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Artificial Intelligence Supported Design Automation: Current Approaches and Applications in Architecture

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Artificial Intelligence in Architecture,
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Abstract: This study investigates recent approaches to artificial intelligence (AI)-supported design automation in architecture, focusing on its impact across various stages of the design process. Using a qualitative, literature-based methodology, it analyzes academic sources and case studies involving GANs (Generative Adversarial Networks), diffusion models, and graph-based systems. Findings show that AI (Artificial Intelligence) enhances efficiency, supports creativity, and accelerates iterative exploration, particularly in conceptual design, layout generation, form development, and performance optimization. Despite these advantages, limitations such as data dependency, algorithmic instability, and lack of transparency remain critical challenges. The study categorizes current applications into four key themes and highlights that the most successful outcomes arise from hybrid workflows combining human creativity and algorithmic intelligence. Emphasizing the importance of AI literacy and ethical frameworks, the research contributes to a broader understanding of AI's transformative role in architectural design. It suggests directions for more effective and responsible integration into professional practice.

Yapay Zekâ Destekli Tasarım Otomasyonu: Mimarlıkta Güncel Yaklaşımlar ve Uygulamalar

Keywords
Yapay Zekâ ve Mimarlık,
Tasarım Otomasyonu,
Üretken Tasarım,
Makine Öğrenmesi Uygulamaları,
İnsan-YZ İş Birliği.

Özet: Bu çalışma, mimarlıkta yapay zekâ (YZ) destekli tasarım otomasyonuna yönelik son yaklaşımları inceleyerek, tasarım sürecinin çeşitli aşamalarındaki etkisine odaklanmaktadır. Niteliksel, literatür temelli bir metodoloji kullanarak, GAN'lar, difüzyon modelleri ve grafik tabanlı sistemleri içeren akademik kaynaklar ve vaka çalışmalarını analiz eder. Bulgular, yapay zekanın verimliliği artırdığını, yaratıcılığı desteklediğini ve özellikle kavramsal tasarım, düzen oluşturma, form geliştirme ve performans optimizasyonu alanlarında yinelemeli keşfi hızlandırdığını göstermektedir. Bu avantajlara rağmen, veri bağımlılığı, algoritmik istikrarsızlık ve şeffaflık eksikliği gibi sınırlamalar kritik zorluklar olarak kalmaktadır. Çalışma, mevcut uygulamaları dört ana tema altında kategorize eder ve en başarılı sonuçların insan yaratıcılığı ile algoritmik zekayı birleştiren hibrit iş akışlarından doğduğunu vurgular. Yapay zekâ okuryazarlığı ve etik çerçevelerin önemini vurgulayan araştırma, mimari tasarımda yapay zekanın dönüştürücü rolünün daha geniş bir anlayışına katkıda bulunmakta ve profesyonel uygulamalara daha etkili ve sorumlu bir entegrasyon için yönler önermektedir.

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1. Introduction

The architectural design process is an extremely complex and creative activity that requires balancing aesthetics and functionality while considering technology, economy, environment, and socio-cultural needs. Today, the rapid developments in artificial intelligence (AI) technologies offer new possibilities for design automation in architecture. Especially in large-scale and complex projects, design teams face increasing pressure to process data; AI-supported tools can alleviate this burden and accelerate the design process [1]. AI's generative design approaches have been on the agenda since the 1990s, and in recent years, with the maturation of machine learning and deep learning techniques, a new wave of research in architectural design has emerged [2]. In this context, AI-supported design automation means the automatic generation, optimization, and guidance of design alternatives under specific constraints. Current research shows that AI can assist architects across a wide range, from automating repetitive tasks to generating creative solutions.

In recent years, interest in innovative AI applications in architecture has intensified. Parametric design tools and AI-supported design methods help architects optimize site layouts, reduce material waste, and design energy-efficient buildings today [1]. Beyond that, with generative artificial intelligence tools, architects can quickly create different concept alternatives during the preliminary design phase. For example, architectural concept sketches and visuals can be produced in seconds using diffusion models that generate images from text prompts (text-to-image) or systems based on Generative Adversarial Networks (GAN). Leading architectural firms have not remained indifferent to these developments; international companies such as MVRDV and Zaha Hadid Architects aim to enhance design efficiency by using artificial intelligence tools during the conceptual phase. Indeed, a survey conducted by the Royal Institute of British Architects (RIBA) in 2024 [3] revealed that 41% of architects in the United Kingdom occasionally use AI in their projects, and 43% believe that AI enhances the efficiency of the design process [4].

This article aims to systematically evaluate the innovative approaches in recent years regarding AI-supported design automation in architecture and present new findings around a unique research question in this context. The research question can be summarized as, "How is AI-based design automation integrated into architectural practice, and what are the effects, advantages, and limitations of these applications on the design process?" Current methods and projects in the literature have been examined to answer this question, and the findings have been deepened through case studies. The workflow of the conducted research is shown in Figure 1. Below.

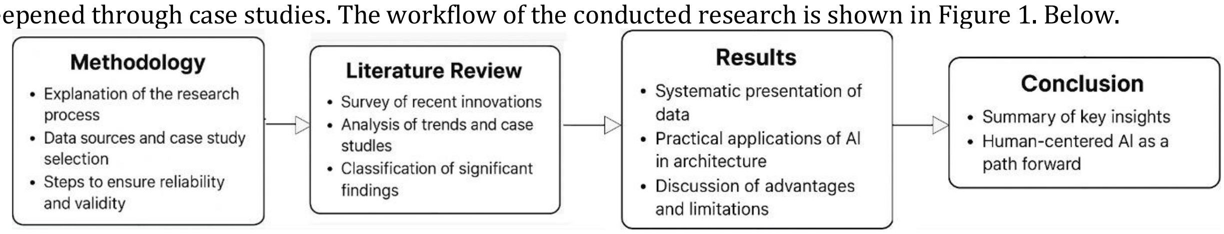

Figure 1. Workflow of the research

2. Methodology

This study adopts a qualitative, interpretive research method based on the systematic review and synthesis of current academic literature, with a particular focus on studies published predominantly in the past five years, as the field of artificial intelligence is characterized by rapid technological advancements and ongoing methodological innovations. The methodology of this article consists of the following 2 key stages.

2.1. Literature-Based Framework Construction

This study is built upon an in-depth and critical review of recent academic articles that explore the applications of artificial intelligence in architectural design. Particular attention is given to sources published between 2020 and 2025, reflecting the rapidly evolving nature of AI technologies. The literature was systematically retrieved from major scholarly databases, including Scopus, Web of Science, and IEEE Xplore, which were selected due to their comprehensive coverage of peer-reviewed literature in architecture, engineering, and computer science. Predefined keyword combinations such as “architectural design,” “artificial intelligence,” “generative design,” “machine learning,” and “design automation” were used to identify relevant studies. Inclusion criteria prioritized peer-reviewed publications written in English and explicitly focused on computational or AI-based approaches within architecture. Sources were examined with regard to the type and structure of AI systems (e.g., rule-based, generative adversarial networks, hybrid models), their application contexts (e.g., conceptual design, optimization, planning, massing), reported potentials and limitations, as well as the epistemological and methodological challenges they present. Studies lacking methodological clarity or architectural relevance were excluded from the analysis. The review process was designed in alignment with the structural logic of the PRISMA framework, particularly in terms of database selection, keyword-based filtering, and inclusion/exclusion criteria. While not claiming to apply the full PRISMA protocol, the study adopts its systematic principles to ensure transparency and reproducibility throughout the literature analysis. The resulting body of literature was thematically categorized to reveal emerging trends and conceptual orientations (Figure 2).

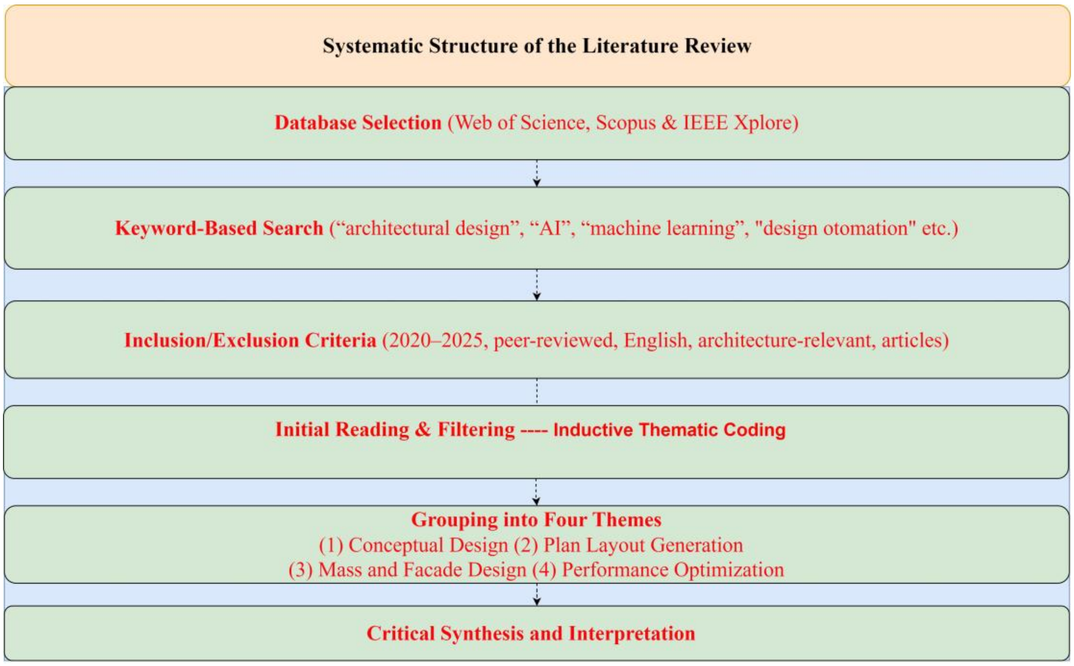

Figure 2. Systematic structure of the literature review

The findings were then grouped into 4 main thematic categories reflecting the current tendencies in the literature related to automated AI-based architectural design approaches:

1. Conceptual Design and Visualization
2. Plan Layout Generation/Machine Learning Applications in Early-stage Design
3. Mass and Facade Design
4. Performance-Oriented Design Optimization

These categories were derived through an inductive thematic analysis of the selected literature. During the review process, recurring patterns were identified in terms of the design phases, scales, and performance criteria addressed by AI implementations. Grouping was based on the functional focus of the AI applications rather than predefined taxonomies, allowing the categorization to emerge organically from the content of the studies. This approach ensured that the thematic structure remained reflective of the most salient and converging areas of inquiry within the current body of literature.

2.2. Synthesis and Critical Evaluation

Rather than simply summarizing the literature, the study synthesizes emerging patterns, tensions, and discourses regarding how AI tools reshape architectural practice and thinking. The methodology prioritizes critical reflection questioning:

- The degree to which AI tools affect or transform the role of the designer,
- The limitations of current tools in terms of transparency, functionality, and compatibility,
- The potential of hybrid systems that combine learning and rule-based components.

The research provides a theoretically robust and context-sensitive understanding of AI-driven design automation in contemporary architectural discourse through this multi-dimensional structure.

3. Literature Background

The following literature review outlines significant theoretical approaches, technological models, and application trends identified in recent research on AI-supported design automation. The reviewed studies are grouped and discussed according to their roles in different stages of the architectural design process. Accordingly, the section is divided into two subsections: the first (3.1) addresses conceptual and technological foundations of AI-supported design automation, while the second (3.2) focuses on machine learning-based design production and performance optimization practices observed in recent studies.

3.1. Artificial Intelligence Approaches in Design Automation

The concept of design automation in architecture has evolved since computer-aided design (CAD) emerged. The generative design methods developed in the 1990s and early 2000s were mostly based on clearly defined algorithms such as parametric rules or shape grammar. Design knowledge was encoded rule-based in these early approaches, and the computer-generated alternative designs were obtained by altering predefined parameters. However, these methods were limited to explicit rules based on the designer's experience, making them inadequate for generalizing to different projects [2].

Artificial intelligence, especially machine learning techniques, has brought a new breath to this field in recent years. AI models capable of extracting patterns from large datasets through implicit learning have the potential to overcome the limitations of previous approaches by learning design rules on their own without human definition.

An important breakthrough in the evolution of generative design is the possibility of design analysis with artificial neural networks. Deep learning-based generative models have especially started to be used to produce architectural form and space. Models such as Generative Adversarial Network (GAN) and Variational Autoencoder (VAE) are among the first approaches to find applications in producing architectural images and plans. For example, a GAN-based method called ArchiGAN has generated new plan schematics from example plans presented as training data. Recently, Diffusion Models (e.g., Stable Diffusion) and large-scale foundation models have been attracting attention for generating content in architectural design. These new models can generate design content in various modalities, from text to image or 3D rendering [4].

In the literature, comprehensive studies examine AI applications for different stages of the architectural design process. For example, Li et al. [4] addressed the architectural design process in six stages: conceptual design, 3D form creation, plan layout, structural system design, facade design, and section creation; they classified post-2020 studies based on these steps and examined how generative AI techniques were used at each stage. This review study comprehensively presents models such as GAN, VAE, and diffusion in architecture while emphasizing a noticeable delay in adopting the latest generative AI approaches in architectural design. While the most commonly used generative AI techniques in architecture are still GAN and its derivatives, applying the latest developments, such as diffusion and large language models, remains limited. This situation is partly attributed to the barriers of knowledge and expertise that stand in the way of architects adopting these complex new technologies; many architects prefer to stick to traditional methods due to the complexity of the tools. Therefore, adopting AI-assisted design automation goes beyond being a technology-focused innovation; it also brings along the need for training and adaptation.

3.2. Design Production and Optimization with Machine Learning

In current research (primarily from the past five years), machine learning is used in both the creative production and performance optimization aspects of architectural design. Plan and layout automation is one of the active research topics in this field. Deep learning models can learn from sample plan data to propose new spatial arrangements. For example, the FloorplanGAN model developed by Luo and Huang [5] customizes the GAN architecture to generate residential plans in vector format; by combining a discriminator that distinguishes outputs in raster (pixel) format with a vector-based plan generator, it creates consistent and scalable residential plans. This study stands out for producing floor plans directly within a CAD environment in an editable vector format. Similarly, Aalaei et al. [6] proposed a graph-constrained Conditional GAN approach, achieving plan generation guided by spatial relationship graphs (such as room adjacencies). This model generates plan drafts that preserve the desired adjacency relationships by considering the function diagram (bubble diagram) or topological requirements provided as input. Especially in complex typologies such as hospitals and offices, it has been noted that this type of graph-based generative approach increases the architectural validity of the produced plans. Indeed, the experiments have shown that this GAN-derived model can produce plan layouts more suitable for use than a randomly learning model.

Another use of machine learning in design automation is generating and optimizing three-dimensional forms. Zhuang et al. [2] compared two different deep generative models using a dataset of existing building forms in the financial district of New York City. In this study, two different data representations were used to represent the 3D volumes of buildings: a voxel matrix and a signed distance function (SDF); the performance of a GAN-based network and an auto-decoder model were evaluated. The results showed that both approaches could learn the formal characteristics in the sample data and generate new building masses similarly. Results have shown that both approaches can learn the formal characteristics of the sample data and produce new building masses in a similar style [2]. It has been noted that the SDF-based auto-solver model provides higher resolution and more detailed outputs, thus offering an advantage in architectural form generation. This study is significant because it demonstrates artificial neural networks' ability to capture implicit formal features and create style-consistent design alternatives. Similar approaches are also being tested in more specific areas such as facade design; for example, new facade designs that mimic existing facade patterns or facade completion tasks have been successfully carried out using deep networks [2].

Another aspect of AI-supported design automation is its integration with design optimization and performance analysis. Considering that design decisions have multidimensional outputs such as structural strength, energy efficiency, and cost, architects seek optimal solutions in this complex problem space. Genetic algorithms and similar search methods have traditionally been used in optimization problems. Currently, artificial learning is coming into play to offer smarter suggestions in the processes of evaluating and improving design alternatives. For example, deep learning models can predict the energy performance or structural behavior of a building design in advance and provide feedback to the designer; thus, the designer can guide the design without waiting for simulation times. There are studies on using artificial neural networks as a predictive analysis tool in architectural design. Machine learning can provide intuitive guidance to designers in complex parameter spaces, such as filtering the best options that meet aesthetic and performance criteria among various facade panel design options. Additionally, AI models can scan the design space and propose Pareto-optimal solutions in high-dimensional design problems where parameters are difficult for humans to comprehend (e.g., multi-objective optimization). Although such applications are still in development, initial results indicate that AI could act as a "suggestion engine" in the design process, thereby reducing the architect's decision-making burden [1].

4. Findings

The literature review shows that artificial intelligence has a wide application spectrum in architecture. This spectrum extends from the initial stages of conceptual design to the development of technical details (Table 1). Based on the reviewed sources, the prominent application areas and methods are discussed below with examples.

Table 1. Overview of AI-Based Design Automation in Architecture

Thematic Area	AI Applications	Key Advantages	Limitations / Challenges
Conceptual Design & Visualization	Image generation from text (e.g., Stable Diffusion, DALL·E 2), conceptual sketch generation via GANs	Speeds up early ideation, provides visual variety	Lack of architectural accuracy, realism depends on user guidance
Plan Layout Generation	FloorplanGAN, graph-based GANs (e.g., Graph2Plan), layout prediction from adjacency graphs	Automates spatial arrangements, supports program-based design	Functional inconsistencies, requires human validation
Mass and Facade Design	3D massing via GANs, semantic facade completion, stylistic facade variation generation	Maintains formal continuity, generates context-aware alternatives	Limited parametric control, difficulty in integrating into BIM/CAD workflows
Performance-Oriented Optimization	Energy prediction, structural behavior estimation, multi-objective optimization with ML and neural networks	Accelerates performance evaluation, supports sustainable design decisions	Explainability issues, black-box nature of models, data and integration dependency

Conceptual Design and Visualization: AI-supported automation is even used in the earliest design phase, conceptual design. Especially diffusion models that generate images from text (e.g., Stable Diffusion) and various GAN derivatives enable architects to create idea sketches and concept visuals quickly. For example, large visual models like DALL-E 2 and Midjourney, which emerged after 2022, can generate images in architectural styles, providing designers with unusual sources of inspiration [4]. In the literature, cases related to using these tools in conceptual design have been reported: Del Campo et al. [7] tested architectural image generation by converting a traditionally hand-drawn church sketch into a realistic perspective image using a GAN model. Similarly, Stigsen et al. [8] developed a model that generates structures in specific architectural styles and functions using text inputs, comparing the results with human designers' drawings.

These examples demonstrate that AI can accelerate the process of visualizing a designer's imagination and facilitate the exploration of alternative ideas. However, the architectural applicability of the outputs produced here (scale, realism, etc.) depends on the designer's interpretation and guidance.

Plan Layout Generation: One of the most concrete contributions of artificial intelligence is the automatic generation of plan layouts suitable for specific functional requirements. The aforementioned FloorplanGAN [5] and Aalaei et al.'s [6] graph-constrained GAN model are two notable works in this field. FloorplanGAN, trained on residential typologies, has generated plans that position and size rooms according to a given use program. Moreover, the vectorized nature of the outputs has allowed them to be directly transferred to CAD environments.

Aalaei et al. [6] offer a solution for complex functional schemas by inputting room types and connections into the model as a graph and proposing spatial arrangements that satisfy this graph structure. In the literature, similar approaches are referred to by names such as Graph2Plan (e.g., in a model developed by Hu et al., [9] spatial relationships in plans were learned in graphical form). Reviews indicate that such AI-based plan generation tools successfully produce numerous alternatives during the early design phase. However, the designer must carefully evaluate each alternative's architectural validity. Indeed, some studies indicate the need for collaboration between human architects and AI to improve the functional integrity and circulation of the produced plans [1]. In this context, rather than fully automated plan production, it is seen as more effective for AI to take on the role of an assistant offering suggestions to the designer.

Mass form and facade design: AI is also a creative tool in building mass and facade composition. The findings obtained in the study by Zhuang et al. [2] have shown that neural networks can learn existing architectural forms and propose new forms in a similar style. This method can produce harmonious designs within a specific urban silhouette or historical texture. Similarly, in facade design, there are applications in the literature that continue existing facade patterns or transfer their style using GAN-based approaches. For example, Cai et al. [10] produced consistent design proposals using a semantic-synchronized GAN model to complete missing facade images. Another application of AI in facade design is to provide diversity: Instead of a single facade design, dozens of alternative facade patterns that comply with the specified design rules can be quickly generated by AI, allowing the designer to choose from these options. This situation can trigger creativity by providing an "idea pool" contribution to the design process [1].

Performance-oriented design optimization: Another finding from the reviewed studies is that AI plays a role in analyzing and optimizing design decisions. Especially in structural system design and energy-efficient design, machine learning models can provide predictions that may replace simulations [11]. For example, one study was able to quickly calculate the energy loads of design alternatives using deep learning and provide customized solution proposals for each variant [12].

Similarly, in structural design, stress distributions or cost analyses of potential load-bearing system variations can be instantaneously predicted by AI, enabling the architect to make more informed decisions. The practical reflection of these applications is that design teams can focus on targeted solutions guided by AI instead of iterative trial and error. For example, in a recent case, the form of a stadium roof structure was optimized using an evolutionary algorithm and an artificial neural network; a lighter design with higher load-bearing capacity was achieved quickly compared to classical methods [13]. It is understood that AI-supported optimization can provide solutions beyond human intuitive reach by combining the computer's processing power with creative exploration. However, it should be emphasized that humans often determine the goals and constraints of this optimization process. AI is a tool that operates within the framework defined by the designer regarding what to optimize; therefore, its success depends on the accuracy and scope of the problem definition.

The current/potential contributions of AI-supported design automation to architectural practice

Literature review and case studies show that AI-supported design automation can bring significant advantages to architectural practice in various ways:

Efficiency and Speed: AI accelerates the design process by automating repetitive and time-consuming tasks. For example, tasks such as document preparation, drawing updates, and generating alternatives can now be completed in minutes thanks to AI. This also gives designers more time to focus on creative decisions instead of routine tasks. Especially a process where many alternatives can be quickly produced and eliminated can shorten design cycles, thereby reducing project delivery times [14,15].

Error Reduction and Accuracy: Automation increases the consistency of project documentation by minimizing human errors. AI-supported tools can consistently update design changes throughout the plan or automatically detect overlapping components. This way, for example, consistency in the drawing set of a complex building is ensured, with fewer errors. Additionally, AI provides highly accurate results in detail-oriented calculations (such as heat load calculations and structural pre-sizing), making it easier to consider engineering estimates during the design phase [16].

Innovation and Creativity: AI can provide designers with unexpected sources of inspiration by analyzing large datasets and previous design examples. An AI system that absorbs much case information can provide solution suggestions that the designer would not think of or draw analogies from different disciplines. For example, after learning dozens of different museum plans, an AI model might suggest an unconventional circulation scheme for a new museum project. This diversity increases the likelihood of innovative ideas emerging during the design process. Some researchers emphasize that with AI taking over routine tasks, the architect's role as a "creative guide" will be strengthened, and the design quality will improve as they can choose from a wider solution space [17,18,19].

Performance and Optimization: Thanks to the integration of artificial intelligence, big data analysis, and simulation, it can quickly predict the performance outcomes of design decisions. This allows for more informed decisions to be made at an early stage. For example, an AI-supported system can optimize the placement of buildings in a campus design, improving wind corridors and sunlight exposure. Similarly, it can enhance sustainability by making formal optimizations that reduce material usage. Thus, AI can elevate design quality and performance beyond what a human could achieve alone [20,21].

Decision Support and Access to Information: AI systems can instantly provide regulations, standards, or references to similar projects that may be necessary during the design decision-making process, thanks to embedded expertise and knowledge bases. Intelligent assistants with natural language processing capabilities can support the design process by answering the architect's questions (such as "What is the fire resistance of this material?"). This also provides an opportunity that accelerates the transfer of experience within the team, which is particularly beneficial for young professionals [22,23].

Limitations and Challenges

Research findings, although they demonstrate many benefits of AI-supported design automation, also reveal various limitations and challenges in the implementation of these technologies:

Data and Training Requirement: Large and high-quality datasets are needed for machine learning-based systems to function effectively. However, in architecture, project data is often limited in number and specific to particular conditions; collecting and sharing this data is challenging. Training an AI model to perform architectural design may require the digital processing of thousands of design examples. The complexity of architectural designs and their context-specific nature make it difficult to create generalizable datasets. Moreover, biases in the available data (e.g., a model trained only on modernist buildings unable to produce designs suitable for historical styles) can reflect in the results [24,25].

Algorithmic Limitations and Stability Issues: Even advanced AI models sometimes cannot consistently consider all variables related to the design problem. For example, even though a GAN model produces plans that appear very realistic, they can sometimes be functionally flawed (such as plans that forget the corridor or have no access to the bathroom). The stability and reliability of algorithms is an important issue; a small change during the training process can dramatically affect the outputs. This also carries the risk of leading to unpredictable results in practice. Additionally, it can be challenging for AI models to find balanced solutions when it is necessary to optimize multiple performance criteria simultaneously (multi-objective problems) [26].

Integration and Compatibility: In architectural design practice, many software tools (CAD, BIM, analysis tools, etc.) are used in an integrated manner. To be adopted, a new AI tool must seamlessly integrate into this existing digital workflow. However, integrating existing design software with AI models is a technical challenge; data formats may not be compatible, and real-time interaction may not be possible. For example, if an architect wants to receive real-time suggestions from AI while working in a CAD program, establishing communication between these two systems requires significant software development effort. This incompatibility emerges as a factor that restricts the practical use of AI tools [27].

Transparency and Understandability: The decisions of artificial intelligence models are often characterized as a "black box"; that is, it may not be clearly understood why the model provided a certain design suggestion. In architecture, decisions are evaluated not only based on the outcome but also the rationale of the process. Without knowing the logic behind an AI suggestion, expecting an architect to trust it is unreasonable. Unfortunately, deep learning models are limited in terms of explainability. This leads to a trust issue: Designers and clients may hesitate to adopt AI's suggestions when they do not fully understand them. For example, suppose an AI-supported design decision later causes problems (such as a structure collapsing or not functioning). In that case, it is unclear who is responsible, and this uncertainty creates concern [28].

Creativity and Identity Loss: Fully automated design systems, if used uncontrollably, can reduce designers' creative roles and lead to uniformity in designs. If everyone uses similar AI tools, there is a risk that the resulting forms will also resemble each other. The architect's unique touch and context-specific creative solutions may be overshadowed by AI. This is a point that needs to be questioned regarding the artistry and individuality inherent in the discipline of architecture. Therefore, AI applications must be positioned as assistants, allowing the designer to maintain creative control. Indeed, the National Council of Architectural Registration Boards (NCARB) emphasizes that artificial intelligence should be viewed as a "workforce-supporting tool" and cannot replace professional judgment, stating that the architect's ultimate responsibility and control are essential [29].

Ethical and Legal Issues: The copyright and ownership status of designs produced by AI can be uncertain. For example, when an AI model learns from existing projects to create a new design, how original is the resulting product? Would this be considered copyright infringement if the model partially copies a design from the training data? Questions like these have not yet been clarified. Additionally, with the widespread use of AI, the dynamics of the workforce in the field of architecture may also change; the automation of some routine tasks could reduce the opportunities for young architects to gain experience or new areas of expertise (such as AI ethics specialist, data specialist) may emerge. These issues have only recently begun to be addressed by professional organizations and lawmakers [30,31].

The above advantages and limitations should be considered to make a balanced assessment of AI-supported design automation. Many researchers emphasize that human-machine collaboration and an appropriate regulatory framework are essential for the most efficient use of these tools. This leads us to draw future-oriented conclusions and highlight the unique contributions of the study in light of the findings obtained.

5. Discussion and Conclusion

As a result of the in-depth examination, new inferences have been drawn by synthesizing the existing information in the literature. Firstly, a significant gap has been identified in the transition of artificial intelligence applications to practice in architecture: There is a time and competency gap between the advanced models developed academically (such as diffusion-based 3D generative models or systems capable of designing on demand) and the tools that architects can use in their daily practice. This situation indicates a need for knowledge transfer between educational institutions and the industry. For architects to effectively use AI tools, they must develop technical knowledge (coding, data science, etc.) and critical awareness (evaluating AI output, understanding biases, etc.).

Another important finding is the necessity to redefine the role of AI in the design process. Instead of a fully automated "designer robot" concept, a partnership model between human designers and artificial intelligence seems more sustainable. For example, in a case study examined, human architects evaluated and edited the plan drafts produced by AI; the results showed that the solutions obtained through the collaboration of humans and AI were superior in terms of spatial quality and originality compared to those produced by AI alone. This provides a clear answer to the question, "Is AI sufficient on its own?": No, but it can be a powerful tool that enhances the architect's capabilities when properly integrated. The literature emphasizes that the best results are achieved when AI is positioned as a teammate supporting the creative process [1].

Despite the creative richness of traditional architectural production methods, they often involve time-consuming iterative cycles, limited access to performance data during early design stages, and difficulties in evaluating multiple design alternatives simultaneously. These challenges restrict both efficiency and evidence-based decision-making. In this context, AI offers valuable tools to support architects through rapid design exploration, predictive analysis, and optimization techniques. However, rather than replacing traditional methods, AI should be integrated as a complementary component within hybrid workflows, where human creativity is empowered, not substituted, by algorithmic intelligence.

Additionally, the suitability of different AI approaches for the task is noteworthy. For example, data-driven deep learning models can provide extraordinary ideas for conceptual designs that carry uncertainty. At the same time, rule-based algorithms (or optimization techniques) can produce more reliable results in detailed designs where precise engineering rules apply. Therefore, it is foreseeable that hybrid systems—platforms that include both learning and rule-based components—will develop. Indeed, some recent studies focus on interfaces that combine AI-supported generative systems with parametric design tools [32]. For example, a designer can create the main structure using parametric modeling tools like Grasshopper and have the AI complete the details or rationalize a form produced by the AI with parametric tools. These interactive workflows can provide more practical solutions by balancing control and creativity.

The conducted research also indicates some gaps in terms of future research topics. One of these is the integration of explainable AI techniques into architectural design tools. Making it understandable "why AI models produced this result" will increase architects' trust in these tools and enable them to use them more effectively in their training processes. Another important issue is clarifying the ethical and legal framework; a delicate balance must be struck between preserving architectural design as a creative act and the automation brought by artificial intelligence. In this field, there is a need for more case studies and guiding principles (such as copyright, distribution of responsibility, etc.) to provide direction to decision-makers. While AI-supported design automation holds great potential in architecture, it is clear that the technological, human, and regulatory dimensions must be addressed together for an effective and sustainable transformation.

In this study, artificial intelligence applications aimed at design automation in architecture have been comprehensively examined, and innovative approaches in recent years have been deeply evaluated. In the introduction section, the effects of AI-supported design automation on architectural practice were discussed in light of current trends and example studies in the literature, following the research question presented. In the Literature Review section, the existing body of knowledge has been summarized within a framework that starts with the historical development of the concept of generative design and extends to new methods based on machine learning and deep learning. The significant studies and findings in this field have been presented by classifying them in the context of different stages of the architectural design process. In the methodology section, how the research was conducted, which sources and case analyses were used, and the steps taken to ensure the reliability and validity of the study are specified. In the findings section, the compiled data is presented systematically; the applications of artificial intelligence in architecture are conveyed with concrete examples, and its advantages and limitations are discussed. Additionally, unique insights and future-oriented recommendations derived from the literature synthesis have also been included in the findings.

One of the most important findings of this research is that AI-supported design automation holds revolutionary potential in architectural practice. However, the human factor must remain central for this potential to be fully realized. AI tools should be positioned not as architects' replacements but as assistants that enrich their capabilities. Without the architect's creative guidance and critical evaluation, it is unlikely that designs produced by AI will be successful. Therefore, future design processes will likely be hybrid models with a strong human-machine partnership. The examples presented in this study also support this view, showing that the best results are obtained in scenarios where the designer interacts with AI.

The research also highlights the importance of integrating artificial intelligence applications into architectural education and their inclusion in professional standards. Increasing architects' AI literacy will be crucial for the next generation of designers to use these tools ethically and creatively. Professional organizations and educational institutions are responsible for raising awareness about artificial intelligence, establishing guidelines, and creating environments for sharing experiences. In this way, the transfer of many innovative approaches that remain at the prototype level in the literature to the industry will be accelerated.

In conclusion, AI-supported design automation has the potential to revolutionize efficiency, creativity, and knowledge-based decision-making processes in architecture. The review and analysis conducted in this article have contributed to filling the knowledge gap in this field by revealing the current state and trends. The findings obtained, in response to the research question, indicate that integrating AI into architectural practice occurs through various tools and workflows that assist in conceptual design, plan generation, form development, and performance optimization. These tools enhance speed and creativity by automating routine tasks and offering novel design alternatives. However, they also introduce challenges, such as data dependency, lack of transparency, and limited integration with existing design platforms. The most successful applications are found in hybrid models where AI supports but does not replace human designers, allowing a balance between algorithmic efficiency and architectural judgment. In the future, with the increase in research in this field and the strengthening of interdisciplinary collaborations, we believe that even more innovative and effective applications will emerge at the intersection of architecture and artificial intelligence. The success of this transformation will depend not only on technological advancements but also on how the architectural community embraces this technology and how society accepts this change.

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