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DIGITAL WORKPLACE ACCESSIBILITY FOR VISUALLY IMPAIRED PEOPLE

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Abstract

Due to the rapid development of modern technology, people with special needs have possibilities for equal access to their working environment. They can access computer resources freely. Nowadays they have opportunities to study, find and start work. The tools that give them these opportunities are called assistive technologies. These are various software applications or hardware devices which aim is to ensure the independence of people with disabilities by enabling people with special needs to perform various tasks that they are sometimes unable or difficult to perform. In this connection, the aim of the current article is to highlight the problems of digital accessibility in the workplace. The scope of the study narrows to the difficulties that people with visual impairments would experience in the workplace. The opinions of social media users regarding digital accessibility in the workplace were investigated using data mining methods. The AHP method was applied for the classification of the personal workplace accessibility for visually impaired people. As a result, a theoretical model for digital accessibility in the workplace is formed, which has wide application regardless of the type of organization and the specifics of its activity.

Keywords: visual impairment accessibility; speech synthesizer; screen reader; digital workplace; assistive tools.

Introduction

Humans' senses are their windows to the world. Through them, people perceive and process information from the environment, transmitted through various stimuli, such as the amount of light, noise, speech, movement of objects, etc. In theory, this is known as information processing. It relates to the processes of receiving, storing, retrieving, and using information

received through the human senses (Gibson, 1966). As a summary of the research of various authors, we can define it as a process of processing the information received by a given intelligent system in a way that meets the needs of this system for the full understanding and perception of information in order to reproduce a response appropriate for a specific situation (Slate and Charlesworth, 1988; Pressley et. al., 1989; Ripoll et. al., 1995; Lutz and Huitt, 2018; Cao et. al.; 2019). The focus of information processing theory is on the individuals' innate mental abilities, not on behaviour that has arisen because of external circumstances. From the perspective of cognitive science, the human mind is taken as an information processor that receives, stores, restores, transforms, and transmits information. In theory, there are various models comparing man to machine (Card et. al., 1986), which are fundamental in building the principles of human-computer interaction.

The information that the human brain receives from the environment through the five senses and processes is diverse. It can be in the form of sounds, images, signals, taste, smell, sensations. Research shows that the largest percentage (about 80) of information a person receives through vision (Jaarsveld, 2010; Rupini and Nandagopal, 2015; RNIB, 2017; Oguego et. al., 2018; Spence, 2020). It registers danger signals from the environment, which are often processed by the brain as life-threatening. If the individual has visual impairment or lack thereof, information processing is carried out through the other senses, which are more acute than those of individuals without visual problems.

According to data from the World Health Organization, over 1 billion people have some form of disability, and with each passing year the number of people increases, which urgently increases the need to include them in the health systems of countries (WHO, 2021a) and in the workplace. According to the World Bank, visual impairment is one of the most common disabilities that can be corrected simply with a pair of eyeglasses (Wodon et. al., 2019). World Health Organisation report about "at least 2.2 billion people have a near or distance vision impairment" (WHO, 2021b). It should be noted that visual impairments are divided into two groups - distance and near vision impairment. According to the World Health Organization, the first group includes mild, moderate, severe vision impairment and blindness. To the second group - near visual impairment (WHO, 2021b).

According to the World Health Organisation „vision impairment poses an enormous global financial burden with the annual global costs of productivity losses associated with vision impairment <…> estimated to be US$ 244 billion and US$ 25.4 billion" (WHO, 2021b).

Research by the statistics portal Statista shows that employers in the UK have the highest rating for workplace accessibility (often abbreviated as A11Y) with a score of 3.83 out of 5, followed by Ireland, Italy, Spain, and the Netherlands. Polish employers have the lowest rating with 3.29 points out of 5 (Statista.com, 2021). According to Eurostat data, countries such as Greece, Bulgaria, Croatia, Cyprus, Romania, and Hungary top the ranking of countries where households with disabled people barely experience serious financial difficulties - between 76.9% and 39% of households (Eurostat, 2021). That is why helping people with disabilities, including those with visual impairments, in the workplace should be one of the important tasks on the agenda of public and private organizations.

Thanks to the rapid development of modern technologies, this type of users has equal access to the surrounding environment. They can freely handle computer resources and have opportunities for training, finding, and starting work. The tools that give them these possibilities are called assistive technologies. They can be various software applications or hardware devices. These type of software and hardware help to provide a digitally accessible environment at the workplace, at school, at the university, at home, in public institutions. Similar can be braille displays, speech synthesizers, screen readers, OCR-programs, specialized keyboards, screen magnifiers, software for changing the colour scheme and contrast (AbilityNet, 2021). The range of assistive technologies through which digital accessibility is ensured depends on the type of disability. For example, poor vision or lack thereof, colour perception disorder, photosensitivity, etc.

In this connection, **the aim of the current article** is to highlight the problems of digital accessibility in the workplace. The scope of the study narrows to the difficulties that people with visual impairments would experience in the workplace. The research objectives of the paper are: (1) Reviewing of literature on assistive technologies, including the current state of visually impaired people's assistive software tools; (2) Proposing a digital workplace accessibility model that could be applied in any institution; (3) Summarizing the findings and proposition of further actions to reinforce the performance of digital workplaces.

The opinions of social media users regarding digital accessibility in the workplace were investigated using data mining methods. The AHP method was applied for the classification of the personal workplace accessibility for visually impaired people.

Limitations of this study are: hardware devices for people with visual impairments are not considered, but only the software provision in the workplace is emphasized. The opinion of social media users has been researched, but no survey has been conducted among the target

audience. It is precisely the limitations of this article that are the object of research in future development.

1. Literature Review

The term **assistive technology** is any item, piece of equipment, software program, or product system that is used to increase, maintain, or improve the functional capabilities of persons with disabilities (ATIA, 2021). It can be interpreted as an umbrella term covering the systems and services related to the delivery of assistive products and services too that maintain or improve an individual's functioning and independence (WHO, 2021c). This type of technology helps to ensure the independence of people with disabilities, giving them the opportunity to perform various tasks that they sometimes cannot perform or have great difficulty in performing; increasing or changing the methods of interacting with the technology necessary to perform a given task. Assistive technologies are related to helping certain groups of people with disabilities, and there is no one-size-fits-all remedy for all types of them. For example, people with visual impairments can use software and/or hardware. Software can be teletext, screen magnifiers, screen readers, speech synthesis programs, etc. Examples of hardware include large monitors, braille displays, braille keyboards, braille printers, etc.

Modern technologies such as artificial intelligence, virtual reality, augmented reality is increasingly dynamically entering the various business sectors, which also implies the acquisition of new skills by employees. The issues of digitization in the workplace, working conditions and digital skills of employees are addressed by several authors (Vasilev and Stoyanova, 2019; Vasilev, 2021a; Vasilev, 2021b; Antonova and Ivanova, 2021; Peicheva, 2021; Koleva and Mileva, 2021). Based on these studies, it can be concluded that more efforts are needed in terms of the acquisition of digital skills by employees in various sectors to meet the needs of businesses in times of crisis. This raises the question of digital accessibility in the workplace. Do people with disabilities have equal access to modern work infrastructure, education, healthcare.

Accessibility is a broad concept that affects several fields from art to transportation to computer systems and technology. In the general sense, it can be defined as the extent to which any product, device, service, or environment is accessible to as many people as possible ('Accessibility', 2021; 'Accessible', 2021; Henry, 2021). The term is often associated with people with disabilities and their rights to access facilities using assistive technology.

Thanks to assistive technologies, users with visual impairments can work with websites, use e-mail clients, work with chat programs. To improve the accessibility of websites, the International WWW Consortium (W3C) develops Web Accessibility Guidelines, which introduce accessibility issues. By following some basic recommendations, any website can become a good medium for information exchange and thus benefit people with disabilities (W3C, 2021).

Ensuring equal access for disabled people to modern work infrastructure, including digital one, is also addressed in the 17 Sustainable Development Goals (SDGs) of United Nations like Quality Education (Goal 4), Decent Work and Economic Growth (Goal 8), Reduce Inequalities (Goal 10), Sustainable Cities and Communities (Goal 11), and Partnership for the Goals (Goal 17) (UN, 2021a). These goals are related to "education, growth and employment, inequality, accessibility of human settlements, as well as data collection and monitoring of the SDGs" (UN, 2021a). According to the goals, cities and human settlements should be developed as inclusive, safe, resilient and sustainable, but in reality the period of the pandemic has intensified inequalities as „affected low-income households and those working in the informal sector" (UN, 2021b). According to UN data, the pandemic is further exacerbating inequalities between people with disabilities and the rest of the population, while job security is declining (UN, 2021b). Therefore, ensuring a digitally accessible workplace is essential not only to fulfill the SDGs, but above all to include disadvantaged groups in our society and provide opportunities for their retraining. To make a workplace accessible to people with visual impairments, it is necessary to use specialized software or hardware.

To meet the purpose of this article, we explore the specifics of digital workplace security with software only. One of the products used by people with visual impairments is the so-called "screen reader". It is a software that identifies and interprets what is displayed on the screen (Gunnarsson and Hreinsson, 2011; AFB, 2021; Sharif et. al., 2021). Feedback to the user is via speech or Braille output (a kind of hardware device). Screen readers are a form of assistive technology used by people who are blind, visually impaired, or who have learning disabilities. It is often used in combination with other assistive technologies such as screen magnifiers or speech synthesizers. Choosing a screen reader depends on multiple factors, such as platform, cost (screen reader renewals can often cost hundreds of dollars), and the role of organizations such as charitable foundations, schools, and employers.

Due to the variety of operating systems, screen readers are increasingly tied to the respective operating system distribution. Microsoft Windows includes Narrator, Apple Mac OS

X includes VoiceOver, and Linux uses the console based Oralux, which accesses the operating system through three purpose-built environments: EmacsSpeak, SpeakUp, and Yasr. More famous open-source screen readers are for example Linux Screen Reader for GNOME, Fire Vox, and NonVisual Desktop Access (NVDA) for Windows, etc. (Gunnarsson and Hreinsson, 2011; AFB, 2021). In the English-speaking market, the most used screen readers are the commercial products JAWS owned by Freedom Scientific, Window-Eyes by GW Micro, and Hal by Dolphin Computer Access. From the conducted research, we found that among the readers listed among the Bulgarian users, the JAWS reader is the most popular and used.

The variety of assistive software applications on the market is great. For the world's most widely used operating system, Microsoft Windows (NetMarketShare, 2021; StatCounter, 2021; W3Schools.com, 2021), two of the most widely used screen readers are Freedom Scientific's JAWS and NV Access's NonVisual Desktop Access (NVDA) . Both screen readers have very good capabilities for working with various basic Windows applications. One of the advantages of JAWS is that it offers a feature for remote access to a given computer - JAWS Tandem (Freedom Scientific, 2021), through which it is possible to train users, provide / receive technical assistance, etc. NVDA has a version that can be run from removable media with no installation required (NV Access, 2021). This allows users to use it on a computer that is not designed for them. Both products provide access to various types of applications, thanks to which users can fully work with a computer, such as an email client, speech synthesizers, office applications. From the point of view of users from a specific language group, such as Bulgarian for example, is that the local language interface is not supported. This makes it difficult for that part of users who do not speak one of the languages supported by the user interface.

Another software to help the visually impaired is the speech synthesizer. "Progress in speech synthesis and recognition research changed the way we communicate and interact with machines" (Oliveira and Prudêncio, 2022). Speech synthesis is the process of artificially producing speech for various applications, such as telephone service systems of mobile operators, banks, hotel reservation systems, for reading electronic text, etc. The most important qualities of a speech synthesis system are naturalness and intelligibility. Naturalness means that the output sounds of the system come as close as possible to human speech. Intelligibility is related to how easy these sounds are to understand. Operating systems have built-in speech synthesizers, which often recognize a limited number of languages or do not have a rich

database. Another common problem with this type of software is inaccurate voice recognition if the user has a low-quality microphone or slurs the words.

eSpeak is one of the speech synthesizers popular among Windows users. It supports multiple voices as well as greater possibilities to expand its database. It also supports Microsoft's Speech Synthesis and Recognition Application Programming Interface (SAPI), which means it can also use the voices of another speech synthesizer installed on the same computer. eSpeak can convert typed text into a phoneme code. It could: expand its database through development tools provided; tracking the current processing that the system is performing; SSML support (eSpeak, 2021). Popular among Bulgarian users, for example, are also Betsy, RealSpeak, Svox, etc. (Liubenov, 2021). According to the same source, the first Bulgarian speech synthesizer, created in the late 1980s by Borislav Zahariev and improved in 1995 by Toros Hovanesian, is Betsy. The synthesizer runs in MS DOS-Prompt on Windows 9x. Bulgarian users worked with it until about 2003. In 2005, the Bulgarian Association for Computational Linguistics developed SpeechLab 2.0, which is distributed through the Horizons Foundation or the Union of the Blind in Bulgaria.

In addition to speech synthesizers and screen readers, the digitally accessible workplace can also be provided for users. For this purpose, magnifiers, color filters and high contrast tools built into the operating system are used. Similar ones are also built into mobile operating systems.

2. Methodology

2.1. Material

3500 worldwide publications in English were retrieved from the social media Twitter in the period 15 – 17 November 2021. The key phrases “accessible workplace”, “digital accessibility”, “digitally accessible workplace”, “accessibility”, and “web accessibility” were used. The connection to Twitter and the data retrieving were done via Orange Data Mining software. Orange’s module Twitter were used to connect Twitter API.

2.2. Design

The observed independent variables are Number of likes, Retweets and Description. The dependent ones are recognized emotions and topics. The experiment’s results are detailed in the next sections of the paper.

2.3. Procedure

The social media contains unstructured data. Due to the diverse type of data - text and multimedia, it is difficult to process them. There are various approaches to social media mining in the scientific literature, which are based on established data mining techniques. Based on the research of some authors we can summarize the main frequently applied stages of social media mining: Social Media Tracking; Pre-processing Data; Social Media Mining Approaches; Analysis Methods and Reporting (Stieglitz et. al., 2018; Krebs et. al., 2018; Calefato et. al., 2019; Sulova and Bankov, 2019; Manguri et. al., 2020; Nasralah et. al., 2020). This paper suggests a social media mining framework (Fig. 1), which is based on sentiment analysis and content analysis methods.

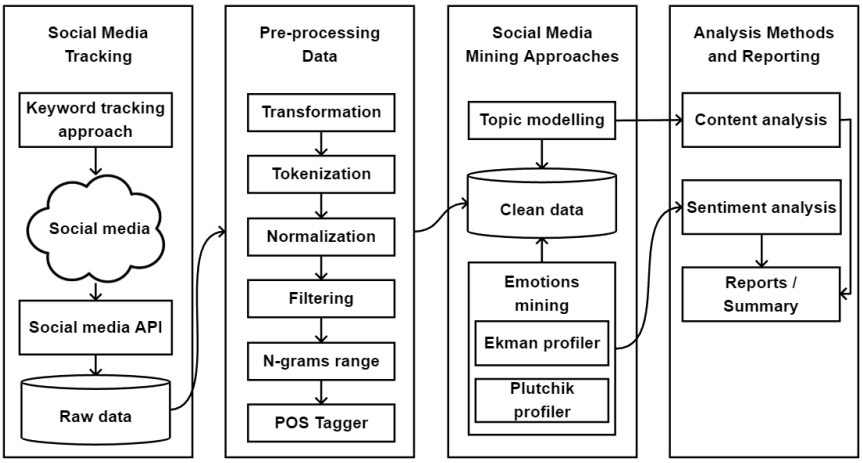

Fig. 1. Social Media Mining Framework

Source: Own Elaboration

The keyword tracking approach was applied to identify the frequently discussed topics related to workplace accessibility. The dataset is retrieved by using social media API. The data mining software usually supports a set of pre-processors that use natural language processing methods (CoreNLP). We applied: Transformation; Tokenization; Normalization; Filtering; N-grams and POS Tagger. After normalizing the raw data, topic modelling and emotion mining techniques are used to classify the highlighted topics and the satisfaction in the social media publications. The final stage of the framework is related to analysis and reporting activities. We applied content and sentiment analysis. The reports are containing charts and recommendations for bettering digital workplace accessibility.

3. Results

It was used a software set to test the proposed approach. These are: data mining tool Orange and Excel Add-in MeaningCloud. The social media tracking stage of the proposed

framework (Fig. 1) and pre-processing of the raw data was done via Orange tool. The emotions mining was performed by using the Tweet Profiler module of Orange, which supports several methods of content classification. These are classes based on the classifications of Plutchnik and Ekman. According to the first classifier 8 emotions groups are recognized: anticipation, acceptance, joy, surprise, anger, disgust, fear, sadness. According to the second one, emotions are: joy, surprise, anger, disgust, fear, sadness.

3.1. Content analysis

The opinions of social media users regarding digital accessibility in the workplace were investigated using data mining methods. Based on that tweets' topics were highlighted. The Orange's module Topic Modelling retrieved the following topics through latent semantic indexing method: digital accessibility, disability barriers, digital surveillance, a11y awareness, disabled citizens rights, a11y affordability, digital accessibility model, ai recommendations.

In contrast, MeaningCloud's text clustering method was used for topics modelling through Interactive Advertising Bureau (IAB 2.0) classification model. The main part of the highlighted topics are: accessibility is important; disabilities; accessibility issues; accessibility support; a11y affordability; people with disabilities; accessible to blind; game for accessibility; people mobility; accessibility features; lack of accessibility; remote hiring; digital inclusion.

Substantial differences are noted between the themes identified, as the two tools use a different taxonomy for their models.

3.2. Sentiment analysis

The sentiment analysis of the open questions was made by applying MeaningCloud – a Microsoft Excel plugin. We used its built-in WordNet model. The analysis confirms that the attitudes of all participants towards digital accessibility are predominantly positive - 58,17% from the whole retrieved tweets set (Table 1).

Table 1

MeaningCloud's Sentiment Analysis

Polarity	Tweets number	Percentage
P+	328	9,37%
P	1708	48,8%
NEU	314	8,97%
N	411	11,74%
N+	91	2,6%
NONE	648	18,52%

The results generated by Orange after applying both classifiers of Plutchik and Ekman are compared in Table 2.

Table 2

Orange's Twitter Profiler Results

Classifier	Ekman	Plutchik
Sadness	29	1501
Joy	2975	1186
Trust	Not supported	513
Surprise	217	254
Anger	6	3
Disgust	2	13
Fear	271	28
Anticipation	Not supported	2

Source: Own Elaboration

According to the Plutchik's classifiers results, it is noticed that the positive emotions joy and trust are formed the highest percentage together – 48,54%. In contracts, Ekman's classifier results are shown that the joy emotion is recognized in 85% of the tweets. The differences in the application of the different classifiers also arise from the pre-defined set of words that is applied for sentiment analysis in Orange.

4. Discussion

Summarizing the results of this research, the paper suggests a digital workplace accessibility model (Fig. 2) that could be applied in any institution. It contains 3 tiers: External environment, Company and Employee. Each of them consists of guidelines, laws, frameworks and politics, as well as workplace equipment.

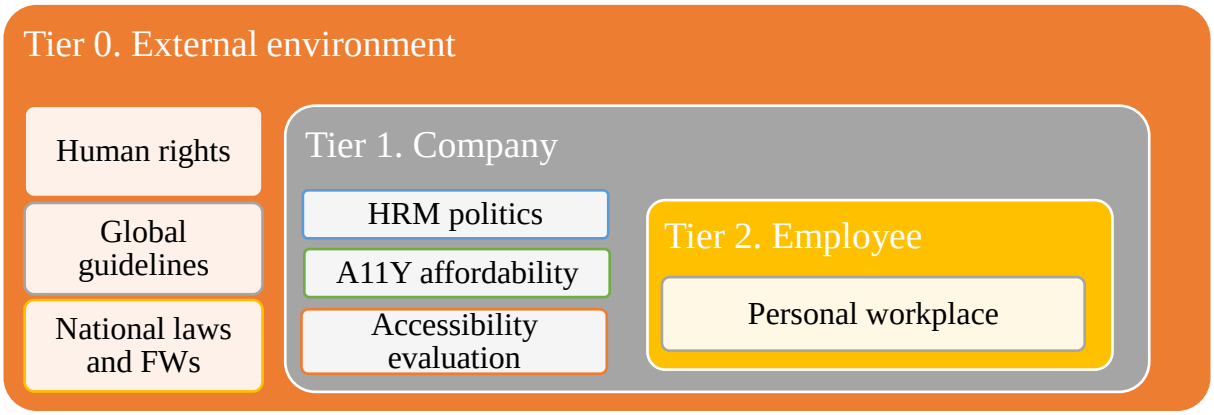

Fig. 2. Digital Workplace Accessibility Model

Source: Own Elaboration

The Tier 0 contains all external environment's formal base of laws and guidelines like human rights related. These are: Convention on the rights of persons with disabilities; Community-based rehabilitation (CBR) guidelines; United Nation's SDGs; National laws and frameworks related to disabled people, mainly visually impaired. The Tier 1 is targeted to human resource management (HRM) politics, including company values for disabled people, remote hiring for disabled people; A11Y affordability related to compliance with workplace digital accessibility standards and guidelines, as well as methods and tools for accessibility evaluation of the workplace.

The last Tier 2 is targeted to the employees who need special access to their workplace. We can suggest the following elements of workplace accessibility: Accessibility standards and guidelines; Accessibility tools support (software and hardware equipment); Keyboard shortcuts support; Physical environment accessibility; Readability (software for ensuring computer display contrast); Color vision support (software for ensuring color accessibility); Performance (speed of human-computer interaction, speed of speech synthesis); Ergonomics (convenience of working with hardware devices). The AHP method was applied for the classification of the personal workplace accessibility for visually impaired people. Number of comparisons is 28 and the consistency ratio is 5.1%. The principal eigen value is 8.501. The eigenvector solution has 5 iterations with delta value 1.8E-8. The results show that the elements of workplace accessibility rank is as follows: Accessibility tools support (21.8%); Physical environment accessibility (20.9%); Ergonomics (16.4%); Color vision support (15.0%); Performance (9.3%); Readability (9.2%); Keyboard shortcuts support (4.1%); Accessibility standards and guidelines (3.2%).

Conclusions

The problems of people with visual impairments worldwide have long been publicized and improvements are being made in the technologies they use in every direction. Within Bulgaria, these problems started to become public knowledge in the last 10 years.

The problems and technologies examined, and the practical experiments carried out lead to the conclusion that when working with modern computer technology, blind people mainly use two types of software applications - a screen reader and a speech synthesizer, and the users of the Twitter social network show a positive attitude towards digital accessibility in the workplace. We can summarize the findings and to propose further actions to reinforce the performance of digital workplaces. The main recommendations for digital accessibility are:

compliance with international standards; workplace compatibility with accessibility tools; physically accessible work environment for ensuring digital freedom.

Providing access to public resources for people with visual impairments promotes their independence and self-reliance. It is also the condition for achieving their better professional realization and their full inclusion in modern dynamic life.

REFERENCES

1. AbilityNet (2021) *Vision impairment and Computing*. [online] Available at: https://abilitynet.org.uk/factsheets/vision-impairment-and-computing [Accessed 23 November 2021].
2. 'Accessibility' (2021) Cambridge Dictionary. [online] Available at: https://dictionary.cambridge.org/dictionary/english/accessibility [Accessed 2 December 2021].
3. 'Accessible' (2021) Merriam-Webster Dictionary. [online] Available at: https://www.merriam-webster.com/dictionary/accessible [Accessed 2 December 2021].
4. AFB (2021) Screen readers. [online] Available at: https://www.afb.org/blindness-and-low-vision/using-technology/assistive-technology-products/screen-readers [Accessed 2 December 2021].
5. Antonova, K., Ivanova, P. (2021) Robotizatsiyata i izkustveniyat intelekt - nov model na satrudnichestvo i/ili vzaimodeystvie mezhdu mashinite i horata na rabotnoto myasto. *Choveshki resursi & Tehnologii = HR & Technologies*, Varna : Sdruzhenie Kreativno prostranstvo, 1, pp. 60-76.
6. ATIA (2021) *What is AT?*. [online] Available at: https://www.atia.org/home/at-resources/what-is-at/ [Accessed 23 November 2021].
7. Calefato, F., Lanubile, F., Novielli, N., Quaranta, L. (2019). EMTk - The Emotion Mining Toolkit. IEEE/ACM 4th International Workshop on Emotion Awareness in Software Engineering (SEmotion), Montreal, QC, Canada, pp. 34-37.
8. Cao et. al. (2019) The link between information processing capability and competitive advantage mediated through decision-making effectiveness. *International Journal of Information Management*, 44, pp. 121-131.

9. Card, S.K, Moran, T. P, Newell, A. (1986) The Model Human Processor: An Engineering Model of Human Performance. In K. R. Boff, L. Kaufman, & J. P. Thomas (Eds.), *Handbook of Perception and Human Performance*, vol. 2: Cognitive Processes and Performance, pp. 1–35.

10. eSpeak (2021) *eSpeak text to speech*. [online] Available at: http://espeak.sourceforge.net/ [Accessed 23 November 2021].

11. Eurostat (2021) *Disability statistics - financial situation*. [online] Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Disability_statistics_-_financial_situation [Accessed 23 November 2021].

12. Freedom Scientific (2021) [online] Available at: http://www.freedomscientific.com [Accessed 23 November 2021].

13. Gibson, J. (1966) The Senses Considered as Perceptual Systems. London: George Allen & Unwin Ltd.

14. Gunnarsson, B., Hreinsson, H. (2011) *Practical Screen Reader Comparison: A user-oriented approach*. [online] Available at: http://easi.cc/archive/screenreader2011/Screen_Reader_Comparison_Study_2010-INIB-with%20page%20numbers.htm [Accessed 23 November 2021].

15. Henry, S. (2021) Introduction to Web Accessibility. [online] Available at: https://www.w3.org/WAI/fundamentals/accessibility-intro/ [Accessed 2 December 2021].

16. Jaarsveld, K. (2010). The Effect of The Senses on The Perception of a Brand. PhD Thesis, Stellenbosch University, South Africa.

17. Koleva, V., Mileva, L. (2021) Vazmozhnosti za prilozhenie na golemite danni v upravlenieto na choveshkite resursi. *Upravlenie na choveshkite resursi : Sbornik s dokladi ot Mezhdunarodna nauchno-prakticheska konferentsia, organizirana ot IU - Varna*, 24 septemvri 2021 g., Varna : Nauka i ikonomika, pp. 222-229.

18. Krebs, F., Lubascher, B., Moers, T., Schaap P., Spanakis, G. (2018). Social Emotion Mining Techniques for Facebook Posts Reaction Prediction. Proceedings of the 10th International Conference on Agents and Artificial Intelligence, vol. 1, pp. 211-220.

19. Liubenov, V. (2021) *First Bulgarian site for visually impaired users.* [online] Available at: http://bezmonitor.com [Accessed 23 November 2021].

20. Lutz, S., Huitt, W. (2018) Information processing and memory: Theory and applications. In W. Huitt (Ed.), *Becoming a Brilliant Star: Twelve core ideas supporting holistic education*, pp. 25-43.

21. Manguri, K., Ramadhan, R., Mohammed Amin, P. (2020). Twitter Sentiment Analysis on Worldwide COVID-19 Outbreaks. Kurdistan Journal of Applied Research, 5(3), pp. 54-65.

22. Nasralah, T., El-Gayar, O., Wang, Y. (2020). Social Media Text Mining Framework for Drug Abuse: Development and Validation Study with an Opioid Crisis Case Analysis. Journal of Medical Internet Research, 22(8):e18350.

23. NetMarketShare (2021) *Operating System Market Share.* [online] Available at: https://netmarketshare.com/operating-system-market-share.aspx [Accessed 25 November 2021].

24. NV Access (2021) [online] Available at: https://www.nvaccess.org/ [Accessed 23 November 2021].

25. Oguego, N. et. al. (2018) Eye health myths, misconceptions and facts: results of a cross-sectional survey among Nigerian school children. *Family Medicine & Primary Care Review*, 20 (2), pp. 144–148.

26. Oliveira, C., Prudêncio, R. (2022) Item Response Theory to Evaluate Speech Synthesis: Beyond Synthetic Speech Difficulty. Proceedings of the Workshop on AI Evaluation Beyond Metrics (EBeM 2022). [online] Available at: http://ceur-ws.org/Vol-3169/paper7.pdf [Accessed 23 November 2021].

27. Peicheva, M. (2021) Artificial Intelligence in Human Resource Functions – Nature and Practical Application, *Choveshki resursi & Tehnologii = HR & Technologies*, Varna : Sdruzhenie Kreativno prostranstvo, 1, pp. 3–12.

28. Pressley et. al. (1989) Good information processing: What it is and how education can promote it. *International Journal of Educational Research*, 13(8), pp. 857-867.

29. Ripoll, H. et. al. (1995) Analysis of information processing, decision making, and visual strategies in complex problem solving sport situations. *Human Movement Science*, Elsevier, 14 (3), pp. 325-349.

30. RNIB (2017) *Eye health and sight loss stats and facts*. [online] Available at: https://www.rnib.org.uk/sites/default/files/Eye%20health%20and%20sight%20loss%20stats%20and%20facts.pdf [Accessed 23 November 2021].

31. Rupini, RV., Nandagopal, R. (2015) A Study on the Influence of Senses and the Effectiveness of Sensory Branding. Journal of Psychiatry, 18(2):236. doi:10.4172/1994-8220.1000236.

32. Sharif, A. et. al. (2021) Understanding Screen-Reader Users' Experiences with Online Data Visualizations. ASSETS '21: The 23rd International ACM SIGACCESS Conference on Computers and Accessibility, October 2021, Article No.: 14, Pages 1–16. https://doi.org/10.1145/3441852.3471202.

33. Slate, J. Charlesworth, J. (1988) Information Processing Theory: Classroom Applications. *Reading Improvement,* California: Chula Vista, 26(1), pp. 2-18.

34. Spence, C. (2020) Senses of place: architectural design for the multisensory mind. Cognitive Research, 5:46.

35. StatCounter (2021) *Desktop Operating System Market Share Worldwide*. [online] Available at: https://gs.statcounter.com/os-market-share/desktop/worldwide/#monthly-202101-202112 [Accessed 25 November 2021].

36. Statista.com (2021) *How high would you rate disability equality at your employer?*. [online] Available at: https://www.statista.com/statistics/1136072/employee-disability-equality-satisfaction-in-europe/ [Accessed 25 November 2021].

37. Stieglitz, S., Mirbabaie, M., Ross, B. Neuberger, C. (2018) Social media analytics – Challenges in topic discovery, data collection, and data preparation. *International Journal of Information Management*, 39, pp. 156-168.

38. Sulova, S., Bankov, B. (2019) Approach for social media content-based analysis for vacation resorts. *Journal of Communications Software and Systems*, 15 (3), 262-271. https://doi.org/10.24138/jcomss.v15i3.712

39. The World Bank (2021) *Disability Inclusion*. [online] Available at: https://www.worldbank.org/en/topic/disability?qterm_test1=visual+impairment [Accessed 23 November 2021].

40. UN (2021a) *Sustainable Development Goals (SDGs) and Disability*. [online] Available at: https://www.un.org/development/desa/disabilities/about-us/sustainable-development-goals-sdgs-and-disability.html [Accessed 23 November 2021].

41. UN (2021b) *The Sustainable Development Goals Report 2021*. [online] Available at: https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf [Accessed 23 November 2021].

42. Vasilev, J. (2021a) Ravnishta na digitalnite umenia na horata v Bulgaria. *Izvestia Sp. Ikonomicheski universitet - Varna*, Varna : Nauka i ikonomika, 65 (4), pp. 385-393.

43. Vasilev, J. (2021b) Nadgrazhdane na bankovia softuer - generirane na deklaratsii po GDPR. *Zashtitata na lichnite danni i digitalizatsiyata - predizvikatelstva i perspektivi : Sbornik s dokladi [ot kragla masa, provedena v IU - Varna*, 1 oktomvri 2021], Varna : Nauka i ikonomika, pp. 56-63.

44. Vasilev, J., Stoyanova, M. (2019) Information Sharing with Upstream Partners of Supply Chains. *19 International Multidisciplinary Scientific Geoconference SGEM 2019, Geoinformatics a. Remote Sensing*, Sofia: STEF92 Technology Ltd., Vol. 19. Informatics, Iss. 2.1, pp. 329 - 336.

45. W3C (2021) *Web Accessibility Initiative (WAI)*. [online] Available at: http://www.w3.org/WAI/ [Accessed 23 November 2021].

46. W3Schools.com (2021) *OS Platform Statistics*. [online] Available at: https://www.w3schools.com/browsers/browsers_os.asp [Accessed 25 November 2021].

47. WHO (2021a) *Disability and health*. [online] Available at: https://www.who.int/news-room/fact-sheets/detail/disability-and-health [Accessed 23 November 2021].

48. WHO (2021b) *Blindness and vision impairment*. [online] Available at: https://cutt.ly/cVdKlNv [Accessed 23 November 2021].

49. WHO (2021c) *Assistive technology*. [online] Available at: https://www.who.int/news-room/fact-sheets/detail/assistive-technology [Accessed 23 November 2021].

50. Wodon, K. et. al. (2019) *The Price of Exclusion: Disability and Education. Looking Ahead: Visual Impairment and School Eye Health Programs*. World Bank Group. [online] Available at: https://cutt.ly/jVdKhJk [Accessed 23 November 2021].