Reimagining the Dining Area for Solitary Agers: Integrating Generative AI With Four Evidence-Based Design Principles

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Abstract

As Asian cities confront rapid population aging and an increasing number of older adults living alone, the home environment has become a critical site for supporting autonomy, emotional stability, and social connection. This study focuses on the dining area—an everyday setting where routines, relationships, and psychological rhythms converge—to examine whether a set of evidence-based age-friendly design principles (emotional comfort, safety-assured independence, community connectivity, and ability-adaptive design) can be effectively operationalized through human–AI collaboration. This study recruited 18 professional interior designers to generate AI-assisted spatial concepts embodying these four principles. Utilizing generative AI tools, participants produced a total of 432 images. Subsequently, three experts in gerontology and design evaluated the outputs using a structured rubric aligned with the principles to assess the feasibility and appropriateness of the proposed solutions. Follow-up semi-structured interviews explored how designers interpreted the diverse needs of older adults, negotiated design constraints, and navigated the relationship between professional judgment and AI-generated suggestions. Emotional comfort received the highest mean rating *(M = 5.91)*, while ability-adaptive design received the lowest *(M = 4.31)*. Findings reveal both the potential and limitations of generative AI in translating age-friendly principles into actionable spatial strategies. While AI accelerates visualization and supports broader concept exploration, it also exposes cultural and contextual gaps—particularly regarding safety, daily routines, and social norms in Asian households. This study provides preliminary empirical grounding for human–AI collaborative design in domestic dining environments, and outlines considerations for future aging-in-place research.

Keywords: generative AI, age-friendly design, dining environment, older adults, interior design

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Introduction

Improvements in medical care and living conditions have contributed to increased life expectancy, while declining fertility rates have accelerated the demographic shift toward an aging population (Nakatani, 2023). In recent years, Asian societies have been experiencing rapid population aging. Within this context, a growing number of older adults are choosing to live independently in urban environments, leading to a continuous rise in single-person households and posing new challenges for residential design and social policy (Jian et al., 2025). Consequently, how residential environments can support older adults' daily activities, emotional well-being, and social participation has become an increasingly important issue in both design research and public policy.

Against this backdrop, the concept of age-friendly design has gained increasing attention in both research and policy domains. This concept emphasizes reducing environmental barriers that older adults may encounter in their daily lives through thoughtful design, while supporting their ability to live independently. Previous studies have indicated that well-designed residential environments can enhance safety, promote autonomy, and improve the psychological well-being and overall quality of life of older adults (Cha, 2025). For older adults living alone, shared meals represent important moments for communication and emotional connection among family members, and the dining environment may influence their daily routines and sense of belonging at home.

Shared meals are not only related to nutrition and physical health, but are also closely associated with emotional experiences and social interaction (Song et al., 2025). As the demand for aging in place continues to grow, in addition to existing research focused on healthcare environments, the configuration of everyday domestic dining spaces has gradually become a key concern in the design field.

Meanwhile, generative AI is increasingly influencing design practices. It enables designers to efficiently explore a wide range of design possibilities and to generate conceptual images and spatial proposals based on textual prompts (Chen et al., 2025). However, prior work has also documented that image-generation models reproduce aesthetic and cultural biases embedded in their training data, and that they often underrepresent assistive or accessibility-related features (Liang & Cai, 2025). Accordingly, there is a growing need to examine whether AI-generated designs can adequately address the complex, human-centered needs associated with older adults' daily lives.

This study takes the domestic dining environment as its research context and evaluates the feasibility and effectiveness of AI-assisted design based on four principles: emotional comfort, safety-assured independence, community connectivity, and ability-adaptive design.

Based on the above background, this study addresses the following research questions:

RQ1: How do AI-assisted design proposals differ in their performance across the four age-friendly design principles?

RQ2: How do designers interpret and translate the four age-friendly design principles into prompts?

RQ3: What limitations of AI-generated design outputs are identified by expert evaluators?

Literature Review

Age-Friendly Design Principles

With the rapid aging of the global population, the concept of age-friendly environments has received increasing attention in both design research and public policy. Age-friendly design aims to create environments that support older adults' independence, safety, and well-being, while responding to changes in their physical, cognitive, and social capacities (Jian et al., 2025).

Within this context, the concept of aging in place emphasizes that older adults should be able to continue living safely and comfortably in familiar residential environments, while maintaining social relationships and a sense of identity. Accordingly, age-friendly environments must address not only accessibility and safety, but also psychological comfort and opportunities for social interaction.

Building on this perspective, a study on the residential environments of older adults living alone in Thailand found that multiple environmental factors influence their psychological health and quality of life, highlighting the need for residential design to address both physical and psychosocial needs. The study further proposed four age-friendly design principles: emotional comfort, safety-assured independence, community connectivity, and ability-adaptive design (Kititarakul, 2025). Although this framework was developed in a Bangkok context, its four dimensions align with widely used aging-in-place criteria and are applicable to comparable urban Asian settings; limitations of this cross-context transfer are discussed in the Limitations section.

Emotional comfort refers to environments that provide psychological ease, familiarity, and a sense of security, helping to reduce loneliness and anxiety among older adults. Safety-assured independence emphasizes minimizing environmental risks while supporting older adults' autonomy and decision-making in daily life. Community connectivity focuses on whether a space facilitates interaction with family members, neighbors, or the broader community, thereby preventing social isolation. Ability-adaptive design refers to the flexibility of environments to accommodate changes in older adults' physical mobility or cognitive abilities.

These four principles provide an important conceptual framework for understanding how residential environments influence the quality of life of older adults. In this study, they serve as the core criteria for design evaluation, used to examine whether design outcomes generated through collaboration between generative AI and professional designers can effectively respond to the needs of the aging population.

Domestic Dining Environment and Aging

Among the various spaces within the home, the design of the dining area influences not only physical comfort but also social interaction and emotional experience in the daily lives of older adults. Eating is not merely a basic physiological necessity; it is also an important social and communicative activity. Shared meals with family members often serve as key moments for daily interaction and emotional bonding, while also helping to maintain a regular daily routine. Typically located between the kitchen and the living room, the dining area frequently functions as a central space for everyday family interaction (Sal Moslehian et al., 2023).

Accordingly, the spatial circulation, furniture arrangement, and environmental conditions all affect whether older adults can independently participate in dining activities (Wang et al., 2022). In addition, factors such as table height, seating comfort, and lighting conditions play a critical role in ensuring safety and ease of use during meals.

Within the field of age-friendly design, relatively limited attention has been given to domestic dining environments, and even fewer studies have examined how generative AI tools might support their design. Most existing studies have focused on healthcare facilities, long-term care settings, or broader residential issues (Wang et al., 2022). In comparison, given the close relationship between daily activities and spatial environments, investigating how domestic dining spaces can support older adults' independent living and social interaction holds significant research value.

Generative AI in Design Practice

Generative AI is capable of rapidly producing visual concepts, spatial configurations, and multiple design alternatives based on textual prompts or predefined parameters (Li et al., 2025). Such technologies have been widely applied across fields including architecture, interior design, and product design, particularly during the early stages of concept development and creative exploration.

By enabling the rapid generation of diverse design possibilities, generative AI assists designers in exploring different spatial configurations and design directions (Li et al., 2025). In most contexts, AI does not replace designers; rather, it functions as a supportive tool that facilitates creative development and iterative exploration throughout the design process (Wang et al., 2025). Within this human–AI collaborative framework, designers are still required to evaluate, refine, and reinterpret AI-generated outcomes based on user needs and contextual conditions.

However, some studies have also identified limitations in AI-assisted design. While generative AI can produce visually appealing outputs, it still faces challenges in understanding complex human needs, social relationships, and cultural contexts (Liang & Cai, 2025). Image-generation models in particular are known to reflect the distribution of their training data, which may overrepresent Western residential aesthetics and underrepresent assistive devices, grab bars, or wheelchair-accessible circulation. These limitations are particularly evident in age-friendly design scenarios, where the needs of older adults involve multiple dimensions, including emotional well-being, social interaction, and cultural background.

As the application of generative AI in design continues to expand, its collaborative role with designers in age-friendly design contexts has begun to attract increasing attention. Whether AI-generated design outcomes can adequately respond to established, human-defined age-friendly design principles and align with actual user needs remains an open question. Therefore, this study adopts emotional comfort, safety-assured independence, community connectivity, and ability-adaptive design as key prompts to generate multiple design concepts, which are subsequently evaluated by experts to examine the effectiveness of these four principles.

Methodology

Research Design

This study adopts a mixed-methods approach, combining quantitative expert evaluation and interviews to examine how the process of generative AI-assisted design translates four age-friendly design principles into concrete spatial design solutions.

All participating designers and experts provided written informed consent prior to participation. The research process consists of three main stages. First, interior designers were invited to use generative AI tools to produce spatial design proposals based on the four age-friendly design principles. Subsequently, experts in aging and design-related fields were invited to conduct quantitative evaluations of the design proposals. Finally, semi-structured in-depth interviews were conducted to collect experts' assessments and perspectives on the design outcomes, in order to further understand the potential and limitations of AI-assisted design.

By integrating quantitative evaluation and qualitative interview data, this study enables a comprehensive analysis of AI-assisted collaborative design in age-friendly environments from both outcome- and process-oriented perspectives.

Task Design

This study recruited 18 interior designers with professional backgrounds and practical experience in spatial design to develop design proposals for domestic dining environments for older adults living alone. The participants exhibited varied levels of professional experience, with most having ≤ 5 years of experience (n = 15) and the remainder having > 15 years (n = 3). Participants were recruited through professional networks and academic referrals within the fields of interior design and spatial design. The sample consisted of 6 male and 12 female designers. In addition, prior experience with generative AI tools was documented, with 94.4% of participants reporting previous use of generative AI in their design practice. The design task aimed to examine how generative AI can assist designers in translating age-friendly design principles into concrete spatial design concepts.

All designers were required to use the same generative AI tool, Google Gemini (Nano Banana image generation model, accessed February 2026), to produce visual representations of indoor dining spaces. Each designer generated 24 design images to ensure sufficient variation across design proposals.

To ensure comparability among different design cases, standardized constraints were applied to the design scenarios. All generated images were required to meet the following conditions: the space type was a residential dining area; the cultural context was an urban Asian residential environment; the target users were older adults aged 65 and above who live alone; and the space was intended for daily meals and basic social interaction. All images were to be presented in an interior perspective view.

During the generation process, designers were required to write prompts in Mandarin and maintain a consistent design style throughout their outputs. In addition, designers were encouraged to incorporate descriptive terms related to spatial atmosphere and emotional experience in their prompts to enhance contextual expression.

Designers were instructed to incorporate four age-friendly design principles into their prompts: emotional comfort, safety-assured independence, community connectivity, and ability-adaptive design. These principles served not only as key inputs in the design generation process but also as the primary criteria for subsequent expert evaluation.

Across the 24 generated images, designers were able to explore a range of design variations, including different levels of safety support, diverse dining interaction scenarios, varying degrees of openness between kitchen and dining areas, and the adaptability of the space to future assistive devices or changes in physical abilities.

Upon completion of the task, participants submitted the full set of prompts along with the generated images. These materials served as the primary data for subsequent expert evaluation and research analysis.

Expert Evaluation

Upon completion of the design task, all design proposals were evaluated by a panel of three expert reviewers. The experts were adjunct instructors with professional backgrounds in interior design and architecture, combining both academic and industry expertise. In addition to their academic roles, all experts had substantial professional experience, with one having 6–15 years of practice and the other two having over 15 years of experience. All experts were also familiar with generative AI tools, ensuring their ability to critically evaluate AI-assisted design outcomes.

Following the evaluation, the experts participated in in-depth interviews. Their involvement ensured that the assessment incorporated both design expertise and perspectives on the needs of older adults. The primary aim of the expert evaluation was to examine whether the spatial design solutions generated through AI-assisted design effectively reflect established age-friendly design principles.

The experts evaluated each design proposal based on four principles: emotional comfort, safety-assured independence, community connectivity, and ability-adaptive design. A 7-point Likert scale was employed (1 = very poor, 7 = very good) to assess the extent to which the AI-generated designs responded to these age-friendly design principles.

To support construct validity and ensure consistency in evaluation, anchor descriptions were provided for key points on the scale (scores of 1, 4, and 7). A score of 1 indicated that the design failed to address the principle, 4 indicated a moderate or partial representation, and 7 indicated a strong and well-integrated representation of the principle within the spatial design. Experts were instructed to evaluate each principle based on observable spatial features, such as layout, furniture configuration, environmental qualities, and adaptability to user needs.

To minimize potential bias, the three experts conducted their evaluations independently and were blinded to designer identity. To examine the consistency of ratings across the three experts, pairwise Pearson correlations were calculated for each design principle, and the mean absolute difference between experts was reported. The unit of analysis was the designer-level mean across the 24 images each designer produced (n = 18).

Expert Interviews

Following the completion of the expert evaluation, semi-structured interviews were conducted with the same group of experts. Each interview lasted approximately 50 minutes and was conducted either in person or via online video conferencing, depending on the availability of the participants.

The purpose of these interviews was to gain deeper insights into the criteria underlying the experts' evaluations. The interview content focused on several aspects, including the design factors considered during the rating process, the experts' understanding of older adults' spatial needs, and their perspectives on the strengths and limitations of generative AI in the design process. In addition, the interviews explored whether AI-generated design solutions can adequately respond to the cultural and social contexts of older adults.

All interviews were conducted individually and were audio-recorded with informed consent from the participants. The interview data provided qualitative insights to support the interpretation of the quantitative results and to further understand how experts interpreted the design proposals.

Data Analysis

This study analyzes two types of data: quantitative evaluation data from expert ratings and qualitative data from in-depth interviews. These two datasets were first processed and analyzed separately and are presented in the subsequent sections.

Given the modest sample size (n = 18 designers), the quantitative data were analyzed primarily using descriptive statistics (means, standard deviations, minimum, and maximum) for each of the four design principles. Inter-rater agreement among the three experts was examined using Pearson correlation coefficients. Because the study is exploratory and the sample is small, no inferential significance testing was conducted; observed differences across principles are therefore described, not tested.

The qualitative data were derived from the in-depth interviews conducted after the expert evaluation. The interview transcripts were reviewed and organized to identify key themes regarding the experts' observations of the design proposals and the AI-assisted design process. The analysis focused on how experts assessed the extent to which the designs responded to the needs of older adults, as well as the design considerations and limitations encountered when using generative AI.

The findings from the qualitative analysis are presented alongside the quantitative results in the Results section to provide a more comprehensive interpretation of the study outcomes.

Results

This study included 18 sets of AI-assisted design proposals for domestic dining environments, which were evaluated by expert reviewers. All design proposals were generated based on the four age-friendly design principles and were assessed by three experts with backgrounds in gerontology and design.

Descriptive Statistics

Table 1

Descriptive Statistics of Four Age-Friendly Design Principles

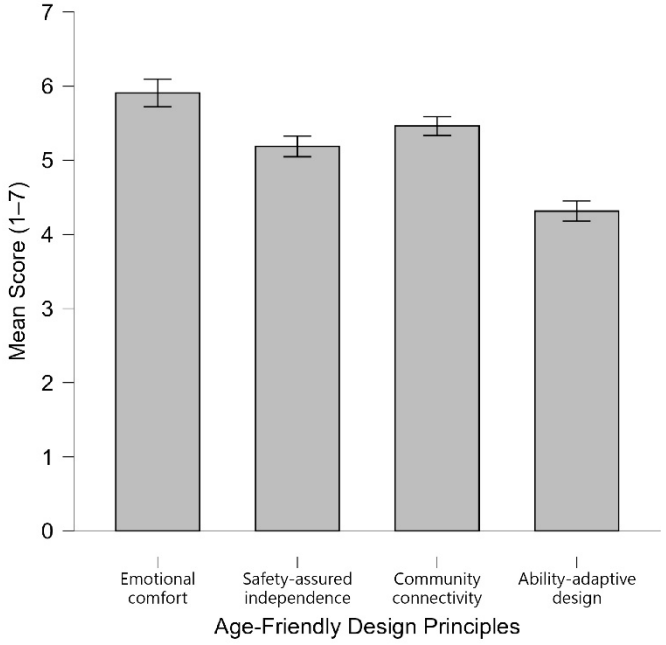
Principles	Emotional comfort	Safety-assured independence	Community connectivity	Ability-adaptive design
Mean	5.91	5.19	5.46	4.31
Std. Deviation	0.30	0.54	0.29	0.54
Minimum	5.33	4.00	5.00	3.33
Maximum	6.33	6.00	6.00	5.33

Note. Scores are based on a 7-point Likert scale (1 = very poor, 7 = very good).

Consistency across the three experts was examined using pairwise Pearson correlations and mean absolute differences. Across the four design principles, pairwise correlations ranged from r = -0.49 to r = 0.55, and the mean absolute difference between any two experts was less than 1.5 points on the 7-point scale. These findings suggest modest consistency among experts in this exploratory study, while also reflecting individual variation in how each principle was interpreted.

Figure 1

Mean Expert Ratings of the Four Age-Friendly Design Principles



Note. Error bars represent standard deviation.

Overall, the expert evaluation results indicate that the AI-assisted design proposals received generally positive ratings across the four age-friendly design principles. Three of the principles achieved mean scores above 5, suggesting that most design proposals demonstrated adequate responsiveness to age-friendly design considerations.

Among the four principles, emotional comfort received the highest mean score *(M = 5.91, SD = 0.30)*, followed by community connectivity *(M = 5.46, SD = 0.29)*, and safety-assured independence *(M = 5.19, SD = 0.54)*. Ability-adaptive design received the lowest mean score *(M = 4.31, SD = 0.54)*.

Comparison Across Design Principles

The descriptive statistical results indicate that there are notable differences in how the age-friendly design principles are reflected in the AI-generated design proposals.

The high rating for emotional comfort suggests that many AI-generated designs successfully create comfortable and visually appealing spatial atmospheres, for example, through the use of lighting, materials, and overall spatial composition to evoke emotional resonance. This finding indicates that generative AI demonstrates particular strengths in expressing visual ambiance and spatial experience.

“I think emotional comfort is related to color, lighting, and even the tone of the images. Warmer tones tend to make you feel more at ease.” (Expert 1)

Similarly, community connectivity also received relatively high ratings *(M = 5.46, SD = 0.29)*, suggesting that some design proposals effectively promote social interaction through features such as open-plan kitchen–dining layouts, shared dining tables, and interactive spatial configurations.

However, ability-adaptive design received the lowest mean rating among the four principles (M = 4.31, SD = 0.54), suggesting that AI-generated designs were less consistent in addressing the long-term needs of older adults. In particular, design strategies related to changes in physical abilities, the use of assistive devices, or future spatial adaptability were not clearly represented in some proposals.

“I think having a kitchen island takes up a lot of space. For older adults with reduced mobility, they would have to walk around it, which makes the space less usable.” (Expert 2)

“Due to ergonomic considerations, some Japanese-style designs may feel comforting, but they are not practical for older adults—the distances between tables and kitchen elements are not suitable for users with limited mobility.” (Expert 3)

The difference in mean scores between emotional comfort and ability-adaptive design further suggests that different age-friendly design principles may vary in their degree of translatability within the AI-assisted design process.

Score Distribution and Design Variability

The distribution of ratings indicates that the degree of variation differs across the four design principles.

The relatively small standard deviations for emotional comfort *(SD = 0.30)* and community connectivity *(SD = 0.29)* suggest a high level of agreement among experts in their evaluations of these two principles. This implies that most AI-generated designs demonstrate a consistent level of performance in terms of spatial atmosphere and interactive environments.

In contrast, safety-assured independence *(SD = 0.54)* and ability-adaptive design *(SD = 0.54)* show greater variability, indicating that the extent to which these principles are reflected varies more substantially across design proposals.

Notably, for ability-adaptive design, the scores range from 3.33 to 5.33, suggesting that while some design proposals incorporate a certain degree of adaptive design considerations, others exhibit limited inclusion of such strategies.

Discussion

This study employed expert evaluation and in-depth interviews to examine whether collaboration between generative AI and designers can effectively address four age-friendly design principles in domestic dining environments: emotional comfort, safety-assured independence, community connectivity, and ability-adaptive design.

The findings indicate that, in terms of emotional comfort, AI-generated designs are more capable of representing design elements related to spatial atmosphere. Such features can be readily expressed through image generation, making it easier to produce concrete design outcomes associated with emotional experience and environmental ambiance. This pattern is consistent with the findings of (Chen et al., 2025), who report that current generative image models excel at surface-level aesthetic qualities—lighting, material, color—while being weaker on functional or constraint-driven features.

Regarding safety-assured independence, experts noted that AI-generated designs can offer diverse spatial concepts, providing new perspectives for design exploration. However, their practical application in real residential settings still requires careful consideration of factors such as spatial dimensions, furniture configuration, and circulation within the living environment.

In terms of community connectivity, older adults' lifestyles and patterns of family interaction often vary significantly, and these contextual factors are not always fully captured in AI-generated designs. Therefore, the implementation of age-friendly design still requires the integration of professional design expertise and an understanding of local living contexts.

As for ability-adaptive design, the needs of older adults often involve more complex usage scenarios and long-term living requirements. These considerations are difficult to fully represent through image generation alone, indicating that professional design input and contextual analysis remain essential in the design translation process. One plausible explanation is that Nano Banana's training distribution overrepresents stylized residential interiors and underrepresents assistive devices such as grab bars, anti-slip flooring, or wheelchair-accessible circulation; this is consistent with (Liang & Cai, 2025) observation that generative models often underrepresent accessibility features. Future work could test this hypothesis by systematically comparing prompts with and without explicit assistive-device vocabulary.

"While AI can certainly generate designs, the judgment required to interpret user needs still needs to be carried out by designers at this stage." (Expert 2)

Limitations

First, the sample consists of 18 interior designers and three expert raters. While this is adequate for an exploratory descriptive study, it limits the statistical power for comparative inference. Accordingly, no inferential testing was conducted, and all cross-principle comparisons are interpreted as descriptive.

Second, the four age-friendly design principles were originally derived from a study conducted in Bangkok, Thailand (Kititarakul, 2025). Although these principles are conceptually applicable to other urban Asian settings, their operationalization may vary across cultural contexts. The present study does not explicitly examine such cross-cultural variation.

Third, the study employed a single generative AI tool (Google Gemini, Nano Banana image generation model) accessed within a specific time frame. As generative models are continuously updated, the exact outputs observed in this study may not be fully reproducible in future versions.

Fourth, prompts were written in Mandarin Chinese, and the design outputs were evaluated within the context of urban Asian residential environments. Therefore, the generalizability of the findings to other languages, cultural contexts, or housing typologies remains limited.

Fifth, expert evaluation was based solely on visual image outputs and did not include physical mock-ups, virtual reality walkthroughs, or feedback from end users (older adults). Future research should incorporate older adults as evaluators to better capture user-centered perspectives.

Conclusion

This study explored the application of collaboration between generative AI and designers in the design of age-friendly domestic dining environments, and examined how age-friendly design principles are translated within AI-assisted design processes. The findings indicate that generative AI demonstrates significant potential in design exploration and the expression of spatial atmosphere, enabling designers to efficiently generate diverse design concepts. However, when addressing issues related to older adults' long-term living needs and spatial functionality, professional judgment from designers remains essential.

The results also highlight that, within the context of aging societies in Asia, cultural and lifestyle factors play a critical role in shaping age-friendly spatial design. Overall, this study provides preliminary empirical evidence that, in the specific context of domestic dining environments, generative AI offers stronger support for emotional and social dimensions of age-friendly design than for ability-adaptive considerations. Building on this finding, future work should (a) extend the sample to include end users themselves, (b) test whether explicit assistive-device prompt vocabulary narrows the observed gap, and (c) examine cross-cultural variation across urban Asian contexts.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

In the writing process of this manuscript, ChatGPT (OpenAI, GPT-5.3; accessed March 2026) was used as an AI-assisted language tool. Its use was limited to translation, grammar correction, and improving clarity and academic expression.

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