

AI-Driven Personalized Design: Adapting Building Interior Design Based on User Preferences

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ABSTRACT

The adoption of Artificial Intelligence (AI) increases efficiency in the design industry. However, the implementation of AI is not entirely received positively by designers. This study aims to explore the application of AI technology in personalizing building interior design based on user preferences. A qualitative approach was employed using the design thinking method. Data were collected through in-depth interviews with product and graphic designers and subsequently validated by experts in the field of AI. The results of this study indicate that the integration of AI in interior design based on user preferences can assist designers in generating more personalized, efficient, and client-specific design recommendations. AI has proven capable of processing both explicit and implicit preference data to predict optimal layouts, color selections, materials, and lighting. However, this study also found several significant challenges, such as inconsistent data quality, limitations of algorithms in understanding subjective and emotional aspects, and concerns regarding user data privacy. Nonetheless, the use of AI in interior design still offers great opportunities to create spaces that are more functional, innovative, and adaptive to the evolving lifestyles of their occupants.

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1. INTRODUCTION

The needs of modern society, which prioritize speed, ease of understanding, effectiveness, and efficiency, have driven the increased use of visual media as an aid. Visuals have proven to be easier to comprehend, quick to adapt, and more effective and efficient, making them increasingly popular among today's society (Mahadipta & Aditya, 2024). This condition has spurred the emergence of visual technologies designed to help plan or create visual products that appear more realistic. Additionally, the current development of the internet has facilitated the rise of creative ideas in advancing these technologies (Santoso & Priahndono, 2025). The progress of visual technology is not only limited to digital platforms but has also evolved by leveraging Artificial Intelligence (AI), an innovation capable of making visual products appear even more lifelike (Tahsin & Afkar, 2023).

Artificial Intelligence (AI) itself is a branch of computer science that focuses on developing systems or machines capable of performing tasks that typically require human intelligence, such as recognizing patterns, learning from experience, making decisions, and solving complex problems (Widianti et al., 2024). According to Russell (2022), AI can be defined as systems designed to think rationally and act in a human-like manner. In the context of visual technology, AI plays a crucial role in processing visual data, understanding user preferences, and generating adaptive and personalized visual representations. With the ability to learn autonomously through machine learning algorithms, AI enables the creation of visualizations that are not only more realistic but can also dynamically adjust to the needs and desires of users. This technology is then used to support professions in the visual field, one of which is interior design (Gunao & Lie, 2022).

Interior design is a discipline and art that focuses on planning, arranging, and managing spaces within a building to create environments that are functional, aesthetic, and comfortable for their users (Nurcahyo, 2022). According to Konigk (2011), interior design does not only consider visual aspects such as color, shape, and material, but also takes into account psychological factors, ergonomics, and the specific needs of the space's

occupants. Interior design involves a structured creative process, starting from needs analysis, concept development, layout planning, selection of decorative elements, to supervision of implementation. Thus, interior design is not merely about beautifying spaces but also aims to improve quality of life by creating environments that align with the function, identity, and preferences of their users (Al-Zamil, 2017).

In the context of today's rapidly growing creative industry, Artificial Intelligence (AI) emerges as an important component driving innovation, particularly in the field of interior design (Maarif & Rifanindio, 2025). The interior design process involves a series of complex stages, from user data collection, analysis of space needs and functions, formulation of design concepts, selection of appropriate materials, adjustments to budgets, to considering individual aesthetic preferences (Sholahuddin, 2017). In this regard, the application of AI technology becomes highly crucial due to its ability to process and analyze data quickly, accurately, and in a structured manner, thereby providing more targeted design recommendations. Not only limited to the planning stage, AI also contributes to improving work efficiency, offering personalized design solutions, and optimizing space utilization to be more functional and suited to the characteristics of the occupants (Wasista et al., 2024).

With machine learning algorithms, AI can learn patterns in user choices regarding colors, layouts, types of materials, and desired lighting (Trisna et al., 2025). This data can then be used to recommend or even automatically generate interior designs that match the unique characteristics of individuals or specific groups, resulting in spaces that are truly personal and contextual (Atmadi, 2020). Beyond personalization, the integration of AI in interior design also contributes to time and cost efficiency. Traditional design processes often require lengthy manual iterations, from concept discussions, design revisions, to visual testing. With AI support, this process can be streamlined through rapid design simulations, real-time visualizations, and automatic adjustments to certain parameters such as budget and space dimensions (Sugianto et al., 2024). As a result, building owners and designers can make more precise design decisions in a shorter period.

The concept of AI-driven personalized design in the context of interior design refers to an approach to space planning that utilizes artificial intelligence to automatically or semi-automatically adjust design elements based on the preferences, needs, and unique characteristics of users (Ibrahim et al., 2023). By relying on machine learning algorithms and data analytics, this system can identify patterns of individual preferences—such as color choices, furniture styles, layouts, lighting, and material use—based on data collected through surveys, behavioral sensors, or digital interactions. AI then processes this information to produce design recommendations or alternatives that are not only aesthetic and functional but also more personal and relevant to the user's emotional experiences and habits (Anshory, 2025).

Several previous studies have demonstrated the role of AI in supporting interior design processes, although generally still focusing on technical aspects. Sun (2021) examined the use of machine learning to optimize furniture layouts for more efficient space circulation, while Yu et al. (2020) developed an AI-based automatic lighting system that adjusts light intensity throughout the day to enhance visual comfort. Chen & Zang (2014) also utilized data mining to identify trends in colors and textures which were then applied to generative design models. However, these studies essentially still emphasize space design optimization within a general framework, without exploring the specific personalization of designs based on individual user preferences.

This is what constitutes the research gap as well as the novelty of this study. This research specifically examines how AI can be used to produce building interior designs that are adaptive and truly tailored to users' personal preferences. Thus, this study not only broadens the application of AI beyond mere efficiency and general aesthetics but also offers a more human-centered design approach that can enhance the relevance and spatial experience for each individual.

2. METHOD

This study employs a qualitative approach using the design thinking method, chosen because it facilitates an in-depth exploration of user needs, preferences, and experiences, while also providing space for an iterative process in formulating AI-based interior design solutions. The data collection stage began with in-depth interviews conducted with product designers and graphic designers to gain insights into their understanding of current interior design practices, including the challenges of meeting highly diverse user desires. The data obtained from these interviews was then analyzed to identify insights and patterns related to the need for personalized design. Subsequently, the initial findings were validated through a Focus Group Discussion (FGD) with experts in the fields of artificial intelligence and interior design, aimed at obtaining critical input regarding the concept of integrating AI for the personalization of building interior designs.

3. RESULT AND DISCUSSION

AI-Driven Personalization in Interior Design Based on User Preferences

In today's rapidly evolving digital landscape, personalization has transformed from merely an added value into an absolute necessity. Consumers today do not only appreciate products or services that are aesthetically pleasing and functional, but they also seek experiences that are specifically designed for them, aligned with their unique preferences, needs, and lifestyles. In the context of interior design, this opens up a new space where design is no longer generic, but instead responsive to behavioral data and individual desires.

One interior designer in this study expressed:

"Clients now come with high expectations. They want their homes or offices not only to look beautiful, but also to truly represent who they are." (Informant D)

Technological advancements, particularly in artificial intelligence (AI), offer significant breakthroughs in meeting these demands for personalization. AI enables the massive and rapid collection, analysis, and processing of user preference data, which can then be translated into relevant and personalized interior design recommendations. A graphic designer who participated in this study noted:

"In the past, we only relied on general briefs from clients. Now, with AI-based systems, we can get more detailed insights into their tastes just from their digital interaction patterns or even behavioral data." (Informant AG)

It's not only on the creative process side; AI also broadens the horizon of how spaces can adapt. In a focus group discussion (FGD) with AI experts, ideas emerged about how machine learning algorithms could study the activity patterns of building occupants and automatically propose changes to layouts or décor. An AI expert explained:

"Imagine if an AI system could recommend different workspace arrangements on certain days based on the user's mood or stress levels. That's the future of personalized interior design." (Expert I)

However, the adaptation of AI in interior design does not come without challenges. Designers highlighted the potential loss of human aesthetic touch if too much reliance is placed on algorithmic recommendations. One designer remarked:

"AI is amazing, but we mustn't let our designs become rigid or overly mathematical. We still need human feeling and intuition." (Informant D)

This underscores the importance of close collaboration between human creativity and artificial intelligence so that the final outcome continues to prioritize both aesthetic value and personalization.

One of the main advantages of using AI in interior design lies in its ability to provide design recommendations that are both personal and adaptive. Through such systems, designers simply input a number of initial parameters, such as aesthetic preferences, functional space requirements, as well as creative ideas from both designer and client. The AI algorithms then process this data and intelligently generate various relevant design alternatives, from furniture selection, color combinations, materials, to other decorative elements that match the user's character.

With this technology, the design research stage, which usually requires a long period, can be significantly shortened. AI helps automate the exploration of styles and design options, allowing designers to shift their focus to more strategic and profound aspects, such as developing spatial concepts that reflect the client's identity or building storytelling into the design. In this context, AI serves not merely as a technical tool, but also as a creative partner that facilitates conceptual thinking, providing room for designers to further explore innovation and artistic value in their work.

In the world of modern interior design, artificial intelligence (AI) has a variety of functions that not only make designers' jobs easier but also enrich client experiences. One important contribution of AI is its ability to produce personalized design recommendations. By utilizing this technology, designers need only input preferences, initial ideas, and inspirations from themselves or the client, after which the AI processes the information and presents various relevant recommendations—from furniture choices, color palettes, to other décor elements. Such features significantly reduce the time usually spent on lengthy research, so designers can concentrate more on conceptual and strategic aspects, while exploratory work can be automated by AI.

Furthermore, AI can also help designers analyze historical client preference data. This data is processed to identify detailed patterns that users might desire, enabling designers to predict trends or tastes that may emerge for the client in the future. In this way, the resulting design can be more targeted and meet customer expectations. This benefit is mutual; for designers, it becomes easier to interpret what the client wants, even if the client cannot clearly articulate their preferences, while for clients, this technology can open up new insights into design preferences that suit their personality and lifestyle.

Not only that, AI is also extremely helpful in assisting designers to optimize space layouts so they are more efficient and functional. With its capability to analyze dimensions and space characteristics, AI can help determine the precise placement of interior elements according to user preferences. AI can even design energy-efficient interior systems, for example by suggesting the optimization of cooling, heating, or lighting usage. In addition to providing conventional solutions that meet standards, the adaptive intelligence of AI allows for innovative recommendations that might never have been thought of before by either designer or client. Thus, AI not only enriches design options but also drives the emergence of creative approaches that can deliver truly new spatial experiences.

Personalized AI has immense potential to enhance interior design based on user preferences by automating, optimizing, and personalizing interior concepts. Let us break down how AI-based personalization works in interior design according to insights from interviews with designers and IT experts regarding user preferences:

1. User data collection

Data collection is a crucial initial stage in implementing AI-based personalization for interior design, as the quality of data will largely determine the accuracy of the resulting recommendations. At the explicit data level, information is gathered directly from users through various instruments such as surveys, questionnaires, or in-depth interviews. Through these methods, declarative data can be obtained regarding preferred design styles, favorite color schemes, furniture choices, and specific functional needs of spaces, such as work areas, relaxation zones, or children's playrooms. This explicit data forms the foundation for the AI system to map out users' aesthetic and functional needs and helps shape the core characteristics of interior designs that align with the client's identity.

In addition to explicit data, the personalization process in interior design also heavily relies on implicit data acquired by automatically observing user behavior through smart technology. IoT sensors installed on home devices such as smart lights, thermostats, or lighting and climate controllers enable the AI system to monitor daily activity patterns of occupants, including room usage intensity, specific times when spaces are used, as well as temperature or lighting preferences. This implicit data is dynamic and contextual, providing a realistic picture of how residents truly interact with their spaces. By integrating explicit and implicit data, the AI system can build a comprehensive user profile, allowing interior designs to be tailored not only to aesthetic tastes but also to users' actual behaviors and practical daily needs.

2. Data analysis with AI

The data analysis stage assisted by AI plays a pivotal role in ensuring that the resulting interior designs are truly personal and relevant to the user. At this stage, machine learning algorithms process and analyze the collected data, both explicit and implicit. Through techniques such as clustering, classification, or association rule mining, AI can identify user preference patterns that might not be immediately apparent to designers manually. For example, AI might discover that users with certain activity patterns tend to prefer open layouts dominated by neutral colors, or that users who spend more time at home in the evenings require warmer ambient lighting. This process allows the system to develop a deep, holistic understanding of user preferences and tendencies.

Beyond pattern discovery, AI also classifies various interior design characteristics based on user behavior and preferences. Thus, AI can recommend design elements that match specific lifestyles, such as ergonomic furniture choices for users who frequently work from home or multifunctional designs for families with young children needing flexible spaces. This analysis not only enhances the precision of design personalization but also helps ensure that every aspect of the interior aligns with the practical and psychological needs of the user. Ultimately, integrating machine learning algorithms allows interior design to evolve from mere aesthetics into adaptive, contextual, and truly human-centered solutions.

3. Predictive modeling & design recommendations

The predictive modeling and design recommendation stage is at the heart of applying AI-based personalization in interior design. Based on the analysis of user preference data and behavioral patterns, AI algorithms generate comprehensive predictions regarding the most suitable design elements. These systems utilize predictive models to determine optimal room layouts, select materials and textures that resonate with the user's character, and define color palettes and lighting schemes that can enhance comfort and the psychological atmosphere of the space. This process combines the user's historical data with an extensive knowledge base of design, producing recommendations that are not only aesthetic but also functional, ergonomic, and aligned with the resident's lifestyle.

Furthermore, AI-generated design recommendations are typically presented in interactive visualizations using 3D simulation or augmented reality (AR) technologies. This approach allows users to view virtual representations of the personalized interior design before actual implementation. This feature enables clients to realistically explore various design alternatives, observe how materials, colors, and layouts perform within their

real-life context, and provide feedback or make early adjustments. Thus, predictive modeling supported by AI not only accelerates the design process but also minimizes the risk of mismatches between user expectations and final outcomes, while reinforcing the principles of truly user-centered design.

4. Dynamic & continuous adjustments

Dynamic and continuous adjustments represent an advanced phase in applying AI-based personalization to interior design, emphasizing the adaptive capacity of spaces to changes in user behavior over time. At this stage, the AI system does not stop at the initial design implementation but continues to monitor occupants' activities in real-time through IoT devices and smart sensors distributed throughout the space. This continuously updated data enables AI to detect shifts in space usage patterns — for example, an increase in home office usage due to a transition to more frequent remote work, or the addition of family members affecting shared space functions.

Based on such monitoring, the AI system can automatically adjust spatial elements to continue accommodating the evolving needs of users. For instance, smart lights can automatically adapt their intensity and spectrum to follow the occupants' circadian rhythms, climate controllers can regulate optimal temperatures depending on whether users are present, and even modular furniture layouts can be reconfigured to provide additional flexibility. As a result, interior design becomes dynamic rather than static, ensuring living spaces remain relevant, comfortable, and aligned with the latest routines of their users. This approach creates a truly responsive living ecosystem, making interior design more alive and deeply integrated with everyday life.

5. User feedback

The user feedback stage becomes a vital component in the AI-based personalization cycle for interior design, ensuring that the generated designs truly meet user expectations and comfort levels. After the initial design implementation, the system collects direct feedback from residents through various channels, such as smart home applications connected to interior devices. Users can provide subjective evaluations of specific design elements — from layout comfort, color suitability, to lighting efficiency — or submit more specific complaints and suggestions. Thus, the personalization process does not stop at prediction and execution but continues as a two-way interaction involving the real user experience within the space.

This feedback is then processed by AI algorithms to continuously refine their understanding of user preferences, thereby improving the accuracy and quality of design recommendations in the future. AI uses this feedback data to adjust weights in its predictive models, fine-tune previously identified preference patterns, and prepare alternative design solutions in case of significant changes in needs or lifestyle. With this continuous approach, interior design personalization becomes not only adaptive but also progressive, creating a learning cycle that makes living spaces increasingly aligned with the dynamic lives of their users.

The presence of AI must be recognized as having brought about a significant revolution in the interior design industry. With diverse advantages — from deep data analysis capabilities, predicting user preferences, to generating adaptive design recommendations — AI helps designers create spaces that are not only aesthetic but also functional and sustainable. This technology allows interior design to be tailored more precisely to the lifestyle, activity patterns, and unique needs of each occupant. Moreover, AI opens up innovation opportunities that surpass the limits of conventional imagination, merging human creativity with machine intelligence to deliver smart and relevant design solutions. Thus, AI is not merely a technical tool but also a strategic partner in realizing interior environments that are more meaningful, comfortable, and aligned with the times.

Challenges of Integrating Artificial Intelligence (AI) in Interior Design

1. Data quality and reliability

In the context of personalized interior design supported by artificial intelligence (AI), the quality and reliability of data become the main foundation that determines the effectiveness of the system. AI operates under the principle of “garbage in, garbage out,” meaning the quality of output produced is entirely dependent on the quality of input data used to train and run the model. In interior design based on customer preferences, the data collected usually includes explicit information such as style, color, and material preferences, as well as implicit data such as daily activity patterns, room usage history, and interactions with smart home devices. However, in practice, the data obtained is often inconsistent, fragmented, or comes in different standard formats, posing significant challenges at the data integration and analysis stages.

Moreover, data bias is also an important issue. The preference data collected often reflects the tastes of a particular segment of the population, while ignoring broader cultural, aesthetic, and individual needs. This can occur due to limited data sources (for example, only from a single e-commerce platform or specific smart home application), or due to survey methods that lack inclusivity. Such data imbalances have the potential to produce design recommendations that are homogeneous, insensitive to diversity, and less relevant for certain user

segments. Thus, data bias not only disrupts the technical performance of AI but also carries deeper social and ethical implications related to inclusivity in design.

Data incompleteness is another obstacle. In many cases, clients themselves are not fully aware of their design preferences, so the explicit data collected is often shallow or ambiguous. Meanwhile, relying on implicit data such as movement patterns or IoT sensor usage also faces challenges in privacy, sensor technology limitations, and behavioral context interpretations that remain prone to error. As a result, the AI models built may become less precise in mapping the real needs of users, leading to designs that do not fully meet the expectations of space occupants.

2. Reduction of preference complexity

One of the most significant conceptual challenges in applying AI to personalized interior design is the issue of reducing the complexity of preferences. Essentially, aesthetic preferences, cultural values, and emotional aspects that influence the perception of space are highly complex, subjective human constructs that are often inconsistent. These preferences are shaped not only by rational factors such as room function or favorite colors but also by personal memories, cultural symbols, and ever-changing social trends. When AI systems attempt to model these aspects, there is inevitably a process of quantification or parameterization: emotions, symbolism, and visual tastes are broken down into numerical or categorical variables to be processed by algorithms.

This reduction process carries substantial risks. Because not all aspects of preference can be adequately represented by structured data, AI models tend to oversimplify the richly layered needs of users. For instance, color preference is not merely about choosing between “dark blue” or “light blue,” but may be tied to childhood memories, social status symbols, or specific cultural identities. Likewise, spatial layouts are not solely about movement efficiency but may involve spiritual needs or family rituals. In many cases, AI built on generic parameters can fail to capture these subtle nuances, resulting in designs that are “sterile” or too generic, lacking the personal uniqueness of the user experience.

Furthermore, this reduction in complexity can lead to lost opportunities for truly contextual design innovation. Rather than encouraging design exploration based on a client’s personal narrative, AI systems tend to optimize toward dominant patterns in existing datasets (such as modern minimalist trends), thus increasing the risk of design homogenization. To address this, a hybrid approach is needed that combines AI’s capability to process large data sets with human-centered design sensibilities. This approach allows designers to remain curators of meaning, while AI serves as an analytical and visual exploration tool. Thus, the challenge of reducing preference complexity reminds us that AI is not a replacement for human intuition and empathy, but rather requires a collaborative framework so that interior design stays rooted in authentic human experiences.

3. Limitations of AI algorithms in understanding subjectivity

A fundamental challenge in integrating AI into interior design is the limitation of algorithms in capturing subjective aspects. Machine learning algorithms are generally trained to recognize patterns based on mathematical correlations in the available data. However, in interior design, many elements are intrinsic, emotional, and cannot be objectively defined. For example, the concept of comfort or emotional warmth when someone enters a space is closely linked to life experiences, childhood memories, or certain cultural associations that cannot be fully represented by numerical datasets or images.

AI might be able to identify that warm colors are often associated with comfort based on population trends, but it fails to understand the personal context that makes a client feel “comfortable”—which may in fact run counter to general preferences. Similarly, the symbolic meaning of a design element such as traditional ornaments or family heirlooms often carries emotional weight that cannot be interpreted merely by visual parameters. This causes AI to be prone to producing design recommendations that may be aesthetically optimized according to data but are not “connected” to the feelings or identity of the space owner.

4. Ethical and data privacy issues

The implementation of AI in personalized interior design almost always requires large amounts of personal data, ranging from lifestyle preferences to daily activity patterns. For example, smart home usage data, history of room temperatures and lighting, even movement habits inside the house will be processed by the system to map out the ideal spatial needs. The problem is, the richer the data collected, the higher the risk of privacy breaches. Such data leaks not only affect comfort but also open security vulnerabilities to irresponsible parties.

There is also an ethical dimension related to transparency and informed consent. Many users may not fully understand how far their data is used or stored. If the data collection and processing are not communicated transparently, the use of AI in interior design could be deemed to violate the principle of user autonomy. Therefore, the success of integrating AI in interior design is not only about technology but also requires a clear data protection policy framework and user education so they can make informed decisions about the use of their personal data.

5. Resistance to change

Another challenge is resistance to adopting new technology, both from designers and clients. Many interior designers are accustomed to traditional approaches—relying on visual intuition, direct discussions with clients, and manual mood boards—thus viewing AI solutions with skepticism. These concerns may arise from the perception that AI will “take over human creativity” or diminish the professional role of designers in the creative process.

From the client’s perspective, some may also feel more comfortable communicating emotionally with a human designer rather than relying on recommendations from an algorithm that feels cold and impersonal. In many cases, the experience of direct interaction, sharing personal stories, and watching the designer translate ideas into sketches becomes an irreplaceable emotional value that automated systems cannot provide. Therefore, the application of AI in interior design needs to pay attention to change management aspects—educating and demonstrating how AI can enhance, not replace, the creative role of humans so that the acceptance of this technology can proceed more smoothly.

4. CONCLUSION

The presence of artificial intelligence (AI) has brought about a major transformation in the interior design industry. AI offers innovative solutions in personalizing designs based on user preferences, shortening research time, and helping to formulate the right design recommendations ranging from furniture selection, color schemes, to lighting. With its ability to analyze explicit and implicit preference data, AI can map the functional and aesthetic needs of a space that suits the user's lifestyle. This not only makes it easier for designers to formulate interior designs, but also provides a new, more proactive experience for clients in exploring design possibilities according to their wishes. However, the integration of AI in interior design also faces a number of challenges that cannot be ignored. Challenges ranging from the quality and reliability of data that is often biased or incomplete, the difficulty of algorithms in converting the complexity of aesthetic preferences and emotions into numerical parameters, to the limitations of AI in understanding subjective aspects such as comfort and the symbolic meaning of design. In addition, ethical and privacy issues are very crucial because the use of AI generally requires personal data of home occupants, which if not managed wisely has the potential to violate privacy rights. Not to mention the resistance to change from some designers and clients who still believe more in conventional approaches and creative processes based on direct human interaction. Thus, the application of AI in interior design requires a holistic approach. AI should not be viewed as a substitute for human creativity, but rather as a partner that enriches the design process with data and predictive simulations. For this, transparent data governance, strong privacy regulations, and ongoing education for designers and clients are needed so that they can optimally utilize the potential of AI. Ultimately, the synergy between human artistic sensitivity and sophisticated AI analytics is expected to produce interior designs that are not only efficient and adaptive, but also remain meaningful, personal, and touch the emotional side of the occupants.

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