

Evaluating customer experience of using virtual reality technology for interior design projects: Case study of projects for an interior design agency in Medina

Assist.Prof. Dr. Abeer Abdulaziz Al-Awwad

Associate Professor, Department of Interior Design and Furniture, College of Human Sciences and Design, King Abdulaziz University, Jeddah.

aalawad@kau.edu.sa

Assist.Prof. Dr. Raghda Hassan Hareri

Assistant Professor, Department of Interior Design and Furniture, College of Human Sciences and Design, King Abdulaziz University, Jeddah.

rhareeri@kau.edu.sa

Researcher. Walaa Abdul Kareem Mohammad

Master's Student of Space Design, Department of Interior Design and Furniture, College of Human Sciences and Design, King Abdulaziz University, Jeddah.

wmohammed0028@stu.kau.edu.sa

Abstract

The extensive development of virtual reality (VR) technology in all aspects of life has been positively reflected in several areas, including architecture and interior design. Therefore, this study aimed to evaluate the experience of clients of interior design projects in using virtual reality technology to visualize the final outputs. The study used a qualitative approach through interviews with eight clients of interior design projects for commercial and residential projects, noting their physical emotions such as hand movements, face, standing and sitting, and their spoken words during the virtual reality experience, and the time spent during this experience. The interviews were divided into two types: The first, with clients, included eliciting the client's opinion of the virtual reality experience. The second was with four in-house designers, to see how effective they considered virtual reality to be in design projects. The result of this study suggests that using virtual reality technology is somewhat more successful for commercial projects than for residential ones. It appeared that the effectiveness of the technology led to the ease of perception of the client and increased confidence in the work of the interior design agencies, thus saving time, effort, and money. And that the virtual reality experience increased the clients' confidence in their ability to visualize the final output of the design, which contributed to increasing the profits of the interior design office. It is expected that the clients of commercial projects had greater interaction because the financial returns of commercial projects are more than residential. It is hoped that the results of this study will help draw the attention of company owners in the field of interior design to the effectiveness of this technology by creating a virtual environment that contributes to convincing customers of the appropriateness of their designs and avoiding waste of resources. This technology also provides the clients with a complete visualization of the project before implementation. To make decisions about the project design and to identify proposals, design modifications and undesirable designs before starting the implementation of the project.

Keywords:

Interior design, virtual reality technology, interior designer, user experience.

المخلص:

انعكس التطور الشامل لتقنية الواقع الافتراضي في جميع جوانب الحياة بشكل إيجابي في العديد من المجالات، بما في ذلك الهندسة المعمارية والتصميم الداخلي. لذلك تهدف هذه الدراسة إلى تقييم تجربة عملاء مشاريع التصميم الداخلي في استخدام تقنية الواقع الافتراضي لتصوير المخرجات النهائية. استخدمت الدراسة مقارنة نوعية من خلال مقابلات مع ثمانية عملاء مشاريع تصميم داخلي لمشاريع تجارية وسكنية، مع ملاحظة مشاعرهم الجسدية مثل حركات اليد، الوجه، الوقوف والجلوس، وكلماتهم المنطوقة أثناء تجربة الواقع الافتراضي والوقت الذي يقضونه خلال هذه التجربة. تم تقسيم المقابلات إلى نوعين: الأول مع العملاء، ويتضمن استخلاص رأي العميل في تجربة الواقع الافتراضي. كان الثاني مع أربعة مصممين داخليين، لمعرفة مدى فاعلية الواقع الافتراضي في مشاريع التصميم. تشير نتيجة هذه الدراسة إلى أن استخدام تقنية الواقع الافتراضي أكثر نجاحًا إلى حد ما في المشاريع التجارية مقارنة بالمشاريع السكنية. وبدا أن فاعلية التقنية أدت إلى سهولة إدراك العميل وزيادة الثقة في عمل مكاتب التصميم الداخلي وبالتالي توفير الوقت والجهد والمال وأن تجربة الواقع الافتراضي زادت ثقة العملاء لقدرتهم على تصور المخرج النهائي للتصميم الذي ساهم في زيادة أرباح مكتب التصميم الداخلي ومن المتوقع أن عملاء المشاريع التجارية كان تفاعلهم أكبر لأن العوائد المالية للمشاريع التجارية أكثر من السكنية. ومن المؤمل أن تساعد نتائج هذه الدراسة في لفت انتباه أصحاب الشركات في مجال التصميم الداخلي إلى فاعلية هذه التقنية من خلال خلق بيئة افتراضية تساهم في إقناع العملاء بمدى ملاءمة تصاميمهم وتجذب إهدار الموارد. توفر هذه التقنية أيضًا للعملاء تصورًا كاملاً للمشروع قبل التنفيذ لاتخاذ القرارات حول تصميم المشروع وتحديد المقترحات والتعديلات التصميمية والتصاميم غير المرغوب بها قبل بدء تنفيذ المشروع.

الكلمات المفتاحية:

التصميم الداخلي، تقنية الواقع الافتراضي، المصمم الداخلي، تجربة المستخدم.

Introduction:

The field of interior design involves studying human behaviour and needs to create internal spaces that meet the consumers' needs and fulfil their requirements to ensure a good quality of life in the interior space. Since the role of the client is important in all stages of the design, alongside the designer, the client has to imagine the project from its beginning. This means the designer must clarify designs in different ways for clients, who are often from outside the field, so that misunderstanding does not cause disputes after implementation. Several studies have focused on the communication skills between the designer and the client. Abdel Moneim & Hasan (2019) mentioned that some designers cannot communicate their design idea due to their inability to convince the client, and that the success of persuading the client is the success of the project. The misunderstanding between the designer and the client is caused by the lack of a common language for design that brings them together (Chuang & Chien, 2021). New technology has contributed to the emergence of techniques to assist this process, offering advanced simulation of project outputs in all fields. One of the most pertinent of these techniques is virtual reality (VR). This technology helped simulate reality through 3D models (Safwa, Munawna and Sheikh, 2014). According to Khalil, Ismail and Saeed (2013) the concept of virtual reality can be divided into two parts: The first is the events experienced by the individual and the second is the use of imagination and approximation, which illustrates the possibility of using virtual reality technology to help visualize and imagine the reality.

Research Objective:

Study aims to evaluate the experience of clients of interior design projects in using virtual reality technology to visualize the final outputs.

About virtual reality technology:

Previous literature on the study of virtual reality technology has varied in terms of its focus on the concept and features of this technology, the systems used, and the components and tools of virtual reality technology. Virtual reality is “virtual reality in an artificial environment inspired by the imagination of its maker and making him interact with it as if it were real” (Mohammed and Ali, 2019). It has been defined as “one of the technological innovations that use the computer, in addition to hardware and software, as an integrated system in creating a three-dimensional imaginary environment, enabling the individual to live, interact and deal with it, through his senses, and some other tools, and the degree of realism varies. The absorption, interaction, and coexistence available to the individual differ from the same type of virtual reality” (Al-Hussary, 5: 2002). Another study clarified the definition of virtual reality based on a set of three axes. The first is related to sense, perception and sight, the second is related to the user's ability, and the third is related to the necessary tools and equipment (Safwa, Munawna and Sheikh, 2014).

According to Jogo (2019) a feature of virtual reality is that each type of technology has features and characteristics that distinguish it from other technologies, according to the user’s need.

- 1- Immersion: Transferring the real environment to immerse the user in a virtual environment.
- 2- Interaction: This depends on the viewer's ability to imagine the virtual environment as a real one.
- 3- Simulation: Simulating reality by allowing the user to walk and see within the virtual environment.
- 4- Interactive: Using input and output tools to control the virtual environment.
- 5- Interactive shared: The participation of more than one user from multiple regions via the Internet.
- 6- Remote Presence: The participation of the user located in a remote location from the activity through a virtual environment.

Two types of VR systems are shown in Table 1 and we note that although these authors describe VR systems from multiple points of view, all systems depend on the tools used. Thus each category depends on the availability of tools that enable the user to interact with virtual reality, starting from just a screen and up to wearing a set of tools to achieve the sense of the other environment.

Table 1: Virtual Reality Systems

Authors	Categories	Division	Meaning
Hamza & Horne (2006)	Virtual reality systems	Full immersion	The user wears all tools such as headphones and gloves, aiming to get the feel of the real other environment.
		Half immersion	The presence of the user in a small cinema, helps the user to feel the virtual presence and control in

			the hands of another user, and this helps to see more than one person in the same virtual environment.
		Desktop VR	The user sits in front of the VR desktop computer screen. This type of technology has spread due to the development of the computer and its accessories.
Khalil et al. (2013)	Virtual reality systems according to user interaction	Surface virtual reality	Presentation is through screen and pictures only.
		Holographic virtual reality	3D screens are used and interact with the user through the use of glasses.
		Complete interaction systems in the virtual environment	The user interacts with several screens while immersing themselves in the virtual environment using a helmet.

Some studies of virtual reality technology divide the systems according to their components, from the beginning, with the designer, to the feedback stage, while other studies focus on the tools associated with each system, as shown in Table 2.

Table 2: Virtual reality components and tools

Authors	Categories	Division	Meaning
Abdul Majid (2016)	Virtual reality components	Virtual environment executing person	The architectural designer who designs within 3D applications.
		Virtual environment	The designed 3D models.
		The user	The user of virtual reality technology.
		Sensors	Devices that help the user sense reality.
		Feedback devices	Help to influence the virtual environment as a real one.
Muhammad& Ali (2018)	Tools according to the system of virtual technology used	Desktop VR	Keyboard, computer, display.
		Semi-immersive	Display screen, glasses.
		Full immersion	Helmet, 3D mouses, gloves, motion tracker.
Al-Saeed, Ayoub and Al-Far (2019)	Tools used in virtual reality technology	Type of tools	Simple vision goggles.
			Computer screens.
			3D models.
			Virtual reality glasses.
			Data Gloves.
Programs used.			

It is clear from the table that the components of virtual reality comprise a system that starts from the designer and ends with the feedback, while the tools used range from the computer screen to the almost complete wearing of some special devices, and all of these components and tools depend on the extent of the user's interaction with the virtual reality.

Virtual reality applications:

Virtual reality technology has become one of the most important technologies used in many fields, and helped users to simulate the real environment and interact with it, this technique reflected positives on different areas, including an idea about urban and architectural documentation (Amer, 2021 and El Jogo, 2019 and Abdul Majeed 2016). These fields include academic practices (Safwa et al, 2014 and Abd al-Karim & Salim, 2012), the Arts (Al-Saeed et al, 2019 and Radwan, 2019), interior and furniture design (Davidson et al., 2020 and Freitag et al., 2018) and in the field of engineering design (Carrasco & Chen, 2021 and Wolfersberger, 2019).

Virtual reality technology has been used in the context of architectural and urban heritage, as one of the effective methods for preserving heritage from damage. This technology is used to record and document architectural heritage by providing a recorded simulation of heritage sites that accurately simulates reality (Amer, 2021). A study by Abdul Majeed (2016)'s highlighted the various uses of three-dimensional documentation tools to record urban heritage through virtual reality technology, including research purposes, architectural education, virtual tourism, and the production of cultural films and artistic works.

In a different approach, Jogo (2019) investigated the level of knowledge of those working with virtual reality technology in architectural documentation. Using the descriptive survey method, 15 participants in architectural documentation were interviewed to measure their experience in the field of architectural heritage and their knowledge of virtual reality technology. The study found that their level of experience was high, but their knowledge of VR Technology was low (Jogo, 2019).

In the field of academic practice in architectural studies, virtual reality technology has emerged as one of the most important outputs of the digital revolution that has affected the architectural design process in the academic field. The research of Safwa et al. (2014) showed the impact of employing virtual reality technology in academic architectural practices, and found that the use of four-dimensional techniques in the academic field helped increase the understanding of recipient students. Other techniques emerged from applications of virtual reality technology, including the CAVE system technology, which employed the third dimension of space through an applied study of an integrated architectural project. The study concluded that the system helped architectural designers to visualize and absorb design errors, using scientific material in an applied way that helped them understand information faster than from a computer screen (Abdul Karim and Salim, 2012).

According to Al-Saeed et al (2019) technology, including virtual reality, has contributed to the development of arts in general, and sculpture in particular, enabling every artist to serve his or her idea, and helping them to be more creative in order to fully protect the idea. Radwan (2019) explored the features and capabilities offered by virtual reality technology and how this technology can be exploited to teach new media arts for photography from a new perspective.

The results of the study highlighted the advantages this technology has for plastic processors and how other techniques can be added to the image, including audio, kinetic and interactive techniques.

Virtual reality technologies have emerged prominently in the field of interior design and furniture, and methods of development and use of virtual reality technology have become more important for product manufacturers nowadays. Freitag aimed to investigating the possible methods to avoid errors and costs when designing furniture products. Furniture proposals were designed for a departmental room and office spaces as well as the main hall and meeting room. In the study, 14 participants were asked to move between 12 3D design models to see the best model of a piece of furniture (Freitag et al, 2018). Another study included adding the customer into the design process, in which Davidson and others suggested the possibility of adding the customer in the design process by integrating building information modelling along with virtual reality. (Davidson et al, 2020).

From the engineering design side, Carrasco and Chen (2021) conducted a study in which participants were divided into two groups, the first analysed the architectural design using mixed reality techniques, and the second analysed the architectural design by two-dimensional media. The results showed that the transfer of information to the client showed its effectiveness by 85% using mixed reality, and 70% by means of two-dimensional media. (Carrasco & Chen, 2021). In another study which illustrated the effectiveness of virtual reality technology), an engineering design was reviewed by 72 users (Wolfersberger, 2019). It was found that virtual reality technology allowed more errors to be seen in the 3D engineering model and reduced potential risks.

We note that previous studies dealt with virtual reality in terms of the concept and the definition of its tools, and also with the applied approach: However, there is a dearth of research focusing on the impact of this technology on the interior design client. Thus, this study aimed to evaluate the customers' experience of virtual reality technology in visualizing the final outputs for interior design projects in specialized offices. The research questions were: What type of experience do clients of interior design projects have when using virtual reality technology in visualizing the final outputs? How effective is the virtual reality experience for clients in interior design projects?

The results of this study may help draw the attention of professionals in the field of interior design to the effectiveness of this technology in creating a virtual environment that provides the clients with a complete visualization of the project before implementation and contributes to convincing customers and avoiding waste of resources.

Methodology:

In order to answer the research questions, the study followed the qualitative approach, this type of methodology is followed for the purpose of using a specific sample to collect data, to achieve the objectives of the research with tools including observation, participation and interview (Al-Qasim, 2021). An experiment was also conducted using eight clients of interior design projects to evaluate clients' experience of using virtual reality technology for interior design projects in interior design agencies in Medina, Kingdom of Saudi Arabia, 1443 AH.

Sample:

A case study was conducted of eight clients (aged 30-50 years) for commercial and residential interior design projects from an interior design agency in the Medina region of Saudi Arabia that provides clients with interior and architectural design and execution. The company was specifically chosen to provide virtual reality technology to simulate the design details by walking around the project. In this study, each client represents his own project: Four clients for residential projects and four clients for commercial projects.

Procedure:

The approval of the interior design company was obtained for the study's work in their office and permission to enlist the help of new clients in applying the study and evaluating their experience in using virtual reality in their projects. We agreed not to show the designs of their projects, to preserve the privacy and rights of the client. Pre-model was made to see the design on the computer screen, and a 3-dimensional model to see the design using virtual reality, noting the participants responses, physical reactions, spoken words, and the time taken to visualize the project. The appropriate precautionary measures under the circumstances of the Covid 19 pandemic, were taken into account when using virtual reality glasses between each part of the study then conducting separate interviews for the eight clients and the four interior designers inside the office. The interior design projects (commercial and residential) were on REVIT2020 and exported to TWINMOTION, which consists of virtual reality glasses consisting of glasses and a controller from HTC (version 2019).

Tools:

The observation tool and the interview tool were judged by four arbitrators specialized in the field, taking into account their observations and amending them.

Observation:

The items observed were divided into three sections: the physical emotions, the exclamations or words spoken and the time taken for the interaction. Each item was classified according to the reactions shown in Table 3 and was observed before and after the experiment.

Table 3 Observed Items

Observation	Explanation
Physical agitation	Body movements such as hand or facial movements, standing and sitting.
Comments and exclamations	The audible words and the way they are delivered while using the virtual reality glasses.
The time taken to interact with the project	Determine the time using the clock timer.

The interview:

The interviews were conducted with the clients of the interior design projects and the interior designers inside the office. The first objective of the interview with clients was to obtain their views on the experience and the difference between the project’s vision on a computer screen and the experience of virtual reality, while the aim of interviewing interior designers was to identify the effectiveness of this technology in interior design projects. The topics of the interview questions included the points below.

Client Interview:

A set of questions was presented in the customer interview to evaluate their experience in using virtual reality technology for their residential and commercial projects. The topics included finding out the customer's opinion of the virtual reality experience in general, and their ability to visualize the space, and the ability to make decisions about the design.

The first axis concerns the customer's opinion of the virtual reality technology experience.

The second axis concerns the ability of the client to visualize the space using virtual reality technology.

The third axis concerns the ability of the customer to make decisions about the design of the space using virtual reality technology.

Interview with interior designers:

A set of questions was presented to the participating interior designers to find out the effectiveness of the technology and its impact on the client and the company in terms of saving time, effort and material aspects.

Results:

To assess the experience of clients of commercial and residential interior design projects when using virtual reality technology, clients were first observed during the presentation of projects through the computer, where the client's discussion with the designer and enquiries about design points were observed, this was considered to be the pre-observation. In the main observation, each subject's movements and spoken words when viewing the project while wearing VR glasses and using the control arm to roam the project were recorded, together with the time the subject spent in interacting with the design, as shown in Table 4, which were physical manifestations of emotions, spoken words, and the time the subjects spent in interacting with the design.

Table 4: Results of observation of subjects while using virtual reality technology

Clients	Observation			
	Physical agitation	Comments and exclamations	Time taken to interact with the project	Project type
1	Walking Hand wave	Wonderful, Amazing	5 minutes	Residential
2	Rotation	Very beautiful	7 minutes	Residential

	Smile			
3	Standing up Amazement	I hope to do it this way	5 minutes	Commercial
4	Going back a few steps Head touching	I'm so impressed	9 minutes	Commercial
5	Sitting Smiling	Beautiful and wonderful	8 minutes	Commercial
6	Rotation Smiling	I can move	5 minutes	Residential
7	Walking Smiling	I see the space from all directions	6 minutes	Commercial
8	Walking Clasping hands	I'm in the room	6 minutes	Residential

It can be seen that during the experiment; five out of the eight customers moved in different directions while using virtual reality technology, while that three out of eight customers used their hands to express their physical emotions, and that five out of eight customers showed their emotions in the movements that indicated their destination, such as wonderful, beautiful and amazing. The time taken by the clients in viewing the project using the virtual reality technology ranged from 5-9 minutes.

The results of the interior design client interview were divided into three axes:

The first axis includes obtaining the customer's opinion of the virtual reality technology experience through the following questions:

- 1- How was the experience of using the virtual reality glasses?
- 2- What was the difference between seeing the space using a computer and seeing the space using virtual reality glasses?
- 3- What was the degree of ease and comfort of using virtual reality technology?
- 4- Did you feel visual enjoyment while trying the virtual reality glasses?

Most of the participants reacted positively to the experience and said that it was enjoyable and the reality was imagined in it and that it differed from the computer experience. The participants explained that it was an easy-to-use experience, although one of the participants experienced dizziness and a headache.

The second axis assesses the ability of the client to visualize the space using VR technology.

- 1- Did seeing the project through virtual reality glasses make it easy to visualize your project on the ground?
- 2- Were you able to sense the balance between the design elements such as colours and shapes within the space?

- 3- Were you able to realize the proportionality between the space and the size of the furnishing elements?
- 4- Did you realize the effect of lighting in making the space more beautiful and attractive?

The participants agreed on the ease of seeing the project and being able to criticize the design elements that were not in line with their desires. The balance was also felt and the proportionality between the space and its components was realized.

The third axis investigates the ability of the customer to make decisions about the design of the space using VR technology:

- 1- How satisfied are you with the design of the space?
- 2- How did you evaluate the proposed design ideas within the space?
- 3- Were you able to identify a design that you did not like or modifications within the space?
- 4- Were you able to identify design proposals in the space?

The participants agreed that they were being generally satisfied, and differed in their degree of satisfaction by proposing some modifications to the project. The participants were able to evaluate the design from their own point of view and identify the modifications with ease and give other suggestions.

Table 5: Participants' evaluation in relation to each axis

Axes			
Clients	Client's opinion of virtual reality technology experience	Client's ability to visualize the space using virtual reality technology	The client' ability to make decisions about space design using virtual reality technology
1	The experience was fun, I hope to try it again.	It made it easier to see the project and was able to see the design clearly.	The space is beautiful and does not need modifications.
2	I am amazed by the details and the experience is easy, simple and realistic.	The design is easy to see and the lighting makes the space more beautiful and attractive.	Very satisfied and the design is more than wonderful.
3	Admire the quality of virtual reality and admire the development of technology.	I was able to perceive the proportion in the space and the sense of balance in the design.	Managed to identify modifications in the project.
4	The experience is fun and easy, I didn't find it difficult to use it.	The project needs more lighting and the movement paths are narrow.	Satisfaction with ability, seeing unwanted designs, and modifying the design.

5	I did not find it difficult to use virtual reality technology.	The project is easy to see, but the colours are a bit dark.	I managed to find out the wrong design in the project and told the designer about it.
6	An extraordinary fun experience out of the ordinary.	Seeing the house easily, the emptiness, the colours and the lighting are very beautiful.	There are no suggestions and the design is beautiful.
7	Admiring how it feels to live in the space.	Distribution of furniture in a crowded space needs expansion.	I can see the distribution of the tables and I want to expand the indoor sessions.
8	Dizziness and headache	Attractive and beautiful living room colours.	No modifications, great design ideas.

As can be seen from Table 5, none of the clients had difficulty in using the VR equipment and seven out of the eight interviewees reported that using VR technology to see commercial and residential projects was enjoyable and enabled them to clearly see the details. However, one client reported feeling dizzy and having a headache from moving the head in different directions while using the VR technology. In terms of the clients' ability to visualize the space, they all agreed that using virtual reality technology allowed them to see the project easily, and five of the clients reported that they were able to sense the balance between the design elements and the proportion between the space and the distribution of furniture. In terms of customer decision-making, all the clients were able to determine their satisfaction with the project, and six out of the eight customers were able to suggest design modifications according to their requirements.

Results of interior designers' interviews:

Four interior designers were interviewed inside the firm. They were asked questions designed to evaluate the effectiveness of the technology and its impact on the client and the firm in terms of saving time and effort and with regard to financial aspects.

1- To what extent do clients of interior design projects interact with virtual reality technology? The designers explained that the interaction of commercial project customers was greater than that of residential project customers, evident through the time taken and the questions asked and emotions revealed during the experience.

2- Did the virtual reality technology have a role in the ease of visualizing design proposals by interior design clients?

They reported that the use of VR technology made visualization of the space design by clients easier, as opposed to explaining it through drawing or displaying it through a computer screen.

3- Did virtual reality technology help save time for design modifications?

The designers all felt that technology helped to reduce the wastage of time, effort and money for the client in addition to the firm, due to the ease of perception by clients of designs and the ability to give feedback and approval to move to the other stages of the project.

4- Has virtual reality technology helped increase customer confidence in interior design agencies?

The participants agreed that virtual reality technology helped to attract clients and this was reflected in increasing confidence in interior design agencies, because the clients were able to visualize the final output of the design.

Discussion:

We note that the results of the observation before and after using VR differed, as the clients' interaction while using VR technology was greater and clearer through physical expression of emotions, where they moved in different directions, smiled, and made hand movements as well as through their spoken words in which they expressed their admiration for this technology. Moreover, saying that they 'are inside the project' means their imagination was able to construct the actual reality. This confirms the conclusion of Khalil et al. (2013) that virtual reality technology helps to visualize the approximation of reality, as illustrated by the overall positive emotions observed and reported in using the technique in the present study.

The average time taken to view the project using VR technology for all clients was six minutes and forty seconds. However, it was observed that the two groups differed, where the average time taken for clients of commercial projects was seven minutes, while the average time taken for clients of residential projects was only five minutes. This indicates that the clients of residential projects did not interact as significantly with VR technology as the customers of commercial projects. This may be due to the large number of details in the commercial projects and their marketing objective, which meant the project must be carefully observed by these clients.

Although the majority of clients in both groups reported that the experience as enjoyable and the technology was effective and not difficult to use, it was noted that one client felt dizzy. This may be due to the rapid movement of the head, in addition to the fact that it is a new technique that has not been used. The ability of the clients to visualize the project on the ground became evident, and the clients were able to sense the balance between the design elements such as colours and shapes within the space, which corresponded with the findings of Freitag et al. (2018) that the clients gained knowledge of the visual impression, colour and proportions by using VR technology.

This additional knowledge also resulted in the effectiveness of technology through the ability of customers to make decisions about project design and to identify proposals, design modifications, and identify undesirable designs. Thus, the use of VR technology appears to reduce potential risks.

The interview with the interior designers also confirmed that the clients' experience of VR was good, that it was easy to use and increased the clients' confidence in their ability to visualize the final outcome of the design, which also contributed to the increase in the profits of the interior design agency. They also noted that the clients of commercial projects had a higher

level of interaction because the greater financial outlay and returns of commercial projects compared with residential projects.

Conclusions:

This study evaluated the experience of clients of commercial and residential interior design projects, and recommends the use of virtual reality technology for commercial projects in interior design agencies, as it showed its effectiveness through positive interaction by clients as well as the positive effects of saving time, effort and money in modifications by facilitating clients' perception of the project and identifying their wishes and design modifications. The use of VR presentations also has positive effects by facilitating communication between the client and the designer and increasing confidence in interior design agencies, which increases the demand for designs. We suggest the application of virtual reality technology in future studies for a larger group of clients with a diversity of projects, as we encountered some difficulties in conducting the study at the time of the Covid 19 pandemic, and because there is a shortage of agencies that currently use this technology.

References:

- AbdulKareem, Ola Muhammed, and Yunis Mahmood Muhammed Saleem. "System CAVE technology as one of the most important applications of virtual reality in the architectural aspect." *Iraqi Journal of Architecture and Planning* 11 ,no. 1 (2012): 183-204.
- Abdel Moneim, Lamis and Awadh, Hassan. "Persuasion skills in architectural designs and their role in design development." [Master's Thesis]. Sudan University of Science and Technology, (2019).
- Abdul Majeed, Khaled. "Documenting urban heritage using virtual reality techniques - opportunities and challenges." *Al Azhar university* (2016): 882-893.
- Al-Hussary, Ahmed. "The Educational Technology System in Schools: Reality and Hope. The Seventh Annual Scientific Conference of the Egyptian Association for Educational Technology." Mansoura, Dar Al-Wafaa (2002).
- Al-Qasim, Mayada. " The differences between qualitative and quantitative methods in social research. " *The Arab Journal of Scientific Publishing* (2021): 332-358.
- Al-Saeed, Doaa and Ayoub, Manal and Al-Far, Maysa. "Sculpture between virtual reality and the philosophy of the contemporary sculptor. " [PhD thesis]. Damietta University (2019).
- Amer, Nermin. "The use of virtual reality technology in recording the architectural heritage. " *CU Theses* (2021).
- Carrasco, Moises David Osorto, and Po-Han Chen. "Application of mixed reality for improving architectural design comprehension effectiveness." *Automation in Construction* 126 (2021): 103677.
- Chuang, Cheng-Lin, and Sheng-Fen Chien. "Facilitating Architect-Client Communication in the Pre-design Phase." *26th International Conference of the Association for Computer* (2021) Volume 2: 71-80 .
- Davidson, Jordan, John Fowler, Charalampos Pantazis, Massimo Sannino, Jordan Walker, Moslem Sheikh khachkar, and Farzad Pour Rahimian. "Integration of VR with BIM to facilitate

real-time creation of bill of quantities during the design phase: A proof of concept study." *Frontiers of Engineering Management* 7, no. 3 (2020): 396-403.

- Freitag, Mike, Phil Wesner, Christian Schiller, Maria Jose Nunez, Fernando Gigante, and Soledad Berbegal. "Agile Product-Service Design with VR-technology: A use case in the furniture industry." *Procedia CIRP* 73 (2018): 114-119.
- Hamza, Neveen, and Margaret Horne. "Integration of virtual reality within the built environment curriculum." *Journal of Information Technology in Construction* 11 (2006): 311-324.
- Jogo, Ahmed. "The level of knowledge of those working in architectural documentation in the Gaza Strip about virtual reality and its applications." *The Fourth International Conference on Architectural Cultural Heritage for the Rehabilitation of Archaeological Sites and Buildings in the Light of Contemporary Requirements* (2019).
- Khalil, Imad, Ismail, Fatima, and Saeed, Muhammad. "Virtual Reality and Archaeology." *Yearbook of the General Union of Arab Archaeologists* (2013): 364-382.
- Muhammad, Umm Kulthum and Ali, Yasser. "The effectiveness of communication technology in developing the skills of producing virtual reality applications." [Master's Thesis] Sudan University of Science and Technology (2018).
- Radwan, Shadi. "Virtual reality in new media art as an introduction to experimentation in postmodern photography." *CU Theses* (2019).
- Safwa, Baida, Mnouneh, Yes and Sheikh, and Shatha. "The Effect of Employing Virtual Reality in Architectural Academic Practices." *Al-Rafidain Engineering Journal (AREJ)* 22, no. 3 (2014): 1-18.
- Wolfersberger, Josef. "Analysing the potential of Virtual Reality for engineering design review." *Automation in Construction* 104 (2019): 27-37.