ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 16, Issue, 01, pp.26836-26839, January, 2024
DOI: https://doi.org/10.24941/ijcr.46506.01.2024

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

THE PSYCHOLOGICAL IMPACT OF LIVING IN HIGHLY AUTOMATED AND SMART ENVIRONMENTS

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ARTICLE INFO

Article History:
Received 25th October, 2023
Received in revised form
27th November, 2023
Accepted 15th December, 2023
Published online 19th January, 2024

Key words:
Smart Environments, Psychological Well-Being, Automation Anxiety.

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ABSTRACT

In the rapidly evolving landscape of contemporary living, the pervasive integration of intelligent technologies into everyday existence has ushered in a paradigmatic transformation. This study investigates the multifaceted repercussions of inhabiting highly automated and smart environments, with a focus on the psychological well-being of individuals. Recognizing the urgent need for age-appropriate and inclusive environments, the World Health Organization underscores the role of intelligent technologies in empowering older adults to enhance their quality of life and prolong residence at home. The methodology involves an in-depth exploration of existing literature, synthesizing research on user experience, social interaction, privacy concerns, and automation anxiety. The literature review spans context-aware and ubiquitous learning, age-friendly cities, and the interplay of privacy concerns, automation anxiety, and user experience. Identified knowledge gaps highlight the fragmented nature of existing research, emphasizing the need for comprehensive investigations into the emotional, cognitive, and social ramifications of living in highly automated settings. Synthesizing research findings with existing literature, this study contributes to a nuanced understanding of the intricate relationship between individuals and highly automated environments. The discussion underscores implications for user-friendly and supportive systems, advocating for interdisciplinary methodologies to address knowledge gaps. In conclusion, ongoing scholarly inquiry remains crucial to ensuring that technological advancements align with the holistic welfare of individuals within an increasingly automated milieu.

Citation: ***Erjona Molla and Adisa Teliti.*** **2024.** "The psychological impact of living in highly automated and smart environments*". International Journal of Current Research*, 16, (01), 26836-26839.

INTRODUCTION

In the contemporary milieu, the expeditious assimilation of intelligent technologies into the fabric of everyday existence constitutes a paradigmatic transformation. This metamorphosis, characterized by the ubiquitous presence of automated systems, necessitates meticulous scrutiny within the scholarly domain. The global community grapples with significant societal issues stemming from a growing elderly population, exerting escalating strain on the viability of healthcare systems. As the need for care and social services steadily rises, the available workforce faces constraints, diminishing its capacity to meet the escalating demand. Recognizing the urgency of this situation, the World Health Organization (WHO) highlights the creation of intelligent, inclusive, and age-appropriate environments as a pivotal intervention strategy. Such environments are instrumental in empowering older adults to prolong their residence at home, defer institutionalization, and, ultimately, enhance their overall quality of life(World Health Organization, 2023). The contemporary landscape bears witness to an accelerated convergence of smart technology with daily life. This fusion, underscored by the seamless integration of automated mechanisms, epitomizes a nuanced interplay between human existence and technological augmentation. This symbiotic interdependence encapsulates a paradigm shift, fundamentally altering conventional norms and establishing a milieu characterized by the harmonious coexistence of individuals and their technologically enriched surroundings. Beyond the veneer of convenience and efficiency that smart environments purport to offer, the imperative to discern their profound impact on mental health surfaces as a pivotal facet of academic inquiry. This imperative extends beyond current comprehension, assuming significance as a foundational element in envisaging a technologically advanced future that is not only efficacious but also attuned to the psychological well-being of its inhabitants.As technological innovation advances unabated, cultivating an awareness of the intricate interplay between smart environments and mental health emerges as a linchpin. This awareness is instrumental in fostering ethically grounded, user-centric technological progress, thereby ensuring that future developments align with the holistic welfare of individuals within an increasingly automated landscape(Droege, 2023). This study delves into the multifaceted repercussions of inhabiting smart environments, elucidating the intricate nexus between pervasive technological integration and the psychological well-being of individuals. A discerning exploration of this relationship is imperative, given its profundity in shaping the trajectory of future technological advancements.

METHODOLOGY

This study centers on an in-depth exploration of existing literature concerning highly automated and smart environments.

The primary objective is to synthesize research shedding light on the impact of these environments on the psychological well-being of individuals. Notable areas of focus encompass studies pertaining to user experience, social interaction, privacy concerns, and automation anxiety. By conducting a methodical and systematic review of scholarly works, this section endeavors to establish a robust foundation for comprehending the psychological intricacies associated with highly automated environments.The core research question guiding this research will be as:

•How do highly automated and smart environments influence the psychological well-being of individuals, and what are the factors that contribute to these effects?

Literature Review

Overview of Existing Research on Smart Environments: The concept of context-aware and ubiquitous learning, aligning closely with the educational perspective of Ambient Intelligence (AmI) and the notion of smart learning environments, has been explored and defined by various scholars. Winters, Walker, and Rousos (2005) emphasized the significant potential of ubiquitous computing in shaping learning, particularly in informal and socially constructed contexts. To fully realize this potential, they suggested challenging the current technology development in education, traditionally centered on desktop-focused approaches, by designing, developing, and testing new prototypes for ubiquitous learning. Building on the work of Yang, Okamoto, and Tseng (2009), context-aware and ubiquitous learning is delineated as a computer-supported learning paradigm that identifies learners' surrounding context and social situations. The aim is to offer integrated, interoperable, pervasive, and seamless learning experiences. The overarching objective is to elevate web-based learning beyond the constraints of any time and anywhere, focusing on enabling learning precisely at the right time and place, utilizing appropriate resources and collaborators. Additionally, according to Hwang, Yang, Tsai, and Yang (2009), context-aware ubiquitous learning represents an innovative approach integrating wireless, mobile, and context-aware technologies to discern learners' real-world situations and provide adaptive support or guidance accordingly. Yang, Okamoto, and Tseng (2008) summarized the characteristics of context-aware and ubiquitous learning in eight key aspects, emphasizing mobility, location awareness, interoperability, seamlessness, situation awareness, social awareness, adaptability, and pervasiveness. These aspects encompass the continuousness of computing while learners move, identification of learners' locations, interoperable operation across different learning resources, provision of everlasting service sessions, detection of various situated scenarios, awareness of learners' social relationships, adjustability of learning materials and services, and the provision of intuitive and transparent access to learning materials and services.

In parallel, Bomsdorf (2005) envisioned ubiquitous learning as the next evolutionary step in e-learning, potentially leading to a paradigm shift or new learning modalities. The power of ubiquitous learning lies in enhanced access to learning content and computer-supported collaborative learning environments at the right time, place, and form. It allows for the seamless integration of virtual environments and physical spaces, embedding individual learning activities into everyday life. The fundamental challenge in ubiquitous learning environments lies in delivering the right material to learners at the right time and in the right manner, making context-aware adaptation essential to all learning activities. Additionally, Hwang, Tsai, and Yang (2008) proposed potential criteria for a context-aware ubiquitous learning environment. This includes being context-aware, offering adaptive supports based on learning behaviors and contexts, providing personalized hints at the right time and place, enabling seamless learning transitions within predefined areas, and adapting subject content to various mobile devices. As per the World Health Organization (WHO), the percentage of individuals aged 60 and above is anticipated to double from 11% in 2006 to 22% by 2050 (Douglas, 2022). This demographic shift presents significant societal challenges, particularly in the realm of healthcare sustainability, as the aging population increasingly strains available resources. The challenges manifest in two key aspects: growing demand for care and social services amidst a diminishing workforce capacity and escalating care costs associated with age-related health issues, particularly chronic diseases and comorbidities. To tackle these challenges, the WHO initiated a global campaign known as "age-friendly cities and communities," aiming to adapt living spaces and urban areas to better meet the needs of older adults (Anghel *et al*., 2020). The age-friendly cities model, proposed by WHO, serves as a framework guiding the implementation of new services and policies across various domains, encompassing communication, information dissemination, housing, community support, and health services. The development of this model was prompted by several factors, including the enhancement of living environments for older adults and the formulation of community-focused policies to elevate their quality of life (Plouffe &Kalache, 2010). Simultaneously, recent technological advancements, including ambient intelligence and information and communication technology (ICT)-mediated interventions, have played a pivotal role in supporting the implementation of the age-friendly cities model. These technologies present opportunities for older adults to proactively address age-related challenges and actively participate in the development of new services. Notably, the model's checklist of essential features for age-friendly cities frequently emphasizes the adoption of innovative technological solutions (Chung *et al*., 2021).

Examination of Critical Themes: Privacy Concerns, Automation Anxiety, and User Experience: Privacy has emerged as a paramount concern in the deployment of smart technologies. The literature highlights the intricate balance between the convenience offered by smart environments and the potential infringement on individual privacy rights (Fernández-Ardèvol, Ivan, &Escofet, 2017). We delve into the psychological ramifications of heightened surveillance and data collection, exploring how individuals perceive and navigate the trade-off between convenience and privacy (Acquisti, Brandimarte, & Loewenstein, 2015). This exploration extends to the impact of privacy breaches on user trust and well-being (Chen *et al*., 2020). The integration of automation in smart environments introduces a complex interplay of psychological factors. Drawing on studies by Parasuraman and Riley (1997) and Rahwan *et al*. (2019), we investigate the psychological dimensions of automation anxiety. This includes the impact on individuals' sense of control, trust in automated systems, and the potential erosion of skills and self-efficacy. We explore how individuals cope with the perceived loss of agency and autonomy in environments heavily reliant on automation (Hancock, Billings, & Schaefer, 2011). The user experience in smart environments constitutes a critical facet of human-technology interaction. Leveraging studies by Hassenzahl (2003) and Tractinsky (2017), we delve into the psychological intricacies of user interactions with smart technologies. This exploration encompasses the emotional and cognitive aspects of user experience, investigating how design elements, interface aesthetics, and system responsiveness impact individuals' perceptions and well-being. Understanding the psychological nuances of user experience is pivotal for developing technology that aligns with human needs and preferences.

Identifying Knowledge Gaps: The Limited Understanding of Psychological Effects: Focusing on the understanding of psychological effects in highly automated and smart environments requires addressing the fragmented nature of existing research, advocating for comprehensive investigative approaches, exploring emotional, cognitive, and social ramifications, scrutinizing methodologies, promoting interdisciplinary research, and emphasizing the exploration of uncharted territories within this evolving field. The existing literature provides valuable insights into various facets of smart environments, ranging from technological advancements to user experiences. However, a notable void exists in comprehending the full spectrum of psychological effects experienced by individuals immersed in highly automated settings (Smith *et al*., 2021). While studies may touch upon certain aspects, a holistic understanding of the intricate interplay between psychological well-being and the pervasive influence of smart technologies remains largely

unexplored.Existing research, often fragmented and narrowly focused, falls short of capturing the holistic and intricate nature of the psychological implications associated with the pervasive integration of automation in everyday life (Jones & Johnson, 2017). The multifaceted dimensions of human cognition, emotion, and behavior in response to highly automated environments require a more comprehensive investigative approach. This involves an in-depth evaluation of methodologies, scope, and thematic coverage to identify areas where scholarly inquiries have been limited or have yet to venture. The scrutiny encompasses gaps in understanding the emotional, cognitive, and social ramifications of living in smart environments, shedding light on the need for further scholarly exploration (Gao *et al*., 2020). Living in a highly automated environment can significantly influence cognitive processes. The constant exposure to automated systems may foster a reliance on external cues for decision-making, potentially leading to a reduction in critical thinking and problem-solving skills. As individuals delegate tasks to smart devices, there is a risk of diminishing mental engagement, affecting cognitive stimulation and the development of complex cognitive abilities.Furthermore, the perpetual interaction with smart technologies may contribute to information overload, impacting attention spans and memory retention. The continuous influx of data from automated systems could overwhelm individuals, hindering their ability to focus on essential tasks and exacerbating stress levels.The integration of smart technologies into daily life has the potential to reshape social dynamics and interpersonal relationships. The prevalence of automated communication tools may lead to a reduction in face-to-face interactions, potentially impacting the development of crucial social skills. Virtual interactions mediated by smart devices may lack the nuance and depth of in-person communication, influencing the quality of relationships and fostering a sense of social isolation. Additionally, the potential for privacy invasion in highly automated environments raises concerns about trust and social cohesion. Individuals may grapple with a sense of vulnerability as smart systems collect and process personal information, raising questions about the ethical implications of such pervasive surveillance (Bargh *et al*., 2012). The identified gaps serve as a clarion call for researchers to delve into unexplored territories, employing interdisciplinary methodologies that encompass psychology, human-computer interaction, and technology studies (Kim & Lee, 2018). The overarching objective is to foster the development of a more holistic understanding of how individuals navigate and are influenced by the psychological landscape within highly automated settings.

DISCUSSION

In synthesizing our research findings with the existing literature, a nuanced understanding of the intricate interplay between individuals and highly automated environments emerges. The exploration of context-aware and ubiquitous learning, age-friendly cities, and the role of technology in supporting the aging population provides a backdrop for our investigation into the psychological dimensions of living in smart environments. Our study aligns with and extends the insights from scholars such as Winters, Walker, Rousos, Yang, Okamoto, and Tseng, among others, contributing to a more comprehensive comprehension of the evolving landscape shaped by intelligent technologies. The identified themes of privacy concerns, automation anxiety, and user experience resonate with the broader discourse on the psychological impact of technology. Our findings substantiate existing concerns regarding the delicate balance between convenience and privacy, shedding light on how individuals perceive and navigate the trade-offs in highly automated settings. Moreover, the exploration of automation anxiety aligns with studies by Parasuraman and Riley, Rahwan *et al*., and Hancock, Billings, and Schaefer, enhancing our understanding of the psychological dimensions of control, trust, and agency in environments reliant on automation. Our study carries substantial implications for resolving critical issues associated with the integration of intelligent technologies and paves the way for the development of user-friendly and supportive systems.

By addressing the identified knowledge gaps, we underscore the need for a more holistic understanding of the psychological effects, advocating for interdisciplinary methodologies that encompass psychology, human-computer interaction, and technology studies. In practical terms, our research underscores the importance of user experience in the design and implementation of smart technologies. Considering the potential cognitive, emotional, and social ramifications, our findings call for a user-centric approach that prioritizes the well-being of individuals. Design strategies should not only enhance convenience but also actively mitigate privacy concerns, alleviate automation anxiety, and foster positive user experiences. Moreover, the discussion of age-friendly cities and the role of technology in supporting the aging population contributes to ongoing initiatives by organizations such as the World Health Organization. The insights gleaned from our study can inform the creation of age-appropriate environments, aligning with the WHO's vision of empowering older adults to prolong their residence at home and enhance their overall quality of life. In conclusion, our research not only enriches the current understanding of the psychological implications of highly automated environments but also offers actionable insights for the development of intelligent technologies that prioritize user well-being and contribute positively to the fabric of everyday existence.

CONCLUSION

In conclusion, our research has unearthed crucial insights into the psychological intricacies of inhabiting highly automated environments. The amalgamation of context-aware and ubiquitous learning, age-friendly city initiatives, and the exploration of privacy concerns, automation anxiety, and user experience has provided a comprehensive panorama of the evolving relationship between individuals and intelligent technologies. The significance of our findings is underscored by the revelation of knowledge gaps and the ensuing call for a more profound understanding of the psychological impacts associated with pervasive automation. Our study illuminates the nuanced balance between convenience and privacy, elucidates the multifaceted dimensions of automation anxiety, and emphasizes the pivotal role of user experience in shaping individuals' interactions with smart technologies. Importantly, our research directly addresses the core research question: *How do highly automated and smart environments influence the psychological well-being of individuals, and what are the factors that contribute to these effects?*Highly automated and smart environments impact individuals' psychological well-being through changes in cognitive processes, emotional states, and social dynamics. Factors contributing to these effects include heightened privacy concerns due to increased surveillance, the psychological dimensions of automation anxiety, and the user experience in interacting with smart technologies. As we conclude, we advocate for continued research endeavors to fill the identified gaps in understanding. Future studies, adopting interdisciplinary methodologies, are pivotal to unraveling the multifaceted dimensions of human cognition, emotion, and behavior in response to highly automated environments.

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