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AI Driven Design Evolution: Catalyzing for Architectural Design Development and Unlocking Business Opportunities.

Omer Shujat Bhatti*, Hafiz Muhammad Ahmed Nadeem, Muhammad Usman

Chronicle

Omer Shujat Bhatti is currently affiliated with Dept. of Architecture, School of Architecture & Planning, UMT Lahore, Pakistan.
Email: omer.shujat@umt.edu.pk

Hafiz Muhammad Ahmed Nadeem is currently affiliated with Independent Architect & Researcher, Lahore, Pakistan.
Email: arch.ahmed773@gmail.com

Muhammad Usman is currently affiliated with Civil & Environmental Engineer, Researcher & Designer, GCUF, Faisalabad, Pakistan.
Email: usmanbhatti00@gmail.com

Corresponding Author*

Abstract

There are new and exciting dimensions of structuring our buildings as a result of the integration of artificial intelligence (AI) in architectural design. This change does not enhances the values of creativity but also promotes smart working on processes, opening possibilities of invention and effectiveness. With the help of AI algorithms, architects can massively increase the actual number of calculations to look for patterns and trends that can form the basis for a more informed architectural decision-making process. This phenomena gives way to new business avenues in smart working of design industry and welcoming new arenas for business development through freelance, online and entrepreneurship integration. The research explores the potential of these new dimensions through advancements in AI integration in architectural design process through expanding their ability to offer more value to their business partners and innovate clients' interaction. The research opted for mixed method approach using both qualitative and quantitative data for analysis from modern day and young architects towards challenges, opportunities and business avenue potential in AI for design industry. Purposive sampling consisting of above 100 young designers was used. The results show promising outcomes and anticipate strong future utilization and optimization of processes, quality and output. However it also highlighted challenges of transformation, adoption, technology gaps, communication challenges and enhancement through evolution. The research contributes to the existing body of knowledge through future direction and dimensions for AI potential positive usage in the architecture and design industry.

INTRODUCTION

The quick development of Artificial Intelligence (AI) has revolutionized worldwide industries by altering business operations along with innovation and market competition. AI functions in a modern day fashion as a fundamental element in the modern day technological progress because it facilitates both the automation or systemic digitalization of repetitive work and with the help of the usage of data-based decision making towards facilitation and optimization of decision in the design process (Nabizadeh et al., 2023). Different business sectors including healthcare finance manufacturing and retail utilize the technology to boost their operations while decreasing expenses and discovering new opportunities. AI's ongoing development requires businesses globally to integrate such technology because it brings essential competiveness within digital

markets (Khair et al., 2023). While the architectural design industry maintained its roots in creative and manual precision until now it has experienced the effects of technological revolution. AI has been a source to brought forward transformative and evolutionary new approaches that help in modernizing how architects and designers as part of the bigger AEC industry think about process/product/project and deliver their targeted designs to fulfill projects objectives and needs (C. J. S. Alcaraz et al., 2024). AI improvements and enhancements in architectural based design and construction practices appear to have proven through delivery criteria by building layout of the projects explored and in the process to optimize generative design algorithms and hence AI-driven environmental and framework effects anticipated outcomes and simulations that predict successful outputs. The architectural industry benefits from this transition because it shortens the project timeline while architects use precise methods to solve complex sustainability-based and urbanization problems (Hegazy & Saleh, 2023).

AI solutions for architecture present both favorable features and technical obstacles throughout their implementation. AI technology brings two main advantages by enhancing workflow management and error reduction and generating solutions that would never exist without AI (Rane, 2024). This technology helps organizations manage resources more effectively along with increasing the collaborative abilities between stakeholders (Alhwaiti, 2023). Reports have surfaced about potential problems with excessive AI usage because it might reduce personal creativity and generate ethical issues including data protection problems and job loss situations (Xiao & Xiao, 2021). The essential step for architecture to utilize AI potential requires managing its benefits versus drawbacks to preserve the characteristics that define human-centered design. The study examines how Artificial Intelligence affects architectural design practice by reviewing both positive and negative aspects as well as foreseeable advancements in this combination between human creativity and computational systems (Cudzik et al., 2018).

There are new and exciting dimensions of structuring our buildings as a result of the integration of artificial intelligence (AI) in architectural design. This change does not enhances the values of creativity but also promotes smart working on processes, opening possibilities of invention and effectiveness. With the help of AI algorithms, architects can massively increase the actual number of calculations to look for patterns and trends that can form the basis for a more informed architectural decision-making process. Hence a need was felt with respect to explore how these AI transformations have affected the mindset of the existing modern day architects as well as those who are about to become architects or professionals very soon in near future. Following major research objectives were set forth:

1. To explore the architects and designers prioritization of AI in the design development process in the current context of Pakistan.

2. To highlight the challenges as well as the responsiveness and way forward based on the respondents feedback.

The research contributed to identification of recent challenges as well as perceptions and risks associated with the modern day AEC professionals and specially Architects who face

challenging in adoption as well as competing on the global scale in the form of free lancing or entrepreneurs in the local Pakistan industry.

REVIEW OF LITERATURE

Multiple research studies were explored to identify the current aspects and their implications with respect to AI adoption and its impacts on the Architectural design industry and processes engaged with the standard industry practices. Recent projects and design industry seems to adopt to AI integration with respect to managing the project managerial skillset for enhancement in the design and delivery of projects (Shah et al., 2023). Artificial Intelligence (AI) is transforming architecture among other industrial sectors within the current period of quick technological advancement and modernization (Shah et al., 2023a). In a recent research exploration, Architecture student opinions about using AI in both design applications and educational programs through descriptive-correlational assessment. A survey of 45 students from different academic institutions showed their neutral opinions about AI education and its influence on future careers yet they expressed worries about the impact on job availability. The study revealed a minimal connection between how students perceive AI technology and their thoughts about its effect on their future careers since students displayed doubt. More studies should investigate AI limitations to optimize its adoption as a complementary tool for human architectural creativity (C. J. S. Alcaraz et al., 2024).
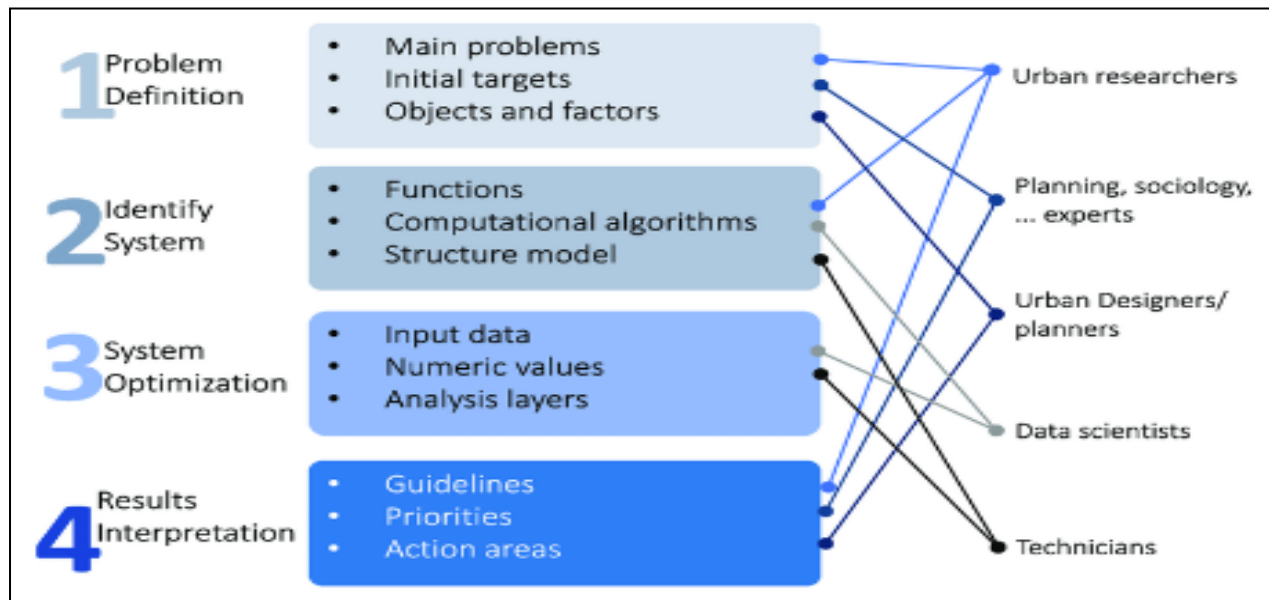

Figure 1:
Framework of using AI technology in design & planning process

AI serves as a transformative power that shapes our future by spreading across IT, cybersecurity, medicine, manufacturing and manufacturing across multiple industries to enable endless creative outcomes. The architectural sector shows limited AI adoption because people frequently doubt that robots will take over human design responsibilities. AI functions as a tool that supports human creativity because it completes complex processes like decision-making while architects retain ultimate control over the artistic freedom of their work. Researchers and professional designers along with architects

answered this inquiry to study AI functions and its positive effects in architecture design while identifying potential hurdles. The study examines how AI transforms design strategies among architects in order to connect technological interventions with original human design concepts (Atwa & Saleh, 2023). Recent technological inventions and transformation in the domain of research and industry has shown promising intent towards adoption of AI in the industry at large. However this adaptation requires social inclusion as well as willingness apart from the industry. Research about user acceptance of AI continues to spread across various studies without achieving an integrated conceptual framework. In a recent study done based on systematic review of 7,912 evaluated research articles helped in identification of 60 key studies that formed the basis of further analysis. Most studies about AI do not clarify the nature of artificial intelligence while the extended Technology Acceptance Model (TAM) stands as the leading approach to study user acceptance. The adoption of AI by different industries depends highly on perceived usefulness, performance expectancy and trust and ease of use factors.

However it has been observed that in the domain of AI, the cultural settings have shown a different tendency where the human contact and personal influence or priority holds string ground despite the industrial inclination towards AI. Future research about AI adoption requires naturalistic methods to validate models because most studies depend on subjective participant reports (Bölek et al., 2023). The General public is well aware that the advancement of artificial intelligence particularly affected and influenced processes within different spheres of activity, including those associated with creativity, from architectural and arts spheres up to technical ones (Agarwal, 2024). Artificial intelligence is about a computer imitating precise functions of human plus performing tasks (Mahendarto, 2023). AI architecture is an extended level of evolution in comparison with the previous rule-based systems and machine learning along with the new-gen generative design applications (C. S. Alcaraz et al., 2024).

People have switched from manually drawing their structures to using computers in drawing structures, and now designers are implementing a new form of designing which incorporates AI (Ridzqo & Demami, 2024). It raises questions related to the theoretical framework and future development of this branch of science and the practical realities of the use of AI in architecture, standards and legal frameworks, unforeseen societal implications of AI use (Sadek, 2023). In turn, AI supports creativeness at the design stage, increases the effectiveness of buildings and the construction industry (Sadek, 2023). Architectural procedures vary across the different fields and requires identifying a number of specialists over days to years. Under a contextual consideration, the two major concerns are how this will affect industry practitioners as AI evolves and progresses (C. J. S. Alcaraz et al., 2024). AI-generated designs are not only more creative and beautiful than human tastes, but they are also more perfect (Sukkar et al., 2024). This going to show how AI designs can be innovative and at the same time beautiful (Akti, 2024). Naturally, as their research demonstrates AI designs— literally, when compared to actual works of a famous architect Antoni Gaudi – can still be proven to remain more authentic and harmonious, besides being undeniably more people-oriented (Castro Pena et al., 2021). In another turn, the integration of AI in architecture brings ethical and societal issues including threat of human displacement and premised on the fact that the use of AI blurs

the essence of architectural practice as a humane pursuit more than the implications of efficiency (Matter & Gado, 2024).
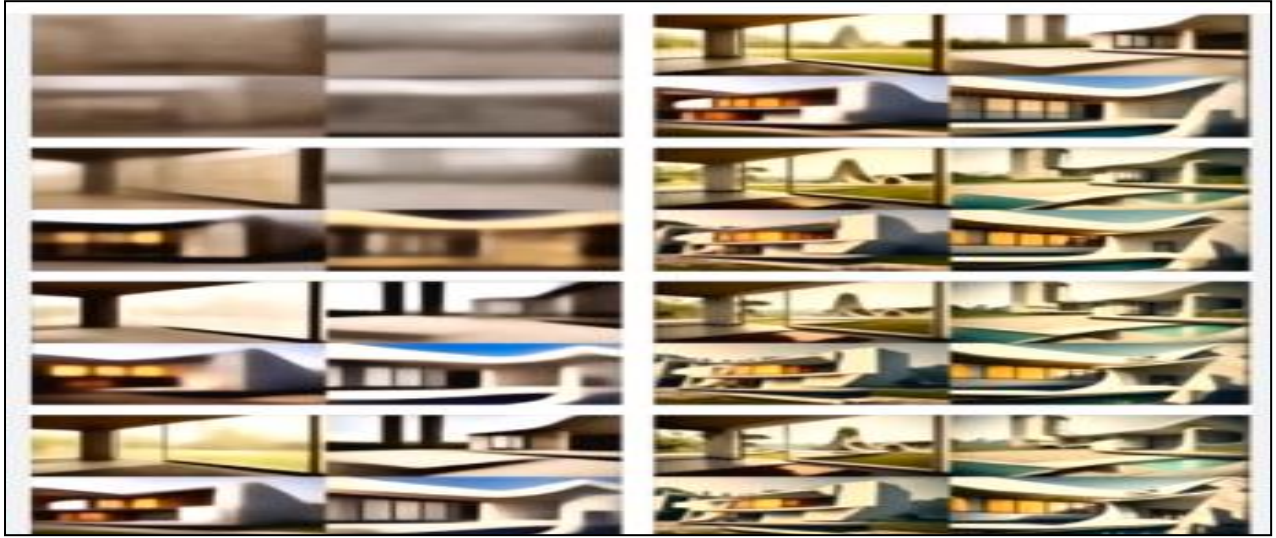

Figure 2:
AI usage in text to Image development using Prompt engineering

In another recent exploration of AI influence towards conceptual development and solution identification, it was observed that there has been a remarkable and tremendous increase in the usage of AI methods to solve the Architectural conceptual design issues with an increase to 85% over the last 5 years globally (Pena et al., 2021). It was concluded that if the human resources are trained on the AI functionality and integration of AI into the systems for optimization of delivery mechanism (Heo et al., 2021). Artificial intelligence as a modern day high end and high tech opportunity, brings innovative technological advancements at the door step of design process that helps to improve technical and complex design procedures and architectural development integration together with enhanced and improved visualization tools and techniques (Rane, 2024). AI reshapes the future of this profession through means that extend past Building Information Modeling (BIM) software tools (Hegazy & Saleh, 2023). The inclusion of artificial intelligence in architecture education constitutes a required element for long-term educational advancement.

In a recent study, analysis examined how AI technologies affect multiple aspects of structural engineering along with HVAC systems and electrical engineering and plumbing and fire protection engineering practices whereas it also evaluates their impact on sustainability and net-zero and green building design and Building Information Modeling (BIM) methods and urban planning and project management approaches (Atwa & Saleh, 2023). Through its capabilities ChatGPT enables plumbing and fire protection engineers to develop regulated and efficient plumbing networks coupled with fire safety systems. The assessment capabilities of ChatGPT in environmental factors lead to sustainable design choices because it recommends sustainable materials and building structures that minimize environmental impact. The implementation of generative AI in architectural engineering produces challenges which include ethical complications and security issues regarding data protection and the necessity for staff who can analyze AI-generated understanding (Nabizadeh et al., 2023).

Based on the above explored review of literature and contextualization with respect to Pakistan and Architecture related academia, the research further opted towards gathering of data from recent graduates and ongoing final year thesis students of relevant degrees.

RESEARCH METHODOLOGY

Data collection tool in the form of a questionnaire was used through face to face and online platforms to collect data from recent graduate Architects and practicing in the current market. The overall questionnaire was based on the review of literature with major focus through work by C. J. S. Alcaraz et al., 2024.

Figure 3:
Overall Research phases and stages

Two way approach was used. Face to face interview based data collection was done from 60 architects while online questionnaire was shared across multiple platforms with 42 respondents giving feedback (102 respondents). Questionnaire consisted of two parts. One focused on the respondents demographics data including their Gender, Age and type of professional stage which included Architect in a Firm, Architect as a Freelancer, Interior Designer, Architectural Engineer, Facility Management team or engaged with Teaching/academia. The second mainly considered the role of AI and its implication as an opportunity or threat to the existing Architectural Design Practices in the current context of services industry of Pakistan.

DATA COLLECTION & ANALYSIS

Based on the defined research methodology extracted and explored from review of literature was deployed in research exploration ahead. Data collection initiated through a defined timeline where recent graduates and ongoing pay out students along with anticipated graduates could be gathered together and then data collection was completed. The overall respondents based data is shared below:

Table 1:
Respondents Demographics

		Count	Percentage
Gender	Male	69	68%
	Female	33	32%
Age Group	Below 20	3	3%
	21-25	48	47%
	26-30	38	37%
	31-35	13	13%
Profession	Architect - Firm	26	25%
	Architect - Freelancer	28	27%
	Interior Designer	19	19%
	Architectural Engineer	7	7%
	Facility Management	7	7%
	Teaching	15	15%
Practicing Architect	Yes	91	89%
	Not at the moment	11	11%
	Not anymore	0	0%

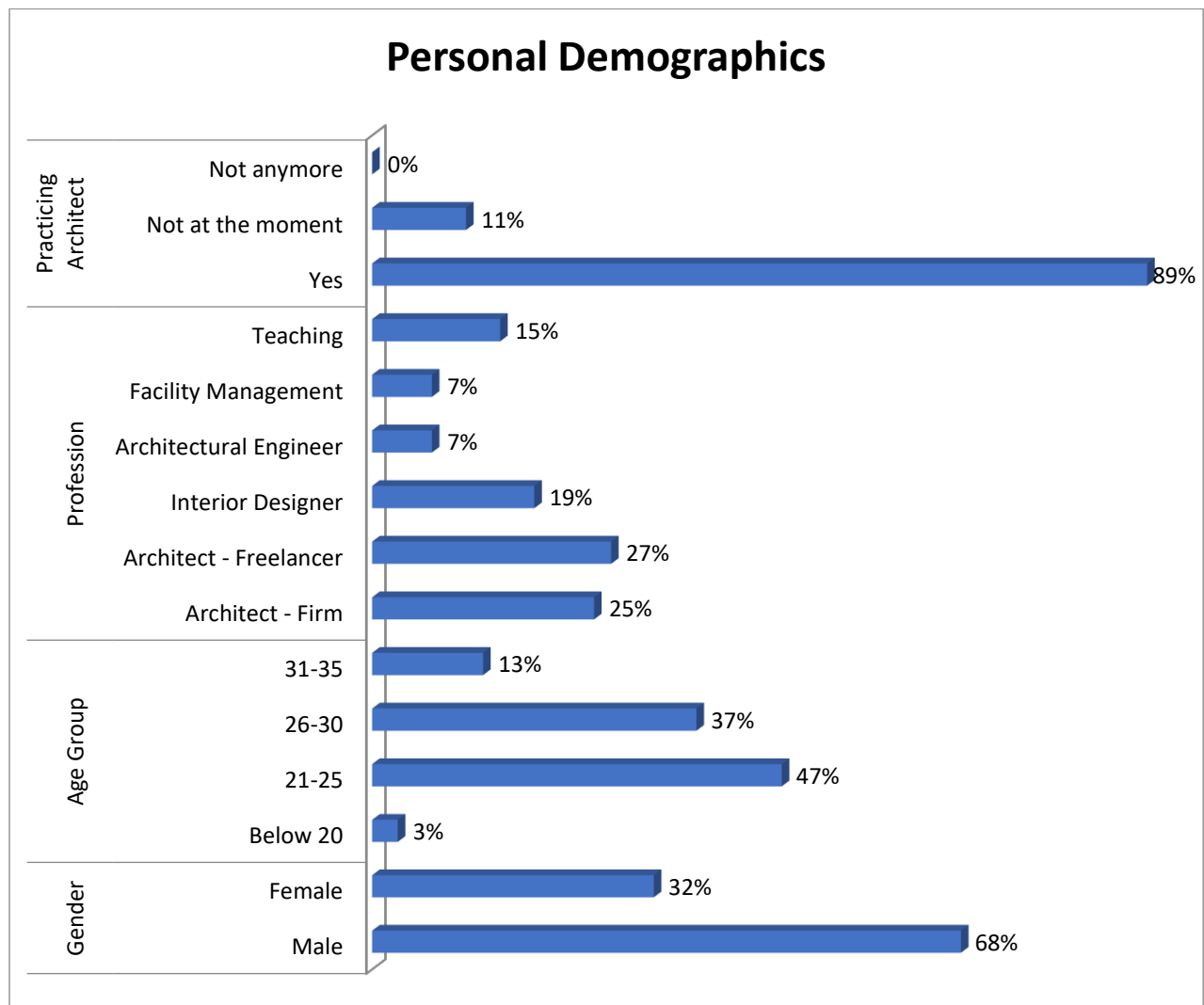The graphical representation of the above respondents data is shown below:

Figure 4:
Personal Demographics of the Respondents

Later questionnaire was shared with the respondents through the two way approach, following major results came forward as shown below.

Table 2:
Respondents Data Related to AI Exploration

QUESTIONS	Highly Disagree	Disagree	Neutral	Agree	Highly Agree
Heard of AI usage in Architecture design	0	2	4	78	18
Used AI in architecture design	15	18	31	33	5
Likely to use AI in developing architectural concepts	3	8	22	64	5
Likely to use AI for digital image services	0	7	23	48	24
Likely to use AI to aid your architectural work	0	2	7	88	5
Likely to support the integration of AI in Architecture	3	11	29	55	4
Use of AI to be incorporated in academe's curriculum	4	9	13	65	11
Likely AI will affect the employment and career development	0	0	9	44	49
Likely anticipate AI becoming a crucial skill in architecture	4	12	8	61	17
AI can become a threat to the future of the architectural industry	0	3	14	81	4
AI can take over the role of architects in terms of design development	9	18	22	45	8
AI technologies will create more job opportunities	0	9	11	72	10
AI can improve the architectural design process	0	0	8	21	73
Recommend use of AI in the design process	0	5	32	45	20
Integration of AI into the academic curriculum	0	4	9	29	60
The incorporation of AI into the academic curriculum is essential in preparing students for future career opportunities.	0	2	3	19	78
My ability to adapt and utilize AI technologies effectively	2	6	21	51	22
AI into the academic curriculum would lead to a more engaging and interactive learning environment.	3	18	21	38	22
I would be receptive to participate in courses or modules specifically focused on AI and its applications within my academic discipline.	2	8	11	78	3

As shown above in the table 02, the respondents data is shared. Graphical representation of the data is shown below in figure 05 and 06.
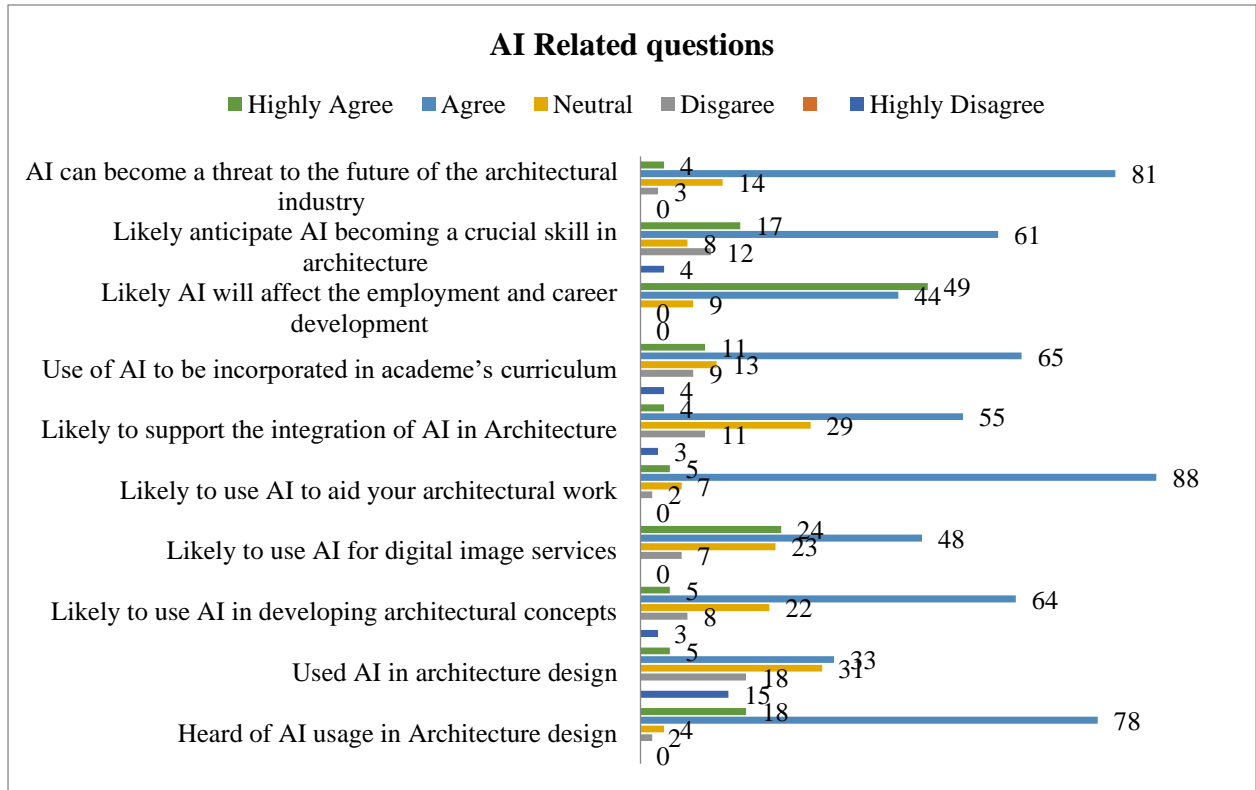
Figure 5:
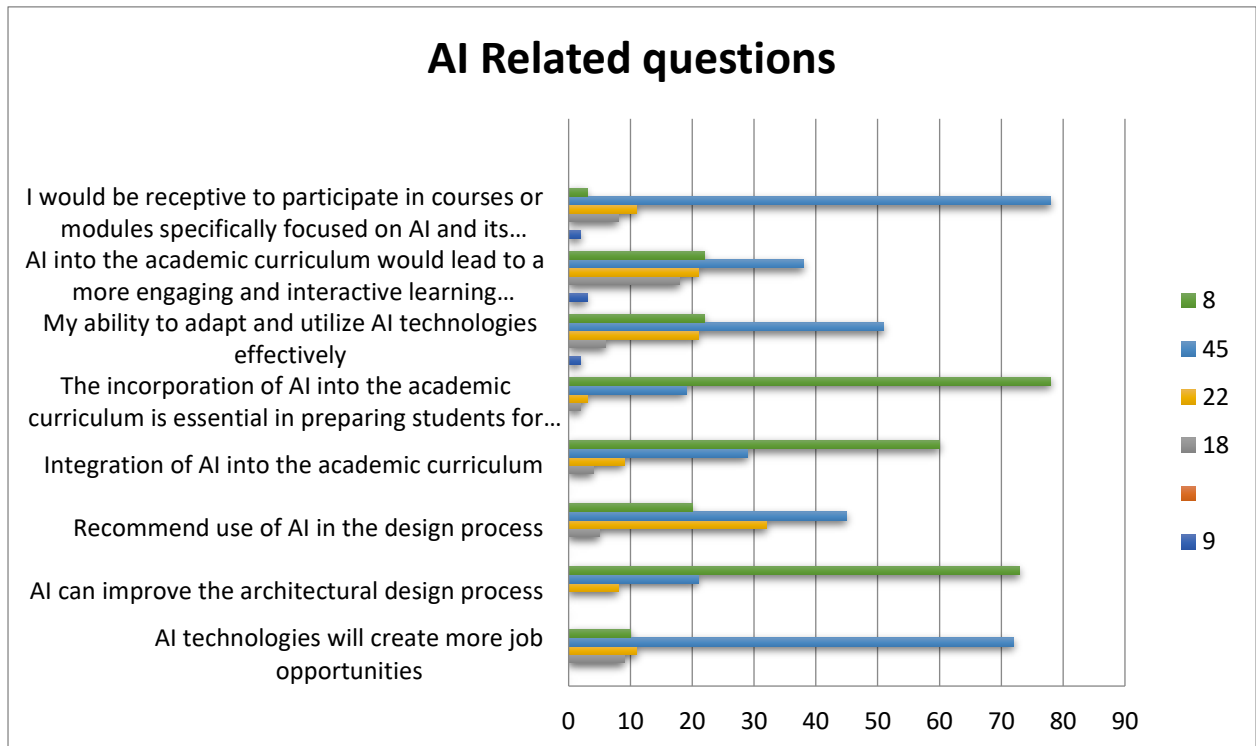**AI related respondents data 01**

Figure 6:
AI related respondents data 02

As evident above from the collected data, majority of the respondents were male. They mainly comprise of early carrier architects with major proportion of the respondents belonging to the 21-30 years old age group. Prioritization of professionals towards freelancing trend was higher as compared to working in a firm. Most of the respondents were active in the field which showed the engagement of the professionals with the architectural domain.

DISCUSSION

With respect to AI related data exploration, many new aspects were explored and identified. A large number of professionals (96%) are aware of AI in architecture although disagreement is minimal (2%) while neutrality exists in only 4% of respondents. A large majority within the architectural community demonstrates a clear awareness about AI applications. The reality shows lower actual usage levels since 38% have used AI in architectural design yet 33% neither agree nor disagree with its implementation while 33% express disagreement. Knowledge about AI exists among a broad range of professionals but its actual practical utilization remains restricted because of potential difficulties with accessibility training and utilization of AI tools. A substantial 69% of respondents plan to utilize AI for developing architectural ideas although 22% keep an open mind while 11% show opposition. More professionals are showing interest in benefits of AI for generating new ideas. A large 72% of the survey respondents indicated favorable opinions about employing AI technology within digital image services although 23% answered neutrally while 7% remained opposed. The usage of artificial intelligence tools specifically generative design software has been increasing because architects rely on such software to render concepts and create visualizations. Over eighty-eight percent of participants expressed agreement about using AI to support their work as architects while disagreement remained minimal at two percent.

The higher level of confidence in the opportunity among architects and allied professionals demonstrates their belief in AI tools and technology as an assistive device. A total of 59% of architecture professionals support working together with AI systems but 29% maintain neutral views while 14% express opposition to this integration. People in this group show mixed reactions to AI's effect on architectural Workflow redesign because security issues and technological difficulties may cause doubts. A large number of 76% of respondents endorse AI's integration into educational curricula while 13% maintain neutrality and 13% express opposition. The industry recognizes artificial intelligence as a fundamental competency needed for aspiring architects. Analysts express overwhelming agreement that artificial intelligence will transform careers as shown by the 93% who agree while only 9% take a neutral stance and no one opposes this view. Research indicates that the anticipated radical changes through AI in architectural professions reveal why learning AI capabilities has become essential. AI's impact on the architectural field generates contrasting responses from professionals where 85% perceive threats and another 14% stand in the center while 3% express no such concern. The survey results show that 82% of participants anticipate AI technology will establish fresh employment opportunities though professionals recognize its disruptive function. A substantial percentage of 53% believe AI lacks the capabilities to perform architectural work independently while 22% stay neutral and 27% disagree. This shows most architectural

professionals maintain human creativity essential. The majority of 94% endorse AI as an enhancement tool for architectural design methods while neutral responses make up just 8%. There is no disagreement with this assessment. Most experts accept that AI provides value by redesigning workflow patterns in addition to raising operational efficiency levels. The usage recommendation for AI in design matches 65% of respondents yet neutral responses reached 32% indicating concerns about AI integration. The majority of 89 percent backs academic AI integration but there are 13 percent who show indifference. Nearly all respondents (97%) agree that AI schooling creates career-ready graduates highlighting why architects must acquire AI literacy in their academic studies. The majority of 73% express confidence about AI adaptability while 21% stay neutral and 8% disagree about adaptability to AI technologies. Close to four-fifths of the participants (81%) support the notion that AI integration in education creates a more engaging learning space although 21% are undecided and 21% disagree. The majority of 81% of participants show interest in taking AI-specific courses as demonstrated by their positive response to AI education in architecture. A significant portion of the data shows that the architectural field is moderately utilizing AI technology even though professionals demonstrate strong knowledge about AI applications. Most participants understand how AI brings benefits to the table yet they remain cautious because of its disruptive effects on current systems. The workplace shows substantial interest in AI education because professionals understand that it determines future job prospects.

FINDINGS

Following were the major findings of the research exploration:

1. 96% of respondents are aware of AI usage in architecture.

2. 38% reported having used AI tools in architecture.

3. 69% are likely to use tools like ChatGPT for concept development.

4. 72% are inclined to use AI for generating and enhancing images.

5. 93% are open to integrating AI into architectural work or studies.

6. 59% support integrating AI in architecture, though 29% remain neutral.

7. 76% foresee AI becoming part of architectural curricula, ensuring students are prepared for AI-driven practices.

8. 93% believe AI will influence employment and career development in architecture.

9. 78% view AI as a crucial skill for future careers.

10. 85% see AI as a potential threat to the architecture industry.

11. 53% believe AI may replace some architectural roles, but 82% think it will create new job opportunities.

12. 94% agree that AI will significantly improve architectural design processes.

CONCLUSIONS

The research evaluation demonstrated that the architectural design sector in Pakistan adopts artificial intelligence methods at an increasing pace although it advances gradually. The research exploration has highlighted and shown that the architectural

community of architects as well as designers demonstrated adaptive favorable attitudes and priority about AI integration and deployment both in academic settings like universities and research centers as well as in the professional applications. The mitigation of potential threats alongside avoiding replacement of architects can be achieved through active measures such as training improvements and ethical standards alongside implementation moderation. The research data also has highlighted that artificial intelligence has string potential of transformative capacity and capabilities for the professionals to reshape architecture while still emphasizing and signifying the greater need of adopting with a positive step ahead with forward-thinking policies that include all major stakeholders on board with an open mindset towards growth.

RECOMMENDATIONS

With respect to the recommendations based on the conclusions and findings, following major recommendations were proposed. AI applications need training to demonstrate how they assist architects in their work while conserving their creative expression instead of taking their role so professionals should learn how to use AI for creative design generation and optimization. Ethical guidelines will establish transparent design mechanisms while securing privacy data and ensuring unbiased freedom during automated structural design processes to develop trust-based accountability systems. The education system of architecture must adopt AI and machine learning as core components because they teach students the practical skills needed to develop sustainable creative solutions. AI automation does away with repetitive tasks in material selection and energy optimization which allows architects to dedicate their attention to cultural design creativity yet preserve human innovation by using automation systems. AI technology tools should serve sustainability by using data analytics for designing sustainable energy-efficient buildings and enhancing structural optimization systems. Official policies are needed to protect architects from AI restrictions that would uphold design freedom as a human practice. Architects who develop co-creation partnerships involving engineers and developers create tools through ecosystem collaborations that solve practical needs without compromising design integrity or aesthetic quality. Through such strategies AI becomes an architecture enhancer that supports structural transformation capabilities.

DECLARATIONS

REFERENCES

Agarwal, D. M. K. (2024). Paradigm Shift in Architectural Pedagogy incorporating Artificial Intelligence. *International Journal for Research in Applied Science and Engineering Technology*. https://doi.org/10.22214/ijraset.2024.60055

Akti, M. (2024). The Use and Development of Artificial Intelligence in Architectural Design Processes. *Black Sea Journal of Engineering and Science*. https://doi.org/10.34248/bsengineering.1559637

Alcaraz, C. J. S., Diocena, L. Z., Dizon, J. M. L., Lascano, R. J. B., Mawac, T. I. M., Uy, M. D. C., … Vallespin, M. R. D. (2024). Envisioning the Future: A Quantitative Analysis of Architecture Students' Perspectives on Artificial Intelligence Integration in Architectural Design across Region III, IV-A, and NCR, Philippines. *International Journal of Current Science Research and Review*. https://doi.org/10.47191/ijcsrr/v7-i5-11

Alcaraz, C. S., Diocena, L. Z., L. Dizon, J. M., B. Lascano, R. J., M. Mawac, T. I., C. Uy, M. D., … D. Vallespin, M. R. (2024). Envisioning the Future: A Quantitative Analysis of Architecture Students' Perspectives on Artificial Intelligence Integration in Architectural Design across Region III, IV-A, and NCR, Philippines. *International Journal of Current Science Research and Review*, *07*(05), 2513–2525. https://doi.org/10.47191/ijcsrr/v7-i5-11

Alhwaiti, M. (2023). Acceptance of Artificial Intelligence Application in the Post-Covid Era and Its Impact on Faculty Members' Occupational Well-being and Teaching Self Efficacy: A Path Analysis Using the UTAUT 2 Model. *Applied Artificial Intelligence*. https://doi.org/10.1080/08839514.2023.2175110

Atwa, S., & Saleh, A. (2023). Understanding the Role of Architect in the Artificial Intelligence Era - "An Approach to AIA in Egypt." *MSA Engineering Journal*, 2(2), 532–550. https://doi.org/10.21608/msaeng.2023.291901

Bölek, B., Tutal, O., & Özbaşaran, H. (2023). A systematic review on artificial intelligence applications in architecture. *Journal of Design for Resilience in Architecture and Planning*, *4*(1), 91–104. https://doi.org/10.47818/drarch.2023.v4i1085

Castro Pena, M. L., Carballal, A., Rodríguez-Fernández, N., Santos, I., & Romero, J. (2021). Artificial intelligence applied to conceptual design. A review of its use in architecture. *Automation in Construction*, *124*. https://doi.org/10.1016/j.autcon.2021.103550

Cudzik, J., Cudzik, J., Radziszewski, K., & Radziszewski, K. (2018). Artificial Intelligence Aided Architectural Design. *ECAADe Proceedings*. https://doi.org/10.52842/conf.ecaade.2018.1.077

Hegazy, M., & Saleh, A. (2023). Evolution of AI role in architectural design: between parametric exploration and machine hallucination. *MSA Engineering Journal*, 2(2), 262–288. https://doi.org/10.21608/msaeng.2023.291873

Heo, S., Han, S., Shin, Y., & Na, S. (2021). Challenges of data refining process during the artificial intelligence development projects in the architecture, engineering and construction industry. *Applied Sciences (Switzerland)*, *11*(22). https://doi.org/10.3390/app112210919

Mahendarto, T. (2023). From Artificial Intelligence to Artificial Consciousness: An Interior Design Implication. *Journal of Artificial Intelligence in Architecture*. https://doi.org/10.24002/jarina.v2i1.6627

MMatter, N., & GGado, N. (2024). Artificial Intelligence in Architecture: Integration into Architectural Design Process. *Et AI/Engineering Research Journal*, *181*, 1–16. Retrieved from https://www.datacamp.com/blog/how-to-learn-ai

Nabizadeh Rafsanjani, H., & Nabizadeh, A. H. (2023). Towards human-centered artificial intelligence (AI) in architecture, engineering, and construction (AEC) industry. *Computers in Human Behavior Reports*, *11*(July 2022), 100319. https://doi.org/10.1016/j.chbr.2023.100319

Rane, N. L. (2024). Potential Role and Challenges of ChatGPT and Similar Generative Artificial Intelligence in Architectural Engineering. *International Journal of Artificial Intelligence and Machine Learning*, *4*(1), 22–47. https://doi.org/10.51483/ijaiml.4.1.2024.22-47

Ridzqo, I. F., & Demami, A. (2024). Introduction and Demo of Virtual Reality Technology to Initiate Active Learning in Architectural Design. *Journal of Artificial Intelligence in Architecture*. https://doi.org/10.24002/jarina.v3i1.6988

Sadek, M. (2023). Artificial Intelligence as a pedagogical tool for architectural education: What does the empirical evidence tell us? *MSA Engineering Journal*. https://doi.org/10.21608/msaeng.2023.291867

Sayed Abul Khair, S. M. A., Zainal Abidin, M. N., Khamaruzaman, A. R., Anuar, I., & Yuserrie, F. A. H. (2023). Measuring Undergraduate Architecture Students' Acceptance Using Artificial Intelligent Image Generator Bot for Conceptual Study: A Case Study of Midjourney. *International Journal of Business and Technology Management*, *5*(S3), 2682–7646. Retrieved from

http://myjms.mohe.gov.my/index.php/ijbtmhttp://myjms.mohe.gov.my/index.php/ijbtm

Shah, F. H., Bhatti, O. S., & Ahmed, S. (2023a). A Review of the Effects of Project Management Practices on Cost Overrun in Construction Projects †. *Engineering Proceedings*, *44*(1), 1–5. https://doi.org/10.3390/engproc2023044001

Shah, F. H., Bhatti, O. S., & Ahmed, S. (2023b). Project Management Practices in Construction Projects and Their Roles in Achieving Sustainability—A Comprehensive Review †. *Engineering Proceedings*, *44*(1), 1–5. https://doi.org/10.3390/engproc2023044002

Sukkar, A. W., Fareed, M. W., Yahia, M. W., Mushtaha, E., & de Giosa, S. L. (2024). Artificial Intelligence Islamic Architecture (AIIA): What Is Islamic Architecture in the Age of Artificial Intelligence? *Buildings*, *14*(3). https://doi.org/10.3390/buildings14030781

Xiao, Y., & Xiao, Y. (2021). Auxiliary Role of Artificial Intelligence Technology in Landscape Architecture Design. *International Conference on Applications and Techniques in Cyber Intelligence*. https://doi.org/10.1007/978-3-030-79200-8_87