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Exploring the Impact of Artificial Intelligence on Urban Design

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Keywords
Artificial Intelligence, Urban Design, AI Tools Plan Finder, Test Fit, and Luma.

Abstract: This study examines the impact of artificial intelligence (AI) on urban design through an experimental evaluation of three tools—PlanFinder, TestFit, and Luma. Each tool was tested under simulated conditions to assess performance in terms of accuracy, speed, usability, flexibility, output quality, and software integration. Findings reveal that AI tools significantly enhance workflow efficiency, creativity, and communication in urban planning, while also presenting challenges such as data dependency and limited customization. This research offers practical insights for designers and planners aiming to adopt AI-driven solutions in the built environment.

1. Introduction

Artificial intelligence has brought a major transformation to the field of architecture, particularly in urban design methodologies. As its adoption increases, AI is playing a crucial role in city planning by equipping architects and urban planners with advanced tools that help them tackle challenges, develop innovative solutions, and make more efficient decisions. Today, AI is utilized across various domains, including energy efficiency, environmental sustainability, and urban development. AI has significantly influenced how spaces are structured and designed. By processing vast amounts of data, it assists architects in optimizing layouts in ways that would be difficult to achieve manually. Intelligent algorithms can analyse spatial relationships and propose designs that align with user requirements and energy efficiency standards.

One of the most prominent areas where AI has made a substantial impact is urban design, where advanced applications, such as AI-powered image generators, enable the creation of innovative architectural forms that enhance creativity. Additionally, AI contributes to sustainable architecture by optimizing energy consumption and predicting future demands. Furthermore, integrating AI into architectural education provides students with opportunities to explore new design concepts and engage in innovative sustainability projects, fostering collaboration between disciplines such as architecture, data science, engineering, and urban design. Despite these numerous advantages, challenges remain, particularly concerns about AI potentially replacing human workers. Therefore, it is essential to perceive AI as a tool that enhances

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human creativity rather than a substitute for professionals. Additionally, its application requires greater transparency to prevent biases that could negatively impact urban designs or disadvantage certain social groups.

In urban design, AI has become a key instrument in developing cities that are more sustainable and adaptable to climate change. By analysing data and simulating the outcomes of various planning scenarios, AI aids urban planners in identifying optimal solutions for challenges such as traffic management, land use, and pollution reduction.

2. Research Objectives

The primary objectives of this study are to:

- Explore how artificial intelligence applications are transforming urban design processes.
- Examine the specific functions of AI tools—Plan Finder, Test Fit, and Luma—in supporting architects and urban planners.
- Evaluate the benefits and real-world applications of these tools in building design, urban design, and architectural visualization.
- Identify the challenges and ethical considerations associated with the integration of AI in the design field

3. Research Methodology

This study adopts an experimental research methodology to evaluate the practical performance and design impact of three AI-powered tools: Plan Finder, Test Fit, and Luma. The research is grounded in applied experimentation, where each tool was tested under controlled, simulated design conditions reflecting real-world applications in urban planning and architecture. The methodology involved five structured phases) Figure.1):

1- Tool Selection

Tools were selected based on three key criteria:

- Their relevance and adoption in the architectural design market,
- The level of artificial intelligence integration,
- Their specialization across different design functions (layout generation, site planning, and visualization).
- This selection ensured a balanced representation of AI capabilities across the design spectrum.

2- Experimental Case Development

Customized case studies were developed to simulate practical scenarios in architectural and urban design contexts. These case studies served as experimental environments, allowing for consistent testing conditions across tools.

3- Experimental Implementation

- Each tool was applied to its corresponding case study. During implementation, the independent variable was the AI tool used (Plan Finder, Test Fit, or Luma), while dependent variables included speed, output quality, design accuracy, and user experience. Observational data and performance metrics were recorded during each experimental trial.

4- Performance Measurement

Each tool was evaluated using the following performance indicators:

- Accuracy of design output based on user input
- Speed of generation or rendering
- Usability from a user interaction perspective
- Flexibility in customization and iteration
- Output quality for professional or presentation use
- Software integration with other design platforms and workflows

5- Data Analysis

- A comprehensive analysis was conducted using a multi-criteria evaluation matrix, SWOT analysis, and expert reviews. Additional data were gathered through user feedback surveys, enabling qualitative insights into the perceived effectiveness and usability of each tool.
- This experimental approach allowed for the systematic comparison of AI tools under equivalent conditions, providing actionable insights into their capabilities, limitations, and potential contributions to innovation in the built environment.

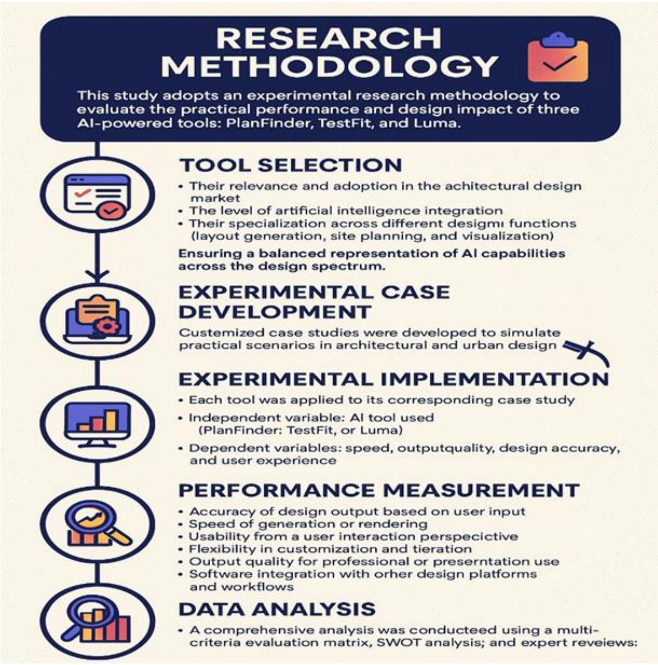


Fig.1: Research Methodology

4. How Artificial Intelligence Works

Artificial Intelligence (AI) functions by processing large datasets through mathematical algorithms and computational models that simulate human learning and decision-making. It employs various machine learning techniques—including supervised, unsupervised, and reinforcement learning—to detect patterns, generate predictions, and improve performance over time. Central to AI are neural networks, which mimic the structure of the human brain. These networks process data through interconnected layers, progressively refining information to deliver accurate outputs. AI-driven decision-making involves analyzing input data, identifying trends, and continuously adapting through new experiences. To address concerns about transparency and trust, Explainable AI (XAI) has emerged as a critical subfield, aiming to make AI decision processes more interpretable and understandable to users. Today, AI applications span a wide range of sectors, including architecture and urban design, healthcare, finance, and autonomous systems—driving enhanced efficiency, automation, and innovation across industries. (Ertel.2024).

Basic input data—including site boundaries and 3D models—were utilized to initiate the testing process. Real-time observations were conducted to evaluate each tool's speed and accuracy in generating outputs. For example, **Test Fit** was employed to develop a site plan in accordance with regulatory constraints. **Plan Finder** was assessed for its capability to produce multiple design alternatives based on inputted spatial parameters. In parallel, **Luma** was tested for its ability to generate animated visualizations that effectively convey the design concepts of architects and urban planners. (Ali et al.2023) This comprehensive approach enabled a thorough evaluation of AI tools in real-world applications, highlighting both their limitations and advantages. The goal of these case studies is to provide architects and urban planners with guidance on effectively integrating AI into their workflows. (Ertel 2024).

Artificial Intelligence (AI) processes data through advanced computing power and mathematical models, aiming to simulate human learning and decision-making. It operates using algorithms—structured sets of rules—that enable the analysis of data and the generation of informed decisions. These algorithms are capable of identifying patterns and relationships within datasets, allowing AI not only to interpret complex information but also to generate new outputs derived from the patterns it. (Liang et al. (2024)).

- **The Core of AI**

At the heart of AI lies machine learning (ML). Instead of relying on explicit instructions, machine learning allows computers to learn from examples. Large datasets are used to train AI models, helping them recognize specific features. For instance, if an AI system is exposed to numerous images of cats, it learns to identify a cat in a new image based on previously detected patterns. (Ertel 2024) .

- **The Foundation of AI Learning**

A critical component of AI learning is the neural network, which functions in a manner analogous to the human brain. These networks are composed of multiple layers of interconnected "neurons" that collaboratively process information. Each layer incrementally reduces the complexity of the input data, enabling the system to more effectively identify patterns and relationships within the analysed information. (Yussuf & Asfour 2024)

- **AI (XAI): Enhancing Transparency**

AI systems are becoming increasingly interpretable and transparent with the advancement of Explainable AI (XAI). The primary objective of XAI is to demystify how AI systems arrive at their conclusions, thereby making the underlying decision-making processes comprehensible to human users. This transparency is essential for building user trust, as individuals seek to understand the rationale behind AI-generated predictions or decisions. XAI tools offer valuable insights into these processes, supporting greater accountability and enhancing the reliability of AI-driven systems. (Ko et al. 2023)

5. AI Decision-Making Process

As illustrated in) Figure.2), AI functions through a structured sequence of algorithms and data-processing stages to generate predictions and support decision-making. By adhering to this systematic approach, AI continues to evolve—enhancing its capacity to contribute across various domains, including design, urban design, automation, and complex problem-solving. Table 1 presents a comparative overview of the features and capabilities of the evaluated AI tools. (Ko et al. 2023).

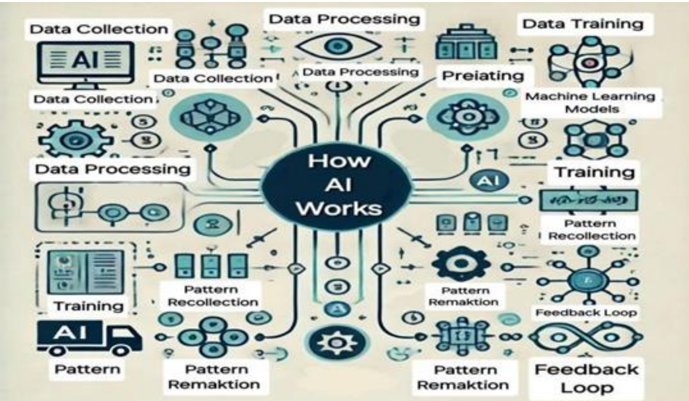


Figure 2 Illustrating how AI functions

The table below provides a comparative analysis of the AI tools assessed, emphasizing their input requirements, output formats, and processing times.(Almaz et al.2024)

Feature	Plan Finder	Test Fit	Luma
Required Inputs	▪ Space dimensions, room details	▪ Site boundaries, zoning criteria	▪ 3D models, initial sketches
Output Format	▪ Multiple design variations	▪ 2D/3D site plans	▪ Realistic animated renderings
Processing Time	▪ Approximately 20-25 seconds	▪ Around 30 seconds	▪ Ranges from 10 to 30 minutes

6. AI Platforms for Urban Design

6.1. Plan Finder AI

Designing a building layout or urban design a space traditionally requires significant time and effort, often involving multiple iterations. Architects and planners typically spend hours or even days refining a design that is both functional and aesthetically pleasing. Plan Finder is an AI-powered tool designed to streamline this process, making it faster, simpler, and more efficient. It is accessible to users with limited design experience while remaining valuable for professionals. By entering basic details, users can instantly generate a layout to work with. (Almaz et al. (2024).

To use Plan Finder, users must provide fundamental details about their project, such as space dimensions, the number of rooms, and specific requirements. During testing, we entered only the external wall layout into the application, and the results were impressive. The first layout was generated in just 20 seconds, with additional options following in 25 seconds. In total, four complete layouts were produced within seconds, demonstrating the tool's efficiency. (Ko et al.2023) One of the most significant advantages of Plan Finder is its speed. Traditional building design involves extensive trial and error, but AI automation significantly reduces the time spent experimenting. The system rapidly selects optimal configurations from multiple possibilities, allowing users to obtain a fully developed layout within seconds instead of spending hours or days refining a single concept. This tool is suitable for users at different levels of design expertise. Beginners can create functional layouts without requiring advanced architectural knowledge, while professionals can use it to expedite the initial stages of a project. (Figure.2).Plan Finder is not just for amateurs it serves as a powerful resource for experienced designers looking to accelerate their workflow. (Ko et al.2023)

A standout feature of Plan Finder is its customization flexibility. Users are not limited to AI-generated designs they can modify the layout, adjust room sizes, or relocate spaces as needed. This ensures the final design meets their specific requirements while maintaining the efficiency of AI automation. Beyond speed and efficiency, Plan Finder is revolutionizing the design process by making professional-grade urban design more accessible. Traditionally, creating high-quality layouts required specialized skills and experience. Now, with Plan Finder, individuals without architectural expertise can generate professional-looking designs. This shift is democratizing the design process, bridging the gap between experts and non-professionals. While Plan Finder offers significant benefits, it also has certain drawbacks: (Ertel.2024).

- **Precision in External Wall Alignment:** One of the major challenges is the need for precisely aligned external walls. If walls or other foundational elements are even slightly misaligned, the tool may fail to generate accurate layouts. This can be frustrating for users unfamiliar with technical drawing, adding an extra step to the setup process.
- **Limited Customization:** While the tool accelerates layout creation, some design refinements may be restricted. Users might find that certain aesthetic preferences or detailed architectural elements cannot be fully customized within the platform. As a result, significant manual adjustments may be necessary, increasing the overall time and effort required.

- **Regional Design Bias:** Another notable limitation is Plan Finder’s primary focus on European design standards. Users in the United States or other non-European countries may encounter difficulties, as building codes, spatial planning norms, and regulatory requirements vary significantly. AI-generated layouts often follow European principles, meaning users may need to adjust designs to comply with local regulations.

Despite these challenges, Plan Finder remains a powerful tool for speeding up urban design processes and enhancing architectural accessibility, making it a valuable asset for designers at all levels**.** (Cudzik et al. 2024).

Example Urban Design for Experimental Area Plan Finder AI

To create a smart and efficient urban design that considers service distribution, density, circulation, and public spaces, leveraging AI tools to speed up decision-making and improve design quality. Analysis Steps Load the base map (200m × 200m site). Then Generate a grid urban network with pedestrian pathways and analyse the network using UNA to measure reach and connectivity. Use Plan Finder to distribute buildings and public services to Evaluate the output and suggest improvements.(Figure.3)

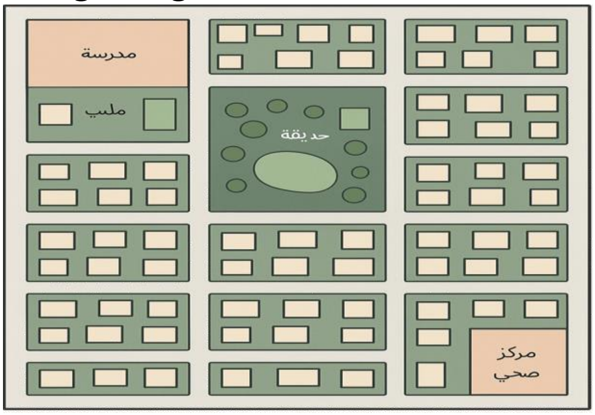
- **Urban Network Analysis Results**

Indicator:	Value:
– Reach (Nearby services reachable):	– 3 out of 4
– Closeness (Proximity to services):	– 0.72 (Very good)
– Between-ess (Movement concentration):	– 65% at the central pathway

- **Plan Finder Output**

- 10 residential buildings (3 floors each)
- A school in the north-west corner
- A healthcare centre in the south-east corner
- Central Park of 4,000 squares. Meter
- Children's play area near the school

- **Design Diagram**



- **Design Evaluation**

Item:	Evaluation:
– Green space	– 22%
– Population density per hectare	– 250 people/hectare
– Service accessibility	– 100% within 7 minutes’ walk
– Pathway congestion	– Low
– Suggested improvement	– Add a third entrance

Figure 3 Plans generated by Plan Finder based on initial input specifications (https://www.planfinder.xyz).

6.2. Test Fit AI

Test Fit AI is a tool designed to assist urban designers and planners in quickly creating community development plans. It is particularly useful for generating site plans for apartments, commercial areas, and other building types. Instead of manually drafting and testing layouts for extended periods, this tool enables users to create detailed plans within minutes. Additionally, it helps determine whether a project is feasible for a specific site while considering key factors such as costs and space utilization. (Cudzik et al.2024). One of the key advantages of Test Fit AI is its ease of use, making the design process faster and more intuitive. It does not require professional expertise, making it accessible to both experienced designers and beginners.

The first step in using Test Fit AI is to provide basic project details. Users must outline the site boundaries, which allows the program to determine the placement of buildings. Additional parameters, such as zoning regulations or parking space requirements, can also be specified. Once the data is entered, the software quickly processes the input and generates a suitable site plan. For instance, when designing a residential building, the tool can determine the required number of parking spaces, unit placements, and available space for pathways or green areas.

This entire process takes only a few seconds. Instead of spending hours or even days on drawings and calculations, users receive an instant, well-structured site plan. Additionally, they can test different design variations by modifying the input parameters and immediately seeing how those changes impact the layout (Yussuf & Asfour .2024).

Another exciting feature is that Test Fit AI can generate a 3D model of the design, which can be viewed directly in the software or exported as an SKP file for use in SketchUp, as demonstrated in (Figure 4&5) Test Fit AI offers several key benefits that enhance the design process (Cudzik et al.2024):

- Speed – Manually creating a site plan is often time-consuming and complex. Test Fit AI significantly reduces the required time by generating instant design solutions, streamlining the urban process.
- Cost Efficiency – The tool minimizes resource waste by optimizing space utilization. It can also calculate estimated project costs, providing developers with accurate financial projections for more effective budgeting.
- Flexibility – Test Fit AI is highly adaptable and supports a wide range of building types, including offices, commercial centres, high-rise towers, and residential units. Users can modify zoning regulations and design parameters, with the system automatically adjusting the layout accordingly.
- Enhanced Collaboration – The platform facilitates clearer communication among development teams by providing precise design outputs. This improves collaboration between architects, engineers, clients, and other stakeholders.
- User-Friendly Interface – Designed for accessibility, the software is intuitive even for users without prior experience in CAD or advanced design tools. The interface simplifies project data input and boundary definition.
- Efficient Modifications – Users can easily update project information at any stage. The tool promptly regenerates layouts, enabling exploration of multiple design alternatives without starting from scratch.

Despite its strengths, Test Fit AI presents several limitations (Yussuf & Asfour.2024). Complex Design Constraints – The software performs optimally with relatively simple layouts and may encounter difficulties when handling highly intricate or unconventional designs. For such complex projects, additional design tools may be necessary to refine or finalize the output. Dependence on Input Data – The accuracy and reliability of Test Fit AI are closely tied to the quality and completeness of the input data. Inaccurate or outdated information can result in suboptimal layouts. For example, if local zoning regulations are modified but not updated within the tool, the generated designs may become non-compliant with current legal standards. Nonetheless, despite these challenges, Test Fit AI remains a powerful resource for accelerating site planning, optimizing spatial efficiency, and enhancing decision-making in urban development projects.

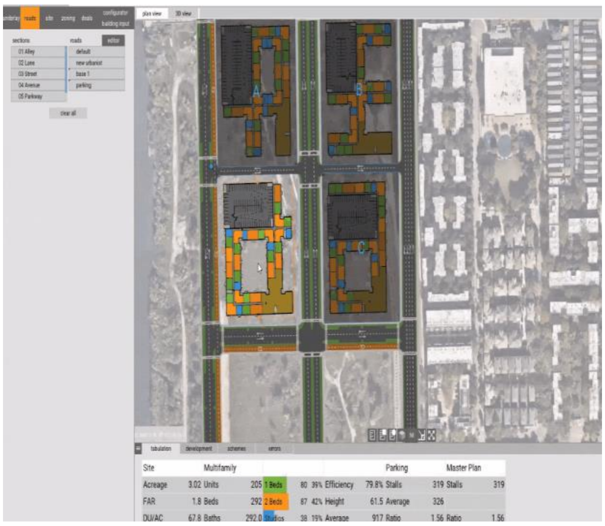


Figure 4 The designed site by Test Fit Ai. Source:(Test Fit. (n.d.)).

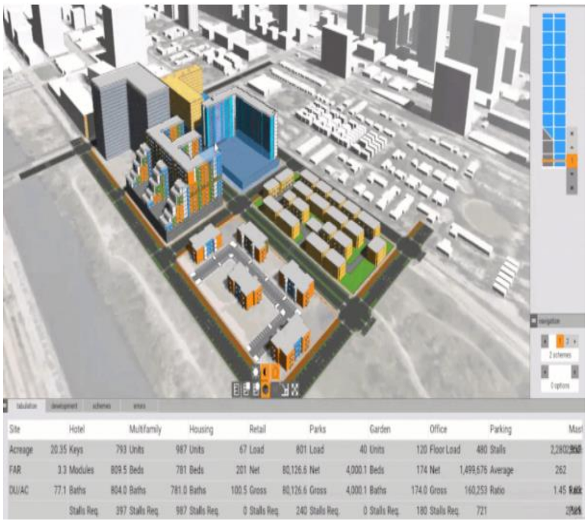


Figure 5 3D Model generated by Test Fit. Source:(Test Fit. (n.d.)).

6.3. Luma AI

Luma AI is an advanced tool designed to enhance visual storytelling in architecture and urban design. It enables designers and architects to create animated presentations of their projects easily using basic 3D models. In the past, generating high-quality renderings and animations required extensive effort and expensive software. However, with Luma AI, much of this process is automated, making it faster and more accessible to create realistic architectural animations. Luma AI is designed for ease of use. Designers upload their drawings or 3D models onto the platform, which can range from small buildings to entire city layouts. Once the model is uploaded, Luma AI transforms it into a lifelike animation, capturing essential elements such as street layouts, surrounding environments, and urban details. (Ali et al.2023). By incorporating natural lighting and shadows, Luma AI goes beyond basic animation—it brings designs to life by making models appear as realistic as possible. This allows viewers to better visualize the final product, whether it's an individual structure or a complete urban landscape. The animation process typically takes less than 10 minutes, but processing times can vary depending on AI usage levels. During peak hours, rendering may take longer. For example, in our project, it took 26 minutes to generate a 5-second animation. Extending the animation is simple users can input a command such as "extend to 15 seconds" to increase the duration. (Ali et al.2023).

Luma AI is an ideal solution for architects and urban designers, especially those who need to effectively communicate their project concepts. Architectural presentations require a realistic 3D format to showcase interior designs, building materials, and spatial relationships. Similarly, urban designers must be able to visualize neighbourhoods or entire communities, incorporating elements such as rooftops, streets, and lighting conditions to provide a comprehensive overview) Figure.6). Luma AI addresses these challenges by offering an intuitive and engaging way to illustrate complex ideas in a visually appealing manner.

Figure: 6 lumalabs.ai/capture example

Source: https://lumalabs.ai/capture/60167d98-b473-40fb-b176-856d9ff3c314

Advantages of Luma AI (Liang et al.2024).

- Enhances Presentations: Allows clients, city officials, and stakeholders to interact with animated, real-time visualizations, making designs more immersive and understandable.
- Simulates Lighting Conditions: Offers the ability to preview how structures appear at various times of the day, enhancing realism and improving lighting-related planning decisions.
- Timesaving: Automates animation production, drastically reducing the time required compared to traditional, manual animation methods.
- Cost-Effective: Eliminates the need for costly rendering software and professional animators by providing high-quality automated animations.
- Supports Design Exploration: Enables rapid prototyping and experimentation with different design options before committing to a final version.
- Boosts Creative Focus: Automates technical processes, giving designers more time and mental space to refine artistic and conceptual aspects of their work.

Disadvantages of Luma AI (Liang et al.2024):

- Reduced Precision: Automated outputs may lack the intricate detailing that professional animators can achieve manually, which could be problematic for highly complex architectural elements.
- Limited Customization and Control: Users may face constraints in adjusting specific parameters like texture realism, nuanced lighting effects, or tailored motion paths.

While Luma AI may not replace traditional animation in contexts requiring hyper-detailed customization, it streamlines the visualization process, lowers costs, and encourages design creativity, making it a powerful asset for architectural and urban design professionals.

7. Results and Discussion

7.1 The Impact of Three AI-Powered Tools on Architecture and Urban Design

The integration of artificial intelligence in architectural and urban design processes was evaluated through three specialized tools: **Plan Finder**, **Test Fit**, and **Luma**. Each tool was assessed based on its core function—architectural design, urban site design, and realistic visualization, respectively. Findings reveal that these tools can significantly accelerate design workflows and **enhance creative output**. Nonetheless, certain limitations persist, including the need for highly accurate input data and the inability to manage complex, large-scale projects efficiently.

7.1.1 Plan Finder: Efficiency urban design

Plan Finder exhibited notable efficiency in generating building layouts. Upon inputting basic parameters such as room dimensions and site boundaries, the tool could generate multiple complete layout options within seconds. For instance, when configured to develop a small residential unit, it produced four distinct layout options in under 30 seconds. This level of automation offers valuable support for novice designers, allowing them to produce professional-level plans with minimal prior experience. At the same time, it assists experienced architects in rapidly testing conceptual ideas. However, Plan Finder's output quality is highly dependent on precise input data. Minor inaccuracies in measurements—such as wall alignment or room dimensions—can lead to unusable or flawed designs, posing a challenge for less technically experienced users.

7.1.2 Test Fit: Enhancing Urban Site Planning

Test Fit was particularly effective in the context of urban site design, providing automated generation of residential or commercial site plans while incorporating factors like zoning laws, parking regulations, and cost estimations. One of the tool's strongest features is its ability to provide real-time feedback. For example, modifications to unit count or parking requirements are instantly reflected in the updated site layout. This feature allows for dynamic, iterative design. Nevertheless, Test Fit encountered difficulties when applied to complex, large-scale developments that required more nuanced spatial relationships. Its focus on structured and formulaic layouts may limit its flexibility in supporting diverse urban design needs.

7.1.3 Luma: Advancing Realistic Architectural Visualization

Luma excelled in transforming basic 3D architectural models into high-fidelity animated visualizations. In one test, the software converted a simple 3D sketch into a 10-second animation, complete with realistic lighting, shadows, and surface textures. This significantly

improved the presentation quality, allowing stakeholders to better engage with proposed designs.
Additionally, Luma's capability to simulate lighting conditions at different times of day added value by enabling more context-aware visualizations.
However, the tool faced two notable limitations:

- During periods of high server demand, rendering times increased substantially, with a 15-second animation taking over 20 minutes to complete.
- In designs requiring extreme detail or precision, Luma struggled to accurately capture intricate architectural elements.

Table 2: Observations from AI Tool Testing: A summary of key observations and performance insights for **Plan Finder, Test Fit, and Luma** is provided in the following table.

AI Tool	Key Findings	Conclusion
Plan Finder	Quickly generated four layouts within seconds but requires accurate input for reliable designs.	Highly effective for rapid design iterations.
Test Fit	Successfully integrated zoning regulations and cost analysis, though best suited for simpler site layouts.	Ideal for initial site feasibility assessments.
Luma	Produced high-quality animations, but rendering time increased during peak usage.	Enhances visual storytelling with minimal effort.

7.2 Advantages of AI in Design

Artificial intelligence has introduced transformative advantages to the fields of architecture and urban design, particularly in terms of speed, accessibility, and visual communication. One of the most notable benefits is the acceleration of the design process. Tasks that previously required hours—or even days—can now be completed within minutes, enabling designers to dedicate more time to refining ideas and exploring creative alternatives, rather than focusing on time-consuming preliminary work.
Moreover, AI-powered tools democratize the design process by accommodating users with varying levels of expertise. For instance:

- Plan Finder and Test Fit allow beginners to generate professional-grade layouts without the need for advanced technical skills. At the same time, experienced architects and urban planners can utilize these platforms to rapidly iterate and test design alternatives, streamlining their workflows.
- Luma significantly enhances visual communication by translating static models into realistic, animated presentations. This not only improves client engagement but also facilitates clearer understanding among stakeholders who may not be familiar with technical design language. By producing high-fidelity, time-aware animations, Luma helps bridge the gap between conceptual design and public perception.

These advantages collectively demonstrate how AI tools are not merely technical aids but are becoming essential components in modern, efficient, and inclusive design practices.

7.3 Limitations of AI Tools

Despite their benefits, these tools come with **clear limitations**.

- All three tools require highly accurate input data to function properly. Incorrect or missing data can lead to inaccurate results, requiring additional effort for corrections.

- These applications are better suited for practical, structured designs rather than highly complex or intricate architectural details.
- Plan Finder excels in basic layout generation but offers limited options for modifying aesthetic aspects.
- Test Fit is efficient in preliminary site planning but struggles with more intricate urban designs.
- Luma, while useful for creating animations, lacks the precision needed to represent fine details such as textured surfaces or material finishes.

7.4 Ethical and Social Concerns:

- The integration of AI in design raises several social and ethical concerns.
- Automation reduces reliance on human Labor, which may impact job opportunities for new designers.
- AI algorithms can be biased, potentially overlooking important cultural or social considerations. If an AI model is trained on data from a specific region, it may struggle to generate designs that are culturally or environmentally appropriate for other locations.

These issues highlight the importance of AI as a tool for enhancing human creativity rather than replacing it. Ensuring fair and unbiased AI models is crucial for responsible and inclusive urban design.

7.5 Improving Sustainability in Design

Findings suggest that AI can play a critical role in promoting sustainability in urban design.

- Test Fit optimizes land use, reducing resource waste by offering instant insights into zoning and cost considerations.
- Plan Finder allows designers to evaluate multiple layouts efficiently, leading to more sustainable spatial allocation.
- Luma's realistic visualizations help clients and communities understand the environmental benefits of sustainable architecture and urban development.

7.6 Future Developments and Priorities

To fully unlock the potential of AI in design, further improvements are necessary.

- Enhancing AI’s ability to manage complex designs will broaden its applicability across different architectural and urban design needs.
- Incorporating local building regulations and zoning codes into AI tools will ensure that generated designs are contextually accurate.
- Addressing ethical concerns such as algorithmic bias and job displacement should be a priority.
- AI developers must ensure transparency and inclusivity, making these tools accessible and beneficial for all users.

7.7 The Future of AI in Urban design

The future of artificial intelligence in urban design is poised for significant advancements, particularly through the integration of real-time environmental data and enhanced customization capabilities. As AI tools evolve, they are expected to play an increasingly central role in shaping responsive, data-driven urban environments that adapt to dynamic variables such as climate, traffic flow, and population density. To ensure the ethical and effective deployment of these applications, interdisciplinary collaboration will be essential. Architects, urban planners, data scientists, and ethicists must work together to develop AI frameworks that prioritize sustainability, inclusivity, and community well-being. Additionally, future educational curricula should emphasize the responsible use of AI in design education. Rather than viewing AI as a replacement for human ingenuity, programs should highlight its potential to augment creativity and enhance decision-making. Designers must be equipped with the technical and ethical literacy needed to navigate the evolving AI landscape, ensuring that innovation is aligned with societal and environmental values.

8. Conclusions

This research highlights the growing impact of artificial intelligence in the architecture and urban design sectors, demonstrating how AI-driven tools are reshaping conventional workflows, enhancing efficiency, and expanding creative possibilities. While the study specifically examined Plan Finder, Test Fit, and Luma, the findings reveal broader insights that are applicable across a wide range of AI applications in the built environment. Key outcomes suggest that AI applications:

- Accelerate design processes, reducing the time needed for ideation, drafting, and revision.
- Enhance creative exploration, enabling designers to rapidly iterate an experiment with diverse solutions.
- Improve communication and stakeholder engagement, particularly through advanced visualization and simulation tools.
- Support sustainable and inclusive design by offering data-driven insights and improving access to complex design capabilities for non-expert users.
- Despite these advantages, challenges persist that are relevant across the AI design landscape:
- AI systems require high-quality, structured input data to function effectively, which can limit accessibility for some users.
- Most tools still exhibit limited adaptability to unconventional or large-scale projects.
- There are computational and performance constraints, especially when handling complex visual outputs or real-time simulations.

These findings confirm that AI, when applied thoughtfully, acts as a valuable augmentation to human expertise rather than a replacement. As AI becomes increasingly integrated into urban design workflows, its success will depend not only on technological advancement but also on addressing ethical, social, and contextual dimensions of its implementation.

In summary, the outcomes of this study contribute to a growing body of knowledge suggesting that urban AI applications—regardless of the specific platform—hold the potential to make the design process faster, smarter, more inclusive, and more sustainable, provided they are developed and used with critical awareness and interdisciplinary collaboration.

9. Recommendations for Researchers

Based on the results and the gaps identified, the study proposes the following research-oriented recommendations:

- Advance Tool Flexibility and Customization :Future research should explore how AI platforms can better accommodate complex, context-sensitive projects, including culturally specific urban forms and non-linear design logic.
- Embed Ethical and Social Frameworks :Scholars should investigate how AI in design can be developed and deployed ethically, particularly in relation to data transparency, bias mitigation, and equitable access.
- Incorporate Real-Time Environmental Data :Studies should focus on integrating climate, mobility, and behavioural data streams into AI systems to create more adaptive and resilient urban design outcomes.
- Evaluate Long-Term Urban Impact :There is a need for longitudinal research examining how AI-designed spaces perform over time in terms of liveability, sustainability, and social inclusion.
- Educate the Next Generation of Designers :Academic institutions should embed AI literacy into architecture and urban design curricula, emphasizing human-AI collaboration, critical thinking, and ethical decision-making.

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الملخص :
تهدف هذه الدراسة إلى تحليل أثر تقنيات الذكاء الاصطناعي على التصميم العمراني من خلال تقييم ثلاث أدوات رقمية Plan Finder :، وTest Fit، و .Luma تم تطبيق منهج تجريبي لمحاكاة ظروف واقعية واختبار كل أداة من حيث الدقة، السرعة، سهولة الاستخدام، المرونة، جودة المخرجات، والتكامل مع البرمجيات الأخرى .أظهرت النتائج أن أدوات الذكاء الاصطناعي تُحسّن كفاءة العمل، وتُعزز الإبداع، وتُسهّل عملية التواصل في مشاريع التخطيط العمراني، رغم ما تواجهه من تحديات تتعلق بدقة البيانات وحدود التخصيص .وتُقدم الدراسة دليلاً عمليًا للمهندسين والمخططين الراغبين في دمج الذكاء الاصطناعي ضمن بيئة التصميم العمراني المعاصر.