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Perspectives on Artificial Intelligence Adoption for European Union Elderly in the Context of Digital Skills Development

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Abstract: In today's digitalized era, embracing new and emerging technologies is a requirement to remain competitive. The present research investigates the adoption of artificial intelligence (AI) by the elderly in the European landscape, emphasizing the importance of individuals' digital skills. As has already been globally recognized, the most imminent demographic challenge is no longer represented by the rapid growth of the population but by its aging. Thus, the paper initially analyzed European perspectives on AI adoption, also discussing the importance of focusing on seniors. A bibliometric analysis was required afterward, and the review of the resulting relevant scientific publications uncovered gaps in understanding the relationship between older individuals and AI, particularly in terms of digital competence. Further exploration considered the EU population's digital literacy and cultural influences using Hofstede's model, while also identifying potential ways to improve the elderly's digital skills and promote the adoption of AI. Results indicate a growing interest in AI adoption among the elderly, underscoring the urgent need for digital skills development. The imperative of personalized approach implementations, such as specialized courses, personalized training sessions, or mentoring programs, was underscored. Moreover, the importance of targeted strategies and collaborative efforts to ensure equitable participation in the digital age was identified as a prerequisite for AI adoption by seniors. In terms of potential implications, the research can serve as a starting point for various stakeholders in promoting an effective and sustainable adoption of AI among older citizens in the EU.

Keywords: artificial intelligence (AI); culture; digital skills; digitalization; elderly; European Union; Hofstede; old people

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1. Introduction

In contemporary society, digitalization represents a primary trend that has penetrated and continues to progress in industries, businesses, and everyday life, while artificial intelligence (AI), part of the digital evolution, is garnering increasing attention [1]. Rapid advances in machine learning algorithms, computing power, and data analysis have led to the development and implementation of sophisticated AI technologies, enabling the efficiency of processes and unlocking new possibilities for performing tasks. In the near future, it is expected that embracing AI will become a necessity, not just a choice, in order to remain relevant and thrive within the rapidly evolving landscape [1,2].

Ensuring the effective intersection of digitalization and demographics while maximizing the benefits of the digital transformation for older people requires an integrated approach, addressing both technological, social, and economic aspects. The elderly are often affected differently by technological change due to differences in digital knowledge and skills, as well as their specific needs in terms of other factors such as health, autonomy, and social inclusion [3].

The analysis of AI adoption and use among the elderly, represented, according to Eurostat, by individuals aged 65 or more [4], is crucial in the existing context of digital transformation. It is worth considering the fact that the elderly population is increasing in many countries. As per the World Health Organization, in 2020, the population of individuals aged 60 years and above surpassed the number of children under the age of 5, while by 2050, the percentage of the global population aged over 60 is projected to almost double, rising from 12% to 22% [5]. Although, at present, there are several classifications of the elderly population (see [4,5]), age 60 or 65 can be used as a threshold to point to the beginning of the third or retirement age in different countries or social contexts. Differences in classifying the elderly are based on various reasons, including variances in eligibility criteria for certain benefits or social services, specific demographic analyses, or diverse orientations in research and public policies related to population aging. In addition, organizations and institutions may use varying criteria depending on their specific purpose and objectives in studying or managing population aging issues.

However, under the circumstances of population aging, adapting digital technologies, including AI, to meet their specific needs becomes a prerequisite. Moreover, AI can be a valuable tool for improving the elderly's quality of life, giving them access to more efficient and personalized health, care, and social support services. By analyzing key aspects regarding AI's successful implementation and adoption in this demographic segment, opportunities for innovation and development that can substantially fuel digital transformation could be further identified.

EU member states are progressing differently in the adoption and implementation of digital technologies and AI, both overall and among older people. There are some obvious differences in available resources, political priorities, and digital infrastructure. Countries such as Finland, Denmark, the Netherlands, and Sweden are recognized for their advanced level of digitalization and significant efforts in the implementation of digital technologies in various sectors, including health care and social assistance [6]. These countries may be in a better position to adopt AI quickly and effectively among the elderly. However, there are also member states that face greater challenges in digitalization, either due to underdeveloped digital infrastructures, a lack of digital skills, reduced financial resources, or poor administrative capacity.

Although there are numerous factors influencing digital progress, over time, human capital has mainly been assessed as deficient in the EU based on the digital skills possessed. In fact, improving digital skills within the EU population emerges as a primary challenge that intersects with various goals and objectives. Also, the European Commission's recent report on the state of the digital decade [7] highlights the fact that a substantial proportion (46%) of Europeans, especially among the older demographic, currently lack basic digital skills, which prevents the use of digital tools for daily activities and access to online services. Even though the gender-based digital skills gap has undoubtedly narrowed in recent times, it remains pronounced among older people, those with limited formal education, and those living in rural or remote areas, while disparities significantly persist between member states.

Taking into account the previously discussed aspects, addressing the segment of older people in improving digital skills is crucial. As the European population ages, the inclusion of older individuals in the digital realm becomes increasingly vital for social cohesion, economic participation, and ensuring equitable access to the benefits of AI technologies.

The main objective of the present scientific research is to explore and provide a better understanding of AI adoption for elderly people, considering the digital skills of individuals in the European context as a factor that needs to be understood. Achieving the proposed main aim required the integration of an interdisciplinary approach to the phenomenon under analysis. The following research questions need to be addressed:

RQ1: Which are the main key directions of interest within the existing scientific literature characterizing the intersection between AI technologies and the elderly population?

RQ2: Does the development of digital skills among the elderly population in Europe influence their uptake of AI technology?

RQ3: What are the key cultural characteristics among the EU population that impact the adoption and use of AI technologies by the elderly, and how can these cultural nuances inform strategies for improving digital skills and sustaining AI adoption in this demographic?

Considering the main purpose of the study and the formulated research questions, the manuscript evolves progressively by first providing a theoretical background comprising the scientific literature considered appropriate for the approached phenomenon and then presenting the main methodology-related aspects. Further, the manuscript explores key issues with respect to the adoption of AI at the European level, later focusing on the elderly and, subsequently, on aspects related to their digital skills. Understanding the existing scientific context regarding the intersection between AI technologies and old people involved performing a preliminary bibliometric analysis and reviewing the main resulting scientific publications. Moving forward, the research seeks to conduct a thorough examination of notable evidence associated with digital skills development, which is seen as pivotal in influencing the elderly population's uptake of AI technology. Finally, this study highlights several directions of interest regarding the possibilities of improving digital skills among the elderly while sustaining AI technologies adoption and use, by considering key cultural characteristics among the EU population.

Nevertheless, several limitations were identified while carrying out the present research. These include, among others, restricted access to recent and relevant public data regarding the integration of AI technologies among the elderly, challenges in adequately capturing the demographic variability of the seniors in Europe, and methodological constraints. Additionally, the bibliometric analysis acknowledges potential gaps in comprehensively covering existing literature, mainly determined by the use of a single database and aspects related to identifying and incorporating all relevant scientific publications due to variations in terminologies used.

2. Theoretical Background

To enhance comprehension of the theoretical framework surrounding the analyzed phenomenon, the current chapter focuses on the following aspects: defining digitalization and artificial intelligence in relation to the elderly and societal development; a historical overview of the evolution of AI and digitalization, including their main domains and uses; the utility and role of AI in enhancing the lives of the elderly and contributing to societal development; and an examination of digital risks and inequalities, along with the ethical aspects of AI and digitalization.

As society hurtles forward into an increasingly digital age, it is impossible to ignore the pervasive presence of technology in our daily lives. Supporting the previous idea, recent studies highlight the fact that digitalization is present in all basic sectors and aspects of everyday life, including bank cards, restaurant menus, medical appointments, and sales [2,8]. But amidst this rapid transformation, another phenomenon has emerged—a profound shift in the way humans interact with machines. Therefore, the human-machine relationship attracted more and more researchers, becoming one of the central themes for understanding contemporaneity [9–11].

Artificial intelligence represents a multidisciplinary approach in computer science and linguistics used to create machines capable of performing tasks that typically require human intelligence. These tasks include, among others, learning, reasoning, problem-solving, natural language understanding, and communication. As a field in computer science, AI focuses on developing technologies that can simulate or replicate human intelligence [12,13]. AI systems are designed to learn from data, recognize patterns, make informed decisions, and interact with people and their environment [13]. Specifically, AI encompasses technologies such as machine learning, natural language understanding, computer vision, and natural language processing that enable machines to learn, adapt, reason, and interact with humans and their environments in a human-like manner [14,15].

Referring to the meaning of the terms, "artificial" could be described as something that is developed by humans rather than occurring naturally, while "intelligence" usually refers to human-like capabilities, which means that computers are able to perform tasks that naturally require normal human intelligence [16,17]. Thus, the term "artificial intelligence" represents the intersection of human ingenuity and computational prowess, heralding a transformative era where machines operate with human-like acumen, reshaping industries and augmenting human endeavors.

Over the years, artificial intelligence was usually described as the use of technological devices to replicate the cognitive abilities of humans to achieve goals autonomously, taking into account any constraints that may be encountered [17], or computer modeling usage to emulate intelligent behavior with limited human intervention [18].

However, chronologically, artificial intelligence began in 1950 with Alan Turing's statement that computers could simulate intelligent behavior and have critical thinking. He also introduced the term "Turing Test", representing a method used in AI to ask whether a computer is capable of thinking like a human being or not [19]. In 1956, John McCarthy defined the term "artificial intelligence" (AI) as "the science and engineering of making intelligent machines" [20,21].

Moreover, George Devol invented the first industrial robot arm, shown on the assembly line at General Motors in 1961. It was a hydraulic manipulator arm capable of performing repetitive tasks [22]. In 1964, Joseph Weizenbaum introduced the first chatbot, Eliza, which was able to imitate conversational patterns using match and substitution methodology [23]. Furthermore, "Shakey", "the first electronic person", was the first mobile robot developed in 1966 that could observe and reason about its surroundings [19,24].

Additionally, artificial intelligence has been used to help solve challenges in a variety of fields. Gunn, a Scottish surgeon, pioneered the application of numerical simulations to identify severe abdominal discomfort in 1976 [25]. During the 1980s, there were organizations around the globe, especially in educational centers, studying the use of AI in medicine. By the end of the 20th century, this advancement helped spread new and creative AI techniques for clinical diagnosis and beyond.

The mentioned landmark moments in the history of artificial intelligence mark the inception and evolution of a field that continues to shape our world profoundly. From Turing's foundational insights to Devol's industrial applications and Weizenbaum's early experiments in conversation, each breakthrough underscores humanity's quest to replicate and augment cognitive abilities. As mentioned, beyond robotics, AI has found applications in diverse fields, including medicine, where pioneers like Gunn paved the way for AI-driven solutions to complex challenges. As we move forward into the future, the trajectory of AI promises even greater strides, shaping the world in ways once thought unimaginable.

Relatively recent research showed that AI usage in medicine allows more accurate interpretation of images such as X-rays, MRIs, or CT scans, facilitating a faster and more accurate diagnosis, earlier identification of diseases, and reduction of human errors [26–30]. Additionally, starting in 2023, artificial intelligence (AI) may be used to develop personalized treatment plans for patients based on their genetic makeup, medical history, and other factors. It could be used to monitor and analyze environmental data, such as air and water quality, to help prevent pollution and promote sustainable practices [19]. However, the application areas of AI are much more comprehensive, including health, business, education, agriculture, finance, law, entertainment and media, software coding and IT processes, security, manufacturing, banking, and transportation [1].

In relation to digitalization and artificial intelligence, we continue to discuss two research directions: one focused on the advances and the enormous benefits brought by them to the quality of life, and another focused on digital inequities and the risks of social exclusion of certain categories of the population, such as the elderly.

Regarding the use of AI, specific techniques have proven their worth and importance in many areas, especially in the fields of medicine, business administration, military applications, and communications [31], but also in business management or in the development of technologies and solutions to environmental problems [32], as well as in various industries [31].

Nevertheless, Mijwil et al. concluded that artificial intelligence and digital technologies are of great importance in the healthcare sector and cannot be dispensed with [31].

Directly related to the elderly, there are studies highlighting the importance of AI in geriatrics [13], in the prevention of falls in the elderly, and in emergency intervention [33], but also in cataract surgeries [34]. Also, AI technologies were recognized as instruments having the potential to improve care and health outcomes for older adults, promote healthy aging, and alleviate the burden on the healthcare system [13].

On the other hand, AI-powered robots can assist caregivers in providing personalized and efficient care while providing rehabilitation and mobility support for the elderly. Collaboration between healthcare professionals and artificial intelligence has a significant potential to facilitate more efficient care delivery, improve patient outcomes, and optimize healthcare resources for an increasingly aging population [13].

For early fall prevention, one of the main advantages of integrating AI technology is the ability to send timely alerts and emergency alarms. This is especially important for the elderly who live independently. Older people can feel safer when their families and loved ones are aware of their physical (external) and mental health. During difficult times, older adults can feel more confident when AI technologies provide protection and safety [32].

Unquestionably, health services represent one of the most important needs of every individual in this universe [35,36]. Health is an important step for achieving physical existence, developing societies, and building nations where they can be socially, economically, and culturally diversified [37,38]. As demonstrated, technology and the improvements that AI brings can always have a positive impact on the quality of life [31,34].

From a health perspective, advanced technologies and methods improve the quality of medical operations, communicate well with patients, keep track of their health status [39–42], and contribute to quality improvement. Some specific ways AI can help medical diagnosis were also listed, including image analysis, medical history analysis, treatment recommendations, and predictive modeling [19,43].

AI technologies can likewise help doctors diagnose, decide treatment options, and predict, classify, and optimize effectiveness for the risks associated with geriatric diseases for both healthcare professionals and patients. AI algorithms, by analyzing vast data sets, can identify patterns and trends that doctors cannot immediately discern. This information can empower healthcare providers to make more informed decisions and provide personalized care to elderly patients [13].

Additionally, AI-assisted devices and wearable sensors can continuously monitor the health status of the elderly, alerting healthcare professionals to abnormal changes or emergencies. In addition, AI facilitates remote monitoring and telehealth services, allowing elderly patients to receive care from the comfort of their homes [44]. By automating routine tasks and administrative processes, AI can ease the burden on healthcare providers, allowing them to use their time and resources more efficiently; contribute to medication management in geriatric care; and potentially improve mental health care in geriatric patients. It could be particularly effective in the early recognition and diagnosis of neurocognitive disorders such as dementia [13].

Supporting caregivers and providing enhanced care for elderly patients can be facilitated, potentially alleviating mental health issues exacerbated by common experiences of loneliness and social isolation among the elderly. AI can analyze symptoms of loneliness during qualitative interviews and understand gender differences and nuances in loneliness reporting processes to provide personalized interventions and support and mitigate the harmful effects of social isolation [13,45].

Due to the rapid growth of the elderly around the world, the AI control framework can collect information and apply it to perform other tasks. Artificial intelligence plays an important role in focusing on the elderly. For example, it can improve the relationship between older people and family members or healthcare teams. Also, the AI chatbot can communicate with the elderly without obstacles and remind them when to take medicine, have a regular physical exam, etc. A significant number of AI applications on mobile phones accessible today could screen wellness information such as the senior's daily exercise, diet, and lifestyle. In such cases, it could help to wait and subsequently prevent any hypertension or unpredictable heart rhythm. Essentially, the mechanical "pets" also help to combat feelings of loneliness, in addition to helping to improve the patient's focus. In a technological society, healthcare is exploring artificial intelligence to provide personalized treatment to people in need [25].

As observed, AI is playing an explosive and critical role in the field of healthcare for the elderly. Conversely, the fact that digital technologies can cause social inequities and negative effects on the population has been shown over time, such as discriminatory behaviors [46] or race and gender bias [47–50].

The COVID-19 pandemic has accentuated the digital transformation process, but the way people integrate digital technologies into their lives is varied. In this regard, Eszter Hargittai explores the concerning aspect of disparities in digital media access, where individuals from less privileged backgrounds face fewer opportunities to harness its benefits and are at a higher risk of encountering negative outcomes or being marginalized [51]. Therefore, while digitalization represents a natural process for a large part of the population and contributes to improving the quality of life, for certain categories of the population, such as the elderly, it could be a source of exclusion and loss of autonomy.

The transition from in-person communication to communication mediated by AI technologies has led to the exclusion of some people from the communication scene [3]. In 1998, Hoffman and Novak discussed digital gaps ("digital divide") as differences between rich and poor information [3]. In their recent study, while examining the market requirements for smart and traditional aging housing units, Li et al. [52] revealed the presence of a digital divide, with certain elderly individuals indicating unfamiliarity with computers and a reluctance to utilize smart home technologies. In addition, Mireia Fernández-Ardèvol highlighted the exclusion of the elderly through digitalization, considering "old age as a periphery of digitized societies" [53].

Additionally, as per Fernández-Ardèvol and Grenier, while examining the impact of incomplete portrayals of older individuals on the analysis of digitalization, challenges such partial descriptions pose to understanding digital practices across different age groups could be observed [54]. Pursuing a similar research interest, Andrea Rosales and Mireia Fernández-Ardèvol investigated how, on digital platforms, innovation teams, following homophilous patterns, ignore older people [55].

In terms of ethical considerations and risks, it is essential to consider potential risks such as errors or incorrect recommendations from AI systems, which could have serious consequences for the health of the elderly. Likewise, we should be aware of the potential lack of human interaction and personalized care when using artificial intelligence in geriatric care. The emotional well-being of the elderly, which depends on human touch and friendship, should not be replaced without careful consideration [13]. Daily life behavior analysis is considered to be useful in activity recognition for applications such as feasible alarm systems for emergency treatment. Nonetheless, how to protect personal privacy and maintain a ubiquitous, low-power, long-term system represents a challenge [56].

It is important to recognize the ethical considerations and potential limitations of AI in geriatric care, and further research and development are needed to ensure its responsible and effective use. Considerations include patient privacy, consent, and the potential for bias in AI algorithms. Additionally, limitations of AI in geriatric care include a lack of emotional intelligence and an inability to provide personalized care that takes into account individual preferences and values. Hence, persisting in researching and advancing AI technologies in geriatric care to tackle these issues is important, ensuring responsible and efficient use of AI to enhance the well-being of elderly individuals [13].

While considerable attention has been conferred on understanding the dynamics of AI usage in the lives of seniors, the current research efforts are shifting focus towards empowering older adults through the development of digital skills. This shift acknowledges the inherent relationship between digital literacy and the adoption of AI technology among the elderly in

Europe. Additionally, recognizing that understanding and respecting cultural characteristics can significantly impact the adoption and sustained use of AI technologies by older adults, cultural nuances are approached to inform strategies for inclusive innovation. These positive strides underscore a future where AI-driven solutions cater to the diverse needs and preferences of the elderly population, fostering inclusivity and empowerment in the digital age.

3. Method

Currently, the adoption of AI technology in Europe represents an area of particular interest, with potentially significant implications for different demographic groups. Therefore, the research path aimed at achieving the predefined objective of the study required following a rigorous, structured process whose stages reside in interdependence (Figure 1).

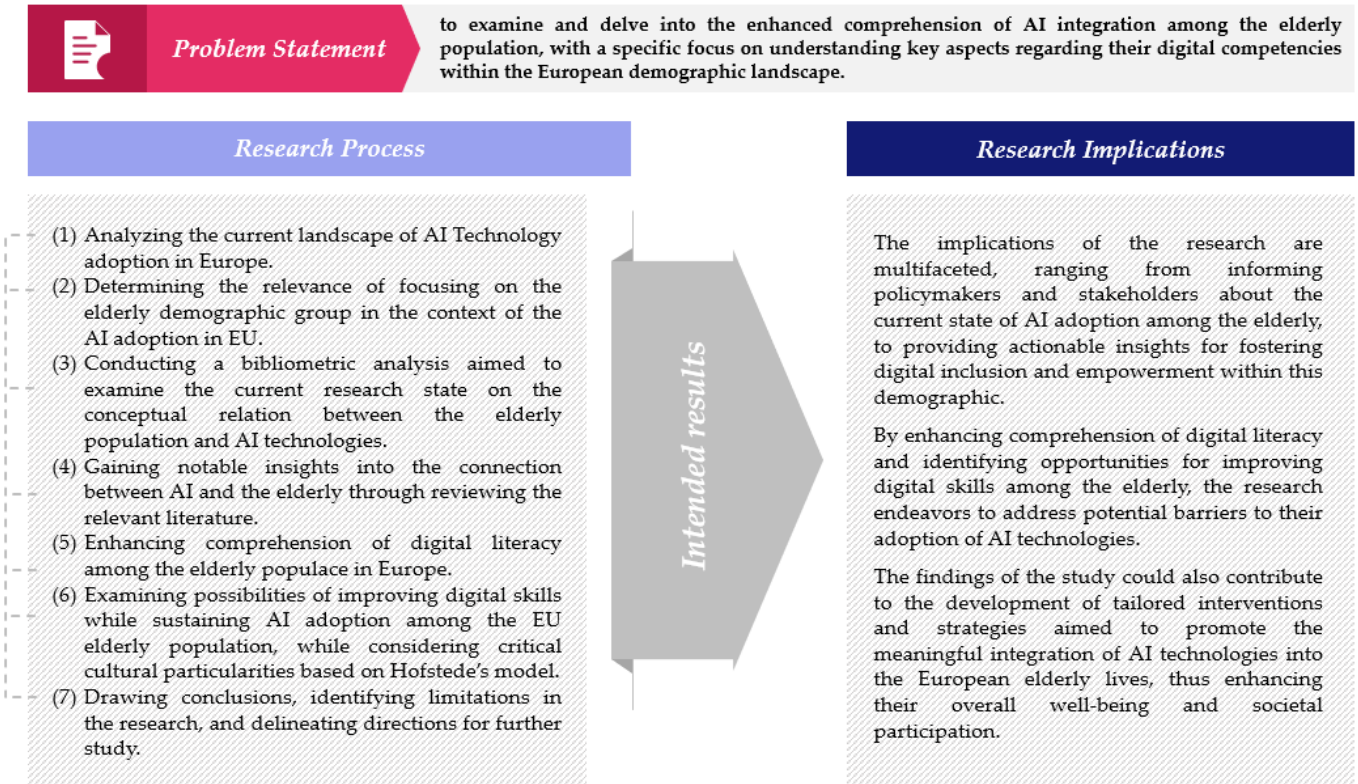

Figure 1. The research process and its implications. Source: Illustrated by the authors.

From the methodological perspective, the research process is based on an interdisciplinary and holistic approach, combining well-known research methods, i.e., preliminary bibliometric analysis, exploratory analysis of statistical data from Eurostat, and cultural analysis using Hofstede's Cultural Dimensions Theory.

This study begins by exploring notable publications of interest in the analysis of the proposed phenomenon, aiming to enhance understanding among the audience. In order to examine and quantify research trends related to the relationship between elderly people and AI technologies, the existing scientific literature was analyzed by conducting a bibliometric study, the characteristics of which will be detailed in the dedicated section of the manuscript. Obtaining the data following the bibliometric analysis led to a detailed analysis of the relevant literature aimed at recognizing the current state, gaps, and future research directions in the field.

The subsequent focus on digital skills among the elderly population in the EU involved the use of statistical data provided by Eurostat relevant to the analysis by age groups. Thus, the composite Digital Skills Indicator—DSI was, among others, subjected to analysis, leading to highlighting, as an overall perspective, the main aspects related to digital competence among EU individuals aged between 65 and 74. By synthesizing this data, a clearer understanding of the digital literacy and competency landscape was achieved. Such insights are invaluable in informing strategies to address deficiencies and enhance digital inclusion, particularly among senior populations.

Intending to identify possibilities of improving digital skills among seniors with the potential to support the integration of AI technologies within their activities, the final examination performed in the present research implied a focus on the cultural sphere and its particularities. Given the fact that the study emphasizes the EU, such an analysis was considered optimal since, as per the World Economic Forum [57], disregarding cultural differences could compromise or even cancel artificial intelligence projects and could undermine citizens' trust in businesses and other institutional entities. The previous statement is also valid when the development of digital skills is targeted, which is considered a major influencing factor in the situation of integrating AI into the everyday lives of the elderly.

Thus, the outlining of possibilities related to the support of digital skills among the EU elderly population was carried out by adapting Hofstede's Cultural Dimensions Theory, updated for six dimensions [58]: Power Distance, Individualism, Motivation towards Achievement and Success, Uncertainty Avoidance, Long-Term Orientation, and Indulgence. Thus, the scores related to each EU member country were taken into account (based on available public information, not including the Republic of Cyprus), with the measurement scale being from 0 to 100, with 50 as the average level. The data collection was carried out based on the information provided by the Culture Factor Group website [59], with the last update on 16 October 2023, according to the previous publication in scientific journals.

The results obtained allow the evaluation of the ways in which these skills can be supported and integrated in different cultural contexts, providing a solid basis for the design and implementation of appropriate policies and programs to improve the level of digital skills and access to technology for all older European citizens.

4. Insights on AI Technologies Adoption in Europe

The adoption of AI technologies represents a central point of interest in digital transformation, with a globally recognized potential impact on the economy and society. In an ever-changing landscape, AI technologies can become the engine that fuels innovation and efficiency in a wide range of fields, from business and industry to health and education. As far as Europe is concerned, AI has the potential to provide opportunities to increase growth, especially in the lethargic services sector [60].

Global decision-makers are increasingly recognizing both the chances and challenges associated with the adoption of AI technologies and are undertaking growing efforts to effectively manage the phenomenon in question. In this regard, the EU focuses on excellence and trust in its approach to AI, encouraging the development of research and industrial capacity while guaranteeing safety and respect for fundamental rights [61].

Constant, progressive efforts are undeniable, and the recent adoption of the AI@EC Communication by the European Commission in January 2024 represents an example in this respect. The AI@EC Communication highlights strategies for strengthening the European Commission's own capabilities in the field of AI and underlines the importance of the responsible, transparent, and human-benefit-oriented use of these technologies [61].

Furthermore, the European Commission's approach [61] aims to support superior quality in the field of AI with the aim of strengthening Europe's ability to engage in global competition by achieving the following objectives: (a) creating a favorable environment for the development and integration of artificial intelligence in the framework of the European Union; (b) making artificial intelligence a center of prosperity, from the laboratory stage to market success; (c) ensuring that artificial intelligence works for the benefit of people and positively contributes to the progress of society; and (d) strengthening a strategic leadership position in sectors with significant impact.

At the same time, decision-makers are employing policies and regulations aimed at facilitating the adoption of AI in various fields. These policies include initiatives to promote common security and ethical standards in the development and implementation of AI solutions. In addition, training and reskilling programs are being implemented to prepare the workforce for the demands of the new digital economy.

Since the adoption of AI involves investments, according to the Coordinated Plan on Artificial Intelligence [62], the European Commission has proposed to allocate at least 1 billion euros annually for investments in artificial intelligence through the Horizon Europe and Digital Europe programs. The objective of EU funding for AI is to attract and strengthen investments, encourage collaboration between member states, and maximize impact.

The existing evidence highlights measures taken to increase Europe's competitiveness on a global level in terms of improving the adoption of AI technologies. Even though the artificial intelligence market has seen considerable growth over the past decade, the market size is expected to register a CAGR of 15.87% from 2024 to 2030, reaching a market volume of USD 202,50 billion by 2030. Europe is still behind the leading regions in the use of AI, such as the United States and China [63].

Under the present circumstances characterized by rapid technological evolution, the fact that the use of AI can contribute to reducing the digital divide between Europe and other regions of the world and can strengthen Europe's position as a leader in cutting-edge technology represents a key point of interest. Undoubtedly, the adoption of AI is essential to ensuring Europe's economic growth and long-term sustainability in the digital age.

As was highlighted, the recognition of the potential benefits of AI technology adoption is indisputable, and the measures taken in this regard at the European level are increasing. However, the slow progress due, to some extent, to some specific challenges determines the gap between the EU and other states. Without assuming an exhaustive vision, challenges such as the regulatory environment in the EU, including the stringent regulations regarding data protection and privacy, the skills gap among individuals, ethical and societal concerns, the level of funding and investments that still lag behind other market players, and the geopolitical competition could be mentioned.

Although they represent only some of the challenges often mentioned in public space, they significantly influence the progress of AI adoption in Europe. In general, strict regulations can slow down innovation, while difficulties regarding the population's digital skills and abilities create barriers to the implementation of these technologies. Ethical concerns and the lack of common standards can lead to delays and uncertainties in their adoption, while low investment and the absence of effective collaboration between countries can hinder progress in this area, allowing other regions to become leaders in innovation and implementation.

Overcoming the presented challenges and other characteristics of the phenomenon requires an integrated approach, leading to the balancing of regulation with innovation, promoting the exchange of data, supporting the development of skills, and encouraging collaboration between the various stakeholders so that Europe can fully exploit the potential of artificial intelligence technologies.

5. Understanding the Relevance of Addressing the Elderly Target Market

Addressing the target market of the elderly in the adoption of AI technologies represents a key aspect in the current context of technological innovation. Nowadays, the most imminent demographic challenge is no longer represented by the rapid growth of the population but by its aging [64].

The issue of population aging is felt globally, as was already mentioned in the introductory part of the present research [4,5]. Considering the EU, Eurostat projections [65], actually representing "what-if scenarios" based on hypothetical developments (with assumptions for fertility, mortality, and net migration) of the size and structure of the population, reveal a significant decrease in it (Figure 2).

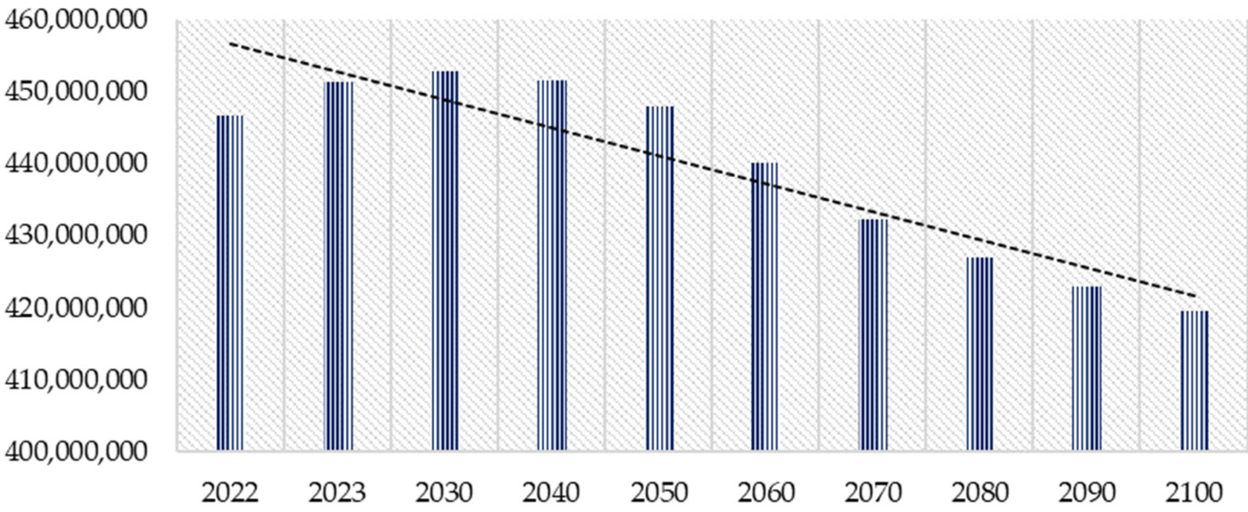

Figure 2. Eurostat projections on the total EU (27 countries) population. Source: Illustrated by the authors based on data provided by Eurostat [65].

Furthermore, the Eurostat publication Ageing Europe—looking at the lives of older people in the EU [4]—highlights a significant increase in the number of EU people aged 65 years or more, rising from 90.5 million at the start of 2019 to an estimated 129.8 million by 2050. During this period, the number of people in the EU aged between 75 and 84 is expected to increase by 56.1%, while the number of those aged between 65 and 74 is expected to increase by 16.6%. On the other hand, according to the latest forecasts, the number of people under the age of 55 living in the EU is expected to decrease by 13.5% until 2050. Thus, a discrepancy between the age groups considered, people over 65 and people under 55, could be noted, reinforcing the critical need to consider, from a long-term perspective, the elderly population as a group of interest.

The significant change in population dynamics has profound consequences for society, the economy, and welfare systems. A continued increase in the proportion of older people creates complex needs in areas such as health care, social care, and others. Hence, addressing this challenge is becoming increasingly vital for the development and sustainability of communities around the world.

With the aging population globally, there is a growing interest in developing and implementing solutions that meet the specific needs of this demographic segment. AI technologies can play a significant role in improving the quality of life of the elderly by providing them with easier access to healthcare, relevant information, and personalized services.

However, it is important to consider the specific needs and concerns of the elderly regarding the adoption of AI technology. Many seniors may have certain reservations or difficulties regarding digital use for various reasons, such as lack of technical knowledge, resistance to change, or fear of feeling outdated. Therefore, it becomes essential to develop and provide intuitive, accessible, and easy-to-use AI solutions for this category of users, but the process itself can only be started in the context of a thorough understanding of the phenomenon and its current state.

6. Mapping the Relationship between Artificial Intelligence and the Elderly

To highlight the interest in the research topic, analyzing the association between artificial intelligence and elderly people from the perspective of existing scientific research was considered appropriate. Reference is thus made to the conceptual association between the terms considered representative of the analyzed phenomenon and obtaining relevant information by performing a bibliometric analysis. For the purpose of carrying out the bibliometric analysis, the following steps were followed:

1. Identification of the database to be used: Given the current context and the possibilities available to the authors, the Web of Science database was chosen for this analysis.
2. Defining the search characteristics: The main search characteristics refer to the search query and the time interval, as follows:

The search query aimed to represent the overall perspective on the analyzed phenomenon, namely the conceptual association between artificial intelligence and elderly people. To define it, the addition of differentiating terms by gender was avoided, referring to a person or persons, respectively, or to people in general. Regarding the representation of the term elderly, in addition to it, the frequently used and synonymous string of characters old was chosen. Artificial intelligence and the well-known acronym AI represent terms used in the query as such, being undoubtedly relevant in the analyzed context.

By using the advanced search feature offered by the Web of Science platform, the query run in its final form included two elements, defined by the TS search tag, as follows: TS = ("artificial intelligence" OR "AI") AND TS = ("elderly people" OR "elderly person" OR "elderly persons" OR "old people" OR "old person" OR "old persons"). Noticeably, the first TS label refers to the concept of artificial intelligence, and the second to the notion of the elderly, through the chosen derivatives. Combining keywords and categories with Boolean operators helped narrow down the search results. Therefore, the "OR" operator was used to group synonyms or related terms within each category, and the "AND" operator was used to connect different categories.

Regarding the period for which the search was carried out, the most extensive possible interval within the Web of Science platform was chosen, namely 1975–2023. Moreover, for better coverage of the results, a specific search language was not imposed within the Web of Science. However, over 95% of the results obtained, in the form of scientific publications, were written in English.

3. Analysis of the raw results obtained through the search.
4. Results processing and interpretation: With the purpose of processing and interpreting the results, the VOSviewer software tool was used, including the features necessary to carry out the targeted bibliometric analysis.

Following the advanced search in the chosen database, 256 results were obtained, representing indexed scientific publications, detailed in the following chapters of this research.

6.1. Raw Results Overview

Considering the fact that the Web of Science platform provides users with the Analyze Results option, the focus was on this for easily finding and interpreting the main characteristics related to the resulting scientific publications. Thus, aspects such as the dissemination of results by categories, the number of publications per year, the number of publications per geographical area, and others were targeted, contributing to defining a valuable overview of the analyzed topic.

The query's dual focus on artificial intelligence and terms related to the elderly population resulted in retrieving articles at the intersection of AI and geriatrics/gerontology, a fact that can be easily observed in Figure 3, depicting the top 10 Web of Science research areas within which the resulted scientific publications were included. Given the diverse range of research areas involved, the topic resulting from the search query could certainly be considered a multidisciplinary one. Researchers and experts from various fields collaborate to address the intersection of AI and the elderly, making it a rich and multifaceted area of study.

The trend in the number of publications per year for the given topic provides valuable insights into its development, popularity, and potential significance within the research community. While the first resulting scientific publication dates from 1991, the topic has shown a consistent increase in research interest over the last 10 years (Figure 4). The year 2023 was not included because, at the time of the analysis, it was not at the end, which would have decreased the relevance of the presented data.

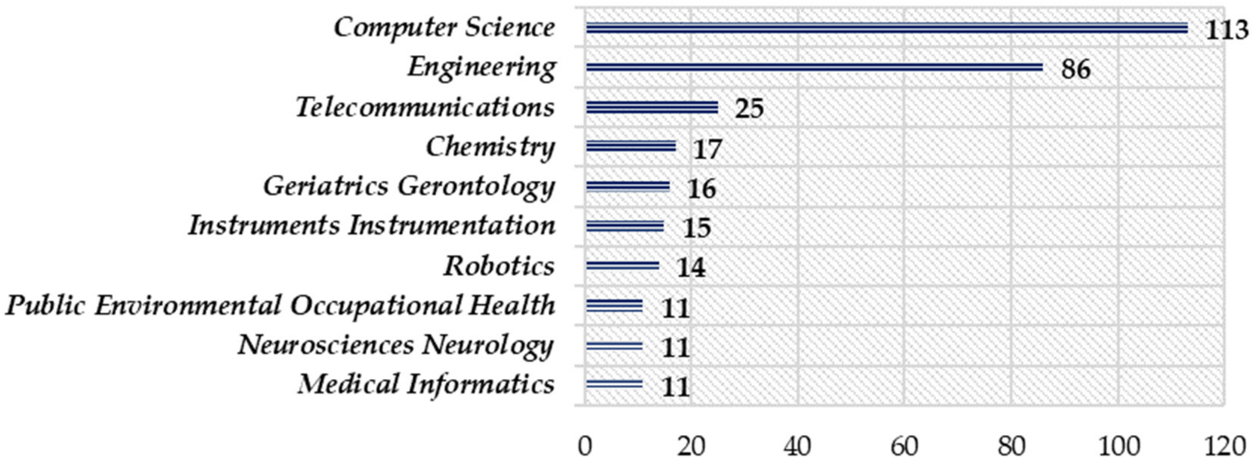

Figure 3. Top 10 resulted Web of Science research areas and the number of included scientific publications. Source: Illustrated by the authors based on data obtained after querying the Web of Science database.

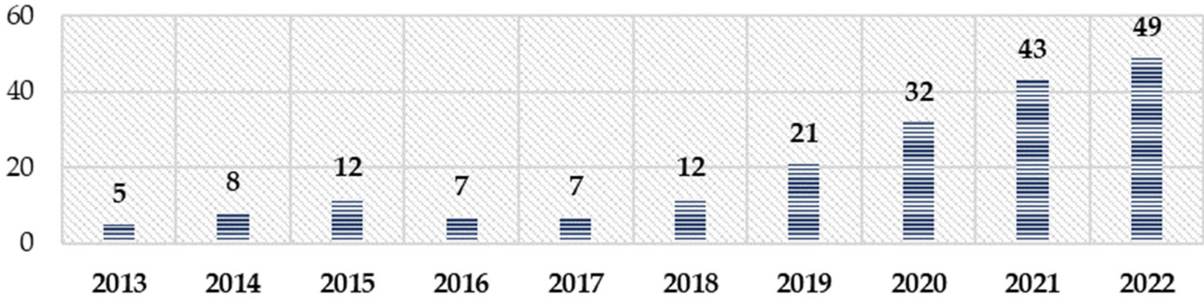

Figure 4. The number of scientific publications per year (2013–2022). Source: Illustrated by the authors based on data obtained after querying the Web of Science database.

The number of publications has gradually risen from 5 in 2013 to 49 in 2022. This growth suggests that the topic has been gaining attention and importance within the academic community. The initial years of lower publication counts (2013–2015) might indicate that the topic was in its early stages of exploration. As the number of publications increased in subsequent years, it suggests that the topic gained recognition as a distinct and relevant research area. While the growth has been steady over the years, there appears to be an acceleration in research output starting around 2018. The number of publications noticeably increased from 12 in 2018 to 49 in 2022. This suggests that the topic has gained momentum and interest in recent times.

The broad representation of countries across different continents indicates that the topic has garnered global interest (Figure 5). Researchers from various regions are actively contributing to the research and development within this field. China stands out with the highest number of publications, suggesting a significant focus on the topic within the Chinese research community. This could be indicative of substantial investment, collaboration, or expertise in the subject. European countries like Italy, Spain, England, France, Germany, and others are well represented in the publication counts. This demonstrates the strong presence of the topic in the European research landscape. The presence of countries from Asia, Europe, North America, and other regions highlights the interdisciplinary and cross-continental nature of the topic. Undoubtedly, the diversity suggests that the topic has implications across various cultural, economic, and social contexts.

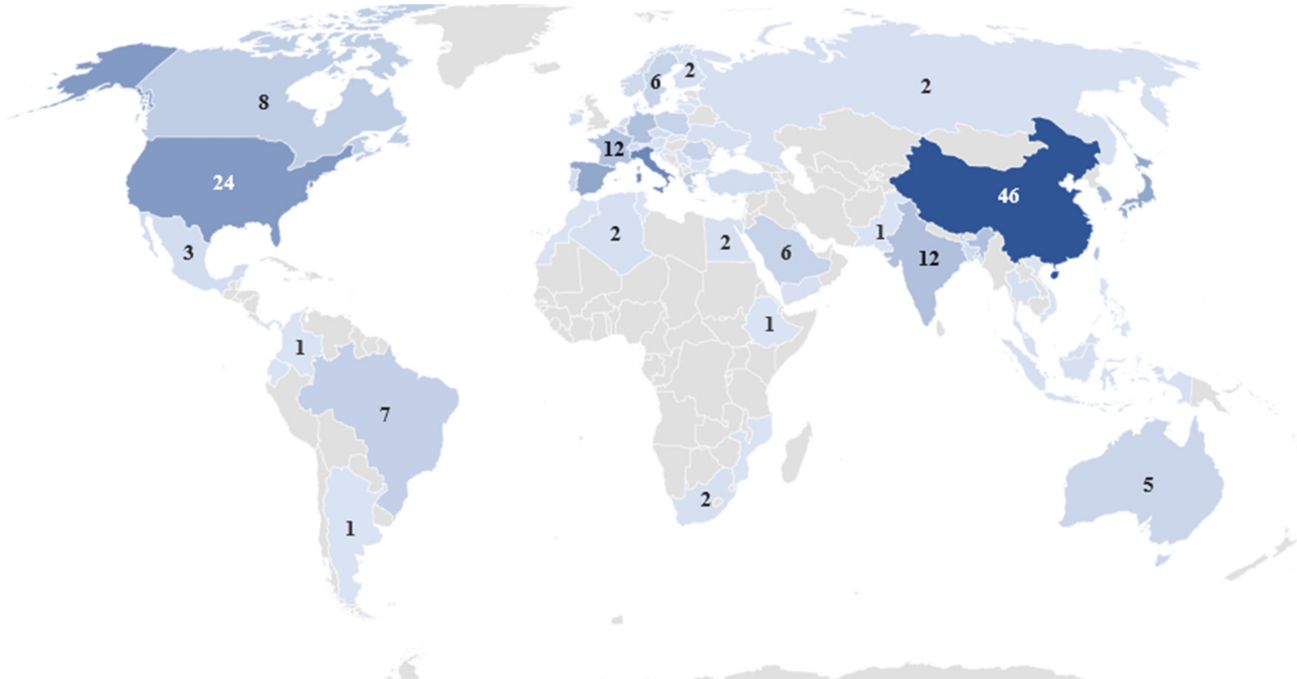

Figure 5. The number of scientific publications per country/region. Source: Illustrated by the authors based on data obtained after querying the Web of Science database.

The distribution of publications by document type (Figure 6) provides insights into the ways of communication and research dissemination within the topic. The dominance of articles, combined with proceeding papers, review articles, and other document types, indicates a robust and multifaceted research landscape. This diverse range of publication types signifies the topic's interdisciplinary nature and its relevance to different forms of scholarly communication and engagement. The high count of articles (161) suggests that research papers presenting original findings, methodologies, and insights are a major component of the scholarly discourse on the topic. This signifies the depth and breadth of research within the field. Moreover, the substantial count of proceeding papers (78) indicates that academic conferences and symposia play a significant role in knowledge dissemination on the topic. These papers often highlight recent developments and emerging trends.

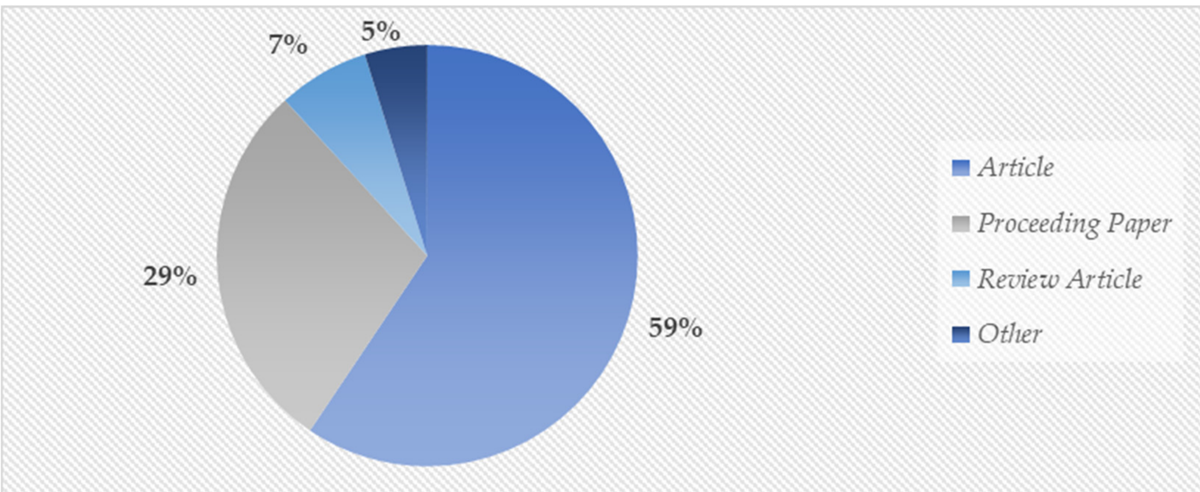

Figure 6. The number of scientific publications per document type. Source: Illustrated by the authors based on data obtained after querying the Web of Science database.

The distribution of publications across different Web of Science Sustainable Development Goals categories (Figure 7) indicates that the topic is intricately connected with various aspects of sustainable development. The high count of publications under SDG 3 (156) signifies that the topic is closely related to health and well-being. This indicates that research within the field is contributing to addressing health challenges, healthcare systems, and overall well-being. However, the emphasis on SDGs related to health, urban development, hunger, education, and industry innovation suggests a comprehensive approach to addressing global challenges. Additionally, the inclusion of other SDGs demonstrates an awareness of the interconnectedness of sustainability goals and the potential impacts of the research on a range of global issues.

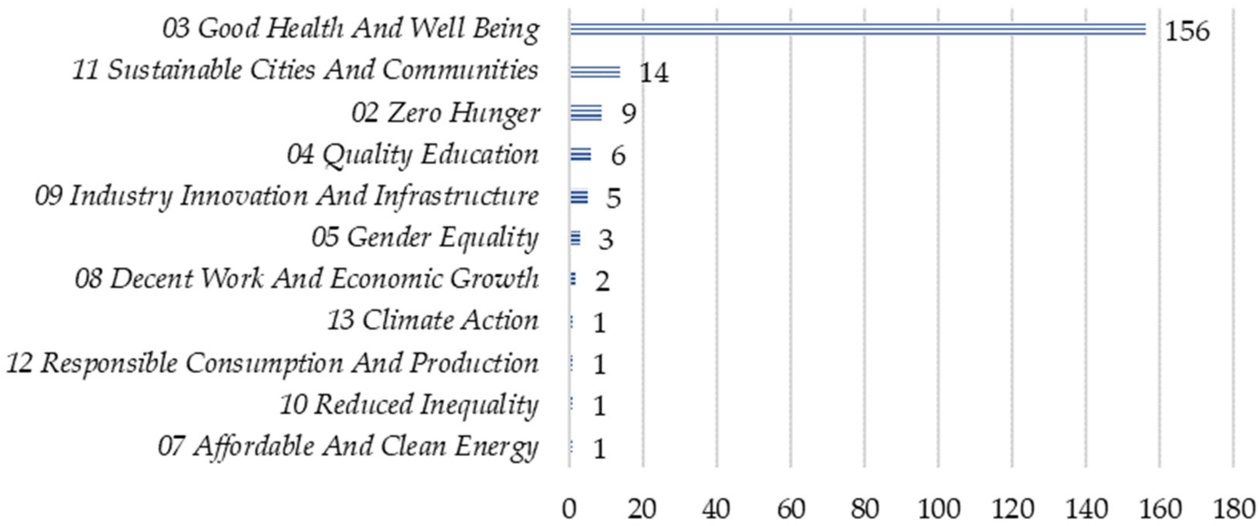

Figure 7. The number of scientific publications per Web of Science Sustainable Development Goals. Source: Illustrated by the authors based on data obtained after querying the Web of Science database.

Despite the limitations to the interpretation of the obtained results, the previously discussed aspects present some main views related to the scientific research revealed as a result of querying the database. Undoubtedly, deepening the subject is imperative, but the novelty and importance of the phenomenon in the scientific research sphere can already be observed.

6.2. Results and Discussion of the Bibliometric Study

Among the many existing types of bibliometric analysis, for the current research, the study of the association between terms was targeted based on their frequency of occurrence. The achievement of the previously mentioned objective involved exporting the titles, abstracts, and keywords related to the scientific publications resulting from the query of the Web of Science database and their processing, as has already been mentioned, through the VOSviewer software, version number 1.6.18.

Under the aforementioned circumstances, based on a minimum number of occurrences of 10, 213 terms out of 7954 were considered relevant. From the 213 selected terms, after applying the predefined VOSviewer relevance score of 60%, 128 terms were extracted. In addition to the filtering provided by means of the VOSviewer tool, manual filtering was also carried out, assuming the exclusion from the analysis of terms that did not serve their purpose (for example, connecting words), a fact that led to narrowing the group of terms included in the final analysis to 100.

The co-occurrence map subsequently generated using VOSviewer (Figure 8) illustrates the relationships and patterns of co-occurrence between different terms, keywords, or concepts within the chosen dataset. Each term within the co-occurrence map is represented as a node (circle), while the size of the node corresponds to the frequency of the term's appearance. An edge, identified as a line, between two nodes indicates a co-occurrence relationship. If two terms frequently appear together in the same documents, an edge connects their corresponding nodes. As per Luo et al. [66], the simultaneous occurrence of two terms suggests a correlation, notwithstanding potential variations in intensity and orientation. By utilizing measures of clustering relationship strength and direction, distinct clusters can be discerned.

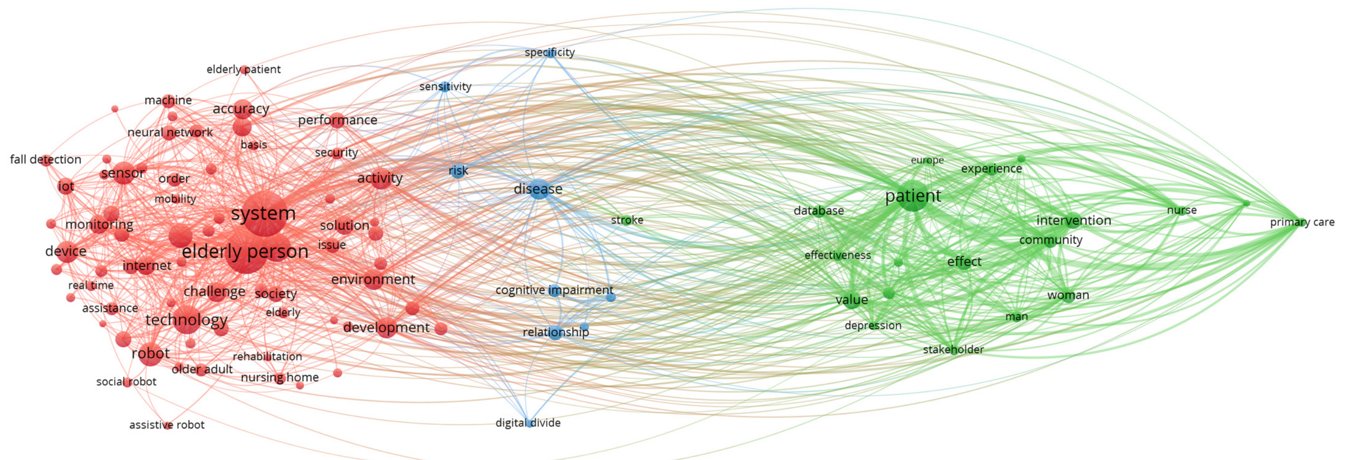

Figure 8. The terms' co-occurrence map. Source: Own processing via VOS Viewer software.

Referring to the top 10 terms considered relevant to the analysis (Table 1), they exceed 80 occurrences, being, to a large extent, naturally associated with the studied phenomenon.

Table 1. Top 10 terms included in the analysis.

No.	Term	Occurrences
1	System	344
2	Elderly Person	306
3	Patient	170
4	Technology	140
5	Artificial Intelligence	136
6	Application	97
7	Robot	92
8	Sensor	86
9	Device	84
10	Activity	83

Source: Data obtained after VOS Viewer processing.

Overall, the top 10 resulting terms suggest a multidisciplinary interest in the addressed topic, indirectly referring to utilizing artificial intelligence and related technologies to develop systems and applications that cater to the needs of elderly individuals. However, based on the top 10 occurring terms and considering the search query (focused on "artificial intelligence" or "AI" and "elderly people" or related terms), there are some insights and observations that can be drawn, as discussed in the following.

The terms "System", "Elderly Person", "Patient", "Technology" and "Artificial Intelligence" appear frequently in the corpus of scientific literature related to the intersection of artificial intelligence and elderly people. The most common term, "System", could refer to various types of AI systems or frameworks designed to assist elderly individuals. It represents a general term that could contain a range of applications and technologies. The string "Elderly Person" is central, indicating a primary focus on studying the elderly population and their needs in relation to artificial intelligence.

Terms like “Patient” and “Application” could indicate a significant focus on medical and healthcare applications of artificial intelligence for elderly individuals, potentially including diagnosis, treatment, and monitoring. Moreover, the presence of terms like “Technology”, “Robot”, “Sensor” and “Device” indicates a strong emphasis on technological solutions, including robotic systems and sensor-based devices designed to assist or interact with elderly people.

The term “Activity” could suggest a focus on understanding and enabling the activities and daily functionalities of elderly individuals through the integration of artificial intelligence. Furthermore, the high occurrence of “Artificial Intelligence” indicates a strong interest in exploring how AI technologies can benefit the elderly population, potentially improving their quality of life and addressing challenges they face.

The potential for assistive technologies is also identified through a combination of terms like “Technology”, “Robot”, “Sensor” and “Device”, suggesting a focus on developing assistive technologies that can aid elderly individuals in various aspects of their lives.

As the keyword co-occurrence map (Figure 8) illustrates, through distinct colors, the selected terms led to the formation of three main clusters, highlighted in red, green, and blue. In fact, the clusters represent groups of keywords that tend to co-occur frequently in the same documents, indicating a thematic connection. Therefore, for a better understanding of the phenomenon, an analysis based on clusters was imposed. In the case of the current research, the process assumed choosing the term with the highest number of occurrences for each cluster and the main 5 terms associated with it, considering the following terms with the highest number of occurrences (Table 2).

Table 2. Keywords clusters based on their number of occurrences (with the number of occurrences in brackets).

Cluster No.	The Most Frequent Key Term in the Cluster	Top Five Associated Key Terms (No of Occurrences)
1 (red)	*System* (344 occurrences)	*Elderly Person* (306), *Technology* (140), *Artificial Intelligence* (136), *Application* (97), *Robot* (92)
2 (green)	*Patient* (170 occurrences)	*Value* (53), *Intervention* (47), *Effect* (43), *Community* (35), *Experience* (30)
3 (blue)	*Disease* (77 occurrences)	*Risk* (38), *Relationship* (36), *Cognitive Impairment* (27), *Sensitivity* (22), *Specificity* (18)

Source: Data obtained after VOS Viewer processing.

This first cluster (red in Figure 8) prominently emphasizes the pivotal role of “System” (344 occurrences) in the context of the association between artificial intelligence (AI) and elderly individuals, likely denoting the overarching technological infrastructure. “Elderly Person” (306) stands out as a central focus, highlighting the target demographic of these AI applications. “Technology” (140) and “Artificial Intelligence” (136), closely interlinked, underscore the integration of advanced techniques in enhancing the lives of seniors. The presence of “Application” (97) suggests the practical utilization of AI-driven solutions, while “Robot” (92) accentuates the potential involvement of robotic systems in catering to the needs and well-being of the elderly population.

However, the VOSviewer analysis reveals a distinct second cluster of terms (green in Figure 8) pertaining to the synergy between artificial intelligence (AI) and the elderly population. At its core, the term “Patient” (170 occurrences) underscores the primary focus on the well-being and health of elderly individuals. Surrounding this, the term “Value” (53) emerges, indicating the significance of AI-based interventions in enriching the lives of seniors. “Intervention” (47) and “Effect” (43) form essential nodes, suggesting the application of AI to create meaningful and positive changes in the lives of elderly individuals. The inclusion of “Community” (35) signifies the broader social context within which these AI interventions operate, hinting at collaborative efforts to support the elderly. Ultimately, “Experience” (30) encapsulates the intended outcome—the enhancement of the elderly's overall experience through AI-driven strategies, reflecting a holistic approach to their well-being.

Central to the third cluster and the most narrowed one (blue in Figure 8) is the term "Disease" (77 occurrences), emphasizing AI's role in disease management and prevention in the elderly population. Adjacent terms such as "Risk" (38) accentuate the proactive nature of AI interventions to mitigate potential health risks. "Relationship" (36) highlights the intricate connection between AI technologies and the elderly's health outcomes, suggesting a personalized approach. "Cognitive Impairment" (27) underscores AI's potential in addressing cognitive health challenges. Notably, "Sensitivity" (22) and "Specificity" (18) imply the precision of AI systems in detecting and predicting health issues, further accentuating their potential in elderly care. Overall, the last cluster delineates AI's significant role in promoting health, early detection, and tailored support for cognitive and physical well-being among the elderly.

Without assuming actual reality, the previously discussed represent, to the greatest extent, the direct assumptions of the authors based on the main key terms obtained. In order to validate the main presented ideas, the analysis of the specialized literature through its direct exploration becomes a necessity.

6.3. The Analysis of AI Literature

Reviewing specialized literature undoubtedly represents a valuable process that can contribute to understanding the results of the bibliometric analysis. The current research focused on the direct exploration of the first ten scientific publications resulting from running the search query, according to their relevance. To obtain the publications subject to analysis, the tool for filtering the results according to relevance, offered by the Web of Science platform, was used. In this context, filtering was related to the search query and the terms included in it.

In the realm of studying the dynamic between AI and the elderly population, the first resulting paper, titled "Monitoring Elderly People with the Robocare Domestic Environment: Interaction Synthesis and User Evaluation" [67], stands as a significant contribution. The paper presents a comprehensive AI framework that orchestrates various intelligent components to provide active assistance to senior citizens within their domestic settings. The paper further adds depth by offering insights into the psychological dimension of this 'system's interaction with elderly users. This entails an evaluation encompassing elements such as system acceptability, perceived utility, modalities of interaction, and emotional responses. By delving into these multifaceted aspects, the paper enhances our understanding of the symbiotic interplay between AI and the elderly, shedding light on the acceptance and effectiveness of AI-driven support systems in enhancing the lives of this demographic.

In the second resulting paper, Vimal et al. [68] discuss the burgeoning impact of the Internet of Things (IoT) on healthcare monitoring, particularly in the context of elderly individuals. The authors highlight the significant advancements in healthcare monitoring in recent years, attributing this progress to the integration of IoT. The paper emphasizes the prevalence of fall accidents among the elderly population and introduces an innovative approach that leverages artificial intelligence (AI) in conjunction with IoT to predict and analyze instances of falls. Moreover, the paper in question exemplifies the potential synergy between AI, IoT, and healthcare, particularly in addressing the pressing concern of fall detection among the elderly population.

In their notable research, Serrano et al. [69] delve into a comprehensive exploration of the burgeoning interaction between AI and Internet of Things (IoT) technologies, heralding a future replete with multi-faceted applications and seamless integrated services. Their investigation spotlights a scenario where AI/IoT-enabled systems intersect with human-centered assistance for the elderly. Through this lens, the paper underlines the enhanced user experiences that can be conferred by AI/IoT-enabled applications. Moreover, the authors stress how the amalgamation of IoT-generated data engenders an ameliorated quality of life for the elderly, serving as a testament to the progressive symbiosis between AI and IoT domains.

In the context of analyzing the relationship between artificial intelligence and elderly individuals, a notable contribution emerged from the paper titled “A Pose Estimation-Based Fall Detection Methodology Using Artificial Intelligence Edge Computing” [70]. The paper underlines the escalating global trend of aging populations and the consequential increase in falls among the elderly, which have become a prominent cause of unintentional fatalities. The manuscript also introduces an innovative artificial intelligence (AI) fall detection approach, denoted as the “pose estimation-based fall detection methodology” (PEFDM), operating within an edge computing framework. Empirical assessments conducted on real human subjects validate PEFDM’s efficacy in detecting elderly falls, boasting an impressive recognition accuracy of up to 98.1%. In the pursuit of enhancing the well-being of elderly individuals through advanced technological interventions, the research presents a pioneering paradigm that harmonizes artificial intelligence, edge computing, and posture recognition to ameliorate fall detection accuracy and operational efficiency.

The fifth scientific publication, titled “Management of Medication using a Mobile Robot and Artificial Intelligence” [71], addresses a pivotal concern for the elderly, i.e., medication adherence, by ingeniously integrating mobile robotics and AI. The authors propose a novel approach employing a mobile robot guided by ultrawideband (UWB)-based navigation, collaboratively with AI capabilities. Upon pill consumption, the robot engages with elderly individuals, providing timely reminders. Largely, the paper contributes to the discourse on AI’s potential to assist and empower the elderly population in managing their health and well-being effectively.

Within their research, de Belen et al. [72] highlight the growing demand for Wearable Assistive Technologies (WATs) that can mitigate functional limitations faced by individuals, particularly the elderly. Similar to the previously quoted papers, this research contributes to the understanding of how AI-driven assistive technologies can positively impact the lives of the elderly population.

The paper titled “Remote Patient Monitoring Using Artificial Intelligence: Current State, Applications, and Challenges” [73] emphasizes the growing integration of AI in the healthcare sector, particularly in the domain of remote patient monitoring (RPM). According to the study, the advent of AI in RPM signifies a transformative shift, enabling advanced technologies to be harnessed for patient-centric care. However, the paper substantiates the integral role of AI in reshaping the landscape of healthcare monitoring for the elderly, offering a panorama of possibilities intertwined with challenges and future prospects.

The publication provided by Bilski et al. [74] introduces the application of Decision Tree (DT) algorithms to address the critical issue of fall detection among senior citizens, a concern that is monitored using infrared depth sensors. Under these circumstances, it can be stated that the paper contributes to the growing body of literature that explores the integration of artificial intelligence and sensor-based technologies to enhance the safety and well-being of elderly individuals.

According to the results of the Cavedoni et al. [75] research, a pioneering approach that combines classical neuropsychological assessments with modern technological tools such as virtual reality (VR) and artificial intelligence (AI) can be employed to generate ecologically precise simulations that replicate the everyday contexts in which patients typically engage in their instrumental activities of daily living (IADLs). Exposing a general perspective close to those presented through the previously discussed manuscripts, the paper underlines the transformative role that AI and VR can play in enhancing the care and well-being of the elderly population.

The last analyzed paper from the top ten resulted in relevance, pointing out the growing prevalence of aging populations worldwide and the resulting challenges in terms of social dynamics and economic implications [56]. As per the authors, with an increasing number of elderly individuals living alone, the significance of assisted living (AL) and healthcare monitoring (HM) becomes paramount. The paper addresses the challenges within the context of human-centered AI and highlights the potential of combining AI with the Internet of Things (IoT) to enhance the quality of life for the elderly. The authors aim to offer a holistic overview of cutting-edge research in this domain, focusing on methodologies, application scenarios, advantages, and limitations of AI–IoT integration.

The brief review previously detailed presents diverse perspectives from the authors, but with a common bridge that encompasses visions related to the possible or demonstrated benefits of artificial intelligence for the elderly. Customized AI tools aimed at improving certain conditions or situations in the lives of elderly people are often discussed. Undeniably, focusing on specific needs and wants represents a desirable direction in the integration of AI for the elderly, and not only. However, reiterating the overall perspective, it can be stated that AI technology has a real beneficial potential for the well-being of elderly people.

The subsequent analysis of the resulting scientific research, by going through their abstracts in addition to the top ten previously reviewed, led to the identification of a certain gap in specialized literature. As has been stated, common points of interest in existing research are oriented toward the analysis of the potential adoption of AI technology among the elderly or how these types of technologies affect, positively or negatively, the elderly. The highlighted gap is represented by the approach to the idea of digital competence among the elderly; only a narrow number of studies have addressed this topic among those evaluated. Therefore, the obtained results emphasize a critical need to better understand the current state, capabilities, and constraints of this demographic group in terms of technology use.

7. Overview of Digital Proficiency among the Elderly across the European Union

In the era of information, digital skills and competencies play a crucial role in shaping and impacting various aspects of our daily lives. Even if the main aim of the European Union is to provide an inclusive framework for economic and social development, the discrepancies between the countries are visible in all fields. This statement is also valid in the case of digital skills, as proved by different statistics. The last available data published by the European Commission bring to attention that, in 2023, the gap between the higher performers in terms of digital skills and the last is 55%. A total of 83% of the Dutch and 82% of the Finish have at least basic overall digital skills, compared with 28% of Romanians [76].

Disparities in educational achievement among individuals stand out as one of the most frequently addressed explanations for the digital divide [77,78]. The digital divide, determined by the digital skills gap, has multiple implications for social and economic activities. According to Brynjolfsson and McAfee, insufficient digital skills among the workforce can lead to decreased productivity, reduced innovation, and hindered economic growth [79]. This issue is translated into an increase in social exclusion due to the fact that individuals with limited digital skills face barriers to accessing essential services, employment opportunities, and civic engagement, exacerbating social inequalities [80]. Socioeconomic factors such as income, education level, and geographic location play a significant role in shaping digital skills acquisition [81]. Also, older individuals and women are often disproportionately affected by the digital skills gap, with younger and male populations exhibiting higher levels of digital proficiency [82].

When examining lower levels of digital skills, gender disparities tend to be particularly pronounced among older and less educated demographics but are less prevalent within the broader population [83]. Gender disparities in digital skills underscore the need for a broader approach to promoting digital literacy. It is essential to understand that these discrepancies are not solely determined by individual skills; they are also influenced by the socioeconomic and cultural context.

As anticipated, there is a gradual decline in proficiency with digital technology as individuals age, observed both in daily activities and within professional contexts [84]. This decline in digital technology competence can create significant difficulties in adapting to the rapid changes in modern society, also affecting access to important opportunities and resources.

With the aim of the targeted analysis of the elderly population, considered in the present research as being formed by individuals aged between 65 and 74 years old, existing metrics provide valuable information. In this instance, the composite Digital Skills Indicator (DSI), offered by Eurostat, can be subjected to analysis.

The indicator in question was developed in collaboration with data users from the European Commission (DG CNECT) and the Joint Research Center (JRC) and is composed of the following sub-dimensions, providing data by age category [85]: (1) Individuals with "above basic" (I_DSK2_AB) level of skills; (2) individuals with a "basic" (I_DSK2_B) level of skills; (3) individuals with "at least basic" level of skills; (4) individuals with "low" (I_DSK2_LW) level of skills; (5) individuals with "narrow" (I_DSK2_N) level of skills; (6) individuals with "limited" (I_DSK2_LM) level of skills; and (7) individuals with "no skills" (I_DSK2_X). There is also the category of individuals for whom digital skills could not be assessed (I_DSK2_NA), i.e., individuals who have not used the internet in the last 3 months.

Examining the data pertaining to the DSI indicator, specifically targeting individuals aged between 65 and 74 within the EU, reveals advancements in digital skills from 2021 to 2023 (Figure 9), but also an increase in the number of people with no digital skills.

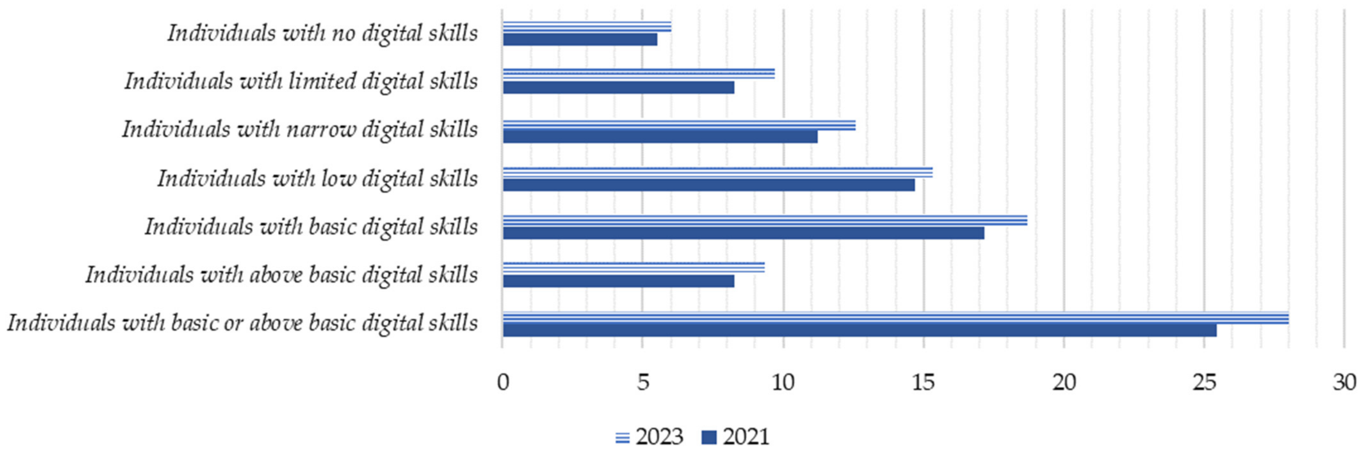

Figure 9. Individuals' level of digital skills (65 to 74 years old). Source: Authors' elaboration based on the data provided by Eurostat, 2023 [76].

Between 2021 and 2023, modest but significant growth can be seen in the People with basic general digital skills dimension for individuals aged 65 to 74, according to the Digital Skills Indicator (DSI). From an average of 17.18 to 18.68, this progress reflects the adaptation and learning efforts among this age group in terms of using digital technology. However, it is important to emphasize that this increase is not so impressive compared to other age groups. Factors such as prior familiarity with technology and the availability of resources can influence the pace of the adoption of digital skills.

In contrast to younger individuals, older adults across the EU typically exhibit lower proficiency levels in digital skills. As of 2023, statistics show that only 25% of individuals aged 65–74 had attained basic digital skills, starkly contrasting with the 71% reported among those aged 25–34 [76]. This evident gap underscores a notable digital divide within the population. Even if we consider the case of the performers in terms of digital skills, we can state that basic digital skills are slightly more prevalent in the Netherlands, yet surveys indicate both the Netherlands and Finland experience significant age disparities. Approximately 89.32% of males and 92.98% of females aged 16–24 in the Netherlands and 89.37% of males and 98.36 in Finland possess at least basic digital skills. However, this percentage drops for people aged 55–64 to 78.66% (Finish females) and 69.10% (Finish males) or 75.28% (Deutsch females) and 78.25% (Deutsch males). Notably, differences between the two countries become more pronounced when considering education levels. At the European level, 23.17% of females aged between 65 and 74 years, compared with 33.62% of males, possess at least basic digital skills.

Digital skills play a dual role, serving not only to enhance the efficient completion of current tasks but also to function as catalysts for innovation. These e-skills enable individuals to access, imitate, and integrate external knowledge sources, thereby fostering the creation of novel products and services [86].

The significant disparities observed between age groups concerning everyday life skills compared to those employed in professional settings may stem from the incremental acquisition of new technologies in the workplace, often facilitated through structured training initiatives. Subsequently, the proficiency of digital skills within the workforce serves as a favorable indicator for regions' capacity to specialize in emerging technological fields. Additionally, digital skills exert a negative moderating influence on the relationship between relatedness and technological diversification [87].

8. Addressing Cultural Differences: Potential Measures for Enhancing Elderly Digital Competence in the EU

Improving the level of digital skills among EU citizens represents one of the most complex challenges, impacting all the established targets and objectives [7]. Consistent with the European Commission [88] statement, the ability to use digital technologies confidently, responsibly, and critically, both in the professional environment, in the context of learning, and for involvement in society, constitutes digital competence, which is additionally characterized as a combination of knowledge, skills, and attitudes. It can thus be referred to as the fact that the ability to use digital technologies is not only a technical competence but also a manifestation of interaction with the environment and, among others, cultural values.

As recently demonstrated [89], the national culture has the potential to impact the digital skills of individuals, while their perception and the actual use of digital technologies are precisely dictated by cultural traits. Moreover, recent findings comparing Australia and Hong Kong show that potential factors contributing to diverse preferences for AI could stem from cultural differences, including variations in power distance, collectivism, short-term orientation, and indulgence [90]. At the same time, older adults' adaptation to technology evolves over time, and their willingness to use technology is also affected by sociocultural factors such as social norms, trust levels, and tolerance for uncertainty in each community [91].

Consequently, developing and implementing measures for the development of digital skills and AI technology adoption among older people definitely implies, among others, understanding the cultural particularities of the considered demographic group. However, as expected, from a cultural point of view, as in the case of other spheres of interest, disparities exist between EU countries, and obtaining relevant information requires their differentiation.

8.1. Harnessing Hofstede's Cultural Dimensions in the EU Context

Considering the previously mentioned aspects, the present study focuses on adapting Hofstede's Theory of Cultural Dimensions, focusing on its six cultural dimensions that influence human behavior [58]. To analyze the possibilities of developing the digital skills of EU elderly people and to facilitate embracing AI technologies, since developing a unitary model could not be assessed, the countries were divided into two groups according to the scores obtained for each dimension in Hofstede's model (equal, under 50, and over 50). Thus, the information presented below provides a detailed perspective in this regard.

- Power Distance

The Power Distance dimension can be described [58] as the degree to which less influential members of a country's institutions and organizations anticipate and accept the unequal distribution of power. Institutions, such as the family, school, and community, constitute the fundamental elements of society, while organizations represent the environments in which people carry out work activities. Regarding the Power Distance scores available for EU countries, Table 3 groups the states according to the category in which they are ranked, as mentioned.

Table 3. Power Distance scores for EU countries [1].

Group 1	Group 2
Austria (11), Denmark (18), Ireland (28), Sweden (31), Finland (33), Germany (35), Netherlands (38), Estonia (40), Luxembourg (40), Lithuania (42), Latvia (44), Hungary (46), Italy (50)	Malta (56), Czech Republic (57), Spain (57), Greece (60), Portugal (63), Belgium (65), France (68), Poland (68), Bulgaria (70), Slovenia (71), Croatia (73), Romania (90), Slovakia (100)

[1] Each country has its score enclosed in brackets. Source: Data provided by the Culture Factor Group website [59]—distribution in groups performed by the authors.

Previous research in the field suggests that in countries with lower power distance, there is a greater tendency to accept technology [92], while, according to Jayaprakash et al., countries with a lower power distance favor the efficient use of technologies, with communication being direct and participatory, which makes all members of society more easily accessible [93]. Although considering a different context, Pfaff, Yuko Melanie, et al. findings highlight the fact that reducing the power distance is essential in digital transformation [94]. Referring to the development of digital skills among the elderly and not only based on previous statements, the idea emerges that a country with a greater capacity to accept technology (low power distance) is more likely to support digital literacy.

Therefore, in countries with a score above 50 on the Power Distance dimension, such as Romania and Slovakia, there is a tendency towards a more rigid social and organizational structure where authority and hierarchy are better defined. This could influence how older people perceive and adopt digital technologies, including AI tools, with the possibility that they may be more reluctant to try new technologies due to a sense of insecurity or fear of making mistakes. Accordingly, providing digital literacy programs that address these concerns and offer appropriate support and guidance to help elders overcome these barriers becomes crucial. Also, collaboration with local institutions and organizations, as well as community leaders, could facilitate the acceptance and adoption of digital technology through educational programs and awareness events.

In contrast, in countries scoring equal to or below 50 in the Power Distance dimension, such as Sweden and Denmark, there is a more egalitarian and open approach to society. Therefore, steps can be taken to promote initiatives that encourage and facilitate self-directed and autonomous learning among older people. This could involve creating digital literacy programs that focus on encouraging individual initiative and developing self-directed learning skills. Also, fostering intergenerational collaboration and community involvement in providing support and guidance could help increase the confidence and digital skills of older people in an environment where authority is less pronounced.

- Individualism

The global population living in societies where individual priorities are considered more important than those of the group is characterized as individualistic, in contrast to collectivism, where the focus is on the common good of the community [58]. At the EU level, only four countries are at the lower end of the spectrum of the Individualism dimension (Table 4) and can present cultural and social characteristics that favor social cohesion and interdependence.

As per Jovanović et al. [95], individualism and digitalization are moderately positively associated, indicating that societies with collectivistic traits are less digitalized compared to those favoring individualism. Building on the previous idea could be the perspective that, in more individualistic societies, where the focus is on autonomy and individual achievement, individuals might be more motivated to develop their digital skills and adapt more quickly to technological change without depending so much on external assistance, which would also indicate an increased degree of digital skills.

Table 4. Individualism scores for EU countries [1].

Group 1	Group 2
Croatia (42), Romania (46), Poland (47), Bulgaria (50)	Italy (53), Lithuania (55), Slovakia (57), Ireland (58), Greece (59), Malta (59), Portugal (59), Luxembourg (60), Estonia (62), Spain (67), Czech Republic (70), Latvia (70), Hungary (71), France (74), Finland (75), Austria (77), Germany (79), Belgium (81), Slovenia (81), Sweden (87), Denmark (89), Netherlands (100)

[1] Each country has its score enclosed in brackets. Source: Data provided by the Culture Factor Group website [59]—distribution in groups performed by the authors.

Therefore, within the more collectivistic EU countries (Croatia, Romania, Poland, and Bulgaria), specialized training programs, mentoring programs, and awareness campaigns can be effective. In states empowering a more collectivist culture, efforts to promote digital skills and the adoption of AI technology by older people must take into account the specific social values and norms of the society. Within these environments, where social relationships are often close and interdependence is valued, it is essential to create training programs and resources adapted to the needs and learning pace of older people. The programs could include not only direct instruction but also social interactions and collaboration.

On the other hand, countries with higher Individualism scores, such as Sweden, Denmark, and the Netherlands, can address the promotion of digital skills and adoption of AI by older people through tailored and flexible programs, including the provision of digital resources and platforms for online learning. Collaborating with older people's organizations and emphasizing the social and individual benefits of this transition can also be key.

- Motivation towards Achievement and Success

Regarding the development of digital skills and the adoption of AI by older people in the analyzed countries, several measures and possibilities can be identified depending on their level of motivation towards achievement and success. As reflected in the dimension in question in Hofstede's model (well known as Masculinity vs. Femininity), disparities between countries could be identified. (Table 5).

Table 5. Motivation towards Achievement and Success scores for EU countries [1].

Group 1	Group 2
Sweden (5), Latvia (9), Netherlands (14), Denmark (16), Lithuania (19), Slovenia (19), Finland (26), Estonia (30), Portugal (31), Bulgaria (40), Croatia (40), Romania (42), Spain (42), France (43), Malta (47), Luxembourg (50)	Belgium (54), Czech Republic (57), Greece (57), Poland (64), Germany (66), Ireland (68), Italy (70), Austria (79), Hungary (88), Slovakia (100)

[1] Each country has its score enclosed in brackets. Source: Data provided by the Culture Factor Group website [59]—distribution in groups performed by the authors.

According to Hofstede [58], a society adopts a masculine connotation when it clearly distinguishes emotional gender roles: men are expected to be assertive, firm, and focused on material success, while women are encouraged to be more modest, delicate, and more concerned with quality of life. On the other hand, society is considered feminine when emotional gender roles overlap; both men and women are encouraged to be modest and gentle and to pay special attention to the quality of life. Stated another way, masculinity in this dimension reflects a preference for achievement, heroism, assertiveness, and material rewards within society, which is generally perceived as more competitive and motivated to achieve success (scores equal to or below 50). In contrast, femininity reflects an inclination toward cooperation, modesty, caring for the vulnerable, and prioritizing quality of life.

Countries with a male-dominant culture (high scores, in this case, for the Motivation towards Achievement and Success dimension) seem to be in a superior position in terms of technology adoption rates compared to those with a predominantly female presence [96] (scores below average, in the present case, for the dimension Motivation towards Achievement and Success).

Under the previously presented circumstances related to the considered dimension, for the group of EU states scoring equal or up to 50, the implementation of digital literacy programs and training courses for the elderly can be targeted to help them understand modern technologies and use them effectively, thus increasing their level of motivation. Also, a direction of interest may be the creation of government or community programs that provide access to digital devices and the Internet in rural and remote areas so that older people have resources to learn and connect online.

In addition, organizing events and counseling sessions to encourage older people to adopt digital technologies and develop their skills in this field is a topic of interest. At the same time, it is recommended to support collaboration with non-governmental organizations and the private sector to offer personalized training and support programs for the elderly, adapted to their specific needs and interests.

Regarding the group of countries with scores higher than 50, the focus could be on advanced training programs and initiatives to encourage older people to use their knowledge and experience in relevant fields to contribute to the development of digital technologies and AI. Facilitating access to projects and programs that enable older people to actively engage in innovation and participate in the digital community in a meaningful way could also be a point of interest.

- Uncertainty Avoidance

The Uncertainty Avoidance dimension was defined by Hofstede [58] as representing the degree to which individuals in a culture feel a threat in ambiguous or unknown situations, while this reaction can manifest itself through nervous stress, a desire for predictability, and the need to have rules, both written and unwritten. States that have a culture characterized by high levels of Uncertainty Avoidance manifest an attitude that is reflected in a lower adoption of digital technologies [97] and are less likely to embrace innovation [90], while individuals who are less prone to uncertainty tend to quickly choose familiar solutions and hesitate to explore new technologies [98]. Due to encountering greater challenges in usability, individuals with a high Uncertainty Avoidance culture exert more effort toward embracing, learning, and integrating new technologies [90].

At the EU level, only three of the states under analysis register a low score (below average) for the dimension in question (Table 6), from which it can be stated that Europeans tend to be more reluctant to adopt new technologies, such as AI and digital tools, because they bring themselves a high degree of complexity and uncertainty.

Table 6. Uncertainty Avoidance scores for EU countries [1].

Group 1	Group 2
Denmark (23), Sweden (29), Ireland (35)	Slovakia (51), Netherlands (53), Finland (59), Estonia (60), Latvia (63), Germany (65), Lithuania (65), Austria (70), Luxembourg (70), Czech Republic (74), Italy (75), Croatia (80), Hungary (82), Bulgaria (85), France (86), Spain (86), Slovenia (88), Romania (90), Poland (93), Belgium (94), Malta (96), Portugal (99), Greece (100)

[1] Each country has its score enclosed in brackets. Source: Data provided by the Culture Factor Group website [59]—distribution in groups performed by the authors.

Countries characterized by a more open attitude toward change and moderate risks in the face of uncertainty (score lower than the average for the Uncertainty Avoidance dimension) could have a higher tendency to adopt digital technologies and AI among older people. Thus, training and education programs for older people with a focus on digital skills and familiarization with AI can be easily implemented. These programs could be integrated into lifelong learning programs and could include both hands-on training and accessible and intuitive online resources. Also, organizations and governments could work together to provide increased accessibility to digital technology and AI for older people through infrastructure projects and specialized equipment. Apps and platforms tailored to the specific needs and preferences of this demographic can also be developed to facilitate their use.

In countries with scores higher than 50 in the Uncertainty Avoidance dimension, such as Slovakia, the Netherlands, and Finland, there is a more conservative attitude towards change and high risks in the face of uncertainty. However, this does not preclude the adoption of digital technologies and AI by older people. In these countries, awareness and education campaigns could be implemented to counter tech reluctance and promote the benefits and opportunities brought by digital skills and AI. Mentoring and personalized assistance programs can also be developed for older people to support them in adopting and using new technologies.

- Long-Term Orientation

With an emphasis on thrift and perseverance, long-term orientation focuses on encouraging virtues that lead to rewards in the future [58]. In contrast, short-term orientation promotes virtues associated with the present and the past, including respect for tradition, maintaining reputation, and fulfilling social obligations.

Along with other relevant aspects analyzed in a business setting, long-term orientation has been used to justify technology adoption, proving that it can improve perceived usefulness and ease of use [99]. Generalizing, the idea that improving the perceived usefulness and ease of use of technology by individuals leads them to be more likely to interact with these technologies and develop their digital skills can be underlined.

Hence, countries with a high score on the Long-Term Orientation dimension (Table 7), such as Luxembourg, the Netherlands, Latvia, or Estonia, may be more likely to sustain digital skills development, seeing them as tools that can bring long-term benefits and can contribute to continuous development and innovation. Nonetheless, at the EU level, there are a significant number of countries that register scores below the average for the dimension in question.

Table 7. Long-Term Orientation scores for EU countries [1].

Group 1	Group 2
Romania (32), Italy (39), Croatia (40), Portugal (42), Hungary (45), Austria (47), Malta (47), Spain (47), Lithuania (49), Poland (49), Slovenia (50)	Bulgaria (51), Czech Republic (51), Greece (51), Ireland (51), Sweden (52), Slovakia (53), Germany (57), Denmark (59), France (60), Belgium (61), Finland (63), Luxembourg (64), Netherlands (67), Latvia (69), Estonia (71)

[1] Each country has its score enclosed in brackets. Source: Data provided by the Culture Factor Group website [59]—distribution in groups performed by the authors.

The countries included in the two groups, according to their scores on the Long-Term Orientation dimension of Hofstede's Model, actually indicate a variety of cultural and socioeconomic contexts that can influence the approach and implementation of measures for the development of digital skills and the adoption of AI by older people.

In countries with scores equal to or below 50, there is a need to increase efforts to grow the digital skills of the elderly. These countries can benefit from the specific educational programs offered at the community or regional level that focus on the use of technology and AI in everyday life. Technology awareness and accessibility efforts should also be improved to ensure that all citizens have the opportunity to engage with and benefit from digital evolution.

At the opposite pole, in countries with scores above 50, a cultural predisposition towards the adoption of innovative technologies and AI can be observed. Hence, efforts should concentrate on ensuring that older people are not excluded from these advances. It is important to provide ongoing training and education programs adapted to the needs and learning pace of these age groups. Initiatives to raise awareness and promote technological advantages and possibilities should also be scaled up to encourage active and safe participation in the digital age.

- Indulgence

Representing the inclination to allow the free satisfaction of fundamental and natural human desires related to the joy of living and having fun, the Indulgence dimension is described in antithesis to Restraint, the latter being the belief that this satisfaction should be controlled and regulated by strict social norms [58].

At the EU level, most countries score below average for the Indulgence dimension (Table 8), which may mean that they are less willing to embrace change, explore new technologies, and support the development of digital skills among seniors. In contrast, given that the use of AI and digital tools requires constant adaptation to new technological trends and developments, more lenient societies may be more responsive to this dynamic, making increased efforts in order to enhance digital proficiency among the elderly.

Table 8. Indulgence scores for EU countries [1].

Group 1	Group 2
Latvia (13), Bulgaria (16), Estonia (16), Lithuania (16), Romania (20), Slovakia (28), Czech Republic (29), Poland (29), Italy (30), Hungary (31), Croatia (33), Portugal (33), Germany (40), Spain (44), France (48), Slovenia (48), Greece (50)	Luxembourg (56), Belgium (57), Finland (57), Austria (63), Ireland (65), Malta (66), Netherlands (68), Denmark (70), Sweden (78)

[1] Each country has its score enclosed in brackets. Source: Data provided by the Culture Factor Group website [59]—distribution in groups performed by the authors.

In countries with scores equal to or up to 50 on the Indulgence dimension, some challenges related to access to resources and digital infrastructure can be encountered. In fact, at the moment, the European Union depends on foreign countries for more than 80% of its digital products, services, infrastructure, and intellectual property [7]. Under these circumstances, countries such as Latvia, Bulgaria, Estonia, and Lithuania can benefit from government programs or private initiatives that offer specialized courses and training to improve the digital skills of the aging population. In addition, approaches tailored to the needs of this demographic, such as personalized training sessions or mentoring programs, could be effective in encouraging the adoption of AI technology.

On the other hand, countries with higher leniency scores, such as Luxembourg, Belgium, and Finland, may already have advanced digital infrastructure and access to resources, which would facilitate learning and adoption of AI technology for older people. In these countries, governments could invest in vocational retraining and continuing education programs tailored to the specific needs of the aging population to encourage the use of digital technologies and AI in everyday life.

8.2. Summative Overview of Cultural Disparities

Based on the cultural differences analysis in the context of digital skills development among the elderly, notable general conclusions about the EU member states can be drawn. Confidently, the scores obtained by the EU countries for the Hofstede dimensions indicate the impossibility of generalizing over all states, as different cultural characteristics are exerted.

As expected, it was observed that EU countries at the top of digital progress [6] register high scores (or, as the case may be, low scores) for dimensions in the Hofstede model that are translated into greater support for the development of digital skills among the population and, consequently, among the seniors. The link between the digital progress of EU countries and the digital skills of the population, including seniors, is crucial in the context of their adoption and use of AI tools. As countries at the forefront of digital progress invest in digital infrastructure, education, and digital inclusion programs, the population becomes more familiar and comfortable with technology. This creates an enabling environment for learning and adopting emerging technologies such as AI, including for seniors. As observed, digital skills among the elderly are more developed in these countries, which could facilitate the understanding and use of AI tools.

Concurrently, the non-existence of the so-called ideal in terms of the pace and progress in the development of digital skills is also outlined following the cultural dimensions examination. Although there are countries that register high or at least above average scores for cultural dimensions that present a context conducive to the development of digital skills among the elderly, such as the Long-Term Orientation dimension, they face barriers regarding other factors, for example, with high scores for the Uncertainty Avoidance dimension. Thus, balancing the situation involves addressing and overcoming these cultural barriers individually, per country, by adapting learning strategies and creating an inclusive and responsive environment for digital learning at all ages. A combination of efforts from all influencers or decision-makers is required to ensure that all individuals benefit from the opportunities offered by the digital age, regardless of cultural context.

According to relatively recent research [100], priorities for adult learners today include, in addition to access to devices and broadband Internet, access to digital instruction. However, focusing the discussion on the elderly, the importance of personalized approaches that take into account the unique cultural context of each country was emphasized. Additionally, whichever dimension is considered, the results of the analysis support the need for strategies adapted to the specific needs and preferences of older individuals. Recent scientific studies also underscore the necessity for an individual and customized approach to acquire relevant digital skills for the elderly [101], promoting at the same time the idea of flexible solutions in view of specific needs and challenges, such as fears, a lack of previous experience, or possible physical limitations [102]. At the same time, the importance of social support is emphasized, considering the process of ensuring the successful implementation of digital skills development programs among the elderly [102].

At the same time, the importance of continuous learning and access to resources in promoting digital literacy among older adults is recognized. In support of the previous, D'Ambrosio and Boriati [103] describe the current context of the knowledge society as one in which the exchange of knowledge through technology is vital for social inclusion, mentioning that the European debate on continuous learning is becoming crucial. Reference is made to the imperative to develop and implement new social policies focused on digital literacy and digital education and to outline new directions for lifelong training, which should allow everyone, including the elderly (65+ years old), to actively integrate into an increasingly digitalized and interconnected society. Unquestionably, the process itself requires collaborative efforts between governments, organizations, and communities to provide targeted support, including educational programs, infrastructure development, and vocational training, to ensure equitable participation in the digital age.

Acknowledging and embracing cultural diversity when striving to enhance digital inclusion among older citizens in the EU is unquestionable. Adopting such an approach has the potential to lead to the effective management of complex challenges and to support older populations in navigating and contributing to Europe's digital future.

9. Discussion

In light of the recognized demographic shift towards an aging population, the current paper explores the adoption of artificial intelligence by elderly individuals within the European landscape, with a focus on the crucial role of digital skills development. In order to discuss the results of the research on a relevant note, reiterating and addressing the formulated research questions becomes mandatory. Thus, their significance in guiding the study is emphasized, ultimately contributing to a comprehensive understanding of the overall research objectives.

The first research question (RQ1) directed attention to the existing body of knowledge, answering it and implying the identification of the predominant themes, trends, and gaps within the literature. The analysis of existing scientific literature revealed several key directions of interest at the intersection of AI technologies and the elderly population. Firstly, considerable attention was given to the potential benefits of AI in enhancing the quality of life and independence of older individuals, particularly in healthcare and assisted living scenarios. Additionally, research was focused on the ethical and social implications of AI adoption among the elderly, including issues related to privacy, autonomy, and the digital divide. Furthermore, emerging trends such as personalized AI solutions tailored to the specific needs and preferences of older adults have garnered interest, highlighting the importance of user-centered design in technology development.

To strengthen the answer to the first research question, the bibliometric analysis carried out using the Web of Science platform provided valuable insights into the main directions of interest regarding the considered subject. By examining the resulting scientific publications, several key themes emerged. Primarily, the analysis revealed a multidisciplinary interest in the topic, as evidenced by the diverse range of research areas represented in the publications. From healthcare and robotics to psychology and sociology, researchers from various disciplines are collaborating to explore the application and implications of AI for elderly individuals. The keywords' analysis conducted as part of the bibliometric study shed light on the specific topics and concepts dominating the discourse. Moreover, the clustering of keywords further revealed thematic connections, such as the emphasis on healthcare monitoring, fall detection, and cognitive impairment, indicating a nuanced exploration of the challenges and opportunities in utilizing AI technologies for elderly care.

The second research question (RQ2) probed the relationship between digital skills development and AI adoption among elderly individuals in Europe. Without a doubt, digital literacy and proficiency in shaping technology acceptance are crucial, consequently affecting AI adoption. Specifically, individuals with higher levels of digital literacy and proficiency are more likely to embrace AI-driven solutions and incorporate them into their daily lives. Based on the analysis of existing evidence, disparities in digital skills persist across EU countries, with older adults generally exhibiting lower proficiency levels, which was easily noticed. While modest growth in basic digital skills was observed among the elderly, age differences are noticeable, indicating a significant digital divide. Therefore, bridging this gap through targeted interventions is crucial for enhancing the uptake of AI technology among older populations.

Answering the last research question (RQ3) determined delving into the cultural dimensions that shape attitudes and behaviors toward AI technology among elderly populations in the EU. The European Union comprises diverse cultures, languages, and traditions across its member states. Each cultural context shapes individuals' perceptions, values, and attitudes toward technology, including AI. Therefore, understanding these cultural nuances could be considered an important process in tailoring interventions and strategies to effectively promote AI adoption among seniors. Based on our analysis, countries leading in digital progress tend to better support digital skills development, fostering an environment for AI adoption. However, tailored strategies are needed due to varied cultural barriers, while personalized approaches, flexible solutions, and social support are fundamental.

The exploration of AI adoption among elderly individuals in Europe, guided by the formulated research questions, has yielded valuable insights into the influence of digital skills development in shaping attitudes towards technology. Moving forward, the responses obtained for each research question could serve as a foundation for targeted strategies aimed at bridging the digital divide, promoting AI adoption, and enhancing the quality of life for older adults in the digital age.

10. Conclusions, Limitations, and Future Research Directions

In a world where technology significantly shapes all domains and realms of activity, competitiveness, and relevance are consequences of adapting to evolution. Artificial intelligence undoubtedly represents a premise of the future, constituting, at the same time, a critical component of digital development, which requires the analysis of the possibilities of adoption and use among individuals.

The findings of the current study shed light on the complex interplay between digital skills, aging populations, and the adoption of artificial intelligence (AI) technologies within the European Union (EU). The discussion encompasses several key themes, including the importance of digital literacy, the disparities in digital skills across age groups, and the need for tailored interventions.

It is important to emphasize that the digital skills of human capital are the determining factor that interconnects and ensures the smooth functioning of all the other specific components of digitalization. The digital skills of individuals from a certain state are, in essence, fundamental to its success and competitiveness in an increasingly technological world.

Therefore, one of the central tenets of the present research revolves around the critical role of digital skills in navigating an increasingly technologically driven world. As highlighted in previous literature and supported by the findings of this study, digital literacy is a fundamental determinant of success and competitiveness in the modern era. However, our analysis reveals significant differentials in digital skills proficiency between age cohorts, with older adults facing challenges in keeping pace with digital advancements.

Actually, the rapid transitions determined by digital progress enforce the need for a thorough approach, among others, to the particularities of each age group of individuals, with the aim of understanding their potential to progress, their needs, and their own characteristics. The present research was focused on the study of the elderly target group, given the importance and relevance of the approach to this population category at the present time. In addition to the aspects detailed in this paper, justifying the relevance of directing the analysis on the elderly population, previous research highlighted the prerequisite to implement digital literacy programs among the elderly population in order to successfully overcome certain conditions of risk and uncertainty, such as the COVID-19 pandemic [104].

Focusing the research efforts on the EU member states involved an interdisciplinary approach, the results of which can be summarized as follows:

- The adoption of artificial intelligence represents a sphere of increased interest at the EU level, whose beneficial potential has been recognized, while constant efforts towards its integration into the modern economy and society have already been undertaken.
- Based on the analyzed scientific evidence, given the increasing yearly number of publications observed in the last decade, there is a progressive interest in the adoption of AI among the elderly, with existing studies mainly highlighting the potential benefits of these technologies for seniors.
- At the EU level, digital skills and abilities, considered decisive factors in digital progress and, consequently, in the adoption of AI, are significantly differentiated both between countries and between age groups. Overall, while people under 65 tend to have more advanced digital skills and progress faster in this regard, major differences are felt in the case of older people. In situations of non-existence or the existence of poor digital skills, seniors have barriers to adopting modern technologies such as AI. This can lead to a discrepancy in access to the benefits of AI and the risk of these individuals being digitally excluded.
- The gap in digital skills proficiency between different age groups, with older adults generally lagging behind younger generations, underscores the need for targeted interventions to bridge this issue. While initiatives for digital skills acquisition in professional settings contribute to narrowing this disparity, concerted efforts are required to ensure equitable access to digital education and training across all EU member states.

- To address the issue of digital skills among the elderly, it is essential to develop programs and initiatives that facilitate digital competence development for them. Since it would be inappropriate to generalize digital literacy measures among the elderly population in the EU, the consideration of cultural characteristics can represent an important starting point. Considering Hofstede's dimensions, it was found that EU member states exhibit different cultures, which require specific approaches.
- Regardless of the cultural differences between the EU states, there is a common need to offer personalized, specialized programs aimed at improving the digital skills of the elderly population. The elderly have specific needs and different learning characteristics, necessitating the adaptation of solutions to them.

The research results could provide essential clues about the digital capabilities of the elderly in Europe and serve as an initial step for the development of policies and initiatives to support the development and adoption of modern digital technologies, such as AI, among the older population. In addition, the results could stimulate further research and innovation in the fields of assistive technologies and human–computer interaction, thereby contributing to the progress of society as a whole.

Overall, the limitations of the present scientific research include narrowed access to relevant and up-to-date public data on the adoption of AI technologies among the elderly population, difficulties in fully representing the demographic diversity of this group in Europe, as well as methodological constraints. Regarding the bibliometric analysis carried out, it is recognized that there are possible gaps in the complete coverage of the existing literature given the fact that a single database was used, as well as difficulties in identifying and including all appropriate scientific publications due to the variation of the chosen terminology.

Considering the identified limitations, future research directions aim to enhance data collection and analysis methodologies, including interdisciplinary collaboration for a deeper understanding of the interaction between the elderly and AI technologies. While this study includes bibliometric analysis, incorporating qualitative methods such as interviews or focus groups with elderly individuals could provide deeper insights into their experiences, attitudes, and barriers related to AI adoption and digital skills. Moreover, taking into account additional scientific databases becomes crucial. Also, exploring beyond the impact of cultural factors on the adoption of AI technologies by the EU's aging population becomes critical. In addition, investigating new trends and innovations in AI technologies, as well as evaluating their impact on the elderly, represents promising directions for future research in the field.

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