Generative Artificial Intelligence in Architectural Design: A Systematic Literature Review and Conceptual Framework for the Transformation of the Architectural Design Process

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Abstract

Generative Artificial Intelligence (GenAI) is rapidly reshaping architectural design by expanding the capabilities of designers in conceptualization, spatial generation, visual representation, and decision support; although research on this topic has grown substantially in recent years, the available evidence remains fragmented across different technologies and stages of the architectural design process. This study presents a Systematic Literature Review (SLR) to synthesize the current state of research on the application of GenAI in architectural design. Following the PRISMA 2020 guidelines, a systematic search was conducted in the Scopus and Web of Science databases. After applying predefined eligibility criteria, 28 peer-reviewed journal articles published between 2022 and 2026 were selected for qualitative synthesis; the review identified Large Language Models (LLMs), diffusion models, multimodal systems, and agentic artificial intelligence as the predominant technologies supporting architectural design. Six application domains emerged from the analysis: problem definition, conceptual design, spatial configuration, design evaluation, architectural representation, and decision support. The findings indicate that GenAI primarily enhances the early stages of the design process by accelerating idea generation, expanding design exploration, and enabling collaborative human–AI workflows; based on these findings, this study proposes a conceptual taxonomy that organizes current GenAI applications according to the stages of the architectural design process. The proposed framework contributes to a more comprehensive understanding of the role of GenAI in architecture and provides a foundation for future research and its integration into professional design practice.

Keywords

Generative Artificial Intelligence, Architectural Design, Architectural Design Process, Large Language Models, Diffusion Models

1. Introduction

Digital transformation has reshaped architectural design practices over the last decades. The incorporation of computer-aided design (CAD), Building Information Modeling (BIM), parametric design, and digital fabrication has expanded the representational, analytical, and productive capacities of architectural practice, changing how architects conceive, develop, and communicate design proposals [1, 2, 3, 4]; within this broader technological transition, Artificial Intelligence (AI) represents a further stage in the evolution of design technologies, introducing computational systems capable of learning from data, generating content, and supporting complex decision-making processes [5, 6].

Early applications of AI in architecture were largely directed toward specific and well-defined problems, including structural optimization, energy analysis, environmental simulation, image classification, and urban planning; these applications relied on evolutionary algorithms, neural networks, expert

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systems, and other computational techniques designed to automate specialized tasks or optimize predefined objectives [7, 8]. Although these approaches contributed significantly to performance-driven design and analytical workflows, their capacity to participate directly in the creative and interpretive dimensions of architectural design remained limited.

A major shift occurred with the emergence of Transformer architectures, introduced by Vaswani et al. in 2017; by using attention mechanisms to process sequential information, Transformers provided the foundation for the development of contemporary Large Language Models (LLMs) [9]. Later systems, including GPT-3, GPT-4, and other foundation models, demonstrated advanced capabilities in natural language understanding, text generation, complex reasoning, and conversational interaction [10, 11]; in parallel, the development of diffusion models enabled the generation of high-quality images from textual descriptions, considerably expanding the possibilities of AI-assisted visual production [12, 13].

These developments gave rise to the notion of Generative Artificial Intelligence (GenAI), understood as a family of models capable of producing new content including text, images, code, three-dimensional models, and multimodal representations based on patterns learned from large-scale training data [11, 13]; unlike earlier AI approaches mainly oriented toward classification, prediction, or optimization, GenAI introduces generative and reasoning capabilities that substantially alter the relationship between human designers and computational systems [5, 11].

In architecture, these capabilities are beginning to influence the architectural design process in significant ways; language-based models can assist in interpreting design briefs, structuring requirements, and generating conceptual alternatives through natural language interaction. Diffusion-based models, in turn, support the rapid production of visual representations, façades, floor plans, and spatial configurations from text prompts, sketches, or reference images; multimodal systems further extend these possibilities by integrating textual, visual, and three-dimensional information within the same design workflow, enabling more iterative forms of design exploration and evaluation [2, 3, 14].

From a disciplinary perspective, these developments represent more than the adoption of a new digital tool. As argued by Carpo [9, 10], the evolution of computational design has progressively shifted from systems that automate predefined tasks toward technologies capable of supporting knowledge generation and creative reasoning. Similarly, Steenson [11] emphasizes that advances in computational intelligence have transformed the relationship between designers and digital systems, enabling more interactive and collaborative forms of design. Within this context, Generative Artificial Intelligence should not be regarded merely as a technology for image production or automated content generation; rather, it constitutes an emerging design paradigm that has the potential to influence problem formulation, conceptual exploration, spatial reasoning, visual communication, and decision-making throughout the architectural design process.

Despite the rapid expansion of research in this field, the existing literature remains fragmented. Most published studies focus on specific tools, algorithms, or isolated applications, while comparatively few investigations examine how Generative Artificial Intelligence supports the architectural design process as an integrated workflow; as a result, the current body of knowledge provides limited understanding of broader research trends, methodological approaches, technological convergence, and the challenges associated with the adoption of GenAI in professional architectural practice.

This fragmentation highlights the need for a comprehensive synthesis of the available evidence. Systematic Literature Reviews (SLRs) provide a rigorous methodological framework for identifying, evaluating, and integrating scientific evidence through transparent and reproducible procedures [15, 16, 17, 18, 19, 20]; compared with traditional narrative reviews, systematic reviews minimize selection bias by applying predefined search strategies, explicit eligibility criteria, and structured methods for evidence synthesis. Consequently, they offer a more reliable foundation for understanding emerging research fields and identifying future research directions.

Furthermore, the emergence of Large Language Models, diffusion models, multimodal architectures, retrieval-augmented generation, and agentic AI has expanded the technological landscape beyond what earlier reviews have addressed; understanding how these technologies contribute to different stages of the architectural design process requires a systematic assessment of recent scientific evidence rather than isolated analyses of individual tools or case studies.

Accordingly, this study conducts a Systematic Literature Review (SLR) to examine the current state of research on the application of Generative Artificial Intelligence throughout the architectural design process; following the PRISMA 2020 guidelines, the review systematically analyzes peer-reviewed journal articles indexed in Scopus and Web of Science to identify the principal technologies, application domains, methodological approaches, benefits, limitations, and emerging research trends associated with GenAI in architecture.

By addressing these questions, this review aims to provide a comprehensive synthesis of the current evidence while proposing a conceptual framework that supports both future research and the effective integration of Generative Artificial Intelligence into architectural design practice.

The remainder of this paper is organized as follows; Section 2 describes the research methodology adopted for the systematic literature review in accordance with the PRISMA 2020 guidelines; Section 3 presents the results of the thematic synthesis of the selected studies; Section 4 discusses the main findings, their implications for research and architectural practice, and identifies directions for future research. Finally, Section 5 summarizes the main conclusions of the study.

2. Methodology

2.1. Research Design

This study adopted a Systematic Literature Review (SLR) to examine the current state of research on the application of Generative Artificial Intelligence (GenAI) throughout the architectural design process; an SLR was considered the most appropriate methodological approach because it enables the systematic identification, critical appraisal, and synthesis of scientific evidence through transparent and reproducible procedures. Compared with conventional narrative reviews, systematic reviews reduce selection bias and provide a more reliable basis for understanding emerging research domains [15]–[20].

The review protocol followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines [15]; these guidelines provide a structured framework for documenting the identification, screening, eligibility assessment, and inclusion of scientific publications. Additional methodological recommendations proposed by Kitchenham and Charters [16], Snyder [17], Webster and Watson [18], Tranfield et al. [19], and Xiao and Watson [20] were also considered to ensure methodological rigor throughout the review process.

The review was designed to identify recent scientific evidence on the use of GenAI within architectural design, emphasizing technologies, application domains, methodological approaches, benefits, limitations, and future research opportunities; to ensure consistency, all stages of the review from search strategy to evidence synthesis were defined before the literature search was conducted.

2.2. Research Questions

The review was guided by five research questions intended to characterize the current landscape of Generative Artificial Intelligence in architectural design.

- **RQ1.** What are the principal applications of Generative Artificial Intelligence throughout the architectural design process?
- **RQ2.** Which stages of the architectural design process have incorporated Generative Artificial Intelligence technologies?
- **RQ3.** How is human–AI collaboration characterized within contemporary architectural design workflows?
- **RQ4.** What benefits, limitations, and challenges have been reported in the scientific literature?
- **RQ5.** What research trends and future directions can be identified for the application of Generative Artificial Intelligence in architecture?
  These questions established the analytical framework for data extraction, thematic coding, and qualitative synthesis.

2.3. Search Strategy

The literature search was conducted on July 6, 2026, using Scopus and Web of Science Core Collection; due to the objective of the review article the strategy was designed to identify studies addressing Generative AI within the architectural design process as a whole, rather than isolated design tasks. The final search expression was:

("Generative Artificial Intelligence" OR "Generative AI" OR "Large Language Model" OR LLM OR ChatGPT OR "Foundation Model*" OR "Diffusion Model*") AND ("Architectural Design" OR "Architectural Design Process")**.

In Scopus, the query covered title, abstract, and keywords (TITLE-ABS-KEY) and was limited to Computer Science, Engineering, Arts and Humanities, Environmental Science, and Decision Sciences; equivalent topic fields were used in Web of Science.

The search covered 2022–2026 and was restricted to journal articles. Stage-specific terms were intentionally not included, as individual applications were expected to emerge from the thematic analysis. Records concerning software, system, neural, network, or computer architecture were excluded during title-and-abstract screening when unrelated to architectural or building design. Ultimately, the search yielded 402 records: 352 from Scopus and 50 from Web of Science.

Table 1
Search strategy and databases.

Database	Coverage	Period	Subject area	Document type	Records retrieved
Scopus	International	2022–2026	Computer Science, Engineering, Arts and Humanities, Environmental Science, and Decision Sciences	Journal Articles	352
Web of Science Core Collection	International	2022–2026	Computer Science, Engineering, Arts and Humanities, Environmental Science	Journal Articles	50
			Total		402

2.4. Eligibility Criteria

Eligibility criteria were established prior to the screening process to ensure methodological transparency, consistency, and reproducibility throughout the study selection procedure; only peer-reviewed journal articles published between 2022 and 2026 were considered for inclusion. Eligible studies were required to be indexed in either Scopus or Web of Science and published in journals classified within the Q1, Q2, or Q3 quartiles. In addition, the full text had to be available, and the primary focus of the study had to be the application of Generative Artificial Intelligence (GenAI) to one or more stages of the architectural design process. To ensure the relevance and quality of the evidence, only studies presenting empirical findings or methodological contributions were included in the final review.

Studies were excluded if they corresponded to conference proceedings, books, book chapters, editorials, or other forms of gray literature; publications primarily concerned with architectural education, software engineering, building operation, facility management, HVAC systems, or energy optimization were also excluded, as these topics fall outside the scope of the present review. Likewise, studies in which Generative Artificial Intelligence was addressed only as a secondary or supporting technology, rather than as the central research focus, were not considered. Finally, articles published in Q4 journals or in journals without quartile classification were excluded to maintain a consistent level of scientific quality across the selected evidence.

2.5. Study Selection Process

The study selection process followed the four phases established by PRISMA 2020: identification, screening, eligibility, and inclusion [15].

Table 2
Eligibility criteria.

Inclusion Criteria	Exclusion Criteria
Peer-reviewed journal articles	Conference papers
Scopus or Web of Science indexed journals	Books and book chapters
Q1, Q2 or Q3 journals	Editorials and gray literature
Published between 2022 and 2026	Q4 or unranked journals
Full-text available	Architectural education studies
Generative AI as the main research topic	Energy, HVAC and facility management
Direct application to the architectural design process	Software architecture studies
Empirical evidence or methodological proposal	Generative AI as a secondary tool

The initial database search retrieved 402 records, including 352 from Scopus and 50 from Web of Science; after merging both databases, 45 duplicate records were identified and removed, resulting in 357 unique publications for title and abstract screening.

During the screening stage, titles, abstracts, and keywords were examined against the predefined eligibility criteria; this process led to the exclusion of 240 records because they did not address the research topic, corresponded to ineligible document types, or were outside the scope of architectural

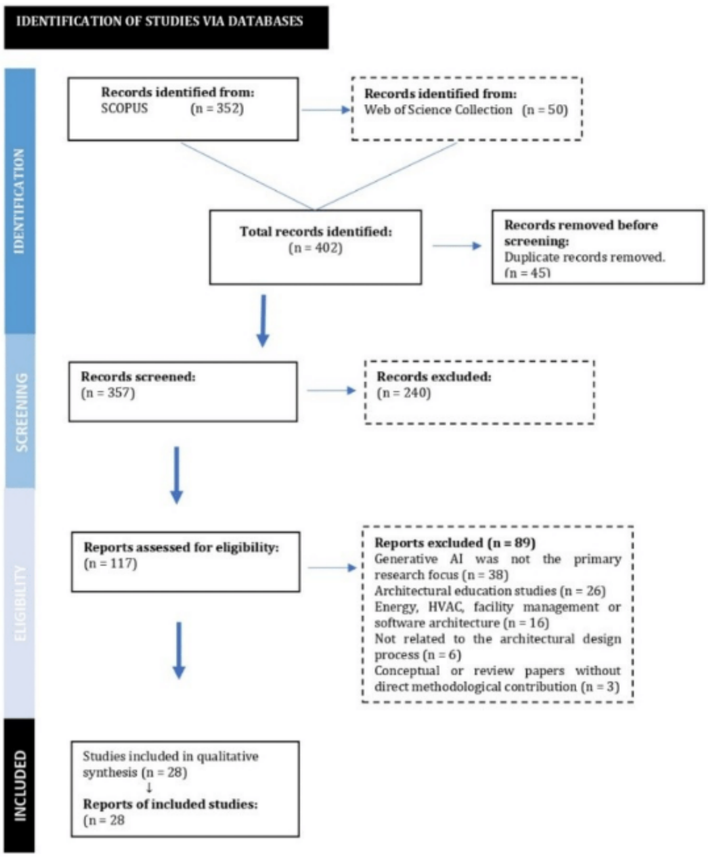

Figure 1: PRISMA 2020 flow diagram of the study selection process.

design; consequently, 117 publications advanced to the full-text eligibility assessment.

Full-text evaluation resulted in the exclusion of 89 studies; the principal reasons for exclusion included research in which Generative Artificial Intelligence was not the primary focus (n = 38), studies addressing architectural education ($n = 26$), publications related to facility management, HVAC systems, energy applications, or software architecture ($n = 16$), investigations not directly associated with the architectural design process ($n = 6$), and conceptual papers lacking empirical or methodological evidence ($n = 3$).

Following the eligibility assessment, 28 journal articles satisfied all selection criteria and constituted the final dataset analyzed in this review.

2.6. Data Extraction and Synthesis

A structured data extraction matrix was developed to ensure consistency throughout the qualitative synthesis; for each selected study, bibliographic information, methodological characteristics, GenAI technologies, architectural applications, design stages, human–AI interaction patterns, reported benefits, identified limitations, and principal research contributions were systematically recorded.

The extracted data were analyzed through an iterative thematic coding process; initial codes were assigned according to the architectural activity addressed by each study, considering the design task, GenAI technology, human–AI interaction, and reported contribution; after which codes with similar functional meanings were compared across the 28 studies and grouped into broader categories. These categories were progressively refined according to their role within the architectural design process, allowing individual studies to be associated with more than one design stage when applicable. Classification differences were discussed among the researchers until consensus was reached.

This process resulted in six thematic domains: problem definition, conceptual design, spatial configuration, design evaluation, architectural representation, and decision support. The conceptual framework was subsequently developed by integrating these thematic domains with the technological configurations and human–AI interaction patterns identified across the selected studies; thus, the framework represents a synthesis of recurring relationships observed in the reviewed literature rather than an independently validated predictive model.

Descriptive frequencies were calculated from the final coding matrix to indicate the number and proportion of studies associated with each thematic domain; because individual studies could address more than one design stage or technological component, categories were treated as non-mutually exclusive, and percentages were calculated using the 28 included studies as the denominator.

3. Results

3.1. General Characteristics of the Included Studies

The study selection process yielded a final dataset of 28 peer-reviewed journal articles that satisfied all predefined eligibility criteria established in the review protocol; these publications, released between 2024 and 2026, represent the current body of scientific evidence on the application of Generative Artificial Intelligence (GenAI) to the architectural design process. Although the search covered the 2022–2026 period, no publication year was excluded a priori; records published in 2022 and 2023 were considered during screening but did not satisfy the complete set of eligibility criteria; therefore, the temporal distribution of the final corpus reflects the eligible literature rather than an additional publication-date restriction. The temporal distribution of the selected studies reflects the rapid expansion of this research field following the emergence of foundation models, Large Language Models (LLMs), and diffusion-based image generation systems, which have substantially accelerated research and innovation in computational architectural design [21, 22].

The selected studies encompass a broad range of research methodologies; experimental investigations and methodological developments constitute the largest group, followed by case studies evaluating the implementation of GenAI in architectural design tasks and comparative analyses assessing the performance of different generative approaches; this methodological diversity illustrates that the field is still evolving, with significant emphasis placed on the development and validation of emerging AI-assisted design workflows.

Although the reviewed studies investigate different technologies and application domains, they share a common objective exploring how Generative Artificial Intelligence can support, augment, or transform one or more stages of the architectural design process; consequently, the selected literature provides an appropriate basis for identifying common technological trends, recurring application patterns, and emerging research directions.

3.2. Bibliometric Distribution of the Studies

The bibliometric analysis reveals a clear increase in scientific publications addressing the application of Generative Artificial Intelligence to architectural design during the review period; this trend closely follows the widespread adoption of foundation models and image-generation technologies, which have expanded the range of AI-assisted design applications available to researchers and practitioners.

Geographically, the reviewed studies originate predominantly from research institutions located in China, the United States, South Korea, Italy, Australia, Singapore, and the United Kingdom. These countries have emerged as leading contributors to research at the intersection of artificial intelligence, computational design, and the built environment [21, 23, 24, 25]; their strong representation reflects substantial investment in digital design technologies and interdisciplinary collaboration among architecture, engineering, and computer science researchers.

The journal distribution further demonstrates the maturity of this emerging field. Most publications appeared in Q1 journals, particularly those specializing in construction informatics, computational design, architectural computing, and building technologies; a smaller but significant number of studies were published in Q2 and Q3 journals, indicating that research on GenAI is rapidly expanding across multiple disciplinary communities.

The reviewed articles were published in journals including Automation in Construction, Building and Environment, Journal of Building Engineering, Architectural Science Review, International Journal of Architectural Computing, Journal of Computational Design and Engineering, Computers in Industry, Buildings, Applied Sciences, and Frontiers of Architectural Research; this diversity demonstrates that Generative Artificial Intelligence has become a multidisciplinary research topic extending beyond computational science into architectural theory, design methodology, digital representation, and professional practice.

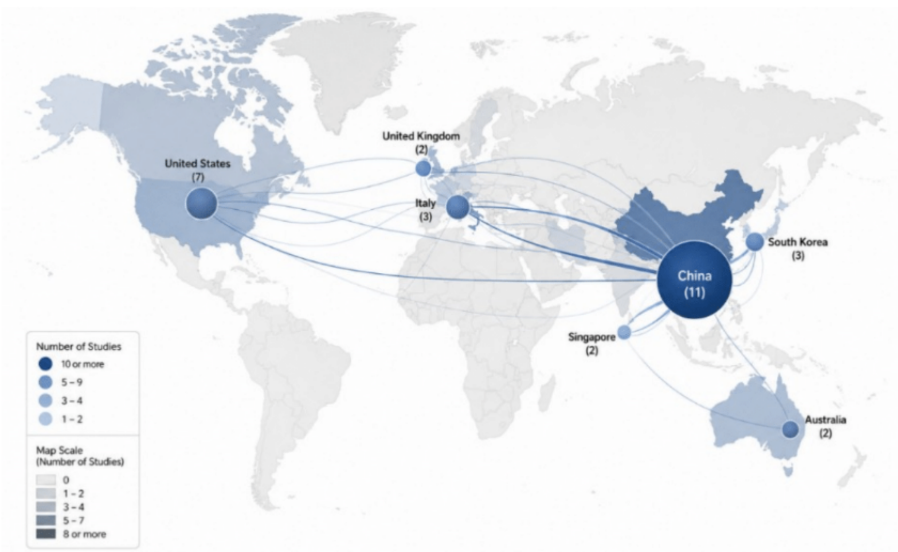

Figure 2: Distribution of studies by country.

Overall, the bibliometric evidence indicates that the scientific community has moved beyond exploratory discussions of AI in architecture toward empirical research focused on practical implementation, methodological innovation, and the integration of Generative Artificial Intelligence into architectural design workflows.

3.3. Generative AI Technologies Identified

The reviewed studies demonstrate that Generative Artificial Intelligence (GenAI) has evolved into a diverse technological ecosystem supporting multiple activities within the architectural design process; across the reviewed studies, four recurrent technological approaches were identified: Large Language Models (LLMs), diffusion models, multimodal AI systems, and agentic AI [21, 22]. These approaches should not be interpreted as equivalent technological categories, since they operate at different levels of GenAI systems; LLMs and diffusion models represent underlying generative models, multimodal AI refers to the integration of different input and output modalities, while agentic AI describes a higher degree of autonomy and orchestration within the design workflow; as summarized in Figure 3 summarizes their presence across the reviewed literature.

LLMs are primarily employed for interpreting design requirements, supporting conceptual reasoning, retrieving architectural knowledge, and facilitating natural language interaction between architects and AI systems [26, 27, 28, 29, 30, 31]; diffusion models constitute the dominant technology for architectural visualization and spatial generation, enabling the automatic production of floor plans, façades, renderings, and three-dimensional architectural forms from textual or graphical inputs [21, 24, 32, 33, 34, 35, 36, 37].

The literature also reveals an increasing adoption of multimodal AI, which integrates text, images, sketches, and 3D models within unified design workflows, thereby enhancing collaborative interaction between architects and intelligent systems [38, 39, 40, 41, 42, 22]; more recently, agentic AI has emerged as a promising research direction, introducing autonomous multi-agent environments capable of coordinating reasoning, content generation, and decision support during architectural design [27, 43, 30, 22].

Figure 3: Main Generative AI technological approaches identified in the reviewed studies.

Table 3
Generative AI technologies identified in the reviewed studies.

Technology	Primary Architectural Applications	Representative Studies
Large Language Models (LLMs)	Requirement interpretation, conceptual reasoning, conversational design assistance.	[26], [27], [28], [29], [30], [31]
Diffusion Models	Floor-plan generation, façade synthesis, rendering, spatial configuration.	[21], [24], [32], [33], [34], [35], [36], [37]
Multimodal AI	Text–image interaction, sketch-based design, multimodal collaboration.	[38], [39], [40], [41], [42], [22]
Retrieval-Augmented Generation (RAG)	Knowledge-assisted architectural reasoning and contextual information retrieval	[27], [43], [30]
Agentic AI	Autonomous collaborative design workflows and multi-agent coordination	[43], [30], [22]

3.4. Applications of Generative AI Across the Architectural Design Process

The thematic analysis indicates that Generative Artificial Intelligence is currently applied throughout several stages of the architectural design process, although research activity is concentrated in the early phases of design; based on the reviewed evidence, six principal application domains were identified: problem definition, conceptual design, spatial configuration, design evaluation, architectural representation, and decision support. During problem definition, LLM-based systems assist architects in interpreting design briefs, organizing project requirements, and retrieving contextual knowledge [27, 43, 30]; represents one of the most extensively investigated domains, where conversational AI and diffusion models support idea generation, creative exploration, and rapid production of conceptual alternatives [26, 44, 28, 42, 31].

Applications related to spatial configuration include automatic generation of floor plans, building layouts, three-dimensional forms, and architectural massing through diffusion-based and multimodal approaches [39, 24, 32, 33, 34, 35, 36, 22]; in contrast, design evaluation remains a relatively emerging research area, mainly focusing on daylight analysis, accessibility assessment, and preliminary performance evaluation of AI-generated solutions [21, 25, 37].

Architectural representation constitutes one of the most mature application domains, where diffusion models enable the rapid generation of renderings, façades, and visualizations that improve communication during early design stages [40, 45, 25, 42, 46]; finally, decision support has recently incorporated LLMs, Retrieval-Augmented Generation, and agentic AI to assist architects in design reasoning, knowledge retrieval, and collaborative decision-making [27, 43, 30, 22].

GenAI applications were unevenly distributed across the architectural design process (Table 4); spatial configuration was the most frequently addressed domain ($n = 16; 57.1\%$), followed by conceptual design ($n = 15; 53.6\%$) and architectural representation ($n = 9; 32.1\%$). Decision support accounted for six studies (21.4%), while problem definition and design evaluation were each identified in five (17.9%); overall, the evidence indicates that current research is concentrated primarily on the generation and exploration of design alternatives [21, 22].

3.5. Human–AI Interaction Patterns

One of the most consistent findings across the reviewed studies is the progressive transition from AI-assisted automation toward collaborative human–AI design workflows; rather than replacing architects, Generative Artificial Intelligence is predominantly employed as a cognitive support system that

Table 4
Applications of Generative AI across architectural design stages.

Design Stage	Main Applications	n	%
Problem definition	Brief interpretation, contextual analysis, requirements	5	17.9
Conceptual design	Ideation, creativity support, concept generation	15	53.6
Spatial configuration	Floor plans, layouts, 3D configuration	16	57.1
Design evaluation	Performance assessment, simulation, optimization	5	17.9
Architectural representation	Rendering, façade generation, visualization	9	32.1
Decision support	Knowledge support, comparison, conversational assistance	6	21.4

complements human creativity, facilitates iterative exploration, and assists decision-making throughout the architectural design process [21, 22]. The reviewed literature indicates that architects continue to define design objectives, interpret contextual constraints, evaluate alternatives, and make final design decisions, whereas GenAI primarily contributes to content generation, knowledge retrieval, visualization, and rapid exploration of multiple design solutions; this collaborative model was consistently observed across applications involving Large Language Models, diffusion models, multimodal systems, and agentic AI.

Several studies also report a gradual evolution toward conversational and multimodal interaction, enabling architects to communicate with AI systems through natural language, sketches, images, and three-dimensional representations [38, 40, 41, 42, 30]; more recent investigations further introduce agentic AI, where multiple intelligent agents cooperate autonomously to retrieve information, generate alternatives, evaluate solutions, and support iterative design refinement [27, 43, 30, 22].

3.6. Thematic Synthesis of the Evidence

The thematic synthesis integrates the findings of the reviewed studies into a unified conceptual perspective on the role of Generative Artificial Intelligence within the architectural design process; despite the diversity of technologies and methodological approaches, the evidence reveals a common trend toward the progressive integration of GenAI into multiple design activities rather than its application to isolated computational tasks.

Across the reviewed literature, six thematic domains consistently emerged: problem definition, conceptual design, spatial configuration, design evaluation, architectural representation, and decision support; together, these domains describe the current scope of GenAI applications and demonstrate that research has evolved from experimental image generation toward increasingly comprehensive design environments capable of supporting reasoning, visualization, and collaborative decision-making.

The review also indicates that the maturity of GenAI applications varies considerably among design stages; spatial configuration, conceptual design, and architectural representation constitute the most developed research areas, whereas design evaluation and decision support remain emerging fields requiring further empirical validation and technological integration.

Based on this synthesis, the reviewed evidence supports the development of a Conceptual Framework for the Transformation of the Architectural Design Process through Generative Artificial Intelligence, which organizes current applications according to the sequence of architectural design activities. Rather than classifying technologies in isolation, the framework emphasizes how different GenAI approaches contribute to specific stages of the design process, providing an integrated perspective that links technological innovation with architectural practice.

Rather than constituting mutually exclusive technology classes, these approaches frequently overlap within the same architectural workflow; their interaction is therefore examined through a layered technological structure in the conceptual framework presented in Figure 4.

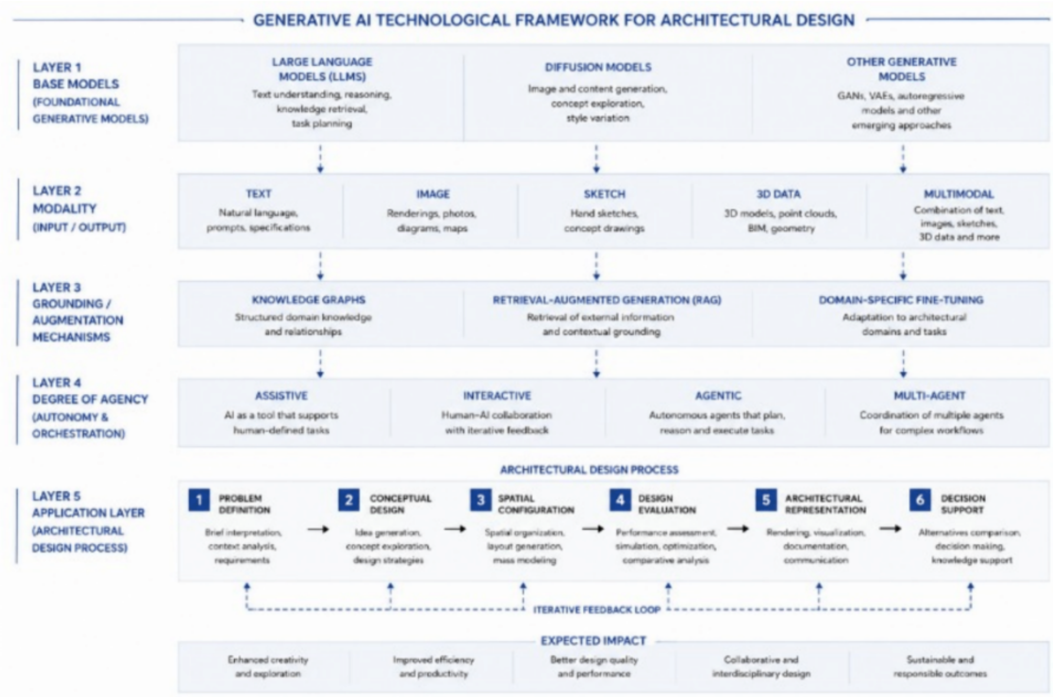

Figure 4: Layered technological framework for the integration of Generative AI into the architectural design process.

4. Discussion

4.1. Interpretation of the Main Findings

The findings of this systematic literature review indicate that Generative Artificial Intelligence (GenAI) is reshaping the architectural design process by extending computational support beyond visualization and representation toward reasoning, spatial generation, and collaborative decision-making; the reviewed evidence demonstrates that recent advances in Large Language Models (LLMs), diffusion models, multimodal AI, and agentic AI have significantly broadened the scope of AI-assisted design, enabling intelligent systems to participate in multiple stages of architectural projects rather than performing isolated computational tasks [21, 22].

A major finding concerns the uneven distribution of GenAI applications across the architectural design process; most studies focus on conceptual design, architectural representation, and spatial configuration, where generative models have already demonstrated considerable maturity and practical applicability. In contrast, applications related to design evaluation, technical documentation, and decision support remain comparatively underdeveloped. This imbalance suggests that current research prioritizes the enhancement of creative exploration and visualization, while the integration of GenAI into evidence-based evaluation and project delivery still requires substantial methodological development.

4.2. Comparison with Previous Research

The results identified in this review are consistent with the broader evolution of Artificial Intelligence in architecture while also highlighting significant differences between traditional AI applications and recent developments in Generative Artificial Intelligence.

Earlier AI research primarily addressed optimization problems associated with structural engineering, environmental simulation, energy performance, and computational analysis; these approaches relied predominantly on expert systems, artificial neural networks, evolutionary algorithms, and machine-learning techniques designed to improve predefined performance indicators [1, 3, 9]. Although these methods substantially contributed to performance-driven architectural design, they rarely participated directly in creative reasoning or conceptual development.

In contrast, the studies reviewed here demonstrate that contemporary GenAI systems increasingly support activities traditionally associated with human creativity, including concept generation, architectural representation, spatial organization, and collaborative design reasoning [26, 27, 44, 42, 30]; this transition represents a fundamental shift from computational optimization toward computational co-creation, where intelligent systems actively contribute to the exploration of design alternatives while architects retain responsibility for interpretation, evaluation, and decision-making.

4.3. Human–AI Collaboration in Architectural Design

One of the most significant findings emerging from this review concerns the transformation of the relationship between architects and intelligent systems; across the reviewed studies, Generative Artificial Intelligence consistently functions as a collaborative design partner rather than an autonomous replacement for professional expertise [21, 22].

Current evidence indicates that architects continue to perform those activities requiring contextual understanding, critical judgment, ethical responsibility, and creative evaluation, whereas AI systems primarily contribute by generating alternatives, retrieving information, supporting visualization, and facilitating iterative exploration; this complementary distribution of responsibilities reflects the emergence of human–AI co-creation, where design knowledge results from continuous interaction between computational capabilities and human expertise.

Several studies further demonstrate that multimodal interfaces and conversational AI significantly improve this collaborative process by allowing architects to communicate with intelligent systems through natural language, sketches, images, and digital models [38, 40, 41, 42, 30]; more recent research extends this paradigm through agentic AI, where specialized intelligent agents cooperate to retrieve knowledge, generate design alternatives, evaluate performance, and coordinate design workflows with limited human intervention [27, 43, 30, 22].

These developments suggest that the future of architectural design is unlikely to be characterized by the automation of professional practice; instead, emerging evidence supports a collaborative model in which Generative Artificial Intelligence augments architectural expertise while preserving human responsibility for creative judgment and decision-making.

Table 5
Comparison between traditional AI and Generative AI in architectural design.

Characteristic	Traditional AI	Generative AI
Primary objective	Optimization and prediction	Content generation and design assistance
Main technologies	Neural networks, evolutionary algorithms	LLMs, diffusion models, multimodal AI
Design role	Analytical support	Collaborative design partner
Human interaction	Limited	Conversational and iterative
Design contribution	Performance optimization	Creativity, reasoning, visualization and decision support

4.4. Scientific and Professional Implications

The findings of this review have important implications for both architectural research and professional practice; from a scientific perspective, the reviewed evidence demonstrates that Generative Artificial Intelligence has evolved beyond isolated experimental applications into an emerging research domain that integrates computational design, artificial intelligence, and architectural knowledge. The rapid increase in publications between 2024 and 2026 confirms that GenAI has become a major research topic within architecture, supported by continuous advances in foundation models, multimodal systems, and autonomous AI agents [21, 22].

From a professional standpoint, the reviewed studies indicate that Generative Artificial Intelligence is progressively becoming part of everyday architectural workflows; current applications demonstrate significant potential to accelerate conceptual exploration, improve communication through AI-assisted visualization, facilitate the generation of alternative design solutions, and enhance collaborative decision-making [26, 27, 40, 42, 30]. Rather than replacing professional expertise, these technologies augment architects' cognitive capabilities by reducing repetitive tasks and expanding opportunities for creative exploration.

The review also highlights the increasing importance of multidisciplinary collaboration among architects, computer scientists, engineers, and data scientists; future design environments will likely require professionals capable of integrating architectural knowledge with artificial intelligence, computational design, and digital information management. Consequently, the adoption of GenAI should be understood not only as a technological innovation but also as a transformation of professional design practice.

4.5. Research Gaps and Future Research Directions

Despite the rapid development of Generative Artificial Intelligence in architecture, the reviewed literature reveals several research gaps that require further investigation; first, most existing studies concentrate on conceptual design, architectural representation, and spatial generation, whereas comparatively limited attention has been devoted to detailed design development, technical documentation, regulatory compliance, and post-design evaluation [21, 22].

A second limitation concerns the relatively limited integration between Generative Artificial Intelligence and established digital design environments, particularly Building Information Modeling (BIM), digital twins, and simulation platforms; although a few studies combine generative models with daylight analysis, accessibility assessment, or environmental simulations [21, 25, 37], comprehensive AI-assisted workflows spanning the entire project lifecycle remain largely unexplored.

The review also identifies the need for greater attention to explainability, transparency, and ethical considerations in AI-assisted architectural design; as intelligent systems become increasingly capable of generating design proposals and supporting professional decisions, understanding how recommendations are produced becomes essential for ensuring accountability, reliability, and trust in architectural practice. These issues remain insufficiently addressed in current empirical research.

Another emerging research direction concerns the development of agentic AI capable of coordinating multiple specialized agents throughout complex architectural workflows; current investigations suggest that autonomous reasoning, collaborative planning, and task coordination may substantially expand the role of AI in architecture; however, empirical validation in real-world professional projects remains limited [27, 43, 30, 22].

Future research should therefore prioritize the integration of GenAI with BIM environments, performance-based simulation, explainable artificial intelligence, regulatory compliance, and interdisciplinary collaborative platforms; longitudinal case studies involving professional architectural practice will also be essential to evaluate the practical impact of these technologies on design quality, productivity, and decision-making.

4.6. Proposed Conceptual Framework

Based on the thematic synthesis, the technological components identified in the reviewed studies were reorganized into a layered framework (Figure 4); rather than treating LLMs, diffusion models, multimodal systems, and agentic AI as equivalent technological categories, the framework distinguishes their different roles within GenAI-supported architectural design; thus five interconnected layers are considered: base models, modality, grounding and augmentation mechanisms, degree of agency, and application within the architectural design process, this structure reflects how different technological components can be combined within the same design workflow [21, 22]. The layers should be understood as complementary dimensions of technological configuration rather than as a mandatory sequential pipeline.

Unlike existing classifications that focus primarily on specific AI techniques, the proposed framework organizes Generative Artificial Intelligence according to its contribution to successive stages of the architectural design process; six interconnected domains are identified: problem definition, conceptual design, spatial configuration, design evaluation, architectural representation, and decision support. These domains are supported by interrelated technological components Large Language Models (LLMs), diffusion models, multimodal AI, and agentic AI which interact throughout iterative design workflows.

The framework conceptualizes GenAI as a cognitive collaborator rather than a replacement for architectural expertise; within this model, architects remain responsible for defining design objectives, interpreting contextual constraints, exercising professional judgment, and making final design decisions, while AI systems contribute through reasoning support, content generation, visualization, information retrieval, and iterative exploration of alternative solutions [21, 22].

By adopting a process-oriented perspective, the framework illustrates how different AI technologies complement one another rather than functioning as isolated computational tools; this integrated representation provides a theoretical foundation for understanding the ongoing transformation of architectural design and offers a reference model for future empirical studies, methodological developments, and professional implementation.

At the foundational level, LLMs, diffusion models, and other generative models provide the main reasoning and generation capabilities; the second layer describes the modalities through which architectural information is exchanged, including text, images, sketches, 3D data, and multimodal combinations; the third layer incorporates grounding and augmentation mechanisms, such as knowledge graphs, retrieval-augmented generation (RAG), and domain-specific fine-tuning; finally, the fourth layer distinguishes the degree of agency, ranging from assistive and interactive systems to agentic and multi-agent configurations. These technological layers converge in the application layer, where GenAI supports one or more of the six architectural design stages identified through the thematic synthesis [21, 22].

5. Conclusion

This study presented a Systematic Literature Review (SLR) on the application of Generative Artificial Intelligence (GenAI) throughout the architectural design process; following the PRISMA 2020 guidelines, the review systematically analyzed 28 peer-reviewed journal articles published between 2024 and 2026 and indexed in Scopus and Web of Science. The review provides an up-to-date synthesis of the rapidly evolving body of knowledge at the intersection of Generative Artificial Intelligence and architectural design.

The findings demonstrate that Generative Artificial Intelligence is progressively transforming architectural practice by extending computational support beyond visualization and image generation toward conceptual reasoning, spatial configuration, collaborative decision-making, and knowledge-assisted design; four major technological families Large Language Models (LLMs), diffusion models, multimodal AI, and agentic AI were identified as the principal technologies currently driving innovation in AI-assisted architectural design [21, 22].

The thematic synthesis further revealed six principal application domains: problem definition, conceptual design, spatial configuration, design evaluation, architectural representation, and decision support; among these, conceptual design and architectural representation constitute the most mature areas of research, whereas applications involving design evaluation, BIM integration, explainable AI, and autonomous collaborative workflows remain at earlier stages of development. These findings suggest that current research is primarily focused on enhancing creativity and early-stage design exploration, while opportunities remain for expanding the application of GenAI throughout the complete architectural project lifecycle.

A central contribution of this study is the proposed Conceptual Framework for the Transformation of the Architectural Design Process through Generative Artificial Intelligence; unlike previous reviews that classify research according to specific computational techniques, the proposed framework organizes current evidence around the sequential stages of the architectural design process. This process-oriented perspective provides a more comprehensive understanding of how different Generative AI technologies support architectural activities and establishes a conceptual foundation for future research and professional implementation.

The review also demonstrates that Generative Artificial Intelligence should not be interpreted as a substitute for architectural expertise; instead, the available evidence consistently supports a collaborative human–AI paradigm, in which architects retain responsibility for design judgment, contextual interpretation, ethical considerations, and final decision-making, while intelligent systems contribute through reasoning support, rapid generation of alternatives, visualization, and information retrieval. This complementary relationship reinforces the role of AI as a cognitive collaborator capable of augmenting, rather than replacing, human creativity and professional expertise.

Despite the rapid expansion of research in this field, several challenges remain unresolved. Future investigations should prioritize the integration of Generative Artificial Intelligence with Building Information Modeling (BIM), digital twins, simulation-based performance assessment, explainable AI, and regulatory compliance; furthermore, longitudinal studies involving professional architectural practice will be essential to evaluate the long-term impact of GenAI on design quality, productivity, collaboration, and decision-making.

Overall, this review contributes to the growing body of knowledge on Artificial Intelligence in architecture by providing a rigorous synthesis of current scientific evidence and proposing a structured conceptual framework that may guide future research, technological development, and the responsible integration of Generative Artificial Intelligence into architectural design practice.

Declaration on Generative AI

During the preparation of this work, the authors used generative artificial intelligence tools as support for organizing ideas, reviewing the writing, and improving the clarity of the text. The authors subsequently reviewed, edited, and verified the resulting content and assume full responsibility for the accuracy, integrity, and final content of the manuscript.

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