (accessed Oct. 17, 2022).

[7]   INE and PORDATA, "Taxa bruta de natalidade," PORDATA, 2022. Retrieved from https://www.pordata.pt/portugal/taxa+bruta+de+natalidade-527 (accessed Oct. 17, 2022).

[8]   INE and PORDATA, "Taxa bruta de mortalidade e taxa de mortalidade infantil," *PORDATA*, 2022. Retrieved from Retrieved from https://www.pordata.pt/portugal/taxa+bruta+de+mortalidade+e+taxa+de+mortalidade+infantil-528 (accessed Oct. 17, 2022).

[9]   Y. Chuvarayan, R. P. Finger, J. Köberlein-Neu, "Economic burden of blindness and visual impairment in Germany from a societal perspective: a cost-of-illness study," *European Journal of Health Economics*, vol. 21, no. 1, pp. 115–127, 2020. https://doi.org/10.1007/s10198-019-01115-5.

[10]   N. Tiraset, A. Poonyathalang, T. Padungkiatsagul, M. Deeyai, P. Vichitkunakorn, and K. Vanikieti, "Comparison of visual acuity measurement using three methods: Standard Etdrs chart, near chart and a smartphone-based eye chart application," *Clinical Ophthalmology*, vol. 15, pp. 859–869, 2021.https://doi.org/10.2147/OPTH.S304272.

[11]   I. L. Bailey and J. E. Lovie-Kitchin, "Visual acuity testing. From the laboratory to the clinic," *Vision Research*, vol. 90, pp. 2–9, Sep. 2013. https://doi.org/10.1016/j.visres.2013.05.004.

[12]   WHO, "Visual disturbances and blindness," ICD- 10 Version:2019, 2022. Retrieved from https://icd.who.int/browse10/2019/en#/H53-H54 (accessed Oct. 09, 2022).

[13]   IAPB, "Causes of Vision Loss - The International Agency for the Prevention of Blindness," International Agency for the Prevention of Blindness, 2021. Retrieved from https://www.iapb.org/learn/vision-atlas/causes-of-vision-loss/ (accessed Nov. 18, 2022).

[14]   D. M. Wright et al., "Visual Field Outcomes from the Multicenter, Randomized Controlled Laser in Glaucoma and Ocular Hypertension Trial (LiGHT)," *Ophthalmology*, vol. 127, no. 10, pp. 1313–1321, 2020. https://doi.org/10.1016/j.ophtha.2020.03.029.

[15]   Z. L. Teo et al., "Global Prevalence of Diabetic Retinopathy and Projection of Burden through 2045: Systematic Review and Meta-analysis," *Ophthalmology*, vol. 128, no. 11, pp. 1580–1591, 2021. https://doi.org/10.1016/j.ophtha.2021.04.027.

[16]   ACAPO, "Deficiência visual | Associação dos Cegos e Amblíopes de Portugal," ACAPO. Retrieved from   https://www.acapo.pt/deficiencia-visual/perguntas-e-respostas/deficiencia-visual   (accessed Oct. 17, 2022).

[17]   INE, "População residente (N.o) por Local de residência, Sexo, Grupo etário e Tipo de doença crónica," INE, 2008. Retrieved from https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0001708&xlang=pt&contexto=bd&selTab=tab2 (accessed Oct. 17, 2022).

[18]   WHO, "Noncommunicable diseases," WHO, 2022. Retrieved from https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases (accessed Oct. 09, 2022).

[19]   S. Byfield, "The purpose of IAPB Briefing Papers is to inform IAPB members and others about important and emerging issues affecting VISION 2020: The Right to Sight," *International Agency for the Prevention of Blindness*, 2011, [Online]. Retrieved from www.vision2020australia.org.au.

[20]   L. N. Allen, "Financing national non-communicable disease responses," *Glob Health Action*, vol. 10, no. 1, 2017. https://doi.org/10.1080/16549716.2017.1326687.

[21]   WHO, "Countries | World Health Organization." 2023. Accessed: Mar. 09, 2023. [Online]. Retrieved from https://www.who.int/countries.

[22]   WHO, "Existence of an operational, multisectoral national NCD policy, strategy or action plan that integrates several NCDs and their risk factors," WHO, 2022. Retrieved from https://www.who.int/data/gho/data/indicators/indicator-details/GHO/existence-of-an-operational-multisectoral-national-ncd-policy-strategy-or-action-plan-that-integrates-several-ncds-and-their-risk-factors (accessed Oct. 12, 2022).

[23]   H. Köttl, V. Gallistl, R. Rohner, and L. Ayalon, "'But at the age of 85? Forget it!': Internalized ageism, a barrier to technology use," *J Aging Stud*, vol. 59, 2021. https://doi.org/10.1016/j.jaging.2021.100971.

[24]   PORDATA, "What are NUTS? | Pordata," 2013. Retrieved from https://www.pordata.pt/en/What+are+NUTS (accessed Mar. 04, 2023).