Optimising AI's Role in Advancing Interior Design Industry

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ABSTRACT

The digital era encourages using artificial intelligence (AI) in various industries, including interior design and architecture. Growth in AI usage is projected to increase by 34% in 2023-2032. AI can improve efficiency, productivity, and decision-making in the design process. With AI, designers can optimise visualisation, space layout, material, and colour selection and predict customer preferences. AI saves time and costs and results in innovative solutions per client requirements. As it evolves, AI improvises technologies to assist designers such as DALL-E, Blender, AI Dungeon, Spline, and CogniCAS. However, the adoption of AI in interior design and business management in Indonesia still needs improvement. This study analysed related articles from 2019 to 2023 using Publish or Perish and VOSviewer visualisation to investigate the optimal utilisation of AI in supporting the interior design process. This research aims to provide practical insights and recommendations for interior designers, students, and practitioners adopting AI solutions to improve performance and competitiveness and develop a standard framework for AI technology platforms.

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1. INTRODUCTION

In the increasingly developing digital era, using Artificial Intelligence (AI) technology has become an exciting topic in various fields, including multiple industries, especially architecture, interior design, and business management. The development and use of AI technology will continue to increase throughout 2023 – 2032 [1]. AI works in service tasks and progresses from lower intelligence to higher intelligence to reduce the importance of analytical skills and increase the importance of skills [2]. The many influences of technology on people's daily lives today have a significant impact on every activity. Various activities such as household automation, security, entertainment, health, work, and personal recommendations can be helped by AI technology.

Designers or architects spend much time and energy designing, innovating, and creating interior modelling to meet clients' needs. As clients and users demand speed in design results and designs that follow the design, designers cannot fulfil these demands just by using traditional methods. With the help of AI technology, methods of modelling, both conventional and manual, are efficient alternatives and can increase design accuracy and quality [3]. AI has great potential to increase efficiency, productivity, and more accurate design decision-making. Using AI can help designers create visualisations, optimise room layouts, choose appropriate materials and colours, and predict customer preferences. Optimising AI can save time and costs in the design process and produce more innovative solutions that align with client needs [4]. Modern technology and artificial intelligence are essential in planning interior spaces that meet institutional and social needs [5]. As time passes, AI develops improvised technology to help designers in their work, such as DALL-E by OpenAI, Blender, AI Dungeon, Spline, and CogniCAS by ParaMatters. As a designer/ architect, it is essential to follow developments in AI to help with energy efficiency, time, quality improvement, design exploration, innovation, and increasing competitiveness in the industry.

To identify decision-making patterns and minimise human intervention, AI can analyse big data using scientific methods, especially machine learning. AI, machine learning, and deep learning are becoming increasingly important in this regard [6]. In early 2022, new large-scale AI models were released every month, marking the start of the AI deployment phase. AI software or systems are used by 24% of companies for ICT security, 23% for business operations, 23% for administrative processes, and the least, 9% for human resources or coding [7]. Indicators that differentiate creativity from other aesthetic standards include the distinctiveness of the design and how far the design deviates from the viewer's mental image. In addition, general and context-specific definitions of creativity are aided by comparative analysis of design pairs. The ability to create novel and emotionally impactful designs, combine inventive form and function, integrate form, function, emotion, materials, textures, and colours, and demonstrate a willingness to experiment with different approaches and take calculated risks are characteristics of creativity. Creativity is an exceptional quality that designers possess, and audiences can appreciate their work, although it is difficult to measure objectively [8].

Interior design AI generally combines technology with design expertise to create functional, aesthetic, and personal spaces. This technology works like an automatic design that is useful for websites, applications, and other products. The way the application/ website works generally includes several stages: looking for references that match the user's ideas and imagination, then carrying out design generation such as layout, furniture selection, and 3D visualisation. How websites work is done by the user entering an image or photo of the space as a source for AI to create a design from the picture and produce the desired image or design [9]. The final stage is to personalise and improve the design to enhance the relevance and satisfaction of users and upgrade the design to a precise and quality one. With this capability, AI interior applications/ websites can help users create interior designs according to their style and preferences efficiently and quickly. Therefore, AI can perform tasks such as pattern recognition and deep learning, solving complex problems efficiently and saving time.[10] [11].

AI in interior design still needs to be improved in Indonesia. Many industry players, especially interior designers, need to fully understand the potential and benefits of AI technology and face challenges in implementing it. Therefore, this research aims to investigate further how AI can be utilised optimally in supporting the interior design process and is expected to provide insight and practical recommendations for interior design practitioners in adopting AI solutions to improve performance and competitiveness as well as developing a work standard framework for AI technology platform in increasing the effectiveness of accessibility and making a positive contribution to the progress of the interior design industry in the future.

2. RESEARCH METHODS

The method used in this research is collecting results from a questionnaire that discusses experience using Design Sense, AI Room Planner, and Spacely AI. The questionnaire is addressed to those who study architecture and interior design. To strengthen this research, an analysis was carried out using Publish or Perish software, which helped find relevant articles in 2019-2023 with the keywords artificial intelligence and interior design. VOS viewer helps understand and predict trends. Future developments in research will be discussed [12]. By using a VOS viewer, we can manage and analyse data in a visualisation manner, considering the relationships between topics and existing potential. Research related to artificial intelligence can be seen in the fact that most of this research is carried out on artificial intelligence technology and artificial neural networks. Research on interior designers still needs to be researched (figure 1). It is proven that the network

connection between interior and artificial intelligence is still far away and does not exist, so there is still an opportunity to discuss this topic.

After getting the results from Figure 1, the data is stored in several systems, such as Bibtex and RIS. Bibtex Format processes data in tables and graphs, while RIS format processes data in networks and maps using the VOS Viewer tool. The VOS Viewer application allows us to explore the basics of scientific literature and the "potential of Mathematics." The results of data processing include three types of visualisations, namely "Network Visualization," "Overlay Visualization," and "Density Visualization." "Network Visualization" is used to see relationships with specific search terms and keywords. "Overview" determines the age of the relevant research subjects. Dense visualisation is used to analyse research topics that are dense or still need to be better understood [13].

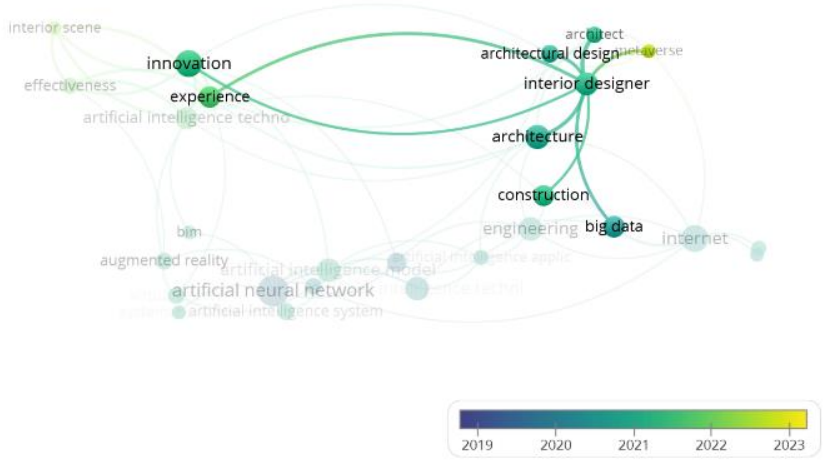

Figure 1 Map of artificial intelligence topic development areas.

In this research, the parameters to be researched are exploring various types of artificial intelligence (AI)-based interior design websites, including Design Sense, AI Space Planning, and Space AI. Then, this research maps the three categories of AI website types in interior design by considering appearance, user convenience, availability and accuracy in selecting features, and the level of integration with interior design tools. The advantages and disadvantages of AI-based interior design websites can be analysed. This research will determine the essential designs to consider in interior design, such as functionality, user preferences in interior design, stages in interior design (design style, design concept, design recommendations, technical considerations, reviewing results, and having manual editing that can be done in teams, and design visualisation) and user satisfaction. To produce AI performance in completing interior design tasks such as accuracy, efficiency, and creativity.

The development of artificial intelligence technology opens up new opportunities to advance the interior design industry. However, it is essential to provide research boundaries in optimising the role of artificial intelligence in the interior field to ensure practical application. The limitation or scope of research is helpful in the researcher's direct focus and ensuring that the research is related to the objectives set. For the research objectives to be achieved, it is necessary to determine several limitations, including (1) This research uses three different artificial intelligence interior websites, (2) This research collects data owned by respondents with roles as practitioners, students, and designers. This research will provide a deeper understanding of the critical parameters and variables in optimising AI integration in interior design. The results of this research are expected to be useful for interior designers, AI developers, and other interested people who want to effectively utilise AI to improve the quality of interior design and advance the industry.

3. RESULTS AND DISCUSSION

3.1 Developments in Artificial Intelligence in Interior Design

Artificial Intelligence (AI) is a field of computer science that focuses on developing computer systems capable of performing tasks that usually require human intelligence, such as reasoning, learning, perception,

problem-solving, and decision-making. The utilisation of AI can take over many tasks to improve the effectiveness of human activities in the future[1] [16].

Susan Smith Barnard identified 12 aspects of design excellence [15]: aesthetic appeal, suitability, artistic value, complexity, creativity, functionality, likeability, novelty, originality, technical excellence, thematic excellence, expression, and expertise. Of the 12 advantages, only artistry was omitted because this research did not discuss the artistry skills displayed in the presentation. This book explains how we must understand each design to avoid misunderstandings. According to the description, the 4-course instructors zeroed in and rated the projects based on 11 benefits by rating each project in both groups from 1 (lowest) to 9 (highest). The average value assigned by the four infrastructures is calculated for each achievement and project. This average value is accepted as the project value for that achievement [17].

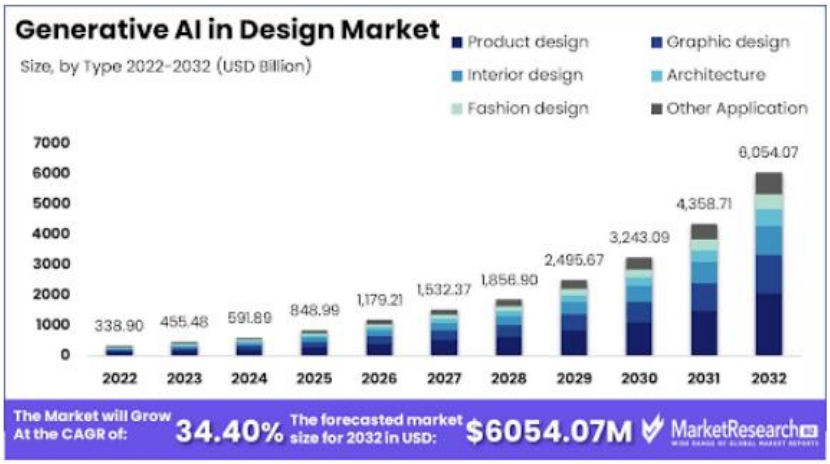

Figure 2. AI Development at CAGR 2023-2032.
Source: https://www.quytech.com/blog/generative-ai-in-interior-design/ [1]

Over time, the use of AI has increased rapidly, estimated to increase by 34% in 2023-2032. A visualisation of AI development can be seen in Figure 2. Various fields will actively utilise this technology, such as product design, interior design, fashion, graphic design, and architecture. Artificial intelligence benefits us by making it possible to choose everyday products more efficiently. It can be personalised for everything from choosing news topics to the primary thing of a comfortable home.

Defining a culture is a challenging task, even more so when describing the culture of a design studio that is individualistic and dynamic. Each architecture school and program develop its distinct culture through its students. In Malaysia, as in many other countries, the discipline of architecture takes great pride in its diverse programs and teaching pedagogy. Design education occurs in physical and mental spaces called design studios, which is considered a cultural phenomenon. [18]. In his writing, Johnson believes that the studio is a pedagogical tool used to teach the design process as applied to culture and the individual creative process. A studio combines place, people, and structured processes led by a mentor [19].

Interior design plays a vital role in architectural design, influencing the types of activities and furniture that adapt to user needs and the space's function by focusing on practical, artistic, and humanistic [20] [21]. In creating interior designs, designers must explore and innovate in their work. The benefits of AI in interior design include design literacy, material visualisation, time optimisation on projects, and information and resource management [22]. Therefore, AI-based interior design improves work efficiency and user experience, maximising space utilisation and reducing costs while meeting diverse needs [23]. AI in interior design can improve energy efficiency, reduce problems such as energy consumption, and provide real-time online layouts with 98% accuracy [24]. 3D virtual reality software effectively improves the effect and practicality of designing space interiors by combining three-dimensional vision and material, shape, and colour information [3], optimising the overall interior design scheme, enhancing intelligent applications, and promoting cooling and improving interior design work experience. For a student studying interiors, it certainly significantly improves problem-solving skills in drawing interior plans [26].

On the other hand, technology is also essential and must be integrated into the curriculum. Effective communication is a necessary skill for interior designers and allows them to effectively convey their ideas, collaborate with clients and colleagues, and ultimately bring their design vision to life. Recognising the

importance of communication skills, the Council for Interior Design Accreditation (CIDA) has developed communication as an essential professional standard for interior design students [7].

However, the preservation of traditional methods to AI in service tasks progresses from lower to higher intelligence, reducing the importance of analytical skills and increasing the importance of auditory skills [27]. This designer's ability is still needed in the design process because it is the centre of the brain and initial ideas. AI will only help create and process prompts from the designer, so the brain device still becomes critical. AI technology in interior design can improve the overall sustainability of buildings, save global resources, and create healthy, functional, and comfortable environments. AI-based interior design can improve the indoor environmental quality index and build a perfect evaluation system for better program design [28].

3.2 Literature Review

Explaining a concept using AI assistance requires similar stages. The concept development usually begins with research and exploring different design styles, materials, colours, and textures. An interior designer also needs to consider the function of the space, the client's needs, and existing architectural features. In a studio space, everyone can sketch and see different visuals. By using descriptive communication, designers can convey the mood and aesthetics of a space to clients [19]. Just like the saying a picture is worth a thousand words, it is believed that using visual aids can help get a better understanding of ideas [29].

Because of creativity, written communication is one of the main ways to spread information between people and express concepts in design. AI can help select interior materials and furniture that save time and reduce errors that occur from human error. A designer should focus on the creative aspect. However, it is essential to remember that AI cannot replace a designer's critical thinking and problem-solving abilities. Instead, it should be used to improve the design process and bring new ideas to the table [30][31][31].

Table 1. Comparison of three website AI interiors

Website Name	Strengths	Limitations
Design Sense [14]	• Wide choice of design styles and room types • Apart from the kind of room, it can help create the exterior • Uploading Photo room that you want to design • Render photo and video interiors	• Limitations creativity and lack of personal touch • Limitations in displaying details of furniture materials and textures • It has limited free features, so users must subscribe to a premium package to access all features • Premium subscription to this platform is $299/ year
AI SPACE PLANNING [15]	• Generate Room Design (can choose room and design style) • Uploading a photo of a room realistically showing that there is already existing furniture. • This platform is accessible for free without a pick-up cost.	• Limitations creativity and lack of personal touch. • The accuracy of the furnishings needs to be supported. • It can be used without having to subscribe, and it is free.
Space AI [34]	• Interactive room interior design (if you subscribe, you can choose the furniture, decoration, and colour you want) • has an extensive library of furniture and decorations • Can provide recommendations according to user style and preferences.	• Spacely AI only focuses on interior design and does not provide other features. • The rendering results are only sometimes perfect; they are just ordinary. • Subscriptions to this platform are $9.99/month (pro) and $39.99/month (premium)

With AI technology, interior design has become easier and more accessible. Various applications for AI-based interior design have been launched, offering innovative solutions to help users design the room of their dreams. Among them are Design Sense, AI Room Planner, and Spacely AI. Each offers different features and disadvantages. Below is a comparison table of the three websites that provide AI interior design (Table 1). The three applications above have advantages and disadvantages. Design Sense has the benefit of taking photos of the room and providing design suggestions based on the style and preferences of the user, and it can render photos and rooms. AI Room Planner has the advantage of producing and uploading room designs. Photo rooms are realistic, and equipment and disks already exist for free. Whereas Space AI has excess,

namely, the interior design of the room is more interactive; there is much complete furniture that can provide recommendations based on the style and preferences of the user.

These three AI technologies have shortcomings that need to be considered. Design Sense has disadvantages, namely limited creativity and lack of personal touch, limitations in displaying detailed material, and limited free features, so if users want to access all the features, they must subscribe to a premium package. AI Space Planner has limited creativity and lacks a personal touch, so the furniture arrangement needs to be more supportive. Spacely AI only focuses on interior design and does not provide features. Spacely AI should subscribe to get all these features. Therefore, optimiser features are needed to maximise AI technology, which is very sophisticated and continues to develop.

3.3 Questionnaire Results

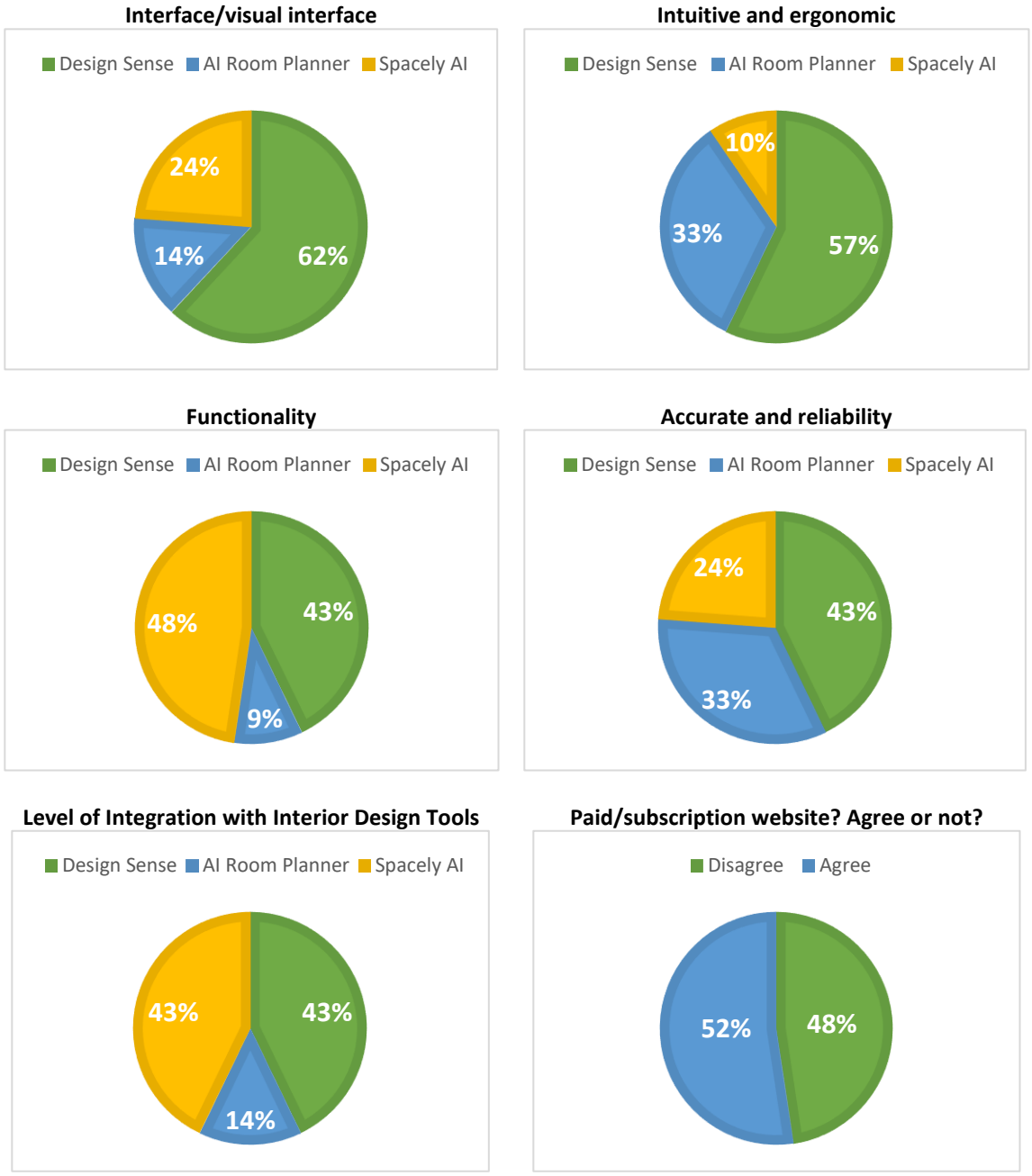

Figure 3. Survey results on user experiences with Design Sense, AI Room Planner, and Spacely AI.

Results of a questionnaire that discussed experience from using Design Sense, AI Room Planner, and Spacely AI and obtained data from the third case study provided: Design Sense, AI Room Planner, and Spacely AI. Design Sense is superior in attractive interface design, with the data obtained reaching 62% compared to AI Room Planner and Spacely AI. When using an AI website, you need a complete selection of functions, which Spacely AI has, around 48 % compared to AI Room Planner and Spacely AI. Then, the level of integration needed with devices' interior design is the same, namely around 43 % of AI technology. Accuracy and reliability are also really needed in designing; on this website, the dominant one is Design Sense, which has a percentage of 43%. Overall, each interior design AI platform has advantages in certain aspects. Design Sense excels in design interface and accuracy, while Spacely AI has more complete functions and good integration with design tools. The choice of platform depends on the user's needs and priorities in the interior design process.

Overall, respondents evaluated Spacely AI and Design Sense as showing superiority. Spacely AI excels in interface design and completeness of functions of the AI website. Meanwhile, Design Sense is superior in terms of accuracy and resolution. In the results questionnaire, respondents still need improvements to the website to improve the AI technology platform in the field of interior design in the future, including expanding AI's capabilities to understand individual preferences (better personalisation). In other words, interior AIs should provide design recommendations that are more personalised and tailored to users' desires (can create design features manually from AI images), integrate with advanced visualisation technologies (improved visualisation technology), help users see the interior design of the space more clearly and realistically before implementation (more detailed functions such as providing room dimensions, material descriptions, furniture dimensions) and space work and edit design together team. So, artificial intelligence can function as a revolution in various aspects of life by automating tasks and thinking through the return methods, combining data, analysing it, and retrieving decisions [35]. In perfecting visualisation, architects and interior designers need to explain and visualise concepts to users to make things easier to understand the design user [36].

4. CONCLUSION

Artificial Intelligence (AI) technology has become an increasingly exciting topic in various industries, including interior design. As a result of discussions and literature observations, interior AI has proven to interest designers because it can help create visualisations, optimise room layouts, choose appropriate materials and colours, and predict customer preferences. AI can save time and costs in the design process and produce more innovative and tailored solutions to client needs.

Optimising AI in designers based on the results of literature reviews and discussion results is that the design process begins by analysing user preferences and needs. Next, a design concept that includes the selection of themes, colours, materials, and textures is developed. After that, it can provide personalised design recommendations that suit user needs, assisted by the AI platform. These aspects also consider system lighting and ventilation. Then, if the design review provided does not fit the user, a manual editing process will be carried out to improve the design based on user feedback. This manual editing feature can be done with a team.

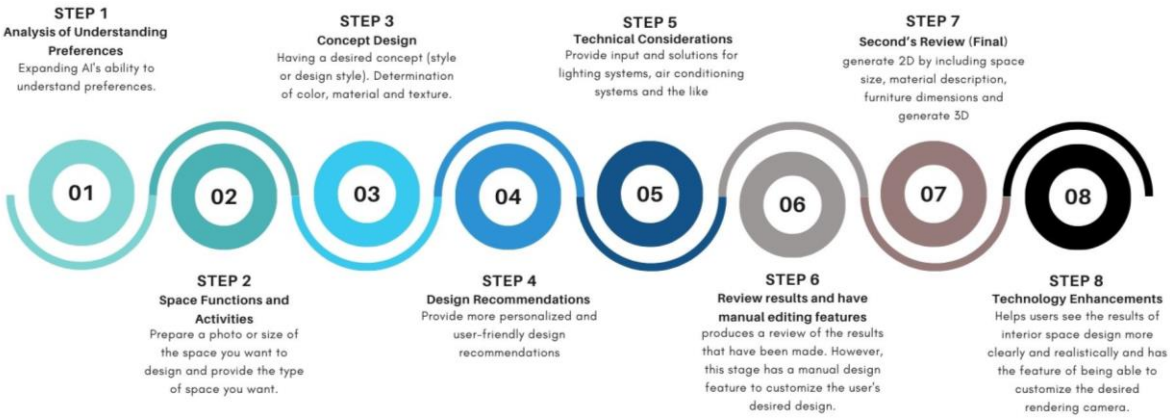

Figure 4. Process Deployment Solutions to perform AI Interior on the Platform

The final review will be displayed in the final stage by producing 3D and 2D visualisations and providing material information, dimensions, and room size. By utilising technology such as AI, you can add features such as rendering results that adjust the camera or display according to the user's wishes to make the rendering results livelier and more realistic. From the results of the framework compiled, features can be used to maximise the interior AI of the website. This plan will be made open source free of charge so that it can be easily accessed by beginner interior designers, students, and professionals.

Implementing these eight design steps using AI technology shows positive results. At this stage, initial analysis Preference uses possible team design to deeply understand their needs and desires; this becomes the basis for developing more personalised design concepts using integrated technologies such as AI platforms and visualisation applications. It is hoped that further research can update and maximise sustainable AI functions in the AI interior design platform to make it easier for designers to optimise their work and positively contribute to the future interior design industry's progress.

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