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Application and Challenges of the Technology Acceptance Model in Elderly Healthcare: Insights from ChatGPT

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Abstract: The Technology Acceptance Model (TAM) plays a pivotal role in elderly healthcare, serving as a theoretical framework. This study aimed to identify TAM's core components, practical applications, challenges arising from its applications, and propose countermeasures in elderly healthcare. This descriptive study was conducted by utilizing OpenAI's ChatGPT, with an access date of 10 January 2024. The three open-ended questions administered to ChatGPT and its responses were collected and qualitatively evaluated for reliability through previous studies. The core components of TAMs were identified as perceived usefulness, perceived ease of use, attitude toward use, behavioral intention to use, subjective norms, image, and facilitating conditions. TAM's application areas span various technologies in elderly healthcare, such as telehealth, wearable devices, mobile health apps, and more. Challenges arising from TAM applications include technological literacy barriers, digital divide concerns, privacy and security apprehensions, resistance to change, limited awareness and information, health conditions and cognitive impairment, trust and reliability concerns, a lack of tailored interventions, overcoming age stereotypes, and integration with traditional healthcare. In conclusion, customized interventions are crucial for successful tech acceptance among the elderly population. The findings of this study are expected to enhance understanding of elderly healthcare and technology adoption, with insights gained through natural language processing models like ChatGPT anticipated to provide a fresh perspective.

Keywords: Technology Acceptance Model (TAM); elderly healthcare; ChatGPT; challenges; countermeasures



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1. Introduction

Background

The integration of technology in healthcare has undergone significant advancements, presenting both challenges and opportunities, particularly in the context of elderly healthcare [1–4]. As the global population ages, the demand for innovative solutions to address the distinctive healthcare needs associated with aging has grown exponentially [5]. These needs encompass a spectrum of age-related health challenges, including but not limited to chronic conditions such as cardiovascular diseases, arthritis, cognitive decline, and sensory impairments [3,5]. Additionally, there is a pronounced requirement for healthcare interventions that consider factors such as mobility issues, social isolation, medication management, and the overall well-being of older individuals [6]. The unique healthcare needs of the elderly also extend to preventive care, rehabilitation, and palliative care, necessitating a comprehensive approach that acknowledges the multifaceted nature of aging-related health concerns. In this context, technology plays a pivotal role in providing tailored solutions that enhance the quality of life, independence, and overall health outcomes for the elderly population [7–11]. Addressing these unique healthcare needs requires a thorough understanding of the aging process and the diverse health challenges that individuals may encounter as they grow older [5].

Within this landscape, the Technology Acceptance Model (TAM) has served as a valuable framework for understanding how individuals, especially the elderly, adopt and utilize healthcare technologies [2,3,5]. The Technology Acceptance Model (TAM) is a widely recognized and influential framework that has been developed to understand and predict individuals' acceptance and adoption of technology [3,4]. Originally proposed by Fred Davis in the late 1980s, TAM emerged as a psychological model aimed at explaining the factors influencing users' decisions to accept and use information technology [12]. The foundational work by Davis led to the evolution of TAM into a comprehensive model widely applied in various contexts, including healthcare [4,8,13]. TAM is rooted in the theory of reasoned action and the theory of planned behavior, which assert that an individual's behavioral intention is a key determinant of their actual behavior [2,4,6]. In the context of technology acceptance, TAM posits that perceived ease of use and perceived usefulness are critical factors influencing an individual's intention to adopt and use a particular technology [2,14–16]. Perceived ease of use refers to the user's perception of how effortless it is to use a technology, while perceived usefulness relates to the belief that the technology will enhance their performance or make their tasks easier [15,16]. These two key determinants shape users' attitudes and behavioral intentions toward adopting technology [2,4,15–17]. Over the years, TAM has been extended and modified to incorporate additional factors and variables that may impact technology acceptance [2,3,15,16]. TAM2, TAM3, and the Unified Theory of Acceptance and Use of Technology (UTAUT) are examples of extended models that consider social influence, cognitive instrumental processes, and other contextual factors [4,15,16,18]. In the healthcare context, TAM has proven to be valuable for understanding how individuals, especially the elderly, approach and integrate healthcare technologies into their lives [3,4,6,19]. It provides a structured framework for researchers and practitioners to assess the factors influencing technology adoption among elderly individuals, contributing to the development and implementation of more effective and user-friendly healthcare technologies tailored to their specific needs [3,4,6,8].

In the realm of human technological advancements, it would not be an exaggeration to assert that ChatGPT stands out as one of the most unique developments of our time. ChatGPT serves as a powerful tool in research, offering real-time and interactive insights that contribute to a dynamic exploration of various topics [20]. Its ability to access up-to-date information from diverse sources ensures the research benefits from the most recent data [20]. ChatGPT's multidisciplinary perspectives, efficient literature review capabilities, and dynamic interaction make it valuable for comprehensive and nuanced exploration. There is controversy regarding trust in the reliability of the data provided by ChatGPT, but the responses from the technological adaptation model can be validated through literature verification, adding rigor to the research methodology. Integrating AI perspectives, ChatGPT will provide a unique analytical dimension to the study of technology acceptance, particularly in the context of the elderly [20]. Furthermore, the diverse insights, enhanced creativity, and accessibility of ChatGPT suggest its contribution to a more iterative and responsive research process. Overall, ChatGPT could be considered to enhance the efficiency, currency, and multidisciplinary nature of research, making it a valuable tool for generating real-time insights and perspectives [20].

Traditional models of technology acceptance often overlook the specific considerations and nuances associated with an aging population [21,22]. To bridge this gap, this study leverages the insights provided by ChatGPT, an advanced artificial intelligence language model, to gain a distinctive viewpoint on technology acceptance in this demographic. By employing ChatGPT as a primary research tool, the present study aims to identify the core construction components, application areas, and challenges in TAM for elderly healthcare. Furthermore, based on these research findings, the study aims to suggest countermeasures for the challenges of TAM in elderly healthcare. Therefore, the findings are expected to inform future research endeavors, policymaking, and the development of tailored interventions to enhance technology acceptance among the elderly population.

2. Materials and Methods

2.1. Study Design

This study employed a qualitative and descriptive design to investigate the core components of the Technology Adaptation Model, its practical applications, challenges, and proposed counterparts in elderly healthcare.

2.2. ChatGPT as a Study Tool

This study utilized OpenAI's real-time interactive ChatGPT as a study tool (OpenAI, L.L.C., San Francisco, CA, USA), specifically leveraging the latest GPT version integrated with Microsoft applications. OpenAI, founded in December 2015 by Elon Musk, Sam Altman, and others, aims to ensure that artificial general intelligence (AGI) benefits humanity. The development of ChatGPT stems from the Generative Pre-trained Transformer (GPT) architecture, initiated with GPT-1 in June 2018, demonstrating the efficacy of pre-training large-scale neural networks for natural language processing (NLP). GPT-2, introduced in February 2019, showcased significant advancements with 1.5 billion parameters, albeit with restricted access due to misuse concerns. GPT-3, announced in June 2020, marked a breakthrough with 175 billion parameters, expanding the boundaries of language modeling. ChatGPT, a specialized application of the GPT model tailored for conversational AI, enhances dialogue systems and chatbots. OpenAI continues to pioneer AI research and development, collaborating globally to advance NLP and conversational AI while prioritizing ethical considerations and safety.

Additionally, ChatGPT has been reported as a powerful research tool in natural language processing (NLP) and conversational artificial intelligence (AI). Specifically, it has generated consistent text for studying language generation, augmented datasets to enhance model robustness, served as a benchmark for model evaluation, enabled exploratory analyses, and facilitated research in specific domains.

While a significant risk or issue associated with AI is its potential to be perceived as a "black box," limiting trust in its reliability [23], this study enhanced credibility by rigorously validating ChatGPT responses through comprehensive literature verification using reputable prior studies. Therefore, a search for previous studies to confirm the reliability of ChatGPT responses was conducted through electronic journal websites such as PubMed, Web of Science, Scopus, and Google Scholar.

2.3. Study Procedures

The procedure of this study is depicted in Figure 1. To explore the topics of this study, ChatGPT was accessed on 10 January 2024 [20]. The three open-ended questions administered to ChatGPT were as follows: First, list the core components of TAM in elderly healthcare. Second, list the application areas of TAM in elderly healthcare. Third, list the challenges arising from the application of TAM in elderly healthcare.

ChatGPT's responses were collected and qualitatively evaluated by the researcher. The evaluation criterion for ChatGPT responses was the reliability of the content. The reliability of ChatGPT responses was evaluated based on the results presented or recommendations for future research on related content in previous studies. If ChatGPT's responses to the author's three open-ended questions were found in previous studies, ChatGPT's responses were recognized as the findings of this study.

Finally, discussions were conducted based on these findings, and furthermore, countermeasures were proposed to manage the challenges due to the application of TAM in elderly healthcare.

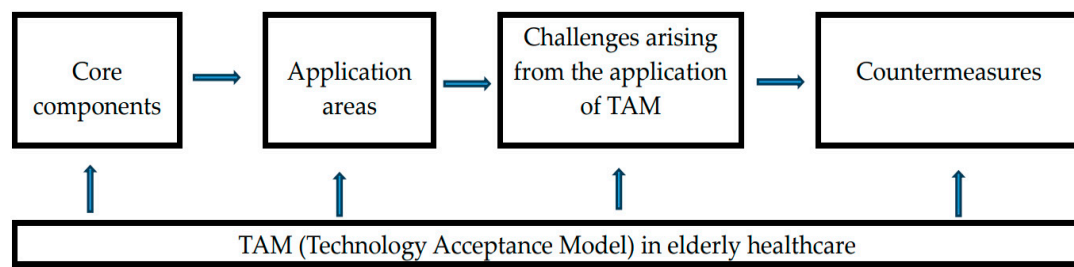


Figure 1. Procedure of this study. The figure illustrates the sequential progression of this study’s procedure, starting with the identification of the core components, followed by exploration of application areas, challenges, and proposals of countermeasures concerning the Technology Acceptance Model (TAM) in elderly healthcare.

2.4. Ethical Considerations

Since this study does not involve the use of personal information, the review of the Institutional Review Board (IRB) is not applicable.

3. Results

3.1. Core Components of TAM in Elderly Healthcare

The core components of TAM in elderly healthcare are presented in Table 1. Additionally, the core components of TAM in early healthcare, facilitated by Generative AI, are illustrated in Figure 2. From ChatGPT’s responses, the core components of TAM in elderly healthcare were identified as follows: perceived usefulness, perceived ease of use, attitude toward using, behavioral intention to use, subjective norms, image, and facilitating conditions. These core components of ChatGPT’s responses to elderly healthcare were consistent with those presented in prior studies.

Table 1. Core components of TAM in elderly healthcare.

| ChatGPT’s Responses | | Previous Studies * |
|-----------------------------------|--|--------------------|
| Perceived Usefulness (PU): | The degree to which elderly individuals believe that using a particular technology will enhance their healthcare experience. In the context of elderly healthcare, perceived usefulness may involve improvements in health monitoring, access to medical information, or assistance with daily living. | [8,14–16,24,25] |
| Perceived Ease of Use (PEOU): | The extent to which elderly individuals believe that using the technology will be free from effort. In elderly healthcare, user-friendly interfaces and intuitive designs are essential for facilitating ease of use, ensuring that the technology is accessible and navigable for older users. | [14–16,24,25] |
| Attitude Toward Using (ATU): | Elderly individuals’ overall evaluation or feeling about using a specific technology in the context of healthcare. Positive attitudes toward using technology are likely to enhance acceptance and adoption among the elderly. | [1,5,7,16,25–30] |
| Behavioral Intention to Use (BI): | The elderly individuals’ expressed willingness to use a particular technology in the future. Behavioral intention reflects their readiness to adopt the technology for managing their healthcare needs. | [7,25,27,31] |
| Subjective Norms (SN): | The perceived social pressure or influence from significant others (family, friends, healthcare providers) regarding the use of technology in healthcare by the elderly. Positive subjective norms can contribute to increased acceptance. | [8,32,33] |

Table 1. Cont.

| ChatGPT's Responses | | Previous Studies * |
|-------------------------------|---|--------------------|
| Image (IM): | The perceived image or reputation associated with using a specific technology. In elderly healthcare, a positive image may involve perceptions of the technology as reliable, secure, and beneficial for health and well-being. | [8,15,30,32,34,35] |
| Facilitating Conditions (FC): | The degree to which elderly individuals believe that the external conditions support the use of technology in healthcare. This could include factors such as the availability of technical support, training, or access to necessary resources. | [7,8,36] |

* This is a prior study related to the core components of TAM in elderly healthcare and refers to the reference number of this text.

This figure illustrates ChatGPT's response to the open-ended question: "What are the core components of TAM in elderly healthcare?" The findings were as follows: perceived usefulness, perceived ease of use, attitude toward using, behavioral intention to use, subjective norms, image, and facilitating conditions.

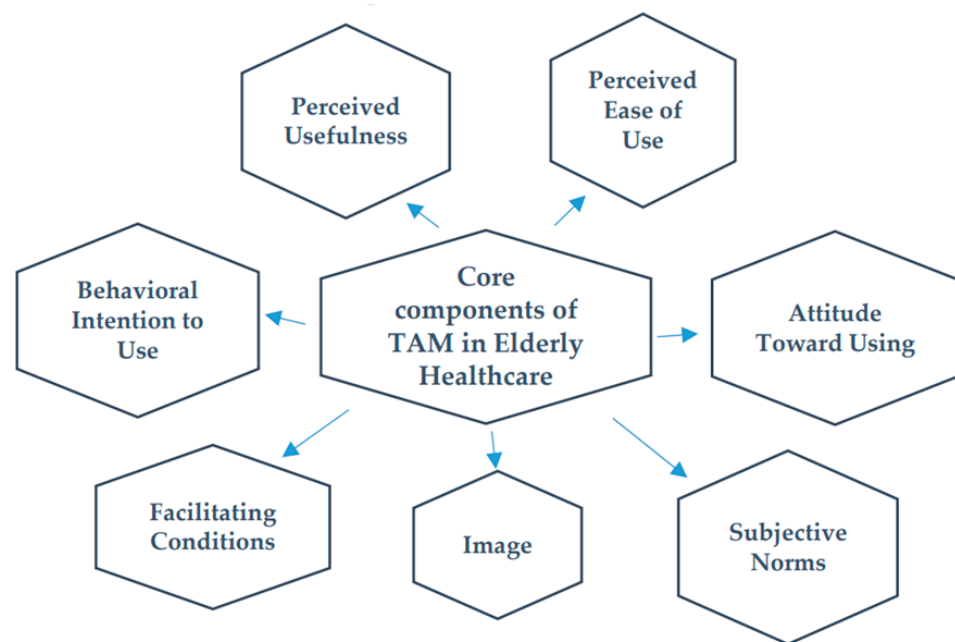


Figure 2. Core components of TAM derived from ChatGPT's responses in elderly healthcare.

3.2. Application Areas of TAM in Elderly Healthcare

The application areas of TAM in elderly healthcare are presented in Table 2. The application areas of TAM in early healthcare, facilitated by Generative AI, are illustrated in Figure 3.

From ChatGPT's responses, the specific application areas of TAM in elderly healthcare included the adoption of telehealth technologies, wearable health devices, mobile health applications, health information systems, assistive technologies, virtual reality, gamification for rehabilitation, health chatbots, AI-assisted healthcare, social connectedness technologies, educational health platforms, and pervasive health monitoring systems. The application areas of TAM derived from ChatGPT's responses in elderly healthcare were consistent with those presented in previous studies.

Table 2. Application area of TAM in elderly healthcare.

| ChatGPT's Responses | | Previous Studies * |
|--|---|-------------------------|
| Adoption of Telehealth Technologies: | TAM can be employed to assess how elderly individuals perceive and accept telehealth technologies for remote consultations, monitoring, and virtual care. | [24,28,34,37–44] |
| Wearable Health Devices: | TAM can help understand the factors influencing the adoption of wearable health devices among the elderly, including smartwatches or fitness trackers that monitor vital signs and activity levels. | [28,45,46] |
| Mobile Health Applications: | Evaluating the acceptance of mobile health applications tailored for elderly users, considering factors like user-friendliness, perceived usefulness, and ease of navigation. | [4,5,15,19,24,28,47,48] |
| Health Information Systems: | TAM can be applied to assess the acceptance of electronic health records, online health portals, and other health information systems by elderly individuals. | [44,49] |
| Assistive Technologies: | Understanding how elderly individuals perceive and adopt assistive technologies, such as smart home devices, medication reminders, and other aids designed to enhance independent living. | [5,21,26,36,50] |
| Virtual Reality and Gamification for Rehabilitation: | Exploring the acceptance of virtual reality and gamified applications for rehabilitation purposes, considering factors like engagement, perceived benefits, and ease of use. | [34,36,40,50–55] |
| Health Chatbots and AI-Assisted Healthcare: | Assessing the elderly's acceptance of AI-driven healthcare support, including health-related chatbots or virtual assistants, leveraging TAM to understand factors affecting adoption. | [39,56] |
| Social Connectedness Technologies: | Investigating the acceptance of technologies aimed at fostering social connectedness among elderly individuals, such as video calling applications or social networking platforms. | [2,24,33,57–59] |
| Educational Health Platforms: | Evaluating the adoption of online platforms providing health education and information tailored for the elderly population. | [1,10,60–62] |
| Pervasive Health Monitoring Systems: | TAM can be utilized to understand how elderly individuals perceive continuous health monitoring systems, including sensors and IoT devices, in their homes or healthcare facilities. | [9,31,32,37,39,63] |

* This is a prior study related to the application area of TAM in elderly healthcare and refers to the reference number of this text.

This figure illustrates ChatGPT's response to the open-ended question: "What are the application areas of TAM in elderly healthcare?".

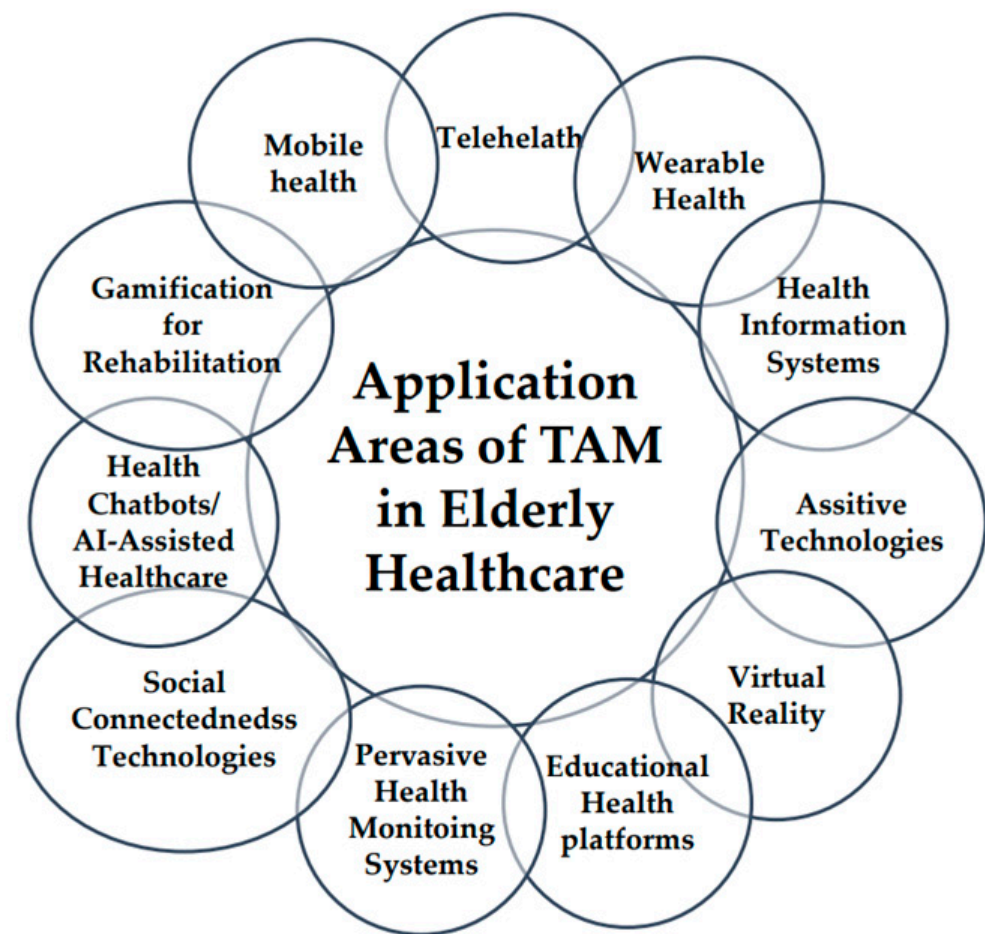


Figure 3. Application areas of TAM derived from ChatGPT’s responses in elderly healthcare.

3.3. Challenges Arising from the Application of TAM in Elderly Healthcare

The challenges arising from the application of TAM in elderly healthcare are presented in Table 3.

From ChatGPT’s responses, the challenges included: Technological literacy barriers, digital divide concerns, privacy and security apprehensions, resistance to change, limited awareness and information, health conditions and cognitive impairment, trust and reliability concerns, lack of tailored interventions, overcoming age stereotypes, and integration with traditional healthcare. The challenges of TAM derived from ChatGPT’s responses in elderly healthcare were consistent with those presented in previous studies.

Table 3. Challenges arising from the application of TAM in elderly healthcare.

| ChatGPT’s Responses | Previous Studies * |
|----------------------------------|--|
| Technological Literacy Barriers: | ChatGPT highlights challenges related to the limited technological literacy among the elderly. Issues such as unfamiliarity with digital interfaces, apprehension toward new technologies, and a lack of confidence in using electronic devices may impede the acceptance of healthcare technologies. [1,3,6,19,25,45,46,58,64,65] |
| Digital Divide Concerns: | ChatGPT acknowledges the existence of a digital divide, where disparities in access to and proficiency in technology may disproportionately affect certain segments of the elderly population. Economic, educational, and cultural factors contribute to this divide, hindering equal opportunities for technology adoption [18,66,67] |

Table 3. Cont.

| ChatGPT's Responses | | Previous Studies * |
|---|--|--------------------|
| Privacy and Security Apprehensions: | Privacy and security concerns are identified as significant barriers. Elderly individuals may harbor reservations about the confidentiality of their health information when using digital platforms, leading to hesitancy in embracing healthcare technologies. | [8,15,24,35] |
| Resistance to Change: | ChatGPT recognizes that resistance to change, often rooted in established routines and a preference for traditional healthcare practices, poses a substantial challenge. Elderly individuals may resist adopting new technologies due to a perceived disruption to their familiar healthcare routines. | [8,68] |
| Limited Awareness and Information: | The model points out the challenge of limited awareness and information among the elderly regarding available healthcare technologies. Insufficient knowledge about the benefits and functionalities of digital healthcare solutions may result in a lack of interest or motivation to adopt these technologies. | [11,49] |
| Health Conditions and Cognitive Impairment: | ChatGPT acknowledges that health conditions and cognitive impairment can be substantial challenges. Elderly individuals facing these issues may find it difficult to engage with or comprehend certain healthcare technologies, affecting their ability to adopt and utilize these tools effectively. | [6,18,21,69] |
| Trust and Reliability Concerns: | The model emphasizes trust and reliability concerns as critical challenges. Elderly users may hesitate to adopt healthcare technologies if they perceive them as unreliable or if there are doubts about the trustworthiness of the technology providers. | [8,27,30,70,71] |
| Lack of Tailored Interventions: | ChatGPT underscores the need for tailored interventions that specifically address the unique needs and preferences of the elderly. The absence of personalized approaches in the design and implementation of healthcare technologies may hinder acceptance. | [43,71–74] |
| Overcoming Age Stereotypes: | The model recognizes the challenge of overcoming age-related stereotypes that assume older individuals are less receptive to technological advancements. Addressing these stereotypes is crucial for promoting a more inclusive approach to technology acceptance among the elderly. | [7,15,26,71,75] |
| Integration with Traditional Healthcare: | ChatGPT suggests that integrating new technologies with traditional healthcare practices poses a challenge. Ensuring seamless compatibility, acceptance by healthcare professionals, and alignment with existing healthcare systems requires careful planning and implementation. | [1,8,76–80] |

* This is a prior study related to the challenges arising from the application of TAM in elderly healthcare and refers to the reference number of this text.

4. Discussion

In the ever-evolving landscape of healthcare, the integration of technology has become a focal point for improving patient outcomes and delivering more efficient and personalized services. Confronting the challenges posed by an aging global population, the application of technology in elderly healthcare has emerged as a crucial area of exploration. This research endeavored to unravel the complexities surrounding the adoption of technology among the elderly, focusing specifically on the Technology Acceptance Model.

This study employed the Technology Acceptance Model, a widely recognized framework for understanding user acceptance of technology, to discern the factors influencing the elderly's willingness to embrace innovative healthcare solutions. Furthermore, this discussion uniquely incorporated insights from ChatGPT, an advanced natural language processing model developed by OpenAI. By leveraging the capabilities of ChatGPT, this study also enriched our understanding of how language models contribute to communication and support in healthcare contexts involving elderly individuals. The intersection of technology, aging, and healthcare is a dynamic space, replete with challenges and opportunities. Additionally, addressing these complexities will contribute valuable insights that can inform the development of tailored healthcare solutions for the elderly. This discussion will also delve into the application of TAM and the challenges due to its application in the realm of elderly healthcare, offering a nuanced perspective that considers both the theoretical framework and the practical implications, guided by the unique viewpoint of ChatGPT.

4.1. Core Components of TAM in Elderly Healthcare

The TAM encompasses fundamental constructs crucial in shaping the acceptance and utilization of technology. In the realm of elderly healthcare, these core components play a pivotal role, offering profound insights into how older individuals perceive and embrace technological solutions. Of the core components of TAM in elderly healthcare, Perceived Usefulness (PU) becomes paramount, reflecting the extent to which the elderly believed that a given technology would enhance their healthcare experience. This involved considerations such as improvements in health monitoring, access to medical information, or assistance with daily living [8,14–16,24,25,81–84].

Parallely, Perceived Ease of Use (PEOU) assumes significance, gauging the elderly individuals' belief in the technology being user-friendly and effortlessly navigable [8,14–16,24,25,81–84]. Attitude Toward Using (ATU) encapsulates their overall evaluation of adopting specific healthcare technologies, where positive attitudes significantly influence acceptance [1,5,7,16,25–30]. Behavioral Intention to Use (BI) delves into the expressed willingness of the elderly to embrace these technologies in the future, underscoring their readiness to manage healthcare needs digitally [7,25,27,31]. Subjective Norms (SN) acknowledged the social pressures and influences from family, friends, and healthcare providers, contributing to heightened acceptance [8,32,33]. The construct of Image (IM) underscored the perceived reputation associated with using technology in elderly healthcare, emphasizing reliability, security, and overall well-being benefits [8,15,30,32,34,35]. Facilitating Conditions (FC) assesses the external support available, including technical assistance and access to resources [7,8,36].

Understanding the intricate interplay of these core components in the context of elderly healthcare is imperative for designing interventions and technologies that align with the distinctive needs and preferences of the aging population. This comprehensive approach will ensure the development of user-centric solutions tailored to enhance the overall healthcare experience for older individuals.

4.2. Application Areas of TAM in Elderly Healthcare

The TAM has served as a valuable framework for assessing the elderly's perception and acceptance of various healthcare technologies. In the realm of telehealth, TAM can be employed to gauge how elderly individuals perceive and embrace remote consultations, monitoring, and virtual care technologies [24,28,34,37–44,81–84]. Furthermore, TAM has been proven useful in understanding the factors influencing the adoption of wearable health devices among the elderly, including smartwatches and fitness trackers designed to monitor vital signs and activity levels [28,45,46]. In the context of mobile health applications, TAM can also help evaluate the acceptance of apps tailored for elderly users, taking into account user-friendliness, perceived usefulness, and ease of navigation [4,5,15,19,24,28,47,48].

The model appears to have extended its applicability to the assessment of health information systems, such as electronic health records and online health portals, by elderly individuals [44,49]. It is also reported as aiding in comprehending how elderly individuals

perceive and adopt assistive technologies, including smart home devices, medication reminders, and other aids that enhance independent living [5,21,26,36,50]. In the domain of rehabilitation, TAM can be employed to explore the acceptance of virtual reality and gamified applications, considering factors like engagement, perceived benefits, and ease of use [34,36,40,50–55]. Additionally, the model is valuable in assessing the elderly's acceptance of AI-driven healthcare support, including health-related chatbots or virtual assistants, and elucidating factors influencing adoption [39,56].

TAM has been suggested to be equally relevant in investigating the acceptance of technologies fostering social connectedness among the elderly, such as video calling applications or social networking platforms [2,24,33,57–59]. In the realm of health education, TAM has been found to aid in evaluating the adoption of online platforms providing health information tailored for the elderly population [1,10,60–62,84]. Moreover, TAM can be utilized to understand how elderly individuals perceive continuous health monitoring systems, including sensors and IoT devices, in their homes or healthcare facilities [9,31,32,37,39,63]. Overall, it could be considered that the model provides a comprehensive framework for studying and enhancing the acceptance of various healthcare technologies among the elderly population.

4.3. Challenges and Countermeasures for the Application of TAM in Elderly Healthcare

As seen in the findings of this study, the application of TAM in elderly healthcare can be accompanied by various problems, which can be interpreted as crises or challenges to the application of TAM. Therefore, it can be seen that it is essential to take measures against challenges that emerge through the application of TAM.

The first challenge can be considered limited technological literacy. To address the challenges associated with limited technological literacy among the elderly, several key countermeasures can be implemented. First and foremost, the development of healthcare technologies should prioritize user-friendly interfaces, featuring intuitive designs with larger fonts, simple navigation, and clear icons. Personalized training programs, tailored to the specific needs and learning styles of the elderly, can play a crucial role in building confidence and familiarity with electronic devices. Community-based training centers should be established to provide hands-on assistance and foster a supportive learning environment, while involving younger generations in mentorship programs can contribute to intergenerational learning. Printed and visual guides, offered in various formats, can serve as valuable resources, accompanied by remote assistance services for immediate support. Incentive programs and recognition schemes may motivate elderly individuals to embrace technology, and regular updates based on user feedback can improve the functionality and user experience of healthcare technologies. Partnerships with senior organizations and retirement communities can integrate technological literacy programs into existing social structures, leveraging community support. Furthermore, advocating for policies that promote inclusive technology design and accessibility standards is essential, as is encouraging government support for initiatives aimed at bridging the technological literacy gap among older adults. By implementing these comprehensive measures, a concerted effort can be made to overcome barriers and enhance the acceptance and utilization of healthcare technologies among the elderly population [1,3,6,19,25,45,46,58,64,65,81–84].

Second, the digital divide can be viewed as a crisis. To tackle the digital divide among the elderly, a range of targeted countermeasures can be implemented. Initiatives such as affordable access programs and community technology hubs aim to provide economic relief and equitable access to digital resources. Mobile technology education, integrated into existing programs, leverages the prevalence of smartphones among older adults. Digital literacy courses and inclusive technology design principles address educational disparities by empowering seniors with essential skills and user-friendly interfaces. Public-private partnerships, emphasizing collaboration between government, nonprofits, and the private sector, offer comprehensive solutions, including grants, training, and outreach efforts. Cultural competency training ensures that support services are attuned to diverse elderly

populations, while accessible online content and user-friendly applications cater to varying levels of technological proficiency. Community outreach campaigns and government incentives further encourage technology adoption by raising awareness and rewarding businesses that contribute to digital inclusion. By combining these measures, a holistic approach can bridge the digital divide, providing equal opportunities for technology adoption among all segments of the elderly population, irrespective of economic, educational, or cultural factors [18,66,67].

The third challenge is privacy and security concerns. To alleviate privacy and security concerns among elderly users of digital healthcare platforms, several countermeasures can be implemented. First and foremost, clear and transparent privacy policies should be developed, using simple language to ensure understanding. Educational resources, such as tutorials and webinars, can be provided to familiarize elderly individuals with the security features of the platform. Robust encryption techniques should be employed for the secure transmission and storage of health information. Multi-factor authentication adds an extra layer of security, combining passwords with additional verification steps. Regular security audits help identify and address vulnerabilities, with results communicated to users to enhance trust. Granular permission controls empower users to manage access to their health information, and the use of secure authentication methods, like biometrics, improves both security and the user experience. Having a well-defined incident response plan assures users that any breaches will be addressed promptly. Regular software updates, accompanied by user awareness campaigns, ensure that security remains up-to-date. Moreover, readily accessible customer support channels, such as helplines and live chats, provide assistance for privacy and security concerns. Collectively, these measures reinforce a commitment to user privacy and security, fostering trust among elderly individuals and encouraging their acceptance of digital healthcare technologies [8,15,24,35,82,83].

Resistance to change can be seen as an important challenge when applying TAM to elderly healthcare. To address resistance to change among elderly individuals when adopting new healthcare technologies, a strategic and empathetic approach is essential. Gradual integration, accompanied by user-friendly educational programs and hands-on training, allows individuals to familiarize themselves with technology at their own pace. Personalized assistance, through dedicated support teams and helplines, provides immediate help and builds user confidence. Emphasizing the benefits of technology, involving healthcare providers in advocacy, and showcasing success stories contribute to a positive perception. Customizable solutions, live demonstrations, and trial periods allow users to adapt technology to their preferences, while feedback mechanisms enable iterative improvements based on user experiences. Community engagement, through support groups and forums, fosters a sense of shared experience and encouragement among elderly users. Importantly, respecting established healthcare routines and ensuring that new technologies complement rather than disrupt these routines helps overcome apprehensions and facilitates a smoother transition to embracing healthcare innovations [8,68].

Next is the challenge due to limited awareness and information. To combat limited awareness and information among the elderly regarding healthcare technologies, targeted strategies can significantly enhance understanding and motivation. Comprehensive educational campaigns, spanning traditional and online media, serve to inform the elderly about the benefits of digital healthcare solutions. Local workshops, partnerships with senior organizations, and community engagement events bring experts directly to the elderly population, fostering direct interaction and addressing queries. User-friendly information materials, such as brochures and pamphlets, simplify complex concepts, while digital literacy programs and training sessions focus on building essential technology skills. Sharing testimonials and success stories amplifies the impact, offering relatable examples. Mobile health clinics and social media engagement extend outreach, providing hands-on experiences and informative content. Interactive online platforms and peer-to-peer support programs cater to diverse learning preferences, allowing the elderly to explore and understand healthcare technologies at their own pace while fostering a sense of community and

shared learning. Through these measures, healthcare providers can bridge the knowledge gap and empower the elderly to make informed decisions about embracing and benefiting from digital healthcare solutions [11,49].

The health conditions and cognitive impairment of the elderly are also challenges that need to be considered when applying TAM. To overcome challenges posed by health conditions and cognitive impairment in elderly individuals adopting healthcare technologies, a user-centric approach is paramount. Designing intuitive interfaces with larger fonts, clear icons, and voice-activated features ensures accessibility. Customizable settings, simplified instructions, and immediate feedback accommodate varying cognitive abilities. Involving caregivers in training and support enhances the user experience. Including reminder features, sensory enhancements, and telehealth options addresses specific needs. Frequent testing and feedback sessions with the target demographic ensure continuous improvement, while collaboration with healthcare professionals ensures technology aligns with medical protocols. Through these tailored measures, healthcare providers can create a more inclusive and supportive environment, facilitating effective adoption and utilization of healthcare technologies among elderly individuals facing health conditions or cognitive impairment [6,18,21,69].

Trust and reliability concerns for TAM applications are reported to be key concepts. To alleviate trust and reliability concerns among elderly users regarding healthcare technologies, a multi-faceted approach is crucial. Transparent communication through user-friendly documentation and FAQs helps address doubts. Featuring positive user testimonials and partnerships with reputable healthcare institutions reinforces credibility. Displaying provider credentials and certifications, along with emphasizing stringent data security measures, builds confidence in the technology's reliability. Regular software updates and accessible customer support contribute to ongoing reassurance, while trial periods and transparent refund policies allow users to test and experience reliability firsthand. Educating users on security practices empowers them, and community engagement through support groups fosters a sense of collective trust. Implementing regular audits and quality assurance checks showcases a commitment to maintaining high standards. Through these measures, healthcare providers can create an environment that not only resolves concerns but actively nurtures trust in the adoption of healthcare technologies by the elderly [8,27,30,70,71].

Due to the vulnerability of the elderly population compared to other age groups, tailored interventions must be considered. To address the lack of tailored interventions for the elderly in healthcare technologies, a comprehensive approach is essential. Prioritizing user-centric design principles and collecting direct feedback through surveys ensures that the unique needs and preferences of the elderly are considered. Customizable interfaces, adaptive learning algorithms, and the integration of wearable devices contribute to a personalized user experience. Virtual assistants with natural language processing capabilities facilitate intuitive interactions, while collaboration with healthcare professionals ensures alignment with medical recommendations. The incorporation of behavioral science principles, gamification elements, and incentives motivates and engages elderly users, making the technology more appealing. Community building and peer support platforms foster a sense of shared experience and encouragement. Continuous user monitoring and updates based on analytics maintain the relevance and effectiveness of tailored interventions over time. Through these measures, healthcare providers can bridge the gap and actively promote the acceptance and utilization of healthcare technologies among the elderly [43,71–74].

Next, stereotypes related to aging can pose a challenge to the application of TAM. To overcome age-related stereotypes hindering technology acceptance among the elderly, a multifaceted approach is vital. Positive media representation and showcasing older individuals as technology role models can challenge misconceptions. Educational campaigns, intergenerational initiatives, and technology training programs foster a culture of continuous learning. Community workshops, inclusive design principles, and empowerment narratives emphasize the benefits of technology for older adults. Engaging older

individuals in community programs, advocating for inclusive policies, and collaborating with senior organizations amplify efforts to challenge stereotypes. This comprehensive strategy aims to promote a positive narrative around technology adoption, recognizing the diverse capabilities and contributions of the elderly in the digital era [7,15,26,71,75].

As a final challenge, there is a need to consider integrating new technologies with traditional healthcare practices. To address the challenge of integrating new technologies with traditional healthcare practices, a strategic and collaborative approach is essential. Fostering collaboration with healthcare professionals from the outset ensures technology alignment with clinical workflows. User-centric design principles, adherence to interoperability standards, and comprehensive training programs facilitate seamless integration into existing healthcare systems. Pilot programs allow for testing and refinement, while regulatory compliance and robust data security measures address industry concerns. Demonstrating clinical benefits through evidence and case studies reinforces the value of the technologies. Incremental implementation and continuous feedback mechanisms ensure a smooth transition, while incentives for adoption motivate healthcare professionals. This comprehensive strategy aims to overcome challenges, promoting the acceptance and successful integration of new technologies within traditional healthcare settings [1,8,76–84].

Based on the aforementioned challenges and measures for applying TAM in elderly healthcare, the theoretical relevance and successful practical application of TAM are as follows. The TAM in elderly healthcare is evident in its ability to offer a comprehensive understanding of the factors influencing the acceptance and adoption of technology by older individuals. By examining user perceptions, TAM becomes a valuable tool for researchers and healthcare professionals, allowing them to discern the attitudes of the elderly toward healthcare technologies. TAM's predictive power is a significant asset in forecasting technology adoption behavior, enabling the anticipation of acceptance based on factors such as perceived ease of use and perceived usefulness. This predictive capability, coupled with the model's flexibility, makes it adaptable to the evolving landscape of healthcare technologies, ensuring its continued applicability. One of TAM's strengths lies in its capacity to tailor interventions to address specific barriers or concerns related to technology adoption among the elderly. This customization is crucial for designing strategies that align with the unique needs and preferences of older users in healthcare settings. Emphasizing user-friendly design principles, TAM aligns with the critical importance of usability in elderly healthcare. The model's focus on intuitive interfaces guides the development of technologies that cater to the aging population, promoting accessibility and user acceptance. TAM's consideration of factors like trust is particularly relevant in healthcare settings, where security and privacy concerns are paramount. Understanding how trust influences technology acceptance is essential for developing systems that address the specific needs and apprehensions of elderly users. Insights from TAM go beyond individual acceptance and can inform health policy and planning for the integration of technology into elderly healthcare. Decision-makers can utilize TAM to allocate resources effectively, ensuring the adoption of technologies that benefit the aging population. Additionally, TAM highlights the significance of effective communication and training in technology adoption. In the context of elderly healthcare, these principles can enhance communication strategies and training programs, bridging the digital divide and facilitating the uptake of healthcare technologies among older individuals. In summary, TAM serves as a valuable framework that not only comprehensively addresses the complexities of technology acceptance among the elderly in healthcare but also contributes to the development of user-centric, effective, and ethically sound technologies tailored to the unique needs of the aging population.

The successful application of the TAM in elderly healthcare is contingent on a nuanced understanding of various facilitators and barriers influencing the acceptance and adoption of healthcare technologies by older individuals. Facilitators encompass key elements such as usability and user-friendly design, where intuitive interfaces contribute to positive perceptions and increased adoption. Clear communication about the perceived usefulness of healthcare technologies, particularly in terms of tangible benefits for health outcomes,

convenience, and independence, enhances acceptance. Additionally, trustworthiness and transparent security measures play a crucial role in establishing trust and confidence among elderly users. Effective training programs and ongoing support emerge as facilitators, contributing to the confidence and competence of elderly individuals in using healthcare technologies. Tailoring interventions to address the specific needs and preferences of the elderly is essential for customization and increased acceptance. Conversely, barriers to the application of TAM in elderly healthcare include challenges related to technological literacy and the digital divide, which may result in resistance to adoption. Perceived complexity in the functionality of healthcare technologies can act as a barrier, hindering acceptance if the technology is deemed too difficult to understand. Concerns about privacy and security pose significant barriers, with fears of unauthorized access to personal health information deterring elderly individuals from adopting healthcare technologies. Resistance to change, often rooted in established routines and familiarity with traditional healthcare practices, can also impede adoption. Limited awareness about available healthcare technologies, particularly among elderly individuals, is a barrier that may lead to a lack of interest. Health conditions and cognitive impairment present additional challenges, making it difficult for elderly individuals facing these issues to engage with or comprehend certain healthcare technologies. Addressing these facilitators and barriers is pivotal for the successful implementation of TAM in elderly healthcare. Customizing interventions, providing comprehensive support, and addressing concerns related to usability and security are essential strategies for promoting the acceptance of healthcare technologies among the aging population.

4.4. Implications and Recommendations for TAM in Elderly Healthcare

The integration of the TAM in elderly healthcare carries important policy implications and recommendations aimed at optimizing the adoption of healthcare technologies among the aging population. To begin, policymakers should prioritize investments in usability and user-friendly design for healthcare technologies. Allocating resources to research and development in this area ensures that technologies are tailored to the unique needs of elderly users. Additionally, the establishment and enforcement of clear privacy and security standards are crucial policy measures, addressing concerns and fostering trust in the protection of personal health information. Digital literacy programs targeted at the elderly population should be implemented to bridge the digital divide and enhance technological literacy. Policymakers can incentivize the development of tailored interventions by offering grants or incentives, encouraging the customization of healthcare technologies to align with the preferences of elderly users.

In terms of recommendations, public awareness campaigns play a vital role in educating the elderly about the benefits and functionalities of healthcare technologies. Policymakers should allocate resources for outreach programs to raise awareness and dispel misconceptions. Training programs for healthcare professionals are also recommended to equip them with the skills and knowledge needed to guide elderly individuals in using healthcare technologies effectively. Incentivizing the development of interoperable healthcare technologies ensures compatibility between different systems, promoting a cohesive and user-friendly experience. Policymakers should strategize the integration of healthcare technologies into existing healthcare systems, creating frameworks for interoperability, reimbursement policies, and guidelines for routine incorporation into healthcare practices. Furthermore, policies for regular evaluation and feedback mechanisms are essential for the continuous improvement of healthcare technologies. Advocating for processes that collect user feedback, address concerns, and update technologies based on evolving needs contributes to their ongoing relevance and effectiveness. Lastly, policymakers should champion inclusive research and development practices. Encouraging studies involving diverse groups of elderly individuals, including those with varying health conditions and cognitive abilities, ensures that technologies cater to a wide range of users. In summary, by incorporating these policy implications and recommendations, policymakers can create

an environment conducive to the successful implementation of TAM in elderly healthcare. This approach promotes the acceptance and effective utilization of healthcare technologies, ultimately contributing to improved healthcare outcomes for the aging population.

The future of research on the application of the TAM in elderly healthcare holds promising directions that can significantly advance our knowledge of technology adoption among older individuals. To gain comprehensive insights, researchers may consider undertaking longitudinal studies, observing changes in acceptance patterns over an extended period among the elderly. Additionally, cross-cultural studies can investigate how cultural variations influence technology acceptance, contributing to the development of culturally sensitive interventions. An exploration of the impact of emerging technologies, such as artificial intelligence and wearable devices, on elderly technology acceptance is essential for staying ahead of technological advancements. Future research should also adopt an inclusive approach, considering varying cognitive and physical abilities among the elderly, to ensure technology designs are accommodating and accessible. Examining the influence of social factors, such as family dynamics and healthcare provider recommendations, will provide a holistic understanding of the contextual elements shaping technology adoption decisions. Focusing on user experience and interface design considerations can contribute to the development of technologies that are more user-centric and engaging for elderly users. Investigations into the integration of healthcare technologies with traditional practices and ethical considerations related to their use are critical for responsible adoption. Moreover, assessing the effectiveness of interventions, including educational programs and training initiatives, can guide the development of targeted strategies to address the specific barriers identified by TAM. Finally, researchers should explore the impact of technology acceptance on health outcomes and overall quality of life among the elderly. Understanding how technology adoption contributes to improved health and well-being will be instrumental in developing interventions with meaningful and positive outcomes. By collectively exploring these future research directions, scholars and practitioners can contribute valuable insights to the evolving landscape of healthcare technology adoption among the elderly, paving the way for informed, effective, and ethically sound interventions.

4.5. Strengths and Limitations of the Present Study

This study exhibits notable strengths in its multidisciplinary approach, integrating insights from information science, gerontology, and medical science to comprehensively explore the application of the TAM in elderly healthcare. The use of OpenAI's real-time interactive ChatGPT adds dynamism to literature responses, ensuring up-to-date information and enhancing the overall reliability of the research outcomes. Furthermore, the rigorous validation of ChatGPT responses through thorough literature verification using reputable databases like PubMed, Web of Science, Scopus, and Google Scholar contributes to the study's credibility.

Despite these strengths, it is essential to acknowledge certain limitations. While ChatGPT serves as a powerful language model, occasional errors or inaccuracies may arise, necessitating careful interpretation of the results. Reliance on internet-based literature for validation raises concerns about source reliability, emphasizing the importance of considering traditional sources. The generalizability of findings may be limited to specific subsets of the elderly population or healthcare contexts, prompting the need for future research to explore diverse populations and technological aspects. The mention of the ChatGPT access date as 10 January 2024, underscores the importance of considering potential updates or improvements to ChatGPT's functionality since that date. In conclusion, this study's multidisciplinary approach and integration of real-time interactive ChatGPT contribute valuable insights into the application of TAM in elderly healthcare. Addressing these limitations will ensure a nuanced interpretation of findings, guiding future research endeavors in this evolving field.

5. Conclusions

In conclusion, the core components of TAM in elderly healthcare include perceived usefulness, perceived ease of use, attitude toward use, behavioral intention to use, subjective norms, image, and facilitating conditions. Additionally, TAM's application areas encompass telehealth, wearable devices, mobile health apps, and more. However, when applying TAM, challenges arise, such as technological literacy barriers, concerns regarding the digital divide, privacy and security apprehensions, resistance to change, limited awareness and information, health conditions and cognitive impairment, trust and reliability concerns, a lack of tailored interventions, overcoming age stereotypes, and integration with traditional healthcare. The necessity to develop and implement personalized interventions for the elderly is emphasized as a countermeasure.

Additionally, this study provides several key conclusions, highlighting the application of TAM in understanding technology acceptance among the elderly in healthcare. The multidisciplinary approach, incorporating insights from information science, gerontology, and medical science, also proves significant in unraveling the complexities of this acceptance. Leveraging the real-time interactive capabilities of ChatGPT adds a dynamic and timely dimension to literature responses, enhancing the study's credibility through up-to-date information. Furthermore, the reliability of the research is reinforced by the thorough validation of ChatGPT responses through comprehensive literature verification on platforms like PubMed, Web of Science, Scopus, and Google Scholar. The study not only recognizes the limitations associated with ChatGPT but also acknowledges general constraints in the context of technology acceptance among the elderly. In suggesting future research directions, the study emphasizes the need for diverse investigations involving a broader range of elderly populations and considerations of emerging technologies. These conclusions collectively provide a comprehensive understanding of technology acceptance in elderly healthcare, paving the way for inclusive and relevant research and development initiatives in the field.

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