Art-Driven and Intelligent Technology Integration: Innovation in Residential Space Design and Interactive Environment for Empty-Nest Seniors

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Abstract: This paper explores the intersection of art-driven design and intelligent technology integration in the residential spaces of empty-nest seniors. With the demographic shift towards an aging population, there is an increasing need for living environments that meet the functional requirements of the elderly while also addressing their emotional well-being and social connectivity. By employing a multidisciplinary approach that integrates art, design, and technology, this research aims to innovate residential design solutions that enhance the quality of life for seniors living alone. Through the study of case studies, technological advancements, and design methodologies, this paper proposes a framework for creating interactive, adaptive, and emotionally engaging living spaces that promote independence, health, and a sense of community among elderly residents.

Keywords: Art design; Intelligent technology; Empty-Nest seniors; Residential space; Interactive environment; Design innovation

DOI: 10.62639/sspjiss22.20240103

As society accelerates towards aging and family structures evolve, the quality of life for empty-nest seniors has become a focal point of social concern. The loneliness and safety issues faced by empty-nest seniors, along with their pursuit of a healthy lifestyle, compel us to rethink their residential space design. Traditional residential space design often focuses on basic living functions and safety, but seldom addresses how design can enhance the quality of life and spiritual satisfaction for the elderly. With technological advancements, intelligent home technologies offer new possibilities for innovative senior living space design. Simultaneously, art, as the core of human emotion and aesthetics, can be integrated into space design to significantly enhance the comfort and interactivity of living environments, thereby improving the emotional state and quality of life for the elderly.

1. Foundations of Innovative Design for Empty-Nest Senior Living Environments

Innovative design concepts and technological applications can create living environments that support the health, safety, and interaction of seniors. These designs not only address practical issues faced by empty-nest seniors, such as safety monitoring, health management, and social interaction, but also enhance their emotional satisfaction and living

(Manuscript NO.: JISS-24-3-F002)

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Funding

This research was supported by the Green Environment Art Design Research Center of Guangdong Baiyun University、2023 Annual Project of Guangzhou Municipal Philosophy and Social Sciences Development' 14thFive- Year Plan: "A Study on the Empowerment of New Media for the Green Transformation of Smart Campuses" (2023GZGJ255)、"Research on the Construction of Applied Talent Training System for Photography Majors in Universities Based on OBE Concept" (BYJY202349).

experience. This promotes their mental health and social participation, driving residential environment design towards more human-centered, interactive, and intelligent directions. Through the study of art and intelligent technology-driven innovations in the design and interactive environment of empty-nest senior living spaces, we aim to create a more beautiful, comfortable, and interactive living environment for empty-nest seniors. At the same time, we seek to provide new perspectives and research outcomes for the field of residential space design.

(1) Residential needs of empty-nest seniors

The residential needs of empty-nest seniors have become a critical subject of research. As the population ages, the loneliness and safety issues faced by empty-nest seniors, along with their pursuit of a healthy lifestyle, necessitate a rethinking of their residential space design. Studies show that the needs of empty-nest seniors for their living environment extend beyond basic living functions and safety to include enhancements in quality of life and mental satisfaction through design. For instance, research on urban intellectual empty-nest seniors reveals the urgency and necessity of further improving their living conditions and social needs . Additionally, studies on the aging-friendly renovation of old residential areas indicate that external environment modifications based on the psychological and behavioral characteristics of the elderly can significantly enhance their living comfort and safety. Research into the residential needs of empty-nest seniors highlights a pressing demand for improved living conditions. Intelligent residential technologies offer new directions for enhancing living environments, while the integration of art into living spaces provides important avenues for improving comfort and mental satisfaction.

(2) Intelligent residential technologies

The development of intelligent residential technologies opens new possibilities for the design of senior living spaces. These technologies not only improve the convenience and safety of living but also enhance the quality of life for seniors. For example, research on the current state and pathways of elderly financial services from a supply-side perspective emphasizes the importance of intelligent technologies in meeting the multi-level, personalized financial service needs of seniors .

(3) Art and living space

The integration of art into living space design can greatly enhance the comfort and interactivity of residential environments. The evolution of art and design from ancient Chinese legends to modern times shows how art influences our understanding and imagination of the sky and space, and this influence is reflected in residential space design as well . The introduction of artistic elements can enrich the visual effects of a space and enhance the emotional experience of residents, making the living space an important support for the mental well-being of seniors.

2. The Potential Impact of Art-Driven and Intelligent Technology Integration on Enhancing the Quality of Life for Seniors

This paper adopts a comprehensive research methodology to deeply understand how art and intelligent technology jointly impact the design of residential spaces for empty-nest seniors and to assess the potential effects of this integration on improving the quality of life for the elderly. First, a literature review systematically examines existing research in related fields, including the application of art and intelligent technology in residential space design and how these applications meet the needs of empty-nest seniors and enhance their quality of life. Furthermore, several representative design projects are selected as case studies to analyze in detail the integration methods and effects of art elements and intelligent technology in these residential space designs. These cases provide intuitive evidence demonstrating how innovative applications of art and technology are realized and their positive impact on the living environment of empty-nest seniors.

To gain deeper insights from the perspective of empty-nest seniors, a questionnaire was designed and distributed

to collect their needs regarding residential spaces, their attitudes towards the integration of art and intelligent technology, and their perceptions of quality of life. Additionally, in-depth interviews were conducted with designers, empty-nest seniors, and experts in related fields to gather diverse perspectives and feedback. The collection of these primary data provides valuable original material for the research, enabling a multi-faceted understanding of the research questions.

(1) Exploring the perceived quality impact of art and intelligent technology in empty-nest senior living space design

To analyze the specific dimensions of how the integration of art and intelligent technology impacts the living environment of empty-nest seniors and their perceived quality of life, this study constructs and validates a comprehensive data model. The model construction is based on data collected from questionnaires and in-depth interviews. The questionnaires provide quantitative data on residential environment satisfaction, perceived quality of life, frequency of use, and satisfaction with art and intelligent technology. In-depth interviews offer qualitative insights from designers, empty-nest seniors, and related experts on the application effects of integrating art and technology in residential space design.

(2) Model Construction

In the model construction phase, perceived quality of life (LQ) is defined as the dependent variable, while the frequency of use (AI_usage) and satisfaction (AI_satisfaction) with art and intelligent technology are defined as independent variables. The linear regression model is expressed as follows:

$LQ=\beta_0+\beta_1\times AI\ usage+\beta_2\times AI\ satisfaction+\epsilon$

This model aims to evaluate the extent to which the integration of art and intelligent technology in residential space design impacts the perceived quality of life of empty-nest seniors.

Model Validation

The model validation involves two key steps:

1) Model Fit Test: This step assesses the model's ability to explain the variability in the data using the R^2 and adjusted R^2 values.

2) Significance Test of Regression Coefficients: This step uses the t-test to determine whether the influence of each independent variable in the model is statistically significant.

This model evaluates how integrating art and intelligent technology in residential space design affects the perceived quality of life of empty-nest seniors. Model validation involves two steps: a model fit test using R^2 and adjusted R^2 values to assess data variability, and t-tests to determine the statistical significance of each independent variable. These steps ensure the model's reliability. The study found a significant positive correlation between the use and satisfaction with art and intelligent technology and the perceived quality of life of empty-nest seniors. This indicates that such integration enhances both the aesthetics and functionality of residential spaces, significantly improving seniors' quality of life. Based on this finding, the study recommends designing residential environments that integrate art and intelligent technology, emphasizing their crucial role in enhancing senior living environments, and providing theoretical and empirical support for future design practices and research.

3. Optimization of Empty-Nest Senior Living Environments through Art and Intelligent Technology Integration

The design framework of this study focuses on the integration of artistic elements and intelligent technological functions in environmental design. By artistically treating environmental elements such as lighting, color, and materials, and optimizing the layout of living spaces through intelligent technology, we aim to create living environments that

are not only aesthetically pleasing but also meet the daily needs of the elderly. Furthermore, the introduction of smart home systems, such as automated lighting, temperature control, and security monitoring, with user-friendly interfaces, enables seniors to easily manage their living spaces. The incorporation of decorative and symbolic artistic elements enhances the acceptance and user experience of the technology.

(1) Optimization of empty-nest senior living environments through art and intelligent technology integration

The design framework includes interactive facilities mediated by art, such as interactive art walls and intelligent health monitoring devices, aiming to stimulate seniors' interest and promote physical and mental activities, thus increasing the dynamism of their lives. This interactivity not only enhances the functionality of the living space but also provides emotional support and opportunities for social interaction, helping to alleviate feelings of loneliness and improve life satisfaction.

In terms of sustainable development strategies, the design considers environmental protection and efficient resource utilization. Measures such as the selection of renewable materials and the use of energy-saving technologies ensure the long-term sustainability of the design solutions. This not only reflects a sense of environmental responsibility but also ensures that the design can adapt to potential future changes and challenges, guaranteeing that seniors can enjoy a high-quality life in a safe, comfortable, and supportive environment.

In summary, the design principles and framework proposed in this study, through the integration of art and intelligent technology, create a living environment for empty-nest seniors that is both aesthetically pleasing and practical, both comfortable and interactive. This not only enhances the living experience of empty-nest seniors but also provides new perspectives and practical guidance on how design can improve the quality of life for the elderly.

(2) Exploring the application of art and intelligent technology in the design of empty-nest senior living spaces

In the case study and empirical research sections, this study delves into how art and intelligent technology are integrated and applied in real-life empty-nest senior living space design projects, assessing the impact of this integration on enhancing the quality of life for empty-nest seniors. Through carefully selected case studies and empirical data analysis, the study not only reveals innovative practices in the fusion of art and intelligent technology but also provides valuable insights and recommendations for residential space design.

This study identified several representative design projects as case studies to showcase the integration of art and intelligent technology in empty-nest senior living spaces. These projects featured smart home systems, spatial layouts of artistic elements, and their combined role in enhancing comfort and convenience. Each case was analyzed for design concepts, implementation processes, technological applications, and artistic expression. Empirical methods were used to gather quantitative data (e.g., frequency of space use, satisfaction surveys, and effectiveness of intelligent technology) and qualitative data from in-depth interviews with seniors, designers, and project teams. The analysis revealed that integrating art and intelligent technology effectively enhances living comfort, increases interactivity, and meets the needs of seniors, leading to higher emotional satisfaction and psychological support. Based on these findings, the study proposes strategies for designing senior living spaces that emphasize the integration of artistic aesthetics and intelligent technology to create more humanized, intelligent, and interactive environments. These recommendations aim to guide future design practices and promote innovation in senior living environments.

4. Impact of Art and Intelligent Technology Integration on Innovation in Empty-Nest Senior Living Spaces and Research Limitations

In this study, we deeply explored the application of art and intelligent technology integration in the design of empty-nest senior living spaces through case studies and empirical analysis, as well as its potential impact on enhancing the quality of life for empty-nest seniors. The analysis shows that the integration of art and intelligent

technology not only enhances the aesthetic value of living spaces but also effectively increases the satisfaction of empty-nest seniors by adding interactivity and adaptability to the living environment. Additionally, intelligent technologies, such as automated home systems, can maintain residential comfort while providing seniors with greater security and convenience, thereby reducing their living stress and enhancing their ability to live independently.

However, the results of this study are subject to several limitations. Firstly, the selection of case studies may carry a degree of subjectivity. Although we strived to select representative and diverse design projects, it might not fully encompass all types of empty-nest senior living space design practices. Secondly, the empirical research data collection primarily relied on questionnaires and interviews, which could be influenced by the accuracy and truthfulness of self-reported data by participants. Additionally, the sample size and scope might limit the generalizability of the research findings. Moreover, in evaluating the effects of art and intelligent technology integration, this study mainly focused on its direct impact on enhancing the quality of life, with less discussion on other aspects such as psychological health and social participation of the elderly.

Despite these limitations, this study provides new perspectives and insights into the design of empty-nest senior living spaces. The integration of art and intelligent technology offers a feasible path for innovative senior living space design, aiming to improve the living experience of the elderly by enhancing the aesthetics and functionality of the environment. Future research should consider employing broader case studies and more rigorous empirical research methods to further validate the findings of this study and explore other potential impacts and values of art and intelligent technology integration in senior living space design. Additionally, future studies should focus on the long-term effects of this integrated design on the psychological health, social activities, and social participation of the elderly. This would provide a deeper theoretical and practical basis for creating more inclusive, supportive, and enriching living environments for seniors.

5. Conclusion

This study explored the integration of art and intelligent technology in empty-nest senior living spaces, highlighting its positive impact on innovative design and quality of life. The main findings indicate that this integration enhances both the aesthetic and functional aspects of living spaces and improves interactivity, meeting the emotional needs and convenience of empty-nest seniors, thus significantly increasing their life satisfaction. Practical recommendations include emphasizing the integration of art and intelligent technology in residential design, focusing on both functionality and emotional expression. Designers should consider the specific needs and preferences of empty-nest seniors, providing customized solutions for safer, more convenient, and comfortable living environments. Relevant industries and policymakers should support and promote the application of integrated art and intelligent technology to foster innovation and improvement in senior residential design. Future research should further explore the potential values and applications of integrating art and intelligent technology, such as their impact on seniors' psychological health and social participation. Additionally, research should consider the diversity and differences in empty-nest senior residential design across various cultural and regional contexts, as well as the effectiveness of integrating art and intelligent technology in cross-cultural settings. Evaluating the long-term effects and sustainability of integrated art and intelligent technology design is also a crucial issue for future studies.

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