

ACCESS TO THE WORKPLACE FOR DISABLED EMPLOYEES IN THE DIGITALIZATION ERA

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Abstract: *In the age of digitization, access to the workplace for employees with disabilities has seen significant improvements due to advances in technology and a growing awareness of the importance of inclusion in the workforce. Employers, governments, and non-governmental organizations are working together to create more accessible and inclusive workplaces for people with disabilities. Digital tools and assistive technologies play a crucial role in ensuring working conditions for employees with special needs. Screen readers, voice recognition software, zoom tools, adaptive keyboards, and other assistive technologies make it easier for employees with visual, hearing, motor, or cognitive disabilities to perform their tasks effectively. Despite technological progress in some EU countries, levels of digital accessibility in the workplace are still below satisfactory. In this regard, this paper aims to investigate the formal frameworks for digital accessibility across EU that obligate or recommend employers to provide an accessible workplace to their employees with special needs.*

Keywords: *digitization, workplace accessibility, digital accessibility, equal access to work environment*

JEL code: *M14, J81*

Introduction

In the era of digital transformation and rapid development of technology, almost every aspect of our lives is affected. Technological progress in the era of digital revolution also contributes to the development of means of digital inclusion of people with disabilities.

The concept of digital inclusion is primarily associated with the pursuit of equal access to the environment, including work and education, bridging the gap between those who are comfortable with digital technologies and those who are hindered by physical, sensory, or cognitive disabilities.

The digital divide is not only about access to technology but also about the ability to fully participate, engage, and benefit from the digital ecosystem. This divide can manifest itself in various ways, from inaccessible websites and software to the lack of assistive technology to meet their specific needs. The drive for digital inclusion therefore becomes a drive to remove barriers and foster an environment where every person, regardless of ability, can harness the power of technology for personal, educational, and professional enrichment.

The growth in digital advancements provides new opportunities for people with disabilities to participate fully in the workplace or educational environment.

A fundamental aspect of digital inclusion is web accessibility. Studies by Serna-Marjanović et. al. (2020) and Ismail and Kuppusamy (2022) highlight the importance of designing digital content that adheres to accessibility standards, ensuring that websites and applications are accessible to people with visual, hearing, or mobility impairments.

Research by McNicholl et. al. (2019) highlights the transformative impact of assistive technology. From screen readers to adaptive keyboards that enable people with disabilities to engage effectively with digital platforms.

Henn et. al. (2022), as well as Kanev et. al. (2017), identified attitudinal barriers, emphasizing the need for cultural change to recognize the abilities of people with disabilities. Salmi et. al. (2023) examines socioeconomic barriers pointing to disparities in access to technology.

Exploring the intersection of policy and digital inclusion, Filipe et. al. (2022) discusses the impact of formal frameworks and standards, highlighting the importance of robust policies to promote an inclusive digital environment.

Behera (2021) examines the role of education in improving digital inclusion and the integration of digital literacy into educational programs, which is crucial for people with disabilities to acquire new skills to independently navigate the digital landscape.

Beyond simple access, Neves et. al. (2017) explores the wider implications of digital inclusion for the social well-being of people with disabilities. The study shows that digital connectivity improves social interactions, reduces isolation, and promotes a sense of belonging.

In this regard, **this paper aims** to investigate the importance of digital inclusion topic in research papers. The main objective is to study formal frameworks for digital accessibility across the EU that obligate or recommend employers to provide an accessible workplace to their employees with special needs. These good practices and frameworks for the digital inclusion of people with disabilities are aimed at removing barriers for every individual, regardless of their physical or cognitive abilities.

1. Literature review

As the purpose of this study suggests, we need to explore the legal and regulatory frameworks, directives, and standards that shape digital accessibility, offering a comprehensive understanding of the current state of affairs.

Research by Labbé et. al. (2024) delves into the legal foundations of digital accessibility, emphasizing the pivotal role of anti-discrimination laws such as the Americans with Disabilities Act (ADA) in the United States. This work highlights the legal imperative for digital platforms to be accessible to all.

Vila, Alén, and Darcy (2017) provide a global perspective, examining international standards and directives that guide digital accessibility. The Web Content Accessibility Guidelines (WCAG) 2.0 and its subsequent iterations emerge as a common thread, serving as a benchmark for accessibility across countries. According to them, the lack of uniform accessibility criteria for online information can hinder the rehabilitation process for people with disabilities and their supporters worldwide. They outline accessibility issues for websites and provide examples for managers and programmers. Their work outlines inclusive website design criteria for improving accessibility for disabled users.

Workplace accessibility regulations in the European Union (EU) are influenced by EU directives and national laws of individual member states. These regulations aim to ensure workplaces are accessible to all employees, including those with disabilities. The EU Directive on Accessibility Requirements for Products and Services (2019/882) addresses accessibility requirements for various products and services, including those

related to ICT (Martins et. al., 2023). The EU Directive on Accessibility of Websites and Mobile Applications (2016/2102) focuses on ensuring public sector websites and mobile applications are accessible, facilitating equal access to information and services (Ferri and Favalli, 2018). The EU Employment Equality Directive (2000/78/EC) prohibits discrimination in employment based on various grounds, including disability, and requires employers to make reasonable accommodations to ensure equal opportunities for employees with disabilities (Van Den Brink, 2022).

National legislation, such as the Equality Act in the UK and the General Equal Treatment Act (AGG) in Germany, may also have provisions related to workplace accessibility (Watkins, Raisborough and Connor, 2023; Tillmann et. al., 2018). Some countries may have specific accessibility standards that employers must follow, covering physical accessibility, communication accessibility, and the use of assistive technologies. Social partners, including employer and employee representatives, may negotiate agreements or participate in dialogues to enhance workplace accessibility.

For the most accurate and up-to-date information on workplace accessibility regulations in EU countries, consult with national disability or labor authorities, legal professionals, official government websites, and organizations like the European Disability Forum (EDF), the research of Prinz (2018) states that policymakers and researchers need to refer issues like disability definition, rights, societal responsibilities, disability benefits structure, and employer role.

The European Accessibility Act (EAA) has been a focal point in recent literature, with Gutiérrez and Cáceres (2022) assessing its potential impact on digital accessibility in the European Union. This directive, set to harmonize accessibility requirements, is explored in terms of its implications for businesses and the digital service landscape. In detail, their study evaluates the effectiveness of accessibility guidelines on websites for deaf users, focusing on task completion on four websites. Their hypothesis suggests that following accessibility guidelines improves user performance, and content and design impact task success rates.

Another study delves into the relationship between the EAA and individual member state laws. The review explores how national legislations align with or diverge from the EAA, shedding light on the complexities of harmonizing accessibility standards across diverse EU jurisdictions (Llieva, 2021).

Research by Kraus et. al. (2021) investigates the practical implications of the EAA on businesses and digital service providers operating in the EU. The study highlights the challenges and opportunities presented by the directive, emphasizing the need for proactive measures to ensure compliance.

The dynamism of technology calls for a nuanced understanding of digital accessibility standards. Kroon, Alves, and Martins (2021) explore how the EAA adapts to emerging technologies, addressing challenges posed by innovations like AI, IoT, and virtual reality, and ensuring that they contribute to, rather than hinder digital inclusivity.

Bittenbinder, Müller, and Tuncer (2023) take a user-centric approach, examining the lived experiences of individuals with disabilities in the context of the EAA. The study provides valuable insights into the effectiveness of the directive from the perspective of end-users, shedding light on gaps between legal mandates and practical experiences.

An examination of enforcement mechanisms and challenges in compliance is undertaken by Mehigan. et. al. (2022). The review scrutinizes how the EU ensures adherence to digital accessibility laws, discussing the role of monitoring, reporting, and potential penalties in encouraging compliance. Their paper examined the current standards and laws of European Union member states, specifically Ireland, France, and Spain, concerning digital educational practices. The authors investigated that the United Nations Convention on the Rights of Persons with Disabilities outlines equal opportunities for all citizens, with Article 21 focusing on information and communication accessibility, as well.

While legal frameworks provide a foundation, Kulkarni (2019) identifies challenges in the practical implementation of digital accessibility laws. The research outlines barriers to digital accessibility and solutions. It covers accessibility standards, limitations, institutional and technology contexts, and the status of digital accessibility through a panel discussion with stakeholders.

The dynamism of technology necessitates a continuous reassessment of accessibility standards. Fichten et. al. (2023) examine how emerging technologies, such as AI and virtual reality, intersect with established accessibility standards, raising questions about their inclusivity and the need for adaptive guidelines. Their research discusses the evolution of technologies in post-secondary education for students with disabilities. It highlights the increasing accessibility of general use of AI in mainstream technologies, and developments in braille, sign language, virtual reality, voice-based web searches, wearable technologies, and robots. It also discusses barriers to accessibility, such as the limited numbers of individuals with disabilities involved in AI training and the high costs of assistive technologies. It emphasizes the need for stakeholders to engage in these developments.

An exploration of literature by Gong and Ribière (2021) investigates the varying degrees of compliance between the public and private sectors. The study emphasizes the need for a unified approach, as digital accessibility extends beyond governmental websites to encompass a broad spectrum of online services.

Narleva and Gancheva (2023) examined a significant shift due to rapid technological development and digitalization, putting new demands on human resources. Their paper justified the need for a new educational environment in higher education, focusing on digitalization, design, management, and control of the educational process in an innovation environment, using a multimethod approach including systems approach, analysis, and synthesis.

In summary, workplace accessibility regulations are essential for creating inclusive, diverse, and equitable workplaces. They promote inclusivity by ensuring physical spaces, digital platforms, and communication methods are designed to accommodate individuals with diverse abilities. Adherence to these laws directly impacts employee well-being and productivity, promoting efficiency and job satisfaction. They also enhance an organization's reputation and competitiveness, attracting a broader talent pool and demonstrating a commitment to social responsibility.

2. Method

10 000 worldwide scientific papers in English were retrieved from the PubMed repository in the period 20 – 22 September 2023. The key phrases „digital inclusion”

and „workplace accessibility” were used. PubMed is a free online database focusing on life sciences and biomedical literature. The connection to PubMed and the data retrieval were done via the Orange data mining tool.

The emotions mining procedure configuration is shown in Fig. 1.

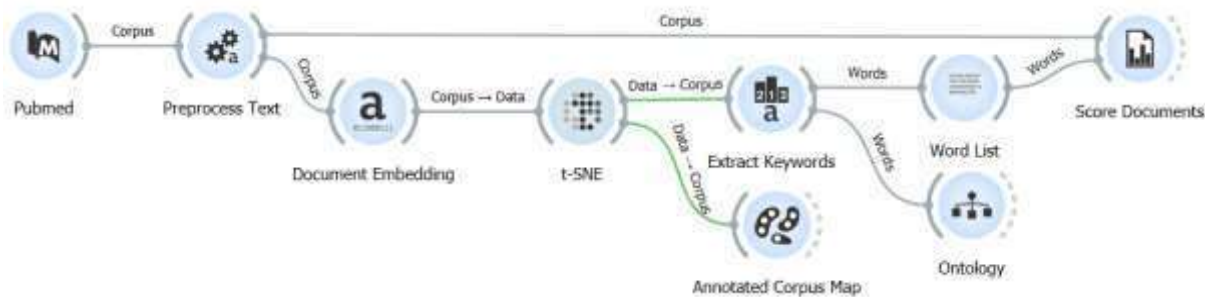


Fig. 1. Research Procedure in Orange Data Mining Tool

Source: Own Elaboration

The procedure follows a set of standard stages, including defining objectives, data collection, text preprocessing, feature extraction, and generating valuable insights. The data mining tool extracted text data from papers with different structures.

The data is collected to cover the scope of this research. Text preprocessing algorithms are essential tools for cleaning, standardizing, and improving the quality of textual information. They include tokenization, which breaks down sentences into smaller units, stop word removal, stemming and lemmatization, which convert words to their root or base form, and lowercasing, which converts all text to lowercase. These algorithms also handle punctuation and special characters, removing or replacing non-alphanumeric symbols to maintain data cleanliness and prevent interference with subsequent analyses. Finally, they remove or replace HTML entities, which represent characters encoded in HTML format, ensuring an accurate representation of characters in the text. These algorithms help in enhancing the efficiency of downstream tasks.

Feature extraction transforms raw data into features suitable for analysis, modelling, and machine learning. The process enhances the representation of the text data by considering features such as n-grams, YAKE! (Yet Another Keyword Extractor), and document embedding. The technique t-Distributed Stochastic Neighbor Embedding (t-SNE) is also applied. It helps reduce the number of features while retaining essential information. The t-SNE algorithm uses a perplexity parameter (30 points are applied in the Orange tool) to balance local and global structures, calculating the number of neighbors for each data point (Orange Data Mining, 2023). The algorithm calculates pairwise similarities using a Gaussian distribution in high-dimensional space and a t-distribution in lower-dimensional space. YAKE! is an algorithm that identifies potential keywords by analyzing the frequency and distribution of terms in a document. It considers single words and multi-word phrases. YAKE! uses feature extraction to capture key term characteristics, such as frequency, position, and length. Each term is assigned a score based on its features, considering factors like term frequency and document frequency. The algorithm also generates keyphrases by combining relevant terms. Bigrams (2-grams) are applied to contain pairs of consecutive items. N-grams are

used as features in text classification tasks, helping models understand the context and semantics of the input.

Visualization is used to represent patterns and insights derived from the text data, using techniques like corpus maps, ontology, and document scoring.

3. Results and Discussion

As a result of the processing of the retrieved research papers, a map of the text corpus was generated, a list of the top 10 most frequent key phrases in the processed text was made, an ontology was generated and the retrieved papers were evaluated based on their compatibility with the used key phrases.

5 clusters were formed from the extracted papers based on Gaussian mixture models and a False Discovery Rate (FDR) value of 0.10. Fig. 2. shows the clusters formed, two of which show that the keyword access is present. The remaining 3 clusters are entirely focused on medical topics, as the purpose of the PubMed database suggests. The results show that only two of the five clusters correspond to the key phrases on which the research papers were curated. The topic of accessibility in the workplace is refracted through the perspective of physical accessibility and specific disabilities.

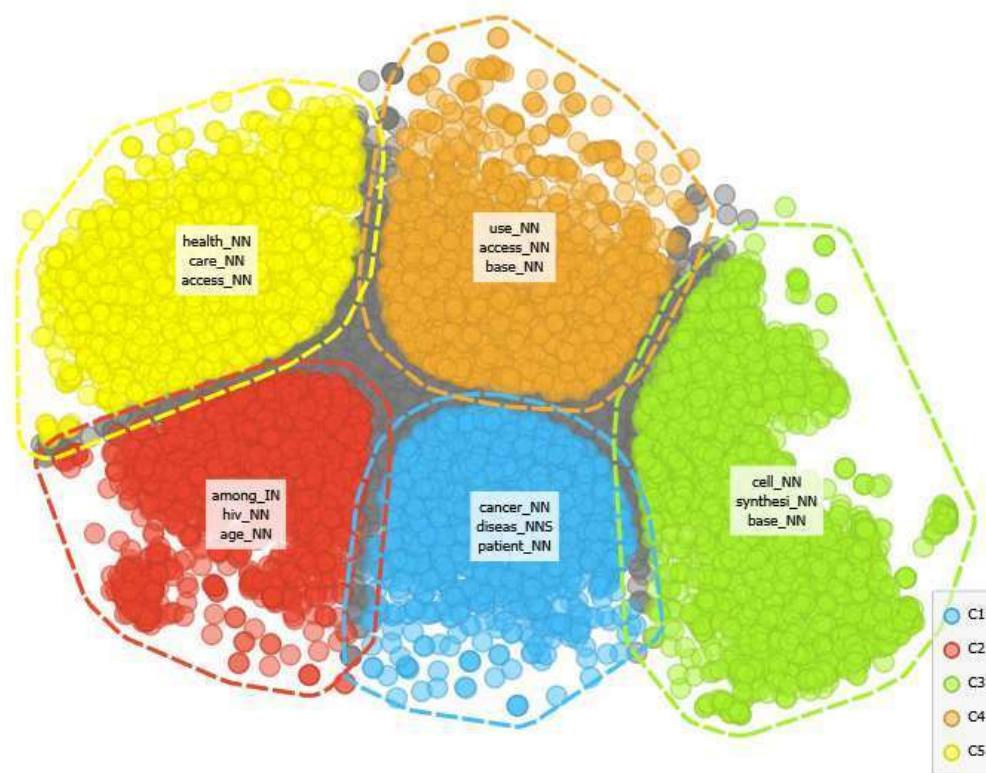


Fig. 2. Corpus map based on t-SNE results

Source: Own Elaboration

Top 10 most frequent key phrases are shown in Fig. 3. They are extracted based on the algorithm YAKE!. The results show that the phrases have a very close relationship with the key phrases from which the research papers were extracted.

Word	YAKE!
financial accessibility	0.899
accessibility effects	0.781
accessing mental	0.781
arterial roads	0.781
case study	0.781
ciliary dyskinesias	0.781
city digital	0.781
comparative analysis	0.781
digital twins'	0.781
elective sterilisation	0.781

Fig. 3. Top 10 bigrams generated by using YAKE! algorithm

Source: Own Elaboration

Fig. 4 summarizes the results of the generated ontology, which includes the top 20 key bigrams extracted from the analyzed papers. It can be concluded that they have a closer relationship with the physical accessibility of people with disabilities than with the digital one.

ciliary dyskinesias
 elective sterilisation
 comparative analysis
 feasibility study
 arterial roads
 case study
 accessing mental
 asynchronous psychosocial
 envisioning productive
 cross-sectional survey
 digital twins'
 accessibility effects
 financial accessibility
 income distribution
 city digital
 engagement metrics
 environmental taxes
 ethnic minorities
 follow-on formula
 food pursuant

Fig. 4. Ontology based on the generated top 20 keywords

Source: Own Elaboration

When evaluating the papers for their compliance with the used key phrases „digital inclusion” and „workplace accessibility”, the word count and word presence methods were used. Fig. 5 shows the top 10 documents in which these phrases occur

most often. Similar to the results shown in Fig. 2, the topic of workplace accessibility is advocated in the evaluated papers from the point of view of physical accessibility and the analysis of medical issues that can be seen.

Document	Word count	Word presence
6945 Comparing ethanol lock therapy versus vancomycin lock as a salivator strategy for totally implantable vascular access device infections due to coagulase negative staphylococci (the ETHALOCK study): a pro...	0.043	0.043
199 Developing knowledge-based psychotherapeutic competencies in non-specialist providers: A pre-post study with a nested randomized controlled trial of a coach-supported versus self-guided digital traini...	0.043	0.043
2562 Effectiveness of full Paludatory compared with float canal treatment in managing teeth with severe and complex indicative of irreversible pulpitis: a protocol for prospective meta-analysis of individual pati...	0.043	0.043
4388 The impact of community-based food access strategies in high-income countries: a systematic review of randomized controlled trials.	0.043	0.043
7318 Implantable Hearing Devices in Ontario: A Population-based Study of Access to Care and Access to Devices.	0.041	0.038
3910 Decision Recruitment and Engagement of Individuals at Risk for Diabetes and Hypertension in Clinical Trials (PREDICT): A Randomized Trial for an E-Persuasive Mobile Application to Inform Decision Makin...	0.037	0.032
4558 Clinical and cost-effectiveness of 'Live Well with Parkinson's' self-management intervention versus treatment as usual for improving quality of life for people with Parkinson's: study protocol for a randomised...	0.037	0.037
5022 Clinical training education, development and pilot evaluation of an education program to improve clinical communication in Aboriginal health care - participant, and health manager perspectives.	0.037	0.030
5244 In what ways do accessible attitudes ease decision making? Examining the reproducibility of accessibility effects across cultural contexts.	0.037	0.030
7012 Applying the Theoretical Domains Framework to identify policy, Soc, and personal preferences for accessing mental health care in a First Responder Operational Stress Injury Clinic: a qualitative study.	0.033	0.033

Fig. 5. Top 10 scored papers

Source: Own Elaboration

As the purpose of the PubMed database suggests, the papers related to workplace accessibility research are vital for understanding the health needs and challenges faced by individuals with medical conditions or disabilities in their work environment. It also helps identify potential occupational health and safety risks associated with specific medical conditions, leading to the development of strategies to mitigate risks and create safer work environments. Research also helps develop preventive measures to reduce work-related health issues, such as ergonomic considerations and stress management. It also informs the development of assistive technologies and devices to enhance accessibility for individuals with specific medical needs.

Conclusion

In conclusion, workplace accessibility is crucial for fostering an inclusive, diverse, and supportive work environment that accommodates the unique needs of all employees. It goes beyond legal compliance and is directly linked to employee well-being and productivity. By ensuring accessible physical spaces, technologies, and communication channels, organizations create an environment where individuals with diverse abilities can contribute their talents and skills. This not only enriches the workplace culture but also promotes a sense of belonging among employees.

Accessibility is also a strategic investment for organizations, enhancing their employer brand, attracting a wider talent pool, and positioning the company as a socially responsible entity. It can lead to higher employee retention rates, lower absenteeism, and improved morale, positively impacting organizational performance.

Compliance with accessibility standards and regulations not only mitigates legal risks but also demonstrates a commitment to corporate social responsibility. Prioritizing accessibility is an investment in people, fostering a culture of equality, respect, and innovation that benefits both employees and the organization as a whole.

Acknowledgments

The author expresses her gratitude to the Bulgarian Scientific Research Fund, Ministry of Education and Science of Bulgaria for the support provided in the implementation of the project „Impact of digitalization on innovative approaches in

human resources management”, Grant No. BG-175467353-2022-04/12-12-2022, contract No. KP-06-H-65/4 – 2022. The author has no conflicts of interest to disclose. The project is implemented by the University of Economics – Varna, in the period 2022 – 2025.

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