The Effect of Applying Artificial Intelligence in Architecture College Developing Design Process

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Abstract

In the last 20 years, the world has seen increasing use of Artificial intelligence (AI) in many disciplines, one of these disciplines is Architecture. This research aims to study the effect of using AI in Architecture schools, especially design studios, in which phase, and in what percentage.

The methodology of the research is applied for AI programs in four main design steps: The concept phase developing the design, coloring and developing the elevations, rendering phasing by using the AI, and distributing a survey to Design 7 students to register their responses using AI in Architecture design selected case studies from students work was selected to reflect the research works.

The results from the survey show that the students achieved applying AI in concept development by 75%, in the development design process by 72.54%, in coloring by 50%, in rendering by 48%, sustainability by 70%, and in developing building form and structure by 72.3%.

The conclusion of the research recommends applying AI in the whole design process including concept development, developing design process, coloring, rendering, form, and structure under the teacher's supervision, and recommends teaching AI as a course in architecture engineering colleges.

Keywords: artificial intelligence, AI in architecture programs, apply of AI in developing design processes

1. Introduction and Literature Review

Limited literature was found in the field of Artificial Intelligence (AI) in Architecture from 2017 to 2023 Here were classified into research five focus areas:

1.1 Definition of AI

Artificial intelligence (AI) is probably the defining technology of the last decade, and perhaps also the next future. The importance of artificial intelligence in GPS and she said 'What good of Artificial intelligence if we cannot summon authentic empathy with it? That's why to get the next 10 years right, we should do the right thing right now (Philip, 2020). (Rania, 2023). Also, this research highlighted two main points The study's findings indicate a growing interest in artificial intelligence in the field of architecture there is a need for novel research to be conducted in these areas using advanced technology and techniques (Bölek, 2023). Another research stated that the value proposition of our study lies in its novel methodology to envisage the ZEB research horizon. By leveraging R&D project data, we offer a holistic vantage point (Jin, 2023). This study provided a comprehensive review of how artificial intelligence has been applied during the period 2010 to 2021 the outcomes of the research provided the challenges for the teachers and students to use the AI (Zhai, 2021) . Another research provided creative problem-solving by AI in a system such as urban planning or adapting existing knowledge. It developed four criteria which are: knowledge, problem, method of knowledge formulation, and method to have innovative solutions (Gizzi, 2022).

1.2 AI in Design Concept

Research stated that AI can creativity in visual design in the early stages of architectural design sketching and modeling and workflow of interior design and creating views for the exterior (Ploennigs, 2023).
1.3 AI in the Architecture Design Process

Chaillou stated that AI will soon massively empower architects in their day-to-day practice. This article gives a practical case study of applying AI in an architecture studio. (Rafsanjani, 2023) stated that the current level of AI is not able to deal with such human information and experience properly because the architecture design process is complicated (Chaillou, 2020).

1.4 AI in Building Form

Studies stated that most initial Artificial intelligence (AI) approaches were oriented toward finding innovative and creative forms, while the latest research focuses on optimizing architectural forms (Pena, 2021).

1.5 AI in Coloring the Elevation

(Khalid, 2023) discussed the future of AI in Architecture and stated that AI is useful in developing design concepts and coloring.

1.6 AI in Sustainability

(Khogali, 2019) discussed the application of smart solutions in indoor environments such as hospitals, in lighting, ecological materials, use of sunscreen, and green roofs. Also (Khogali, 2016) discussed the application of AI in Refinery smart screen follow-up the wastewater and gaseous by-products.

1.7 AI in 3D Rendering

Research is focused on text and voice learning by AI and three-dimensional space to generate conceptual design (Imdat, 2018). Another study stated that AI can creativity in visual design in the early stages of architectural design sketching and modeling and workflow of interior design and creating views for the exterior (Imdat, 2018). Following the provided research comprehensive study to develop heritage forms and morphological features in a renewal work in the region by using AI (Zou, 2023).

1.8 The Future of AI

Future research outcomes are Firstly, according to the current legislation of Ukraine and other countries, as well as scientific doctrine, only a human is a subject who can carry out intellectual, creative activity (Nikolaieva, 2023). Secondly, any activity in which artificial intelligence is used must be controlled by a responsible person for copyright. Also, this research outcomes that According to the analysis results, research trends of total chronology were growing steadily and steeply growth (Kang, 2017). Another research stated that the application of AI in industries is a great risk and needs comprehensive study. It will also highlight the mitigation mechanisms needed for managing these risks (Alabdulkarim, 2023). Also, research exploring the collaborative opportunities of cyber resilience is crucial to building promising technologies in the future (Reisinger, 2023).

Hypothesis

1) To let the students take benefits from Artificial intelligence and new technology.
2) To be able to develop the design concept.
3) To be able to use AI in design development.
4) To be able to use AI to add coloring to the elevation of the project ‘Child and Mother Care Hospital.’
5) To be able to use the AI in final 3D rendering.
2. Method

The methodology of the research is passed through four steps.

1) Applying the AI program in the concept phase in Architecture Design Studio 7

<table>
<thead>
<tr>
<th>Case study No.</th>
<th>AI program</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><a href="http://promeai.com/website">http://promeai.com/website</a> is a rendering concept.</td>
<td>Different development concepts.</td>
<td>AI changes its form.</td>
</tr>
</tbody>
</table>

2) Applying the AI program in four areas: concept development, design development, coloring the main elevation, and Rendering phase.

3) Distribute a survey to the students in Architecture Design Studio 7 to register their responses towards using AI in their design project 7 in the Concept development phase and Rendering phase. The survey was designed by Google Forms and distributed to all the students by email, the total number of students was 20. All the students answered the survey, the response was 100%.

4) Eight case studies from students' work in studio D7 were selected to reflect the research work.

3. Results

3.1 (AI) Results

The results of applying AI program in the concept phase. The selected six case studies are as follows.
<table>
<thead>
<tr>
<th>Case study</th>
<th>Concept drawing</th>
<th>Sketch</th>
<th>Shot one</th>
<th>Shot two</th>
<th>Shot three</th>
</tr>
</thead>
<tbody>
<tr>
<td>one</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
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<td><img src="image4" alt="Image" /></td>
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</tr>
<tr>
<td>two</td>
<td><img src="image6" alt="Image" /></td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
<td><img src="image9" alt="Image" /></td>
<td><img src="image10" alt="Image" /></td>
</tr>
<tr>
<td>three</td>
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<td><img src="image12" alt="Image" /></td>
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<td><img src="image14" alt="Image" /></td>
<td><img src="image15" alt="Image" /></td>
</tr>
<tr>
<td>four</td>
<td><img src="image16" alt="Image" /></td>
<td><img src="image17" alt="Image" /></td>
<td><img src="image18" alt="Image" /></td>
<td><img src="image19" alt="Image" /></td>
<td><img src="image20" alt="Image" /></td>
</tr>
<tr>
<td>five</td>
<td><img src="image21" alt="Image" /></td>
<td><img src="image22" alt="Image" /></td>
<td><img src="image23" alt="Image" /></td>
<td><img src="image24" alt="Image" /></td>
<td><img src="image25" alt="Image" /></td>
</tr>
<tr>
<td>six</td>
<td><img src="image26" alt="Image" /></td>
<td><img src="image27" alt="Image" /></td>
<td><img src="image28" alt="Image" /></td>
<td><img src="image29" alt="Image" /></td>
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<tr>
<td>seven</td>
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<td><img src="image32" alt="Image" /></td>
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<td><img src="image35" alt="Image" /></td>
</tr>
<tr>
<td>eight</td>
<td><img src="image36" alt="Image" /></td>
<td><img src="image37" alt="Image" /></td>
<td><img src="image38" alt="Image" /></td>
<td><img src="image39" alt="Image" /></td>
<td><img src="image40" alt="Image" /></td>
</tr>
</tbody>
</table>

Figure 2. The concept development by using AI
3.2 The Survey Results

Table 2. The survey result

<table>
<thead>
<tr>
<th>Questions</th>
<th>Totally Agree</th>
<th>Agree</th>
<th>Average</th>
<th>Disagree</th>
<th>Totally Disagree</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.1  Do you Apply Artificial Intelligence in Design concepts?</td>
<td>27.6%</td>
<td>34.5%</td>
<td>13.8%</td>
<td>13.8%</td>
<td>10.3%</td>
<td>75%</td>
</tr>
<tr>
<td>Q.2  Do you apply Artificial Intelligence (AI) in the Development Design Process?</td>
<td>17.2%</td>
<td>34.5%</td>
<td>20.7%</td>
<td>13.8%</td>
<td>13.8%</td>
<td>72%</td>
</tr>
<tr>
<td>Q.3  Do you apply Artificial Intelligence in applying coloring in the elevation?</td>
<td>13.3%</td>
<td>13.8%</td>
<td>24.1%</td>
<td>34.5%</td>
<td>17.2%</td>
<td>50%</td>
</tr>
<tr>
<td>Q.4  Do you apply Artificial Intelligence (AI) in Rendering and background?</td>
<td>6.9%</td>
<td>27.6%</td>
<td>13.8%</td>
<td>24.1%</td>
<td>27.8%</td>
<td>48%</td>
</tr>
<tr>
<td>Q.5  Do you apply artificial intelligence in sustainability solutions?</td>
<td>10.3%</td>
<td>17.2%</td>
<td>41.4%</td>
<td>10.3%</td>
<td>20.7%</td>
<td>70%</td>
</tr>
<tr>
<td>Q.6  Do you apply Artificial intelligence in developing the building form and structure?</td>
<td>13.8%</td>
<td>34.5%</td>
<td>24.1%</td>
<td>13.8%</td>
<td>13.8%</td>
<td>72%</td>
</tr>
<tr>
<td>Q.7  Tell us about your experience in using Artificial Intelligence in D7 or other projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I used artificial intelligence in the design to give me a visual idea of what would emerge from the project block and the distribution of spaces. It helped a lot with developing the design and its ideas. It was used in form-finding, material picking, post-production for renders, research, and concept statement generation, architectural and design solutions, as a way for inspiration, a method of summarizing brief documents, a content library for presentations to make u more able to imagine the project. It was exciting and amazing. It inspired me during the design concept process and gave me many creative ideas. I consider myself new to AI, but I enjoyed my experience so far. It applies a new perspective to the design process. I used the http://promeai.com/ website in the rendering concept. It provides me with helpful inspiration in developing the beginning of the project at the level of building mass, also it is useful in developing the project in the advanced stages. It was interesting, and it gave me beautiful ideas. It’s useful for the development of a project and helps me with ideas to improve my project. IA gives more options and solutions in all design stages, especially at the concept development. Very helpful in the initial stages. I once used an AI tool to generate a full concept statement with some words that describe the concept, I'm going for. I don't use it.

I used AI in the concept to see how my project would look at the end.
4. Discussion

The discussion passes through five main research areas: concept development, design process, color system and rendering, and sustainability.

Figure 3. The survey results
4.1 Concept Development

**Case study one**

The Mother and Children Green Hospital is a healthcare facility that provides comprehensive and compassionate care for expectant mothers, newborns, and young children. This concept hospital focuses on creating a nurturing and supportive environment that promotes the health and well-being of both mothers and their children.

**Case study two**

**Case study three**

The concept is about the power of healing with the sound of nature. The sounds of nature help with the environment and can impact patients’ health and psychological well-being. Features such as bright rooms, access to natural daylight, and outdoor views can improve the healing process by giving patients a psychological and physical life healing, and psychological comfort, and this helps in the treatment process.

**Case Study Four**

Figure 4. Case study one develops the design process

Figure 5. A case study two develop a design process

Figure 6. Case study three develops the design process

Figure 7. Case study four develops the design process
Create a unique and inspiring experience through the seamless integration of elements such as light, texture, views, and water. This would be reflected in the shapes of tree branches and s throughout the design.

**Case study five**

![Figure 8. Case study five develops the design process](image)

Inspired by the first letter in the word hospital, which is the letter “H” the environment can impact patients’ health and psychological well-being. Features such as bright rooms, access to natural daylight, and outdoor views can improve the healing process by giving patients a psychological and physical life.

All the students drew three sketches of the concept at the beginning of the project, the teacher helped them choose a suitable concept for their project and state how to develop the concept. Each student has six steps in concept development, a concept with the orientation of the 3D in the plot, a concept with the main entrances, a concept with the main requirements and made zoning, and a concept with the landscape.

**Case Study Six**

![Figure 9. Concept development of case study six](image)

Create an exciting and eye-catching environment for its young patients and their families, and craft an environment where children and expectant mothers feel nurtured and encouraged to explore their surroundings with a curious mind. blending playfulness with function and ensuring a seamless integration of elements. With an emphasis on accommodating the curious nature of children, incorporate areas that ignite their imagination and inspire wonder, inviting little ones to embark on a journey of discovery and learning.

**Case Study Seven**

![Figure 9. Concept development of case study seven](image)
The concept is based on a Bee honey octagon shape, starting with one octagon form, then merging two with the courtyard.

**Case Study eight**

![Figure 10. Concept development of case study eight](image)

Nature's playful and religious sounds give the sense of healing and tranquility, Lifting the spirits of patients through optimistic feelings, providing healing and sanctuary to the patients, An Experience that mixes biophilia with a sense of wonder, Nature and wonder gives a sense of healing and escapism.
4.2 Coloring

Case Study Six

By Refit

Figure 11. Shows applying the AI in coloring the main elevation

Case study 9 applied the color concept in the main elevation, the Refit gave a limited color solution when she inserted the building form in the AI program it gave her unlimited solutions, with degraded, shaded devices.
4.3 Rendering

Case Study Seven.

By Refit

By AI

Figure 11. Applying the AI in rendering

Case study seven applied an octagonal design in the main elevation. The yellow color with degraded by the Refit computer program, and she found difficulties in designing the octagonal shape with the degraded color by the Refit program, when she used the AI, it gave her eight shots according to the applied color, and the AI improved student innovation.
4.4 Sustainability

Case Study Eight

Figure 12. Shows the application of AI in rendering

In case study eight, the student applied terraces in the 3D model, then she applied AI to develop the 3D model, she applied sustainable solutions, and AI gave her green roofs, a glass model, lighting effect.

4.5 Survey Results Discussion

The survey was distributed during November 2023, the total respondents were 20 female students, and 20/20 answered the survey questions. The results showed most of the students applied (AI) in developing their design concept as shown in Figure 2. Here the research agreed with (Ploennigs, 2023) that (AI) is useful in developing design
concepts., about 25% of the students answered that they did not apply AI in concept development, those students had no idea how to use the AI program, they were involved in groups, helping them to apply AI, and helping them to improve their skills. In the second question, more than half of the students agreed that (AI) helped them to develop design processes and gave them more visualization to build form, here the research met with (Pena, 2021) that (AI) was oriented to have creative forms. In the third question, the Results showed that few students applied (AI) in developing the project's main elevation as shown in Figure 9 gives the solutions in coloring the elevation by AI gives fantastia and future colors here the research agreed with (Khalid, 2023) that AI is useful in applying color systems, the research showed that only 50% of the students applied coloring in their elevation it depends on their concept. In question, four quarters of respondents agreed that AI is useful in rendering and said that AI is fast and quick and gives rendering with different backgrounds. In question five the students agreed that they applied AI in sustainability solutions. The AI gave them solutions such as adding green roofs, terraces, more glass in elevations, and green terraces as shown in case studies 8, 9, and 10. In question six the students agreed that AI helped them to develop building forms and structures, here the research agreed with (Zou, 2023) in developing different forms, only 48% of the students used AI to develop structure systems according to their concept. Question 7 was an open question, and the students were asked about their experience with applying AI in the design process they said it was an exciting experience, helped them to develop their projects in the initial process, gave more visualization to develop design forms, elevation color, design concept as shown in Table 2, Q.7. finally, the focus area to use AI was given by the teacher Still, the college needs to apply AI in all design studios to develop students' skills and increase the ILOs, the limit of ILOs is between (75%-100%), it was achieved in concept development, develop design process, and apply sustainability and the ILO not achieved in developing the structure and rendering by using the AI.

Comparing the results with the international level

<table>
<thead>
<tr>
<th>Focus area</th>
<th>(Ploennigs, 2023)</th>
<th>(Khalid, 2023)</th>
<th>(Pena, 2021)</th>
<th>(Zou, 2023)</th>
<th>This research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design concept</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Develop design process</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>coloring</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>sustainability</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form and structure</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

This research is novel in discussing the whole design process including concept, and form coloring in elevation, and form, and provides novel solutions for sustainability.

5. Conclusion

- The novelty of this research lies in the application of Artificial Intelligence throughout the entire architectural design process. AI was utilized to develop the design concept, design process, color selection, and rendering on Design Studio 7. The methodology of the research involved applying AI programs in different stages of the design projects. Additionally, a survey was distributed to record the students' responses to AI.

- The outcomes of the research show that the students applied the AI concept development by 75%, in the development design process by 72.54%, in coloring by 50%, in rendering by 48%, sustainability by 70%, and in developing building form and structure by 72.3%. the limit should be 70% to 100% of the students should apply AI in developing design processes to achieve the ILOs.

- The research recommends applying AI in architecture colleges; to develop the design process, more than fifty percent of the students apply AI in developing the concept, which gives the students great imagination for their projects, and fuel students' creativity for their projects.

- The AI assists students in designing building forms, more than fifty percent of students applied AI in developing building forms, adding canopies, and terraces, and developing the 3D dimensions.

- According to the research, using AI in the development of design concepts is recommended, more than fifty percent of students applied AI in the development of the concept, and the images proceed within a few seconds, AI can transform a sketch or image into a clear project image, which helps students visualize their project and its future appearance.
The research recommends applying AI in coloring the elevation, fifty percent of the students applying AI in developing color concepts in elevation. The research recommends using AI to color elevations, providing a varied and fantastical color system, resulting in a visually striking elevation.

The research suggests using AI for sustainable building designs, more than fifty percent of students applied AI in developing sustainability solutions, such as incorporating green roofs, terraces, natural lighting and ventilation, and elevating buildings on columns.

The research recommends including AI as a course for architecture students. The course should cover syllabus and course specifications to teach the students about new AI technologies in the field.

References


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Obtained.

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Data sharing statement
No additional data are available.

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