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Assistive Technology: Innovations and Evolution a Bibliometric Approach

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Assistive Technology: Innovations and evolution a bibliometric approach

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Abstract.
Assistive Technology (AT) is an adaptive resource designed to promote the inclusion and autonomy of individuals with various types of limitations by incorporating complex and computerized devices. This assists in enhancing the social and interactive participation of people with disabilities and the elderly, whether their limitations are physical, auditory, visual, and/or neurodivergent. Alongside this, we have technological advancements associated with AT, such as the Internet of Things (IoT), robotic assistants, smart homes, among others. Therefore, the research objective is to highlight the major technological advancements and their impacts on AT device users. The literature was searched in Scopus and Web of Science (WoS), and articles focusing on the applicability of technological advancements in AT were selected, including artificial intelligence (AI), Alternative and Augmentative Communication (AAC) devices, robotic exoskeletons, the Internet of Things (IoT), wearable devices, augmented reality, 3D virtual environments, and Brain-Computer Interfaces (BCIs). A bibliometric analysis was conducted as the methodological procedure to explore, delimit, and assess the relevance of articles in this research area. It is evident from this study that sharing knowledge and collaboration between research centers, technological industries, and global universities are crucial for enhancing AT and developing more adaptable and accessible devices for users, based on the gaps found in the literature. The bibliometric analysis applied to the tools revealed that the topics of Deep Learning and robotic assistants represent future research opportunities with a central focus and limited existing research. However, the term 'occupational therapy' showed a tendency towards centrality within AT research.

Keywords: Assistive technology; Technological innovations; Evolution; Adaptive resource

1. Introduction

Assistive Technology (AT) utilizes equipment to support individuals with disabilities in daily activities, excelling in areas such as adapted sports [1], aiding tetraplegic veterans [2], inclusive education [3], and elderly care [4]. This highlights that AT is not just a tool but a provider of significant changes in every society. From dynamic areas in adapted sports to inclusive education and compassionate care for the elderly, it serves as a link that promotes equality and opportunity, empowering users to live their lives fully.

The skills acquired through AT, especially in youth, promote autonomy and preparation for the future [5][6], contributing to social development and participation [7][8]. The evolution of technologies integrates social inclusion, reflecting the transformative impact of assistive devices on people's lives, driving autonomy, personal development, and active participation in society.

AT is applicable in residential environments, facilitating inclusion and improving quality of life, and embedding residential environments in technological advancements [9]. Promoting accessibility in the workplace, supporting workers with reduced mobility, is vital, making them more competent in their relevant functions [10][11]. IoT sensors in AT devices enable health monitoring and smart environments [12] [13].

These measures drive the development of accessible smart homes, promoting autonomy and inclusion in society. In summary, innovation in AT is essential to meet the needs of users, ensuring their inclusion and autonomy.

The research aims to highlight technological advancements, innovations, and evolution through bibliometric analysis, structuring the article into six sections (introduction, systematic literature review (SLR), methodology, results, discussion, and conclusions).

2. Methods

The study adopted the methodology of Systematic Literature Review (SLR) to identify, evaluate, and synthesize existing evidence in response to a specific research question [14] [15]. A meta-analysis-based approach was used to identify association rules in keywords [16][17], employing the SciMAT tool to map research topics, collaborations, citation analyses, temporal evolution, and term co-occurrence [18][19]. The VOSviewer software complemented the process, allowing network mapping, co-occurrence analysis, citations, cluster identification, and trends [20][21].

In the research, various filters were applied to select relevant articles. Criteria included the publication year between 1989 and 2024, document type limited to articles, and English language. Additionally, articles were filtered based on relevant keywords, including "Assistive technology," "Self-care technology," "Assistive User Interfaces," "Ambient Assistant Living," "Work Assistance and adaptive work assistance systems". The chosen keywords were selected based on their relevance to the research topic, aiming to capture a broad range of articles related to assistive technologies. These decisions were made to ensure that the study's findings are based on a comprehensive and representative sample of the existing literature.

The methodological procedure applied in this study consisted of the PRISMA protocol. The research conducted in October 2023 aimed to analyze the comprehensive state of the art of assistive technologies (AT). Initially, articles related to AT were searched in the scientific databases Scopus and Web of Science, resulting in a total of 11,317 documents after filtering. Using Mendeley software, duplicate articles were removed. Next, the titles and abstracts of the remaining documents were analyzed, selecting journals adhering to the theme, with high impact and quartiles 1 and 2, resulting

in 172 relevant documents. These documents were then used in analyses using SciMAT and VOSviewer, dividing them into three periods according to the density of academic productivity: 1989–2006, 2007–2018, and 2019-2024. In SciMAT, articles with the highest h-index were considered, while VOSviewer automatically selected the 60% most relevant articles for network visualization with descriptors. Finally, the data were observed to provide valuable insights, identifying relevant patterns and focusing on specific topics, using keyword co-occurrence graphs, strategic diagrams, evolution maps, overlapping maps, and cluster networks.

3. Results

The historical evolution is portrayed through this "Road map," which demonstrates important milestones in the development of AT over time, highlighting significant technological advancements, paradigm shifts, and progress in understanding the needs and rights of people with disabilities. This representation offers a panoramic view of the historical evolution of AT and serves as a useful tool for understanding how the field has progressed towards the goals of inclusion, autonomy, and improving quality of life over the years. The historical evolution is depicted through this "Roadmap," which showcases significant milestones in the development of AT over time, highlighting technological advancements, paradigm shifts, and progress in understanding the needs and rights of people with disabilities. This representation offers a panoramic view of the historical evolution of AT and serves as a useful tool for understanding how the field has progressed towards the goals of inclusion, autonomy, and improved quality of life over the years.

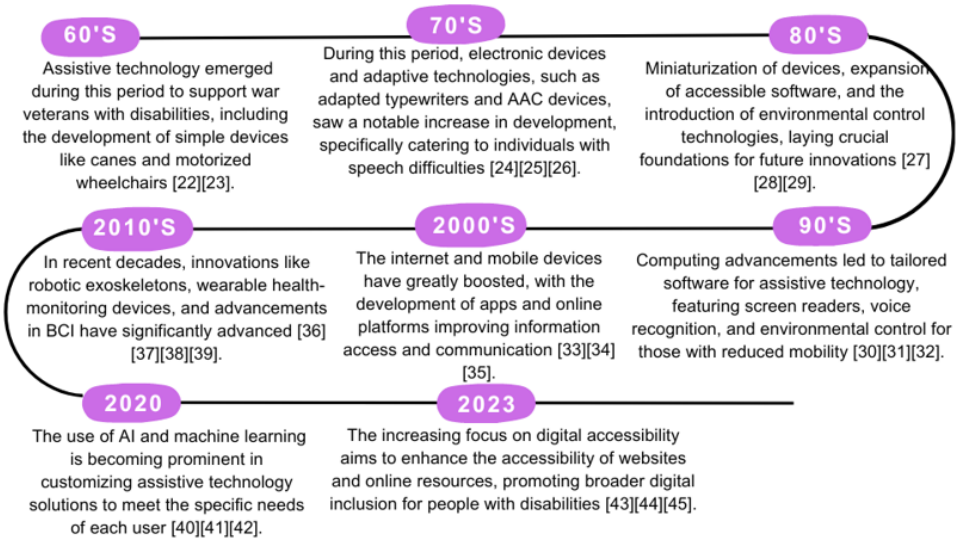

Fig. 1: Road Map (Important milestones in the development of AT over time).

The SLR, conducted according to the described methodological procedure, examined the documents resulting from data mining. Initially, these were used in VOSviewer, as shown in Fig. 2.

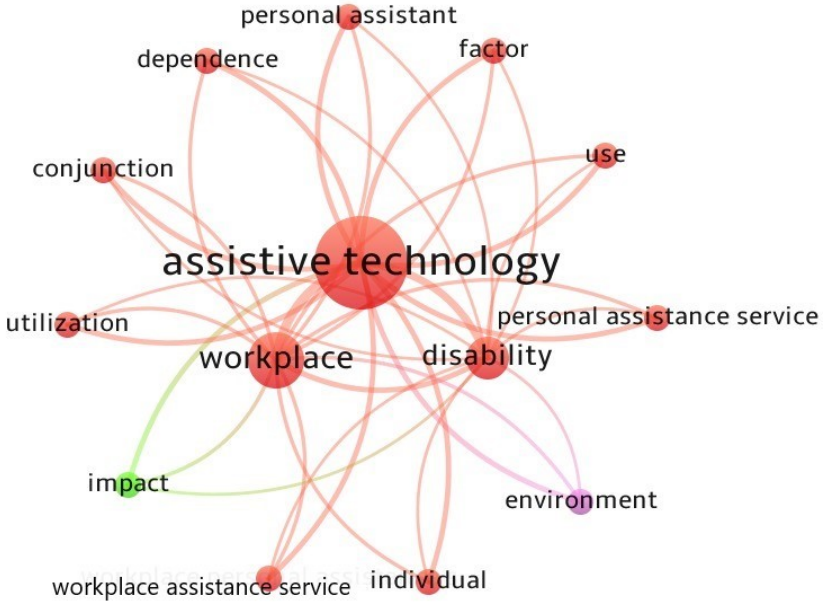

Fig. 2 – Keyword co-occurrence. Adapted by the authors, VOSviewer, 2023

The application, when analyzing the keywords in the 172 articles, notifies that it will select the 60% most relevant terms to be included in the analysis; we chose to follow the program's suggestion. More frequent terms are positioned more centrally and displayed in warmer colors, while less common ones are shown in cooler colors and may be farther from the center, as well as in smaller sizes. It highlighted a significant focus on "Workplace" and "Disability," suggesting a growing emphasis on the application and study of AT in this context, indicating research related to inclusion and the facilitation provided by technologies for people with disabilities, promoting autonomy in task execution. The application of the PRISMA result to SciMAT generated graphs illustrating the evolution of keywords, highlighting the entry and exit of terms, as presented in Fig. 3.

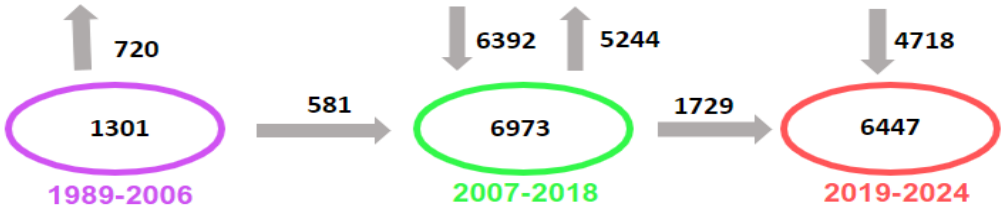

Fig. 3 – Overlapping map. Adapted by the authors, SCIMAT, 2023.

Throughout the temporal periods, there was a significant increase in words related to AT. In the first ellipse (1989-2006), there are 1301 words related to AT, remaining at 581 for the next period, with a decrease of 720. In the second ellipse (2007-2018), the introduction of 6382 new topics occurred, while 5344 were discarded, resulting in 1729 for the most recent period. In the last record (2019-2024), 4718 new expressions were added, totaling 6447 related to AT. The decrease in terms in the last period suggests a stabilization or refinement in the field of AT, where many fundamental technologies have already been explored. This may reflect saturation in certain research topics, changes in study trends, or technological advancements that have solidified existing concepts.

Fig. 4 complements the analysis of Fig. 3, showing the concepts over the same time intervals. The connections represented highlight the frequency and strength of use in journals, while the size of the spheres indicates the number of documents on each topic. "Ambient Assisted Living" stood out, indicating continued interest in this area. There was a decrease in the representation of "Assistive Technology," and new terms such as "Deep Learning," "Ageing," and "VR" emerged, reflecting the evolution of the field.

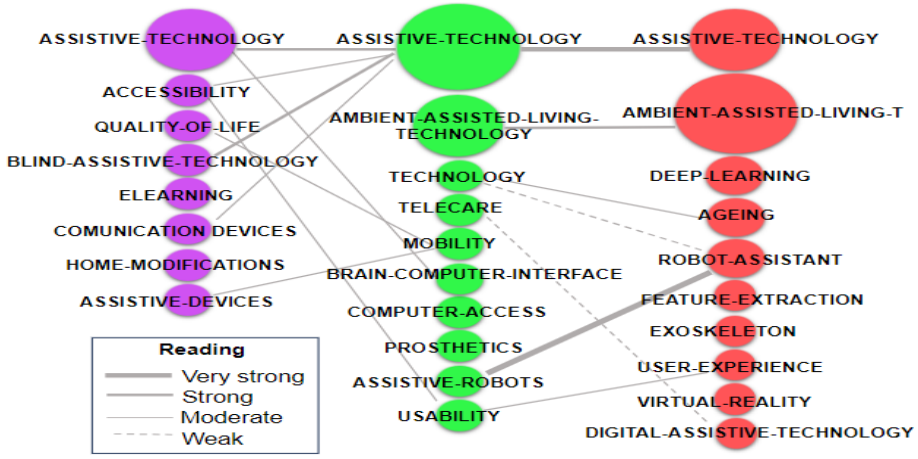

Fig. 4 – Evolution map. Adapted by the authors, SCIMAT, 2023.

In Fig. 5, the strategic density and centrality diagram for the period from 1989 to 2006 stands out. It was noted that the term "AT" appears less dense and centralized, potentially representing an ideal topic for future research in areas that require further exploration and development, possibly in emerging technologies or specific aspects that have not yet been fully explored. On the other hand, "accessibility" shows significant density in the published articles, while "quality of life" and "e-learning" demonstrate density regarding the topics described at the time.

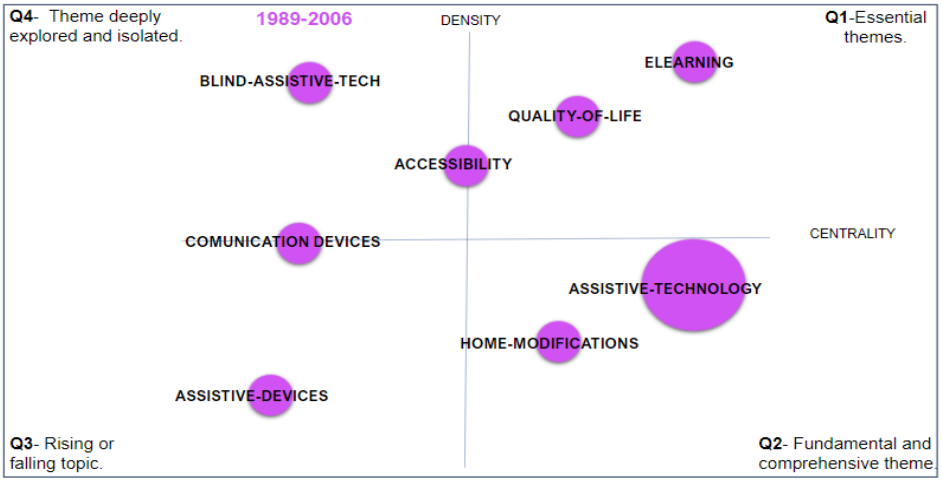

Fig. 5 – Strategic diagram. Adapted by the authors, SCIMAT, 2023.

Similarly, as done in Figure 5, the analysis was applied to the Second (2007 – 2018) and Third (2019 – 2024) temporal segments. In the second temporal segment, there was an increase in the density of citations related to assistive technology (AT), with "microswitches" standing out. In the last period analyzed, AT continues to be the densest topic, followed by "ambient assisted living technology," while "robot assistant" begins to gain space in published documents. Additionally, the topics "ageing" and "deep learning" emerge as promising areas for future research. These insights provide a comprehensive view of the evolution and trends in assistive technology research over time, with an emphasis on specific areas deserving greater attention and investigation. In Figure 6, frames marked with "N/A" mean that word was not found in documents related to AT during the year in question. The word "AT," present in 55.44% of the 2419 articles, shows a significant increase of 452% in the second period. Additionally, new terms have emerged, such as "accessibility," "visual impairment," "communications devices," and "robotic assistant."

NAME	1989-2006		2007-2018		2019-2024	
	DOC	%	DOC	%	DOC	%
ASSISTIVE-TECHNOLOGY	320	59.81%	1341	55.44%	1306	54.30%
DISABILITY	63	11.78%	162	6.70%	162	6.74%
COGNITIVE-ASSISTIVE-TECHNOLOGY	40	7.48%	207	8.56%	166	6.90%
REHABILITATION	37	6.92%	188	7.77%	132	5.49%
OCCUPATIONAL-THERAPY	17	3.18%	59	2.44%	58	2.41%
AUGMENTATIVE-AND-ALTERNATIVE-COMMUNICATION	15	2.80%	N/A	N/A	N/A	N/A
EMPLOYMENT	12	2.24%	N/A	N/A	N/A	N/A
CHILDREN	12	2.24%	N/A	N/A	N/A	N/A
INTERNET	11	2.06%	N/A	N/A	N/A	N/A
BRAIN-COMPUTER-INTERFACE-(BCI)	8	1.50%	N/A	N/A	N/A	N/A
VISUAL-IMPAIRMENT	N/A	N/A	85	3.51%	135	5.61%
WEARABLE-ASSISTIVE-TECHNOLOGY	N/A	N/A	N/A	N/A	123	5.11%
BLIND-ASSISTIVE-TECHNOLOGY	N/A	N/A	88	3.64%	114	4.74%
ROBOTIC-ASSISTANT	N/A	N/A	102	4.22%	113	4.70%
ACCESSIBILITY	N/A	N/A	100	4.13%	96	3.99%
COMUNICATION DEVICES	N/A	N/A	87	3.60%	N/A	N/A

Fig. 6 – Cluster´s network. Adapted by the authors, SCIMAT, 2023.

Currently, the word "AT" is connected to all others in 54.30% of the 2405 journals. "Visual impairment" stands out, along with "accessibility," "cognitive-assistive technology," "blind-assistive-technology," and "wearable-assistive-technology," the latter being a new term. Despite the number of documents remaining constant, there is an increase in connections between words, indicating a higher volume of publications covering similar topics.

4. Discussion

The discussion of the results obtained through trend analysis was conducted. Trends at the intersection of technological innovations and assistive technologies indicate a dynamic and promising landscape. In the field of assistive technologies, six trends stand out. Firstly, artificial intelligence and machine learning have been driving the development of personalized systems, increasingly integrating assistive devices with the Internet of Things, providing a more connected experience. Additionally, there is a growing adoption of wearable devices, such as exoskeletons and high-precision sensors, to enhance users' mobility and functionality. Augmented reality and virtual reality are increasingly being explored to create simulated environments that benefit training, rehabilitation, and daily life for people with disabilities. Interdisciplinary collaborations among professionals in engineering, medicine, psychology, and design are crucial for more comprehensive and effective solutions, emphasizing the importance of digital accessibility and sustainable considerations in the production and use of these technologies. Finally, innovations in communication aim to enhance interaction for people with speech, hearing, or vision impairments, incorporating advances in voice recognition, sign language, and intuitive interfaces. The mentioned trends reflect the ongoing commitment to improving the quality of life for individuals with special needs, seeking autonomy, social inclusion, and full participation in society [46][47][48]. Monitoring these directions can guide

future research and developments in the field of AT. In discussing these trends, it is important to acknowledge the limitations of this study. One limitation is the reliance on data from selected databases (Scopus and Web of Science), which may not capture all relevant literature in the field of assistive technologies [49][50][51]. Additionally, the use of specific keywords and filters may have biased the selection of articles, potentially excluding relevant studies. Furthermore, the exclusion of non-English language articles may have limited the scope of the review. These limitations introduce the possibility of selection bias and may affect the generalizability of the findings. Future research could address these limitations by expanding the search strategy to include additional databases and languages, as well as by using broader search terms to capture a wider range of studies [52][53[54].

5. Conclusion

The ”Road Map” provides an overview of milestones in the development of AT over time, highlighting technological advancements and paradigm shifts. Keyword analysis revealed a growing focus on the application of AT in the workplace and disability-related issues, with more frequent and relevant terms centered and displayed in warmer colors. There has been a significant increase in the number of AT-related terms over the years, although there has been a decrease in the last period, suggesting a possible stabilization or refinement in the field. Fig. 4 complemented this analysis, highlighting concepts over the same time intervals. “Ambient Assisted Living” emerged as a continuous area of interest, while new terms such as “Deep Learning”, “Ageing”, and “VR” have emerged, reflecting the evolution of the field. Subsequent strategic diagrams highlighted the increasing density and centrality of certain terms over time, indicating potential directions for future studies. Changes in keywords over time periods, suggesting a growing interest and publications on similar themes.

The key technological advancements identified in the research encompass areas such as AI, IoT, wearable devices, AR, VR, and innovations in communication for people with disabilities. These technologies are increasingly integrated into everyday life, benefiting sensitive areas such as adapted sports, inclusive education, and elderly care.

Assistive Technology plays a crucial role in promoting autonomy, especially for young people with disabilities, empowering them for adult life. These innovations not only facilitate daily tasks but also extend into residential, educational, corporate, and social environments, promoting contextualized social practices and improving quality of life.

Global digital accessibility not only benefits those with disabilities but also contributes to more inclusive online environments. Consideration of sustainability in AT production highlights the importance of social responsibility and ethical practices.

Innovations in communication, such as voice recognition and sign language, strengthen interaction for people with different abilities, fostering a more inclusive and understanding society.

These trends at the intersection of technological innovations and AT have the potential to positively transform the approach to the needs of people with disabilities, creating a more inclusive, accessible, and empowering future for all [55][56].

As a future perspective, it is suggested to deepen analysis on the applicability of emerging AT in various environments such as the job market, educational centers, health, and sports. Exploring perceived benefits by users, their impact on families and the community can provide valuable insights. Additionally, investigating the users' learning relationship with these technologies and their impact on age and educational attainment would be a promising area for subsequent research."

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References

1. Asare, F.; Townsend, R. C.; Burrows, L. Disentangling assistive technology: exploring the experiences of athletes with physical impairments in disability sport. Qualitative Research in Sport, Exercise and Health, v. 15 (6), p. 729-741, 2023. Doi.org/10.1080/2159676X.2023.2197458
2. Monden KR, Charlifue S, Philippus A, Kilbane M, Muston-Firsch E, MacIntyre B, Welch A, Baldessari J, Coker J, Morse LR. Exploring perspectives on assistive technology use: barriers, facilitators, and access. Disability and Rehability Assistive Technology, v. 27 (1), p. 1-11, 2023. Doi.org/10.1080/17483107.2023.2227235
3. McNicholl A, Desmond D, Gallagher P. Assistive technologies, educational engagement and psychosocial outcomes among students with disabilities in higher education. Disability and Rehability Assistive Technology, v. 18 (1), p. 50-58, 2023. Doi.org/10.1080/17483107.2020.1854874
4. Kabacińska, K.; Vu, K.; Tam, M.; Edwards, O.; Miller, W. C.; Robillard, J. M. "Functioning better is doing better": older adults' priorities for the evaluation of assistive technology. Assistive Technology, V. 35 (4), p. 367-373, 2023. DOI.org/10.1080/10400435.2022.2113180
5. Coster W., Khetani M.A. Measuring Participation of Children with Disabilities: Issues and Challenges. Disability and Rehabilitaion, v. 30, p. 639–648, 2008. Doi.org/10.1080/09638280701400375
6. Rosenbaum, P., Gorter J.W. The "F-Words" in Childhood Disability: I Swear This Is How We Should Think! Child Care, Health Development, v. 38, p. 457–463, 2012. Doi.org/10.1111/j.1365-2214.2011.01338.x
7. Lami F., Egberts K., Ure A., Conroy R., Williams K. Measurement Properties of Instruments That Assess Participation in Young People with Autism Spectrum Disorder: A Systematic Review. Development Medicine and Child Neurology, v. 60 (3), p. 230–243, 2018. Doi.org/10.1111/dmcn.13631
8. Brochard S., Newman C. J. The Need for Innovation in Participation in Childhood Disability. Development Medicine and Child Neurology, v. 61 (5), p. 501, 2019. Doi.org/10.1111/dmcn.14201
9. Mensah-Gourmel, J.; Thépot, M.; Gorter, J. W.; Burgain, M.; Kandalaft, C.; Chatelin, A.; Letellier, G.; Crochard, S.; Pons, C. Assistive products and technology to facilitate activities and participation for children with disabilities. International Journal of Environmental Research and Public Health, v. 20 (3), p. 2086, 2023. Doi.org/10.3390/ijerph20032086

10. Beneteau E., Feldner H., Pratt W. "I miss work:" employment experiences and attitudes of adults with acquired disabilities who use assistive technologies. Disabil Rehabil Assist Technol. 2023 Jun 30:1-10. doi: 10.1080/17483107.2023.2221312. Epub ahead of print. PMID: 37390848.
11. Söderström, S., Bakken H., Østby M., Ellingsen K. E. How Implementation of Cognitive Assistive Technology in Home-Based Services for Young Adults with Intellectual. Disabilities Influences Support Staff`s Professional Practice. J Intellect Disabil. v. 27 (2), p. 419-432, 2023. Doi.org/10.1177/17446295221083137
12. White, K., Han S. S., Britton, A., Hendrix, J. A feasibility study demonstrating that independence, quality of life, and adaptive behavioral skills can improve in children with Down syndrome after using assistive technology. PLoS One. v. 18 (5), e0284738, 2023. Doi.org/10.1371/journal.pone.0284738
13. Travis Kadylak & Shelia R. Cotten (2020) United States older adults' willingness to use emerging technologies. Information, Communication & Society, 23:5, 736-750, DOI: 10.1080/1369118X.2020.1713848.
14. Schaefer J.L., Siluk J.C.M., Carvalho P.S.de. Critical success factors for the implementation and management of energy cloud environments. Int J Energy Res. 2022; 46(10): 13752-13768. doi:10.1002/er.8094
15. Baierle, I. C., Siluk, J. C. M., Gerhardt, V. J., Michelin, C. d. F., Junior, Á. L. N., Benitez Nara, E. O. . Worldwide Innovation and Technology Environments: Research and Future Trends Involving Open Innovation. Journal of Open Innovation: Technology, Market, and Complexity, v. 7 (4), p. 229, 2021. Doi.org/10.3390/joitmc7040229
16. De Carvalho, P. S., Siluk, J. C. M., Schaefer, J. L. Mapping of regulatory actors and processes related to cloud-based energy management environments using the Apriori algorithm. Sustainable Cities and Society, v. 80, 103762, 2022. Doi.org/10.1016/j.scs.2022.103762.
17. Benitez Nara, E. O.; Schaefer, J. L.; de Moraes, J.; Tedesco, L. P. C.; Furtado, J. C.; Baierle. I. C. (2019). Sourcing Research Papers on Small- and Medium-Sized Enterprises' Competitiveness: An approach based on authors' networks. Revista Española de Documentación Científica, 42 (2), e230. https://doi.org/10.3989/redc.2019.2.1602
18. Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E. & Herrera, F. SciMAT: A new science mapping analysis sofware tool. J. Am. Soc. Inf. Sci. Tec., v. 63, p. 1609–1630, 2012. Doi.org/10.1002/asi.22688
19. Costa, M. B. da, Santos, L. M. A. L. dos, Schaefer, J. L., Baierle, I. C.; Benitez Nara, E. O. . Industry 4.0 technologies basic network identification. Scientometrics, v. 121, p. 977–994, 2019. Doi.org/10.1007/s11192-019-03216-7
20. Benitez Nara, E. O.; Schaefer, J. L.; de Moraes, J.; Tedesco, L. P. C.; Furtado, J. C.; Baierle. I. C. (2019). Sourcing Research Papers on Small- and Medium-Sized Enterprises' Competitiveness: An approach based on authors' networks. Revista Española de Documentación Científica, 42 (2), e230. https://doi.org/10.3989/redc.2019.2.1602
21. Singh, N., Arora, S. and Kapur, B. (2022), "Trends in over the top (OTT) research: a bibliometric analysis", VINE Journal of Information and Knowledge Management Systems, Vol. 52 No. 3, pp. 411-425. https://doi.org/10.1108/VJIKMS-12-2021-0316
22. Daly L, J., Rondón-Sulbarán, J., Quinn, E., Ryan, A., McCormack, B., Martin, S. A systematic review of electronic assistive technology within supporting living environments for people with dementia. Dementia (London, England), v. 18 (7-8), p. 2371–2435, 2019. Doi.org/10.1177/1471301217733649

23. Stasolla, F. Bottiroli, S. Fostering Daily Life Skills in Young and Older Adults With Neurodegenerative Diseases Through Technological Supports. Int. J. Ambient Comput. Intell, v. 11 (4), p. 1–15, 2020. Doi.org/10.4018/IJACI.2020100101
24. Bortone I, Leonardis D, Mastronicola N, Crecchi A, Bonfiglio L, Procopio C, Solazzi M, Frisoli A. Wearable Haptics and Immersive Virtual Reality Rehabilitation Training in Children With Neuromotor Impairments. IEEE Trans Neural Syst Rehabil Eng, v. 26 (7), p. 1469-1478, 2018. Doi.org/10.1109/TNSRE.2018.2846814.
25. Schmidt, P., Biessmann, F., Teubner, T. Transparency and trust in artificial intelligence systems, Journal of Decision Systems, v. 29 (4), p. 260-278, 2020, Doi.org/10.1080/12460125.2020.1819094
26. Silva, P. B. E. da, Leal A. S., Ferraz N. N. Usability of smartphone apps as reading aids for low vision patients. Disabil Rehabil Assist Technol. v. 17 (7), p. 848-852, 2022. Doi.org/10.1080/17483107.2020.1820086.
27. Chang, F. H., Liu, C. H., Hung, H. P. An in-depth understanding of the impact of the environment on participation among people with spinal cord injury. Disability and rehabilitation, v. 40 (18), p. 2192–2199, 2018. Doi.org/10.1080/09638288.2017.1327991
28. Jung C., Mehta S., Kulkarni A., Zhao Y., Kim Y-S, Communicating Visualizations without Visuals: Investigation of Visualization Alternative Text for People with Visual Impairments, IEEE Transactions on Visualization and Computer Graphics, v 28 (1), p. 1095-1105, 2022, Doi.org/10.1109/TVCG.2021.3114846.
29. McDonnall, M. C., Steverson, A., Sessler Trinkowsky, R., Sergi, K. Assistive technology use in the workplace by people with blindness and low vision: perceived skill level, satisfaction, and challenges. Assistive technology, v. 8, p. 1–8, 2023. Doi.org/10.1080/10400435.2023.2213762
30. Frauenberger, C., Spiel, K. Makhaeva, J. Thinking OutsideTheBox - Designing Smart Things with Autistic Children. International Journal of Human–Computer Interaction, v. 35 (8), p. 666-678, 2019. Doi.org/10.1080/10447318.2018.1550177
31. Gopal P, Gesta A, Mohebbi A. A Systematic Study on Electromyography-Based Hand Gesture Recognition for Assistive Robots Using Deep Learning and Machine Learning Models. Sensors, v. 22 (10), 3650, 2022. Doi.org/10.3390/s22103650
32. Saxby, D.J., Killen, B.A., Pizzolato, C., Carty, C.P., Diamond, L.E., Modenese, L., Fernandez, J., Davico, G., Barzan, M., Lenton, G.K., Luz, S.B., Suwarganda, E.K., Devaprakash, D., Korhonen, R.K., Alderson, J., Besier, T.F., Barrett, R., Lloyd, D.G. Machine learning methods to support personalized neuromusculoskeletal modelling. Biomechanics and Modeling in Mechanobiology, v. 19, p. 1169 – 1185, 2020. Doi.org/10.1007/s10237-020-01367-8
33. Darcy, S., Green, J., Maxwell, H. I've got a mobile phone too! Hard and soft assistive technology customization and supportive call centres for people with disability. Disability and Rehabilitation Assistive technology, v. 12 (4), p. 341–351, 2017. https://doi.org/10.3109/17483107.2016.1167260
34. Brinsmead, S. Towards an accessible iPad for children and young people with cerebral palsy. Journal of Enabling Technologies, v. 13 (4), p. 228-239, 2019. Doi.org/10.1108/JET-05-2019-0027
35. Jaiswal, A., Fraser, S. Wittich, W. Barriers and Facilitators That Influence Social Participation in Older Adults With Dual Sensory Impairment. Frontiers in Education, v. 5, 2020. Doi.org/10.3389/feduc.2020.00127

36. Gull MA, Bai S, Bak T. A Review on Design of Upper Limb Exoskeletons. Robotics, v. 9 (1), 16, 2020. Doi.org/10.3390/robotics9010016
37. Bleau, M., Jaiswal, A., Holzhey, P., Wittich, W. Applications of Additive Manufacturing, or 3D Printing, in the Rehabilitation of Individuals With Deafblindness: A Scoping Study. SAGE Open, v. 12 (3), 2022. https://doi.org/10.1177/21582440221117805.
38. Ha, M. D., Minh, P., Weihua, S., Dan, Y., Meiqin, L. RiSH: A robot-integrated smart home for elderly care. Robotics and Autonomous Systems, v 101, p. 74-92, 2018. Doi.org/10.1016/j.robot.2017.12.008.
39. Jackowski A, Gebhard M, Thietje R. Head Motion and Head Gesture-Based Robot Control: A Usability Study. IEEE Trans Neural Syst Rehabil Eng, v. 26 (1), p. 161-170, 2018. Doi.org/10.1109/TNSRE.2017.2765362.
40. Johansson, S., Gulliksen, J. Gustavsson, C. Disability digital divide: the use of the internet, smartphones, computers and tablets among people with disabilities in Sweden. Univ Access Inf Soc, v. 20, p. 105–120, 2021. Doi.org/10.1007/s10209-020-00714-x
41. Moraes, J. de, Schaefer, J. L., Schreiber, J. N. C.; Thomas, J. D., Benitez Nara, E. O. . Algorithm applied: attracting MSEs to business associations. The Journal of Business and Industrial Marketing, v. 35 (1), p. 13-22, 2020. Doi.org/10.1108/JBIM-09-2018-0269
42. Nguyen-Truong, C. K. Y., Fritz, R. L., Lee, J., Lau, C., Le, C., Kim, J., Leung, H., Nguyen, T. H., Leung, J., Le, T. V., Truong, A. M., Postma, J., Hoeksel, R., Van Son, C. Interactive CO-learning for Research Engagement and Education (I-COREE) Curriculum to Build Capacity Between Community Partners and Academic Researchers. Asian/Pacific Island nursing journal, v. 3 (4), p. 126–138, 2018. Doi.org/10.31372/20180304.1030
43. Thakur, N, Han CY. Multimodal Approaches for Indoor Localization for Ambient Assisted Living in Smart Homes. Information. V. 12 (3), 114, 2021. Doi.org/10.3390/info12030114
44. Wood, R., Griffith, M., Jordan, J. B., Vanderheiden, G., Lazar, J., Kaine-Krolak, M., Ryson, M., Desai, A., & Folmar, D. "Creatures of habit": influential factors to the adoption of computer personalization and accessibility settings. Universal access in the information society, p. 1–27, 2023. https://doi.org/10.1007/s10209-023-00984-1
45. Wang, J. Chengfeng, P., Haojian, J., Vaibhav, S., Yash, J., Jason, I. H., Carmel, M., Swarun, K. RFID Tattoo: A Wireless Platform for Speech Recognition. Proc. ACM Interact. Mob. Wearable Ubiquitous Technol, v. 3 (4), p. 1-24, 2020. Doi.org/10.1145/3369812
46. Moyle, W. The promise of technology in the future of dementia care. Nat Rev Neurol, v.15 (6), p. 353-359, 2019 doi: 10.1038/s41582-019-0188-y
47. Wangmo, T, Lipps, M, Kressig, R. W., Ienca, M. Ethical concerns with the use of intelligent assistive technology: findings from a qualitative study with professional stakeholders. BMC Med Ethics, v. 20, 98, 2019. Doi.org/10.1186/s12910-019-0437-z
48. Lourenço, F., Nara, E. O. B., Gonçalves, M. C., & Canciglieri Junior, O. (2023). Preliminary construct of sustainable product development focusing on the Brazilian reality: a review and bibliometric analysis. Sustainability in Practice: Addressing Challenges and Creating Opportunities in Latin America, 197-220. https://doi-org.ez433.periodicos.capes.gov.br/10.1007/978-3-031-34436-7_12]
49. Tardio, P.R., Schaefer, J.L., Nara, E.O.B., Gonçalves, M.C., Dias, I.C.P., Benitez, G.B., Castro e Silva, A. (2023). The link between lean manufacturing and Industry 4.0 for product development process: a systemic approach. Journal of Manufacturing Technology Management, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/JMTM-03-2023-0118.

50. Gonçalves, M.C.,Machado, T. R., Nara, E. O. B., Dias, I. C. P., Vaz, L. V. (2023). Integrating Machine Learning for Predicting Future Automobile Prices: A Practical Solution for Enhanced Decision-Making in the Automotive Industry. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics, Vol. 14316, pp. 91 - 1-3. 10.1007/978-3-031-50040-4_8.
51. Tardio, P.R., Schaefer, J.L., Gonçalves, M. C., Nara, E.O.B. (2023). Industry 4.0 and Lean Manufacturing Contribute to the Development of the PDP and Market Performance? A Framework. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics, Vol. 14316, pp. 236 - 249. https://doi.org/10.1007/978-3-031-50040-4_18.
52. Gonçalves, M.C., Pamplona, A.B., Nara, E.O.B., Dias, I.C.P. (2023). Optimizing Dental Implant Distribution: A Strategic Approach for Supply Chain Management in the Beauty and Well-Being Industry. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics, Vol. 14316, pp. 385 - 397 https://doi.org/10.1007/978-3-031-50040-4_28.
53. Gonçalves, M. C., Canciglieri, A., Strobel, K., Antunes, M., Zanellato, R. (2020). Application of operational research in process optimization in the cement industry. Journal of Engineering and Technology for Industrial Applications, vol. 6, no. 24, pp. 36-40. https://doi.org/10.5935/jetia.v6i24.677.
54. Junior, O. J., Gonçalves, M. C. (2019). Application of quality and productivity improvement tools in a potato chips production line | Aplicação de ferramentas de melhoria de qualidade e produtividade em uma linha de produção de batatas tipo chips, Journal of Engineering and Technology for Industrial Applications, vol. 5, no. 18, pp. 65-72. https://doi.org/10.5935/2447-0228.20190029.
55. de Faria, G., Tulik, J., Gonçalves, M .C. (2019). Proposition of A Lean Flow of Processes Based on The Concept of Process Mapping for A Bubalinocultura Based Dairy. Journal of Engineering and Technology for Industrial Applications, vol. 5, no. 18, pp. 23-28. https://doi.org/10.5935/2447-0228.20190022.
56. Vianna, L. V., Gonçalves, M. C., Dias, I. C. P., Nara, E. O. B. (2024). Application of a production planning model based on linear programming and machine learning techniques. JETIA, Vol. 10. No. 45. https://doi.org/10.5935/jetia.v10i45.920.