Journal of Innovative Research (JIR)

ISSN: 2837-6706 (ONLINE)

VOLUME 3 ISSUE 1 (2025)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

Journal of
Innovative Research (JIR)

Volume 3 Issue 1, Year 2025
ISSN: 2837-6706 (Online)
DOI: https://doi.org/10.54536/jir.v3i1.4390
https://journals.e-palli.com/home/index.php/jir

Developing a Framework for Creating Virtual Reality (VR) in Architecture and Interior Design Processes

Abuelainin Hussain[1*]

Article Information

Received: January 08, 2025

Accepted: February 07, 2025

Published: March 15, 2025

Keywords

3D Modeling, Architecture, Client Engagement, Design Collaboration, Design Process, Digital Design Technology, Immersive Design, Interior Design, Technology Integration, Virtual Reality (VR), Visualization, VR Framework, Workflow

ABSTRACT

The following paper aims at providing a framework of how Virtual Reality (VR) can be used in the architectural and interior design field for better design visualisations, client engagements and improving collaborative models. The framework outlines essential stages: planning, technology selection, modelling, simulation using Virtual Reality, presentation to clients, collaborating with team members and transferring projects. They focus on improving architectural 3D models to functional VR, integration with the corresponding hardware and software, and feedback. Due to the challenges like high costs, technical skills, and client awareness, the framework provides feasible approaches aimed at designing practice and implementation of VR. Moreover, it also looks at how through the use of VR, more effective client experience is made possible, where a client in real life is able to navigate through a space or design and make realistic decisions. It also enables cohesiveness through enabling remote teams to work in a world created arthritis and thus enabling communications and decision making. In this manner, the paper also outlines a clear structure of how architects and designers can successfully integrate VR into their operations, which leads to efficiency in processes, costs, and results. This framework intends to identify a road map to effectively adopt VR in a manner that causes minimal disruption and achieves the maximum potential of the technology within the architectural and interior design fields so as to render design a more efficient and client-focused experience.

INTRODUCTION

The relative increase in growth of digital technologies has greatly impacted the ways of thinking, designing and communicating architectural and interior design projects (Avsec *et al.*, 2022). Virtual Reality (VR), as one of the tools of the transformative approach, is an effective instrument for context-spatial imagination, successful client appeal, and collaborative decision-making. Since this technology provides virtual real-life scenes, clients, designers, and other stakeholders can develop more appropriate concepts in architectural design as they have an upper-hand feel of what is to be developed architecturally before the construction. (Kaleja & Kozlovska, 2017). However, virtual Reality is still not widely integrated into the sphere of architecture and interior design, as there are some fundamental issues that VR faces; for example, it is considered expensive and complicated in terms of technical aspects, and there are no unambiguous approaches to its implementation. To this end, overcoming these barriers is vital to further adopting VR and expanding this technology throughout design (Basso, 2017).

The conceptual outline provided in this paper is an attempt to set the essential foundation for incorporating VR into architectural and interior design practices to bring efficiency to the design processes while increasing the overall value of the projects by increasing stakeholder interaction and overall communication. The framework identifies and addresses the core stages of VR implementation: design and pre-visualisation, technology procurement and configuration, 3D modelling and design, VR implementation and trials, client briefing and technical demonstrations, interdisciplinary teamwork, and documentation for transferring to clients. Appropriate measures to address typical challenges are integrated into each phase of the proposed framework, including a model conversion for better visualisation in VR, resolution of compatibility issues between hardware and software, and implementation of feedback mechanisms in real-time. Due to its authoritarian nature, the framework helps design professionals understand the best strategies for the successful implementation of the applicative technology of VR in their practices.

VR within the architectural and interior design process goes beyond aesthetic presentations. It also changes the approach to perceiving spaces as clients easily understand aspects such as scale, spatial arrangement, and size of rooms. Where other tools, by contrast, include two-dimensional drawings, physical mockups, snapshots, or still shots, VR can generate a realistic world in which changes can be made in real-time, which brings a different level of recognition of the design concepts (Milovanovic *et al.*, 2017). In addition, VR encourages building integrated design cooperation with architects, engineers, inside designers, and clients as it is an online collaboration environment (Zaker & Coloma, 2018). This capability benefits large or distributed projects, affords distance design reviews, and improves stakeholder engagement.

[1] Multimedia and Graphic Design, University of Bahrain, Bahrain
[*] Corresponding author's e-mail: abuelainin_00@outlook.com

However, several challenges discourage the widespread use of VR in the design industry. Significant costs associated with startup hardware acquisition and software and training costs are substantial issues that may be challenging for small to medium enterprises. Moreover, VR tools are difficult to learn, and some people can be uncomfortable working in such an environment, where eyestrain, motion sickness, and other similar problems affect the effectiveness of the work (Chang *et al.*, 2020). VR's disconnection from current design processes and tools is another limitation since it makes it difficult for firms to integrate them to require training and upgrades.
These are some of the challenges recognised in this research, so this study seeks to develop and offer practical solutions and strategies to enhance the implementation of VR in architectural and interior design practices. This study evaluates the advantages and disadvantages of VR applications and emerging trends based on survey questionnaires, semi-structured interviews, and a literature review. In an attempt to explain how VR can be practically employed and to provide a ready-to-use model that can be applied to any environment, this paper aims to fill the gap between best practice possibilities and their design usefulness to benefit design professionals and their clients.

LITERATURE REVIEW

Virtual Reality (VR) has become an innovative architecture and interior design tool. It provides a virtual touch-and-feel environment that raises the level of understanding of the logical model of the space to touch level and makes it easier for designers, clients, and other stakeholders to better understand and navigate the room even before it has been physically realised. VR technology offers an innovative form of design communication where design alterations can be made on the spot, areas of interest can be explored, and, most importantly, decisions can be made collectively (Basso, 2017). While it can be appreciated that VR offers significant promise for use within these design disciplines, this technology remains underutilised due to several technological, financial, and usability barriers. The following review looks into the existing literature on VR within the architectural and interior design professions and then discusses this technology's prospects.

Role of VR in Architectural and Interior Design

Virtual Reality is a technology that allows architects and interior designers to build occupants' fully reproducible environments using 3D models of facilities and spaces. In architecture, where it is envisioned to be a great tool in the design process, the creator can do a walk-through in a virtually built structure even if it is not wholly done. This enables them to run a thorough analysis of the building-the lighting, the finishes, the materials, the layouts, and many other concerns within the design (Bailey, 2024). In interior design, VR is a valuable tool to visualise the orientation of furniture, colour, and lighting; it also helps to offer a better insight into the final design to better adjust to the client's proneness and needs (Wu *et al.*, 2024). Furthermore, due to the implementation of VR, it is possible to make corrections instantly about specific design components and thus increase the productivity of the design process while maintaining its high quality (Shehata *et al.*, 2024).

Benefits of VR in Architecture and Interior Design

Enhanced Visualisation

One of the most well-known advantages of VR is having a 3D model of a building or interior space that one can virtually physically navigate. By associating clients with the whole scenario, virtual reality allows a clearer understanding of the work's scale, proportions, and overall idea. According to (Trindade *et al.*, 2023). Clients can better understand architectural designs and the architecture of a space by using VR; this means that designs for spatial flow and dimensions of rooms are made easy to interpret compared to the use of 2D images or models.

Improved Client Engagement

VR has emerged as a very effective means of engaging clients, and these findings confirm this hypothesis. Instead of using images or plan views, a designer can let the client walk through the future building, trying different opinions and seeing it as if it is already constructed. This makes decision-making easier and enhances client satisfaction and confidence in the design exercise (Wang *et al.*, 2020). For the same, VR also enables the clients at any given instance to view several designs, which could be in a different layout or tastefully made from various materials.

Enhanced Collaboration

In cases of extended construction processes or multifunctional projects, it can be a central point for communication and visualisation between architects, engineers, contractors, and clients (Ververidis *et al.*, 2022). Affirms that with VR, the teams can collaborate on the same virtual model in parallel, which is efficient again regarding discussion, problem-solving and decision-making. It is also effective in remote participation, where the participants involved in the design process may be located at different points on the globe, thus making it hard for them to meet in person or due to time differences.

Time and Cost Efficiency

An aspect that makes the use of VR very effective is its ability to save time and costs compared to conventional design techniques. Using VR in construction design enables one to detect specific problems before proceeding to the construction stage. When designing in VR, one primarily uses mock-ups, thus avoiding costly rectifications later (Sacks *et al.*, 2018). Also, this approach can showcase various design variations within a short period, increasing efficiency in the decision-making process without creating numerous physical models (Shehata *et al.*, 2024).

Challenges and Barriers to VR Adoption in Design

However, the introduction of VR in architectural and interior design processes has the following challenges.

High Costs of VR Technology

One limitation of using VR technology is the cost of the equipment's hardware and the software accompanying it remains high, making it even harder for small to medium design firms to access it. Quality VR headsets, robust workstations for computations and high-quality software and applications can be costly (Trindade *et al.*, 2023). Thus, VR stays within the sphere of significant companies or unique endeavours with vast funds, and therefore, the extent of its applicability is still relatively small.

Technical Expertise and Training

The use of VR, therefore, tends to be compared to an official procedure because, to realise, it demands some degree of skills. To work efficiently, architects and designers need to be able to design and update 3D models that can be used with VR technology, which may entail things like extraordinary knowledge of CAD tools and little-known VR programs. According to Wang *et al.* (2020), one of the concerns is the skills that designers may require to master VR tools and software since it takes time, and most designers may require more expertise. Furthermore, some clients with no experience with VR may have difficulties moving around in a VR environment, which would significantly limit the utility of presenting in VR if clients are not trained adequately.

User Experience and Comfort

Another challenge is maintaining a good user experience. Discomfort includes eye strain or motion sickness, and such discomfort occurs when users spend a long time in the VR systems. Such physical constraints may reduce engagement and affect the appropriateness of applying VR for sustained design meetings (Vilar *et al.*, 2022). To counter this problem, designers must maintain that the model is comfortable and that the VR should be involved and not lengthy.

Integration with Existing Design Tools

Implementing VR in design processes might be challenging. Most architectural and interior design practices have incorporated more conventional technologies such as AutoCAD, Rhino, and SketchUp. It can be challenging to incorporate VR because it often demands extra tools and applications. According to (Sacks *et al.*, 2018). The standardisation of VR with traditional design software may present some compatibility challenges that cause delays in the practice of VR.

VR Tools and Applications in Architecture and Interior Design

Several VR tools have been developed to support the integration of VR into architectural and interior design processes, each offering unique features and capabilities. Nowadays, BIM tools such as Revit and VR technologies are compatible due to their advanced integration. The actual models saved in Revit format that contain variant information regarding the components of building constructions can be extended to VR platforms so that the designers can freely design and develop the multi-story buildings and the related number of designs in 3D view. It also allows for spatial visualisation and design decisions to be built upon accurate and current information (Sacks *et al.*, 2018). When integrated with BIM, architects and interior designers should be able to gain design accuracy through VR. One of the practical tools used in architecture and interior design is SketchUp, a kind of 3D modelling that is relatively simple and easy to use. Many SketchUp models can include VR plugins such as VR Sketch or Kubity to enable individuals to navigate through design work physically. This integration will help the architects and interior designers who want to create something similar to virtual reality but do not want to go through the technical details.

This paper aims to present Virtual Reality as a powerful and innovative tool in architecture and interior design for visualisation, communication with clients, and cooperation. Although the application of studied technology has several advantages, including more precise spatial perception, instant changes to the current design, and better communication, it has multiple disadvantages associated with cost, technical skills, people's adaptation, and software compatibility. However, some of these challenges persist as the development of new types of VR tools and platforms continues to progress for use in design fields. The literature points more towards the issue of standardisation of the implementation of VR and the creation of cost-effective, easy-to-use systems that can fit seamlessly within current design pipelines.

Visual Framework Diagram (CONCEPTUAL)

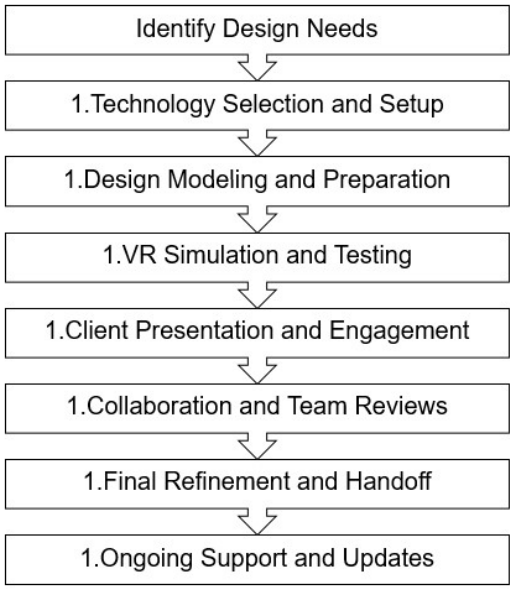

Figure 1: Framework for Creating Virtual Reality (VR)

Figure 1 VR framework guarantees that VR is managed appropriately in the architectural and interior design process, from the planning phase to the post-project phase. It underlines the need to keep progressing, integrating, and interacting with customers; therefore, VR is crucial for design and construction.

Incorporating Virtual Reality (VR) into conceptual planning and design of architectures and interiors first involves understanding the project's VR implementation goals and requirements. This stage requires scrutiny of the problems associated with the current design processes, such as lack of effective client interactions, poor visualisation or improper coordination. Once the needs are specific, one outlines the project objectives and defines which phases of the design work VR will augment: from the initial concept design to the client presentation or an internal review. Goals are stated to advance spatial awareness, interact with clients, and organise feedback from team members. This phase should consider resource requirements in light of budgeting the investment to acquire the VR technology, equipment cost, software costs, and cost of training staff to use the technology, adjusting the existing resource availability, or searching for the resources to cater to the expenditures.

The technology selection and setup process comes next, and in this process, the proper VR hardware and software that can support the design process is identified. Hardware solutions like headsets (Oculus Rift, HTC Vive) and controllers are considered in terms of compatibility with tracking systems and performance computing power requirements. Similarly, software decisions rely on choosing between modelling software such as Autodesk Revit or SketchUp, VR-specific visualisation platforms like Unreal Engine or Enscape, and collaboration tools like IrisVR. Post-production tools may also be employed for fine-tuning, even when creating virtual environments. This makes a match between hardware and software essential, more so the design environment to suit the architectural and interior design applications.

Some preparations and refinements are done in the design modelling and preparation stage, where the model is created and made suitable for use in VR. Architects or designers work with BIM or CAD tools to produce a highly detailed and geometrically accurate model with a proper texture. Many minor details are removed from these models to achieve better results with VR, such as reducing polygons in 3D models, optimising lighting effects and textures, and making the different materials used for real-time rendering. Non-player interactive elements like opening doors or moving furniture are added to the participant's experience. Further, the environment is set up with critical proximal cues, realistic lighting conditions, sounds and bells and interaction objects for an enjoyable session.

As a particular phase, the virtual reality simulation and testing imply creating and improving the virtual reality. The first implementation prototypes, meant to represent the usability, interactivity, and immersion of the VEs, are checked to be free from navigation problems and to provide for proper engagement during interaction within the VEs. Internal reviews determine what the workers say about the project, especially on navigation, scaling and texturing issues. User testing is conducted with potential clients or project managers based on satisfaction, spatial perception, and interaction efficiency. Once the VR experience design is complete, feedback from internal and external sources continues to be collected to make improvements when necessary to meet the project's objective before full implementation.

During client presentations and sales, VR provides a real-life environment and allows clients to visually walk around the space and make modifications such as changing the colour of walls or viewing different layouts. It enhances engagement and makes it active, and it will easily elicit comments from the clients regarding changes that may be made now. Some of the benefits of VR include the flexibility of the new design, the ability to present a range of options, and the ability to assimilate last-fix updates quickly. 3D visualisation elements, like showing the impact of the lighting or materials on the particular surroundings in various conditions in real-time, are more accurate to the final environment than traditional techniques.

The framework also includes decentralised cooperation and team reviews in which VR is a support that allows virtual cooperation and design review meetings. Identified members from remote places can log in to a shared virtual area to deliberate on changes and unearth solutions in real time. Instant feedback and review are made possible by this approach, meaning that overall productivity is increased since logistics occasions no delays. Another deployment of VR is in design review meetings whereby several users have to navigate the virtual environment to evaluate problems and make decisions.

The final polishing and handover stage guarantees that the VR application is fine-tuned for the project's delivery. There is the final survey on the layout to ensure that all the design requirements are correct and adequately oriented for presentation. Further, the client's consent is sought before the completion of work. Some clients may get files for future use that can be viewed in virtual reality to maintain and continue competent collaboration during construction. The framework also provides post-project support and augmentations, with periodic VR model updates based on construction progress, peer research findings, and shared learning of new tools and applications among construction teams. This continuous improvement methodology helps guarantee that VR will continue to be an effective means of improving design processes and clients' experiences in future projects.

Data Collection and Analysis

The research employed qualitative and quantitative data collection methods to develop a wealth of data on Virtual Reality technology in architecture and interior design. This included interview and discussion information from practitioners and questionnaire information from

architects, interior designers, clients, and virtual reality specialists. The two techniques provided a distinctly different perspective on VR usage and implementation and provided insight into both the advantages and limitations of the proposed framework.

Interviews and Discussions

Semi-structured interviews were administered to five architects and five interior designers who use virtual reality in their workflow. The interview questions were structured to elicit their perceptions of VR technology's utilitarian values in design tasks and the experience's advantages, drawbacks, and general effects. Another critical topic is the opportunities VR opens for improving the ways of perceiving and describing spaces to clients. Some of the stakeholders pointed out that due to VR, there needs to be more understanding of ideas, especially when it comes to design work, and it makes clients more confident in their decisions. However, they also pointed out some difficulties, including that VR software is pretty complex and takes time to learn, adequate technical resources are necessary for its implementation, and it is expensive, which might be out of reach for small firms.

The study was not only limited to the opinions of practitioners who engaged in the design of VR but also client feedback when treated to VR throughout the design process. From the client's perspective, the main benefit of using VR to enhance architectural schemes focused on the level of clarity and understanding of these schemes. However, several mentioned problems with orientation in virtual environments, mainly those with limited computer technology experience, underlined the need to develop user-friendly interfaces of VR systems and adequate client orientation.

Survey

A survey question was administered to 100 participants, 50 architects, 30 interior designers, and 20 clients, to measure the awareness of VR in design in a quantitative manner. Some of the questions posed in the survey touched on issues such as virtual Reality's perceived benefits, drawbacks, and usability. A survey with architects and interior designers demonstrated that 70% of the first and only 60% of the second group noticed that VR significantly impacted client relations and their understanding of space. Clients also agreed and supported the findings, with 60% stating that they benefited from the decision-making from VR since it assisted in solution visualisation.

However, the survey, which involved participants from various industries, established that there were key challenges to VR implementation. The biggest problem was high costs; the average number of responses was 65 per cent, and the respondents complained that the VR hardware and software are expensive to acquire and maintain. Moreover, the problem of the need for more professional technical staff in design is supported by 60% of the respondents. Several other challenges, like the one involving the compatibility of VR with current design processes and a similar lack of awareness regarding VR on the part of the clients, were also mentioned, but in these cases, they were seen as significant problems.

RESULTS AND DISCUSSION

Results

Interview Analysis

The findings of this study support the idea that virtual reality (VR) can change the way architectural and interior design is done. Future investigations will be built upon interviews with architects, interior designers, clients, and VR specialists. These discussions also give an insight into the proposed VR framework, including its advantages and limitations, enabling a better understanding of the framework from a design perspective.

Architects and interior designers surveyed for the study asserted that decision-making and communication with stakeholders are enhanced by virtual Reality. Many experts pointed out that clients better understand spatial dimensions, materials, and layouts using VR tools than 2D drawings or physical models. Moreover, a design process in a virtual world also allows VR to come up with solutions to the concerns raised before construction gets out of hand, hence satisfying many clients and meeting high satisfaction levels while at the same time minimising the expenses that could have been spent on making alterations. However, the practitioners interviewed in the study further noted that VR has the potential to improve teamwork because it provides teams with a reference point to review and build their design plans. However, they also described problems like the high time it takes to learn VR tools and the technical skills needed to develop and fine-tune 3D assets for VR environments. The critical issue raised regarding the use of VR was costs, which have yet to come down sufficiently to allow cheap simulation of the real thing, especially for small business entities.

The findings of this study showed that clients who went through the VR had high temporal satisfaction, especially when it came to following tough architectural peculiarities. Some liked that VR allows one to examine designs closely and participate in decision-making. However, some clients need help in VR navigation if they are not used to digital technology, highlighting the need to have friendly interfaces and improve client awareness of VR.

Survey Results

Survey data further backed up these themes to quantify the benefits of VR in design. As can be seen, there was a high level of understanding of the benefits, with 80% identifying improved visualisation as the most significant advantage. The second most significant perceived benefit was enhanced client interaction, with 70% of respondents stating that VR promotes improved communication and trust, courtesy of their ability to be involved in the design process. Real-time feedback and stakeholder participation were also identified, with more than half of respondents noting the applicability of VR to enable timely feedback

while shortening design cycles and eliminating the need for physical models.

However, the survey was able to establish several limitations to the use of VR, as identified below. The most significant difficulty, which 65% of participants noted, was still high cost, specified by financial difficulties connected with the purchase of VR hardware and software. Technical issues also emerged in 60% of cases and can be addressed with increased technical training and easy-to-use virtual reality tools. Although client resistance was mentioned less often, 45% of the respondents reported that a lack of knowledge among clients on VR technology would make its uptake and efficiency low.

The usability of the proposed VR framework received positive feedback, as indicated by the quantised responses, where 90 % of the respondents rated the proposed VR framework as valuable or helpful in directing the integration of VR. It got much appreciation for the opportunity they realised regarding ease of adoption. However, significant comments showed that it needs to be more accessible and supportive.

In conclusion, the study proves that even though VR has excellent potential for adequate visualisation, increased interest, and improved collaboration, there are cost problems, technical barriers, and client unfamiliarity in its implementation. The proposed framework is structured to mitigate these challenges but only becomes effective once enough investment is made in training, cost-controlled solutions, and support systems. These measures will be essential for optimising VR to generate an effective, time-efficient, client-orientated design immersion.

Discussion

This research indicates that virtual reality (VR) offers unexplored possibilities for changing architecture and interior design practices, but some factors hinder their usage. This discussion presents the results and analysis of how the proposed framework can solve these challenges and improve design practices.

The study also agrees that VR is an essential element that enhances visualisation, client relations, and teamwork. In contrast to conventional techniques using simple 2D drawings or physical models, VR allows stakeholders to navigate through and even operate the models, which illustrate the design concepts. This capability improves the degree of spatial recognition and allows the clients to be involved in the process and decide on the design, making the clients more satisfied. The outcome corroborates published works where numerous studies highlighted that VR could close the communication gap between designers and their clients, provide beneficial effects for stakeholder cooperation, and prevent avoidable extra costs for designers to fix the issues that occurred to go unnoticed. These benefits justify the belief in VR as one of the foundational elements of contemporary design and development processes.

However, there are still notable barriers to the adoption of VR technology. The main challenges that were reported were the high costs of the hardware and software and the complexity of the technical skills required. Particular vulnerability is imposed on small and medium-sized businesses, which can barely afford equipment and funds for advertising. Thirdly, the learning curve involved with using VR tools is high and needs to be more easily integrated into existing design processes of current construction. This unfamiliarity hinders them from adopting the technology or only offers limited impact due to lack of knowledge; users need to be educated on this technology, among other things.

The proposed framework provides a solution for tackling the mentioned barriers as a guide to practical implementation in design work in four phases: planning, design, implementation, and handover. It holds the necessary approaches and methods in store to facilitate the integration of VR. The framework also highlights key phases like maximising 3D models for VR, checking hardware and software compatibility before integrating them, and using real-time response techniques. These features make it possible for design teams to efficiently manage the processes involved in designs and increase the quality of the designs. Moreover, as the key of the evaluated framework is about collaboration and engagement of clients, VR still needs to be a technical solution, but how to discuss how creativity and inclusiveness can be brought into the designing processes. However, some prescriptive approaches must be introduced to make this framework successful. Cost is the issue, and seeking affordable variations like open-source VR applications, shareware relying on monthly fees, or collaborations with technology vendors becomes the primary concern. Training and skill development are also required in the same proportion because they will assist the designers and clients in dealing effectively with VR tools. Enhancing the integration process and compatibility of VR platforms with traditional design software can help more firms practice it.

According to the discussion in this paper, the future of VR in architecture and interior design seems promising. In turn, growth in its application will depend on the ability of consumers to afford the technology and the simplification of its processes. They could complement current VR with new features it may have when linked to other modern technologies like Augmented Reality and Artificial Intelligence. All in all, the current challenges need to be solved by using instead of existing technology and sharing knowledge to make VR an essential part of design practice in the years to come.

CONCLUSION

Adopting virtual reality (VR) technologies in architecture and interior design can enhance the visualisation of the design, as well as client interaction and project collaboration. As the present research suggests, through its ability to enrich spatial knowledge, enhance communication, and facilitate decision-making, VR has a profound positive impact on all stages of design. With

the help of VR, individuals can take virtual tours and get a better idea of the designed exterior and interior spaces than they can through plan and elevation drawings and static physical models. Also, changes and visualisations of multiple design decision options in the virtual environment are less expensive and time-consuming due to the identification of flaws in the design.

However, there are limitations to using VR in the classroom or training settings, such as high initial costs, technical difficulties, or the necessity of professional support. Moreover, although most professionals recognise VR's advantages, some clients may still require specific exposure to VR that would shape its acceptance and integration in the design process. However, the increased development of VR technology and its becoming more affordable will increase VR's popularity in architecture and interior design markets. Thus, it is not just a fad but a technology that is already in the process of transforming architectural practice as well as ways in which architects, designers, and clients engage with spaces. At the current stage of the technology's development and its gradual decrease in cost, its introduction into the design process will become critical to offer the client the best solutions based on their needs.

Recommendations

Investment in Training and Skill Development

In addressing the technical barriers to motion interaction techniques, flow professionals are required to devote time and resources to training and skills enhancement of the tools used in virtual reality. Employing the learning process virtually means guaranteeing that the architects, interior designers, and engineers know how best to use VR in their work. Workshops, courses online, or exercises in addition to VR practical applications are ways to improve the necessary technical knowledge to incorporate VR into design practices. Improving Client Education and Familiarity: For clients who may not have used VR before, there is a strong rationale for conducting training or briefing sessions or just taking time to explain how using VR can help their understanding of the design. Therefore, VR designers and architects should question how it is valuable, where, why, when, with whom, etc. The answers that should typically come up are guiding and improving spatial appreciation, affording customisation and decision-making. Explaining the process of the VR experience may help clients feel better about working with the technology, thus improving the corresponding cooperation.

Reducing the Cost Barrier

The development of VR technology is actively proceeding, so changes in the cost of VR tools for marketing are expected in the future. However, until VR becomes more mainstream, design firms should look for ways to reduce the costs of incorporating this technology into their services. The first strategy could be to engage with VR technology suppliers to obtain software and hardware on a lease or rental system because it may be economically unmanageable for those small firms to invest in the technology directly. Furthermore, there might be a way around this if instructors implement open-source or cheaper VR platforms. Standardisation and Interoperability: The current VR applications used in architecture and design must be compatible with other existing architectural tools and software. Creating new cross-platform software or simply utilising existing standards will help the designers incorporate VR into their existing processes. When VR tools are more compatible, it becomes easier for firms to implement VR without the blockage brought about by technical integration problems.

Pilot Projects and Gradual Implementation

Companies entering the VR environment should start with experiments to assess the benefits of using the technology in designing. Firms can use pilot projects to address technical problems, fine-tune the procedures of creating VR, and ask questions about the pros and cons of utilising VR in design. This approach will reduce potential risks, and adaptations to future projects will be more straightforward. Collaboration with VR Specialists: Perhaps it would be efficient to work with specialists in the sphere of VR or even invest in people with experience in the VR technology field. These experts can assist firms in getting the most out of virtual reality, working with the cogs and wheels to develop the best set-up and train the necessary teams to ensure everything runs smoothly. Also, VR specialists help develop customised VR environments that fit a firm's design requirements, making the VR utility in architecture and interior design more efficient.

Continued Research and Development

Thus, firms are recommended to invest in research and development that explore the possibilities and potential benefits of including VR in architecture and interior design. With the growth in technology, better tools and functionalities in creating VR designs will be exhibited in the future. With an increased R&D investment, firms could find new and different ways of using VR technology; perhaps they can integrate AR or MR into designing and creating spaces; this only improves the current ways designers can visualise spaces. To sum up, by implementing these recommendations in the architecture and interior design industries, VR technology would reach a new level of integration and usage in the interior design process.

REFERENCES

Avsec, S., Jagiełło-Kowalczyk, M., & Żabicka, A. (2022). Enhancing transformative learning and innovation skills using remote learning for sustainable architecture design. *Sustainability, 14*(7), 3928.

Bailey, E. (2024). *Interactive evolutionary generative design in augmented reality* (Doctoral dissertation, University of California, Berkeley).

Basso, A. (2017). *Advantages, Critics and Paradoxes of Virtual Reality Applied to Digital Systems of Architectural*

Prefiguration, the Phenomenon of Virtual Migration. Proceedings.

Chang, E., Kim, H. T., & Yoo, B. (2020). Virtual reality sickness: a review of causes and measurements. *International Journal of Human-Computer Interaction, 36*(17), 1658-1682.

Kaleja, P., & Kozlovska, M. (2017). Virtual reality as innovative approach to the interior designing. *Selected Scientific Papers-Journal of Civil Engineering, 12*(1), 109-116.

Milovanovic, J., Moreau, G., Siret, D., & Miguet, F. (2017). Virtual and augmented reality in architectural design and education. *Proceedings of the 17th International Conference, CAAD Futures 2017*,

Sacks, R., Eastman, C., Lee, G., & Teicholz, P. (2018). *BIM handbook: A guide to building information modeling for owners, designers, engineers, contractors, and facility managers* (2nd ed.). John Wiley & Sons.

Shehata, A. O., Noroozinejad Farsangi, E., Mirjalili, S., & Yang, T. (2024). A State-of-the-Art Review and Bibliometric Analysis on the Smart Preservation of Heritages. *Buildings, 14*(12), 3818.

Trindade, N. V., Ferreira, A., & Pereira, J. M. (2023). *Beyond the screen: Reshaping the workplace with virtual and augmented reality*. arXiv preprint arXiv:2312.00408.

Ververidis, D., Nikolopoulos, S., & Kompatsiaris, I. (2022). A review of collaborative virtual reality systems for the architecture, engineering, and construction industry. *Architecture, 2*(3), 476-496.

Vilar, E., Filgueiras, E., & Rebelo, F. (2022). *Virtual and augmented reality for architecture and design*. CRC Press, Taylor & Francis Group.

Wang, P., Zhang, S., Billinghurst, M., Bai, X., He, W., Wang, S., Sun, M., & Zhang, X. (2020). A comprehensive survey of AR/MR-based co-design in manufacturing. *Engineering with Computers, 36,* 1715-1738.

Wu, P., Liu, Y., Chen, H., Li, X., & Wang, H. (2024). VR-empowered interior design: Enhancing efficiency and quality through immersive experiences. *Displays, 102887*.

Zaker, R., & Coloma, E. (2018). Virtual reality-integrated workflow in BIM-enabled projects collaboration and design review: a case study. *Visualization in Engineering, 6,* 1-15.