Ain Shams University
Egypt

Virtual reality as a Design Approach to Promote Community Engagement

A Thesis submitted in the Partial Fulfillment for the Requirement of the Degree of Master of Science in Integrated Urbanism and Sustainable Design

by

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July 2023

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Acknowledgment

I would like to thank …

My greatest support system Dad, Mum, and my sister Aya for always supporting me and being there whenever needed, would not have done this without their continuous support, especially my fiancé Ahmed who was always pushing me forward and being enthusiastic about me getting my MSc. Degree.

My friends Farah, Arig, Raneem, and Dina, for being there any time to listen and encourage me throughout the research process. My colleagues in the urban design and planning department for their insightful feedback along my thesis journey.

Eng. Ahmed Abobakr software developer for giving me the technical support in coding.

My supervisors: Prof.Dr. Samah Elkhateeb and Dr. Wesam El-Bardisy for providing guidance and feedback, without the help that you gave me in developing my research and the emotional support, I wouldn't have made it. Thank you for always being inspiring, I'm grateful for having you as my mentors.

I would like to express my sincere gratitude to the Smart and future cities laboratory for sustainable urban solutions (SFCL) which is funded by the STDF, Faculty of Engineering, Ain Shams University. The Lab provided me with an Oculus Rift headset, which was a mandatory tool to conduct my empirical study and fulfill the research objectives. Also, for giving me the venue to conduct the student's workshop starting from 8-5-2023 till 11-5-2023. I would also like to extend my thanks to the laboratory staff: Eng. Donia and Eng. Safaa for the technical support and assistance required.

Last, I would like to thank the IUSD family, especially Dr. Salheen and Engy for their continuous support throughout the master thesis journey.

Virtual reality as a Design Approach to Promote Community Engagement

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Abstract

Community engagement is a significant aspect to consider in the urban planning and design process, it promotes appropriate development densities and serviced lands. In Egypt, despite the availability of different community engagement methods these tools mostly contribute to informing the citizens but not involving them in the whole design process which doesn't allow better co-creation, In addition to having other drawbacks such as the requirement of a fixed time and location. Focusing on outdoor spaces, which are places where people congregate and interact together, there is a major issue with involving users in the design process, As a result, the number of people using these spaces decreases. Currently, modern technologies are being implemented to enhance the community engagement process, from these technologies is virtual reality (VR) technology, which is now being used widely in the urban design and urban planning process, The scope of the thesis is to highlight the role of VR technology as a design approach that would contribute to the community engagement process in the Egyptian context. The application of VR tools in Egypt is available in different fields such as interior design, tourism and cultural heritage, education, etc... However, a gap was found in utilizing virtual reality as a design approach tool to improve community engagement in the Egyptian context. Deductive reasoning was done through experimental research, where a case study was conducted to investigate the role of virtual reality in promoting community engagement in the Egyptian context, this was achieved by applying a workshop for redesigning a space in a university campus using the VR headsets. The research questions focused on community engagement and the process of applying it by using the virtual reality concept and how it affects the whole design process.

Keywords: Community Engagement, Participation, Co-creation, Virtual reality

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Chapter One: Research Background

1.1 Introduction

Community engagement is a concept that is been widely used now in the process of urban design and urban planning, it refers to the process of allowing users to be a part of the design process and involving citizens with different stakeholders to reach an optimum design, which aims of creating a two-way decision making to have a more collaborative design process (Innes and Booher, 2004). Community engagement has emerged as a critical component of successful urban planning and development projects in recent decades. Although community engagement is being developed in Egypt, the currently used participation methods such as community meetings, interviews, and workshops have some drawbacks and fall under the level of informing the community rather than an active form of participation that allows people to be a part of the design process (Aboelna,2017). As a result, there is a need to develop new methods for involving citizens in the design process. Nowadays the application of digital tools in the

community engagement process is being emerged as it lowers the participation barriers between citizens and stakeholders. Communication regarding the design process is the most important aspect of the participation process, hence new technologies are currently being developed for this purpose, and from these tools' virtual reality and mixed reality concepts. Virtual reality (VR) is introduced as a tool to be implemented for better visual communication which could be easier identified by the participants. Virtual reality could be used in diverse ways in the engagement process whether as an observation tool or a design approach, which would reflect on the community engagement process and the final decision-making (Çakir, 2015).

This research aims to minimize the gap between participants and designers in the design process by applying new technologies to promote the community engagement process, this will be done by conducting a workshop with the users of an open space in the faculty of Engineering Ain shams university to redesign this space using VR headsets and analyzing the user perception to this tool and explore how it affected the participation process in terms of visualization and intractability.

1.2 Research Problem

Community engagement has an important role in the decision-making process which affects the urban design and planning of urban spaces. Although several traditional tools are supporting the concept of community engagement in Egypt as workshops, community meetings, and others, these tools have some drawbacks affecting the engagement process such as the limited time and location that they require and still, it falls under the level of informing people. Hence, having a more interactive tool for community engagement as gaming simulations would better affect the design and co-creation process. The use of new technologies such as virtual reality and information systems for enhancing community engagement is not widely used especially in Egypt, which may be the reason for the problem of having unused open spaces, Hence the main problem statement is:

Lack of using collaboration and co-creation tools that promote community engagement in the Egyptian context.

The gap of knowledge is in the lack of local literature on utilizing new technologies as using virtual reality and gaming simulation tools to enhance community engagement in the Egyptian context, which contributes to the continuity of using the conventional methods in the community engagement process which affects the result of it, Thus, there is a need to rethink and reconsider the new technologies that are being developed in the participation process.

1.3 Research Objectives

The main research objective is to investigate the integration of new technologies, specifically virtual reality, in community engagement to enhance the decision-making process within the Egyptian context. The research aims to highlight and emphasize the role of new technologies in improving the community engagement process, in addition to allowing the designers and planners to use these opinions in order to design based on the user needs, this would be through using virtual reality as a design approach to both users and designers of open spaces.

Sub-Objectives:

-Understanding the key issues of community engagement in Egypt

-Exploring the effectiveness of the VR community engagement process in terms of interactivity and visualization

-Understand the user perception of the VR tool

-Exploring the use of VR (Time, Cost, data collection)

1.4 Research Questions

Based on that, the research questions are:

How can the use of VR promote community engagement in the Egyptian context?

Sub-Questions:

-RQ1: How could virtual reality be used as a design approach?

-RQ2: How Virtual reality models can be used for community engagement?

-RQ3: How could the public perceive these modern technologies?

-RQ4: What are the pros and cons of VR tools?

-RQ5: How does immersive VR technology provide cognitive benefits in the decision-making process?

1.5 Scope of Thesis and Expected Outcomes.

The scope of this research is to promote a further understanding of digital engagement tools and modern technologies for community engagement to contribute to the decision-making process. This shall be achieved by focusing on VR tools as effective tools for community engagement in open space design. Focusing on applying virtual reality models to open space design to improve community engagement in the decision-making process as the current VR technology quality allows the public to have a suitably realistic experience of different design proposals. The application of VR tools in Egypt is available in different fields such as interior design, tourism, and cultural heritage, education. But a gap was found in utilizing these kinds of new technologies for community engagement in urban and landscape design scales specifically open space design, for this regard, the case that will be carried in the thesis will be the application of VR tools for community engagement in redesigning an open space in a Faculty of Engineering, Ain Shams University campus in Cairo.

According to the research aim and problem, Using Virtual reality in the community engagement process enables people to feel connected to their surroundings, hence they have the ability to visualize their needs using this tool. It's expected that the final output will be an evaluation of the VR tool based on the user perception and satisfaction with different impressions of the participants, on the other hand, evaluating the effectiveness of VR as a design approach in the decision-making process, finally providing a demonstration of the importance of new technologies in the community engagement process.

1.6 Conceptual Framework

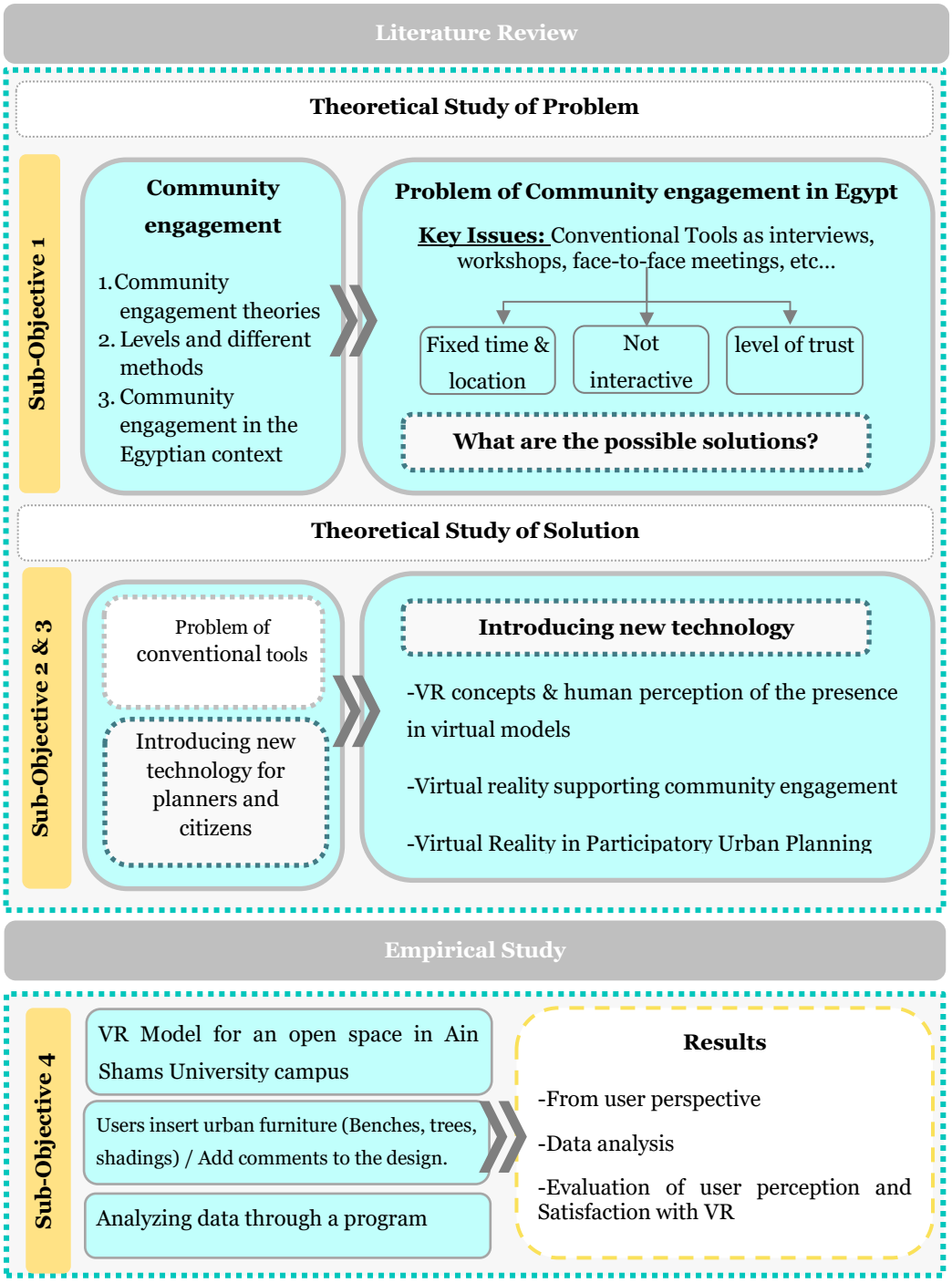

Figure 1: Research conceptual framework (Source: author)

1.7 Research Methodology

This research will adopt deductive reasoning through experimental research based on two parts. The first part will include a theoretical framework and previous research about community engagement and utilizing technologies to improve user engagement in the design process. The second part will be the application of VR in a local case study to find out an effective method to enhance the level of engagement and user perception in open space design.

Data collection methods

The data will be collected through field observation, interviews, and a data analysis program, the following diagram illustrates the research methodology (Figure 2) :

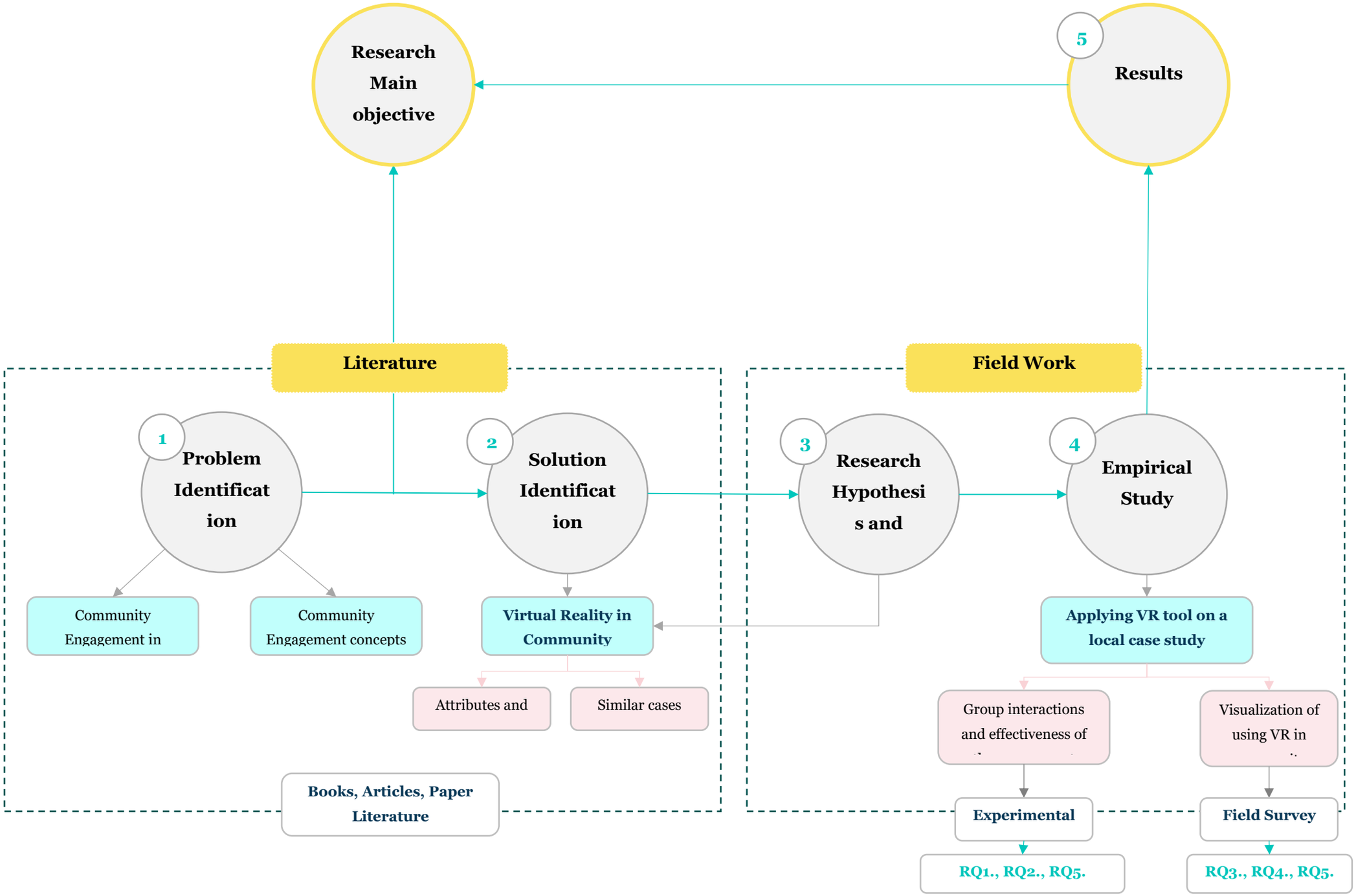

Figure 2: Methodology Diagram (Source: author)

Chapter Two: Community Engagement in Urban Space Design

Since the 1960's the concept of community engagement emerged and became an important aspect of the design process. This chapter focuses mainly on the community engagement concept with its different definitions and levels which affects the final decision, in addition to how it's implemented within the decision-making process.

2.1 Community Engagement Concept

Community engagement is a broad concept that is widely used in different sectors such as technology, urban planning, and urban design. Community engagement has different terminologies such as public participation and community involvement, all refer to the concept of allowing all age groups to be a part of the decision-making process and give opinions about any issue regarding a specific development. It refers to the involvement of citizens in the decision-making process of public affairs (Innes and Booher, 2004). Askari et al. (2021) state that citizens may have solutions to solve community problems hence enhancing the process of urban planning and decision-making According to Innes and Booher (2004), community engagement in the planning process must be a collaborative

tool that allows a two-way decision-making process and is inclusive to all stakeholders & users. This creates a more responsive urban design that is based on the user's perception which is an accumulation of their experiences and interests, this also reflects how people perceive space and their ability to give opinions about it. Moreover, when designing with the involvement of the community this allows the identification of disagreements through listening to different perspectives (Hersperger et al., 2018).

Nowadays, the concept of participatory planning evolved to different standards that reinforce the importance of engagement in the decision-making process and that it is a right that needs to be implemented. Apart from being an inclusive process, integrating the community in the decision-making process in a bottom-up approach results in creating a partnership between users, stakeholders, and community organizations. This collaboration creates mutual trust between these parties and strengthens the common values of the community (San off, 2000). Moreover, it advocates a sense of community and a sense of belonging to the place by bringing the users and stakeholders to share their common interests and goals. This creates a sense of satisfaction from the users as the plans and decisions are based on their needs (San off, 2000). The concept of community engagement started to emerge in the early 1960s when there was a call to include the citizens in the design process by giving questionnaires, and it continued to develop till the 1990s when it became a common step that should be included in the design process, and with using different methods such as interviews, questionnaire, and community meetings. Till the 2000's when a new development happened in the way of community participation, and new technologies started to emerge to enhance the participation process, (Figure 3) shows the development of the community engagement concept and their right to be involved in the decision-making process.

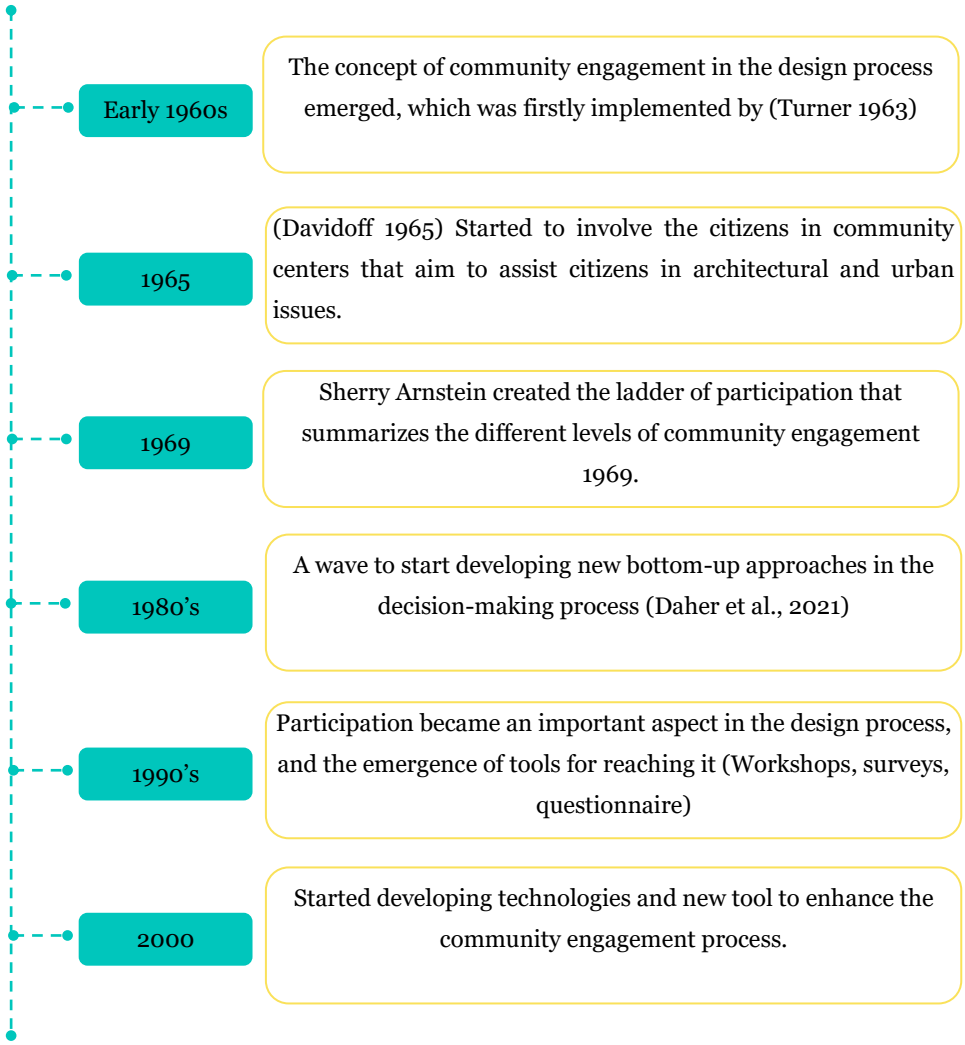

Figure 3: Diagram illustrating the history of community engagement concept (Source: author).

2.2 Role of Community Engagement in Urban Spaces Design

Community involvement happens when the local community participates in municipal works together with the local government to solve issues related to real life, this enables the local community to share their opinions and be part of the design process. The official's understanding of the users' behavior and culture can help eliminate the gap between them and the public (Fares, Taha, and EL Sayad, 2018). Moreover, Users should be included in all phases of the project's

development, whereby allowing authorities to make decisions on their own would have numerous negative effects, thus cooperation between them and the community is essential. Faliu et al. (2018) stated that end users should be considered while designing any open space as this respects their quality of life and builds a sense of belonging to the place.

The majority of scholars assert that urban spaces are one of the most significant components of a city's spatial structure and social system (Szczepańska, Kaźmierczak, and Myszkowska, 2021). Furthermore, the development and production of integrated spaces is one of the key goals that should be sought by local governments, businesses, and residents. This results from the reality that cities and the components inside them are constructed for communities rather than for individuals (Lynch, 1960) This integration could be achieved by having proper community engagement, as this will result that the final output will be more inclusive and according to real issues and problems. When applying community engagement in the urban design process, reflects an application of justice as this allows the community to communicate their perceptions and needs (Meyer, 2011). Based on (Hester, 2007) "Design is a political process," as the use of community engagement process in the landscape design process affects the social realm as well as the personal. Moreover, Expectations for participation in the political power structure developed because of greater social awareness and community involvement. Thus, public engagement in politics and the establishment of local democracy led to pressure that finally modified planning methods and led to the rejection of the concept of comprehensiveness (Suebvises, 2018).

As per Li (2017) community engagement in urban space design could be classified into 2 main categories, Participation as a mean is a top-down decision-making process: engagement is used only for the purpose of using the community to achieve certain development goals. Participation as an end which is a bottom-up decision-making process: in this category, people are in charge of their decisions and free to make any contribution or addition to the design and planning process of urban space. The design process should be influenced by the

power of citizen existence and engagement in the decision-making process in order to fulfill their needs and aspirations in line with their living circumstances and social and economic features (Ostad-Ali-Askari et al., 2021). This leads to improving the cooperation between all city actors in addition to enhancing citizens' feeling of place identification and increasing inhabitants' connection with a place. In general, the Top-down approaches tend to fail as it's more focused on the decisions based on problems and issues from the stakeholder's perspective not from the actual needs and actual problems of users of the space. Based on this, finding appropriate standards and ways for public involvement and initiatives that would prioritize meeting the demands of the public is a must.

2.3 Levels of Community Engagement

There are diverse ways to illustrate the relationship between the government and the community and the degree of interaction of this process. The tools used for community engagement in the decision-making process whether it is on an urban planning scale or urban space reflect on the levels of this engagement. For example, Arnstein's ladder of participation is considered one of the first participation levels illustrations. Arnstein provides a startling typology of eight degrees of citizen engagement based on the power dynamic between what she refers to as the "haves and the have-nots," the first two rugs indicate the lowest form of community engagement, being manipulation and therapy. According to Arnstein this manipulation suggests that certain government organizations have presented a mock figure of involvement when their real objective is to inform the public about accepting the work that has already been cleared.

(Ostad-Ali-Askari et al., 2021). rungs 3, 4, and 5 are degrees of tokenism: where engagement is through informing citizens of the government's plans and their rights and responsibilities, and the available solutions. The last level, which is the highest form of engagement, is the partnership between the citizens and stakeholders. However, Kingston (1998) described the public participation ladder in two main levels (Figure 4).

First is the low level of participation which is considered as one-way decision making. At this level, the users do not have the right to give feedback on the design but are only informed of the new actions that would be taken, and they may say yes or no to a project, but they cannot react to the process itself. The other level of participation is the higher level which is a two-way decision is making process. This is where users have the right to comment on the final design and could be a part of the design and they act as if they are the designers of the space. This level of involvement includes analyzing the impacts of potential decisions and making recommendations for solutions: The public is now actively involved in analyzing the effects of potential decisions and making recommendations for solutions that can be adopted and implemented.

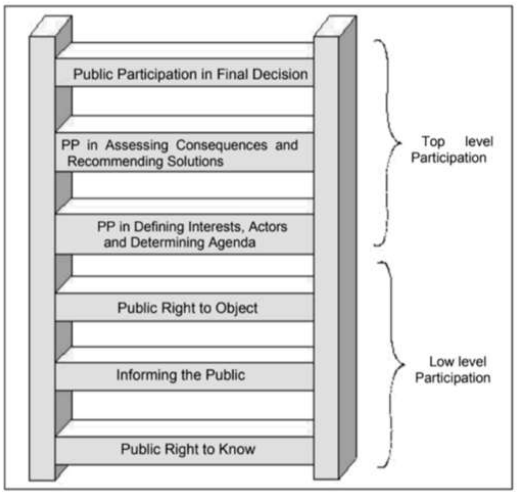

Figure 4: ladder of participation (Kingston,1998)

In general, community engagement in the design process is a two-way process through exchanging knowledge, interests, and viewpoints between users and civic organizations which would help in the final design output to be more inclusive (Daher et al., 2020). The process of participation could be summarized in 3 main levels: to inform citizens about the design process, to consult, which would help in gathering opinions about the design and to discuss which is the

highest level where users share their knowledge with the designers and stakeholders, in addition to implementing their ideas.

2.4 Traditional Tools for Community Engagement

Regarding how and why to incorporate people in planning processes, the urban planning profession has evolved progressively into more complex methods and ideas since the 1960s (Attia and Of Urban, 2011), where Community engagement in the design process requires the designer's responsibility to incorporate the development process and extensive investigation is required for good community engagement. While analyzing the goals and objectives of a community is crucial when planning for participation, there are a variety of methods accessible, each of which serves a particular purpose (Sanoff, 2000), Traditional community engagement tools refer to the common forms of participation that could enable local authorities to learn more about the evaluation of, opinions on, or degree of acceptability for a certain activity, this is through two ways, whether it's by gathering information directly from the participants such as face-to-face meetings, paper questionnaires, discussions among stakeholders and selected groups representing the community in participation workshops or through permanent discussion groups such as in local community forums and periodic community meetings (Szczepańska, Kaźmierczak and Myszkowska, 2021). Currently, these tools' presentation and visualization is mainly depending on the design proposals in the form of 3d physical models or 2D drawings, by which some Participants have difficulties relating these kinds of drawings with the actual world (Fares, Taha and EL Sayad, 2018). According to (Kingston, 2007), Citizens no longer favor traditional community engagement methods like survey questionnaires and open meetings. Although these techniques aid in understanding residents' perspectives, the limited usage of visualization techniques makes it difficult for citizens to fully understand the development process additionally this kind of engagement method requires a specific time and location which usually is not suitable for the participants.

Besides, these methods received some criticism regarding their ability to engage and encourage citizens to participate in the design process, in addition to some drawbacks and limitations that the public, governments, and planners must deal with, including the amount of time and effort invested in participation processes, the level of trust between participants and planners, financial resources, and the management of different perspectives and interests. Fixed times and locations may not be suitable for all, which ended up affecting participation rates and difficulties in evaluating the decisions.

2.5 Community Engagement in Egyptian Context

Focusing on the Egyptian context, the concept of community engagement has emerged in Egypt since 1998 by foreign organizations such as the United Nations (UN) and German technical organizations (GIZ). During the 1990s most of the developing countries started to cooperate with these foreign fundraisers in order to create a participation program. According to El Bayar and Abouelfadl (2021) at this time, promoting participation was a keyword to bring funds from international organizations and non-governmental organizations. The decision-making system at this time was a centralized system, where the states control is over the public sector, Throughout the years, There have been several legal initiatives to decentralize Egypt, and the public sector has experienced major change since 1991. It started by the GIZ started to implement a participatory planning process for upgrading mainsheet Nasser by engaging the community in the whole process (El-Shahat & Elkhateeb,2020). In 1998 After this initiative, a cooperative program was developed between the GIZ and the Egyptian Ministry of Housing to create a Participatory Development Program (PDP) in urban areas. The PDP aims to Cooperate with decision-makers at the national, regional, and local levels to improve informal areas. Its primary goal is to disseminate participatory approaches for integrated urban development within local governments, in addition to promoting participatory planning in informal areas, encouraging decentralization with the goal of fostering the implementation of participatory policy tools between the public and private sectors. In 2005 there was a trend of applying public participation process in urban design and urban

planning known as a decentralization trend, thus in Egypt, it, started to be applied by the GOPP (General Organization of urban planning) when designing strategic plans for cities and villages, that these plans should include the community in the decision-making process (Mahmoud and Arima, 2010), from that time the strategic plans of Egyptian cities and villages was in cooperation with the citizens. Furthermore, in 2015, Egypt's 2030 vision included participatory planning approaches, and that should be implemented in any development project. The following diagram summarizes the development of the community engagement concept in Egypt (Figure 5).

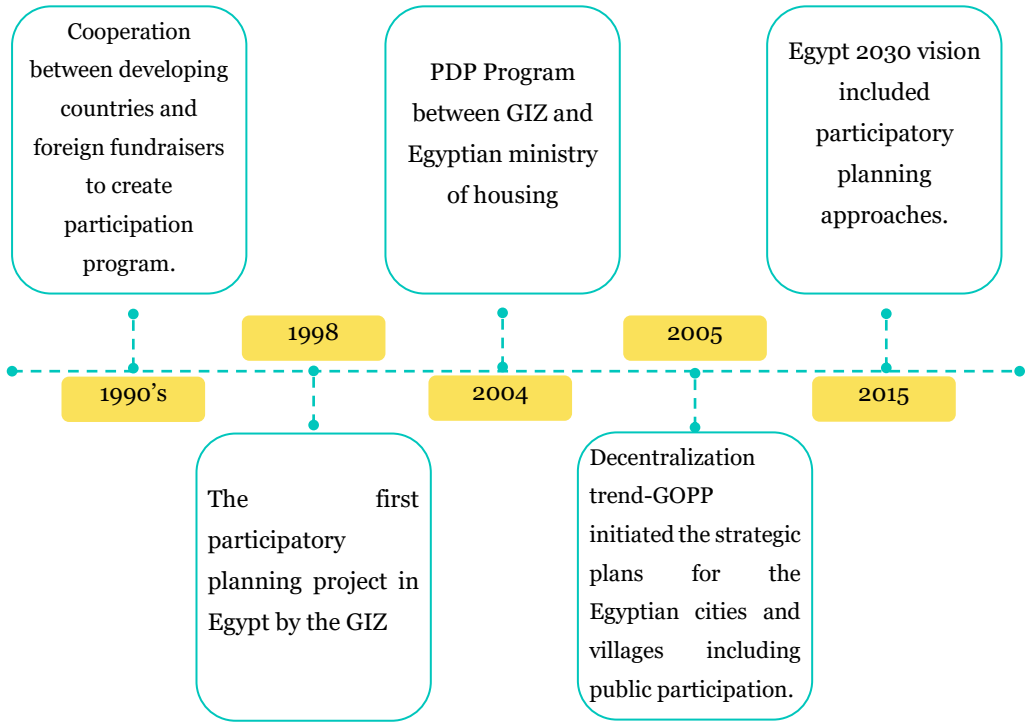

Figure 5: History of community engagement in Egypt (Source: author)

2.5.1 Community Engagement Tools Used in the Egyptian Context.

As per the literature in the previous chapters, Traditional community engagement methods such as questionnaires, surveys, face-to-face meetings, and others have been criticized due to their mentioned limitations. Referring to some examples that applied community engagement through the design process using these conventional tools in Egypt, there are several cases, from these cases:

1-Assyout case for preparing the city strategic plan in 2007, the application of the community engagement process was through having several community meetings under the supervision of a public entity (The GOPP), these meetings included the GOPP as the main initiator, planning team, and development partners and other stakeholders. The process was through 5 phases referred to in (Figure 6):

Figure 6: Asyut strategic city plan phases (Source: author)

Focusing on the third phase which is the community meeting, in this phase young, women and elderly people were invited to participate in the strategic plan preparation, but what happened is that a very minor number of citizens attended the meeting (Aboelnaga, 2017)

2-The GIZ project for upgrading Ain Shams district, the community engagement was through having a participatory planning process this project aimed to promote participation and consultation through meetings with stakeholders and development partners in order to upgrade Ain Shams district in Cairo the consultation was between the community and Experts in all sectors, Project process went as follows (Figure 7):

Phase one: Preparatory stage, where experts in different sectors started gathering data about the district from different aspects: (education, health, facilities, …)

Phase two: Analyzing the existing situation of the district through SWOT analysis, in order to determine the main problems of the district.

Phase three: To manage the problems that were mentioned in phase two, participatory planning workshops were conducted with representatives of the local community, stakeholders, and representatives of civil society, in addition to a participatory planning team to guide the workshops.

Phase 4 and Phase 5: According to the SWOT analysis and the participatory planning workshops, experts started to determine the hot spot areas of the main issues in all sectors in order to prioritize the projects, and according to it, design alternatives were proposed to solve these problems.

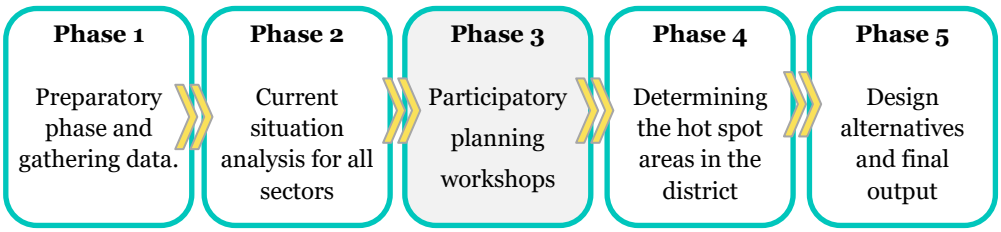

Figure 7: GIZ project phases (Source: author)

Focusing on the third phase which is the Participatory planning workshops, this phase included three workshops with the community using maps and pins to illustrate the current situation of the district and determine their main problems and issues, By the end of the workshop people were engaged with the process but still a limited number of citizens participated in it and it was under the level of informing the community with the project and proposing alternatives without including user opinions about it (Author, 2022).

2.5.2 Problem of Community Engagement in Egypt

After reviewing the previous examples, referring to what hinders community engagement in Egypt, it could be categorized as general problems and Problems related to the tool used. General problems could be summarized in 3 main aspects: First, the lack of interest in being involved in such a process as what happened in the Asyut case, where some of the citizens feel like it's not that important to give their opinions about a design or something, this also could reflect the level of education and awareness of the community of how it's important to react actively in a design process than being a passive factor. Second, lack of awareness of the importance of public participation, third, the lack of legislative factors and rules that set it as important to involve citizens in a decision-making process as per the law decisions are taken locally and then centrally which led that the final decision is still centralized. According to

Aboelnaga (2017), these general problems could be classified as Economic, educational, social, and legislative aspects. Other Problems were related to the tool used in the participation process which could be classified into 3 aspects: First: Communication problems, where the use of verbal or non-verbal communication affects the participation process, moreover, using more visualization techniques and attractive tools will enhance this issue as it may engage more people. Second, the quality of data that people receive, where the quality of data perceived by the community will reflect their response when being a part of a decision-making process of a specific design. Third, most of the tools require a specific time and location which is not always appropriate for the participants, for example, due to some traditions and social customs women usually don't attend community meetings.

Although different tools are used in Egypt for the community engagement process, still it falls under the level of informing people and is not an active form of participation that allows people to be directly involved in taking part in the development process specifically being a part of the co-creation process. Hence, there is a need to develop new tools to promote community engagement in the Egyptian context in order to cover the mentioned drawbacks. Using new technologies and Virtual reality may contribute to this issue. The application of VR tool in Egypt is available in different fields on small-scale projects such as interior design, tourism and cultural heritage, and education. But a gap was found in utilizing this kind of new technologies for public engagement in urban design and landscape scale specifically open space design. One case that applied VR in urban design was the case of designing a plaza in a business complex (Atwal et al., 2019), in this case, public engagement was done using 2 different tools, The first by using a survey, with questions about the design and satisfaction of space, this survey targeted 50 participants but only 28 gave feedback. The second tool was that designers prepared a 3D modeling procedure in static VR to convert the 2D designs into 360° panorama images then these designs were presented to a sample of users from the business complex to view the design through a mobile application using a simple VR headset (Figure 8). By the end of the process, a

survey was conducted about their opinions after viewing the design and it ended up having fifty participants who gave feedback (Atwa et al., 2019).

Figure 8: Employees viewing the design through VR (Atwa et al., 2019)

Chapter Three: Digital Transformation in Community Engagement Tools

As the conventional tools have some drawbacks, such as the fixed time and location, new technologies are now being implemented to enhance the community engagement process, this chapter describes the development of these technologies in the field of participation, in addition to focusing on the virtual reality technologies which the core of the study.

3.1 Development of Digital technologies in Community Engagement

Despite the efforts done in the conventional tools, these tools are still not interactive enough, because they do not allow citizens to choose freely and do not support the exchange of opinion, in which the participant is the recipient of the

proposals, and it is expected that more citizens will be involved in the decision-making process in urban design through the use of modern technologies. conventional tools are currently evolving in new forms owing to new emerging technologies. New potential is emerging now in community engagement by using Information technology, these new technologies allow for providing an interactive environment for decision-making and taking in addition to new forms of participation (Ehab, Burnett, and Heath,2023).In recent years, digital solutions for community engagement in urban design have progressively gained traction, and the use of digital tools to promote community engagement is spreading around the world (Steinbach, Sieweke, and Süß, 2019). As a result, it has been active in the field of urban design and urban planning since the 1990s, when public participation geographic information systems (PPGIS) were developed (Haklay, Jankowski, & Zwoliński, 2018). Digital tools may contribute to promoting community engagement and supporting citizen self-organizations, in addition to lowering participation barriers between citizens and stakeholders and advancing equity and inclusivity. It can also lower the expenses associated with crowdsourcing and citizen consultation for municipal government, the meaning of crowdsourcing here is the process of collecting data and services from different stakeholders and citizens (Citizen Participation in the Information Society, 2022). By facilitating continuous connectivity, making participation more flexible in terms of time and place, and providing new methods of visualization, digital technology can improve opportunities for citizens to participate in the planning process (Narooie, 2014). Digital technologies that can be used in the community engagement process, there are several approaches were implemented, according to Jutraz & Zupancic (2015) examples of these approaches are:

1-3D visualization: The use of 3D models Static pictures and animations to have better visualization for the designs, and then these designs are presented to the community to review it and mention their opinions about it.

2-Virtual Worlds and Extended Reality: such as mixed reality (MR), augmented reality (AR), and virtual reality (VR), these concepts fall under the

umbrella of extended reality (XR). Augmented reality is the way of using mobile applications so the users can insert their mobile phones any place and start viewing the design through the application, and then giving their opinion about it. VR is present in the virtual environment even if it still does not exist. All real-and-virtual mixed environments between human and computer input are described by the XR (Alnagrat et al., 2022). According to Safikhani et al., (2022), Extended reality presents the existing and future spatial computing technologies that enhance human experience.

3- Real-world models: Arc GIS urban, giving different 3D scenarios for a space that people can review.

The Growing of digital technologies in the community engagement process started in 2015 when these approaches tended to boost people's ability to participate in public decision-making (Estafam, 2021). but most of the currently available technologies concentrate on 3D visualization and feedback, which are classified as information and consultation levels of participation (Billger, Thuvander, & Wästberg, 2016), so the issue of not having an active form of participation is still here. The following diagram shows the history of digital community engagement tools (Figure 9):

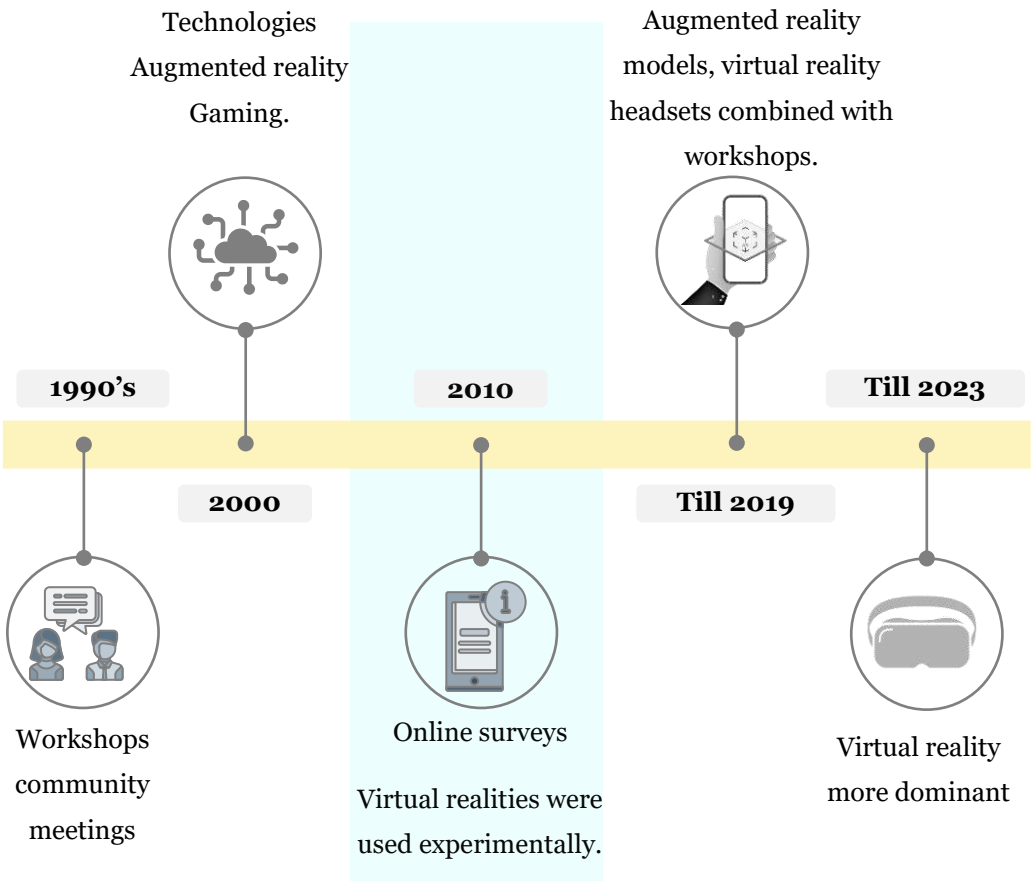

Figure 9: Development of community engagement tools (Source: author)

Accordingly, another shift in technology was done which may contribute to solving the issue of community engagement with conventional tools. Based on the following e-Participation ladder (Figure 10), which is considered as an update of Arnstein ladder, virtual worlds are the most effective level for bringing more people with effective communication where the users are considered as the designers of the space not just commenting on it (Kiwan, Sheta & Michel, 2021). Where the bottom of the rung is when participants react passively, and at the top is the full

Figure 10:An augmented ladder of e-participation (Kingston, 2002)

interactivity level when being a part of the virtual world and of the whole design process, which will affect the decision-making process (Hudson-Smith et al., 2002). Different research has been done on the influence of applying virtual reality in the community engagement process as it fosters collaboration and would minimize the gap between the users and the designers in the design process, where using VR enhances the overall spatial understanding and allows for better interactivity between the different stakeholders (Ehab, Burnett and Heath, 2023).

3.2 Virtual Reality Concept

Virtual Reality (VR) is considered a method for interacting between people and complicated digital data, Strehovec (1992) argues that we are simultaneously present in two worlds—the knowledge is situated in the virtual world and time, while the body stays in the real world and time. Virtual reality is based on generating a virtual environment and displaying it through goggles where new layers of perception of the world are frequently built depending on the view through the camera of the used device. Users often communicate with the world in such a generated virtual environment using specialized controllers. (Szczepańska, Kaźmierczak and Myszkowska, 2021). According to (Alnagrat et al., 2022) VR is a fully artificial environment that allows users to observe and interact with virtual objects and their surroundings via input devices, in addition to the experience of living immersible in a simulated space with independent anchoring. VR is classified as Fully immersive and non-immersive reality (Meenar & Kitson, 2020). Fully immersive reality allows the user to have a more realistic experience of a space through having sight and sound by using headsets, While Nonimmersive reality allows the user to be conscious of and in control of their physical world but gives a computer-generated environment (Wang and Lin, 2023). The degree to which VR technology is immersive, involving users' minds, sights, music, and touch, is a crucial aspect of the technology which will affect the whole community engagement process.

3.3 Virtual Reality as a Community Engagement Tool

The information transferred between the participants and stakeholders who are involved in the community engagement process could be divided into two main categories: verbal information through words, or non-verbal which may include other senses such as vision (Szczepańska, Kaźmierczak and Myszkowska, 2021). Generating direct contact between users and the design is the best way to collect information, as it allows rapid modification based on the comments and the depth of the study. For this instance, Virtual reality is considered one of the most recent visual communications tools. But the way of visualization of VR and its process set it apart from other tools as it is commonly used for the planned and designed realities that still do not exist. VR provides a visual presentation of data with accuracy and clarity, which allows the participants to grasp the information in ways that are different from the conventional used tools, where it helps in transferring information from the virtual environment into real ones, especially spatial information (Wang and Lin, 2023). According to Fares, Taha, and EL Sayad (2018), Virtual reality can be considered a technological advancement that allows users to get more involved in the decision-making process as it enhances the degree of their interactivity. Moreover, Virtual reality provides the users with a fully immersive experience by walking in virtual worlds, in addition to having embedded comments and questionnaires, in this case, users are not just reacting passively by viewing the design from a screen, they become a part of the design process which is considered as a real-world and allowing users to interact with the surrounding (Schrom-Feiertag et al., 2020). Presentation of data in VR through effective image acquisition algorithms blurred the boundaries between the real environment and the virtual objects presented in the VR headsets, which enhanced the overall visualization experience (Szczepańska, Kaźmierczak and Myszkowska, 2021).

Due to the different knowledge of stakeholders and participants involved in the decision-making process of space design and planning, communications regarding the design solutions and proposed implementations may be difficult because of the tool and language used in the participation process (Rodríguez

Estrada and Davis, 2014), hence VR is implemented for visual communication, that is simpler to be identified by untrained participants, this visual communication is formed when information, ideas, and solutions are utilized using visual resources (Jiang and Qing, 2020).

3.4 Applications of Virtual Reality in Urban Space Design

The concept of virtual reality in community engagement has emerged since the 1990s, but at this time it was still used as a visualization tool until 2011, A call for a change in thinking, for citizens to be involved in the design planning process. Urban design professionals started to be motivated by citizen-generated design proposals to provide complete designs that incorporate the views of the public through using virtual reality (Faliu et al., 2018). Van Leeuwen et al. (2018) argued that VR headsets allow the observer to exist virtually in the context of a space design which supports the decision-making process in architecture and urban design. The importance of implementing VR in the community engagement process has emerged in literature, according to Schrom-Feiertag et al. (2020) it is a way for having more Interactive citizen participation which will affect the final understanding of the design. And Kim & Kim (2019) mentioned that Virtual reality allows users and urban designers to view different scenarios of the same space with different viewing angles and the ability to change shapes and parameters which ends up having a more holistic view of the project. According to experimental implementations mobile VR and interactive 3D visualizations may enhance citizens' perception and boost engagement (Ehab, Burnett, and Heath, 2023). Moreover, Fathallah et al. (2022) Argued that this kind of technology attracts the younger generation and the game-loving generation, and it enables people to experience a location without traveling there which solves the issue of the fixed time and location of the traditional tools. Furthermore, Visualization in VR allows the users to insert comments and opinions directly into the design, which saves more time and effort and helps in collecting opinions directly linked to the spatial allocation of these issues on the proposed design. In order to reach a high level of interactivity in the community engagement process

with VR, there is a need to generate high-quality data to create the impression and the feeling of an imaginary world and interacting with non-existent items. The greater the quality of the visual or aural data produced by computer programs, The more realistic and immersive this environment seems to the user (Alnagrat et al., 2022). In addition to this, VR helps in recalling objects when seen in a virtual experience, more than traditional devices. Harman, Brown, and Johnson (2017) made an experiment to differentiate between participants who were able to recall objects seen in a VR headset and Participants who saw the same objects in a computer monitor, and the results showed that participants with the VR headsets were able to remember the objects better. Moreover, According to Yavo-Ayalon et al. (2023), other aspects should be considered while using virtual reality in community engagement, such as the positioning of members who will use it and the time required to prepare the model that will be used in the process.

Virtual reality is considered a design approach and an observation tool. As an observation tool, where the space could be created in a virtual tour and navigating in it through a 360-living environment which gives the users the opportunity to view the design and move around the space. and as a design approach, where it gives an additional function to the observation tool, as it allows the designers to digitalize the environment including the objects placed in it, and gives the users the ability to view the design and integrate the users by allowing them to handle objects virtually through sensors and input devices, where the transmitted information could be audio, sound, or spatial allocations (Çakir, 2015). The following diagram illustrates the virtual reality system how it works, and why it could have a significant influence on the community engagement process. Where it starts by having a 3D model of the space whether it's a model or 360 image m then simulation to introduce this model on the headset by which the participant will use to view the model (Figure 11).

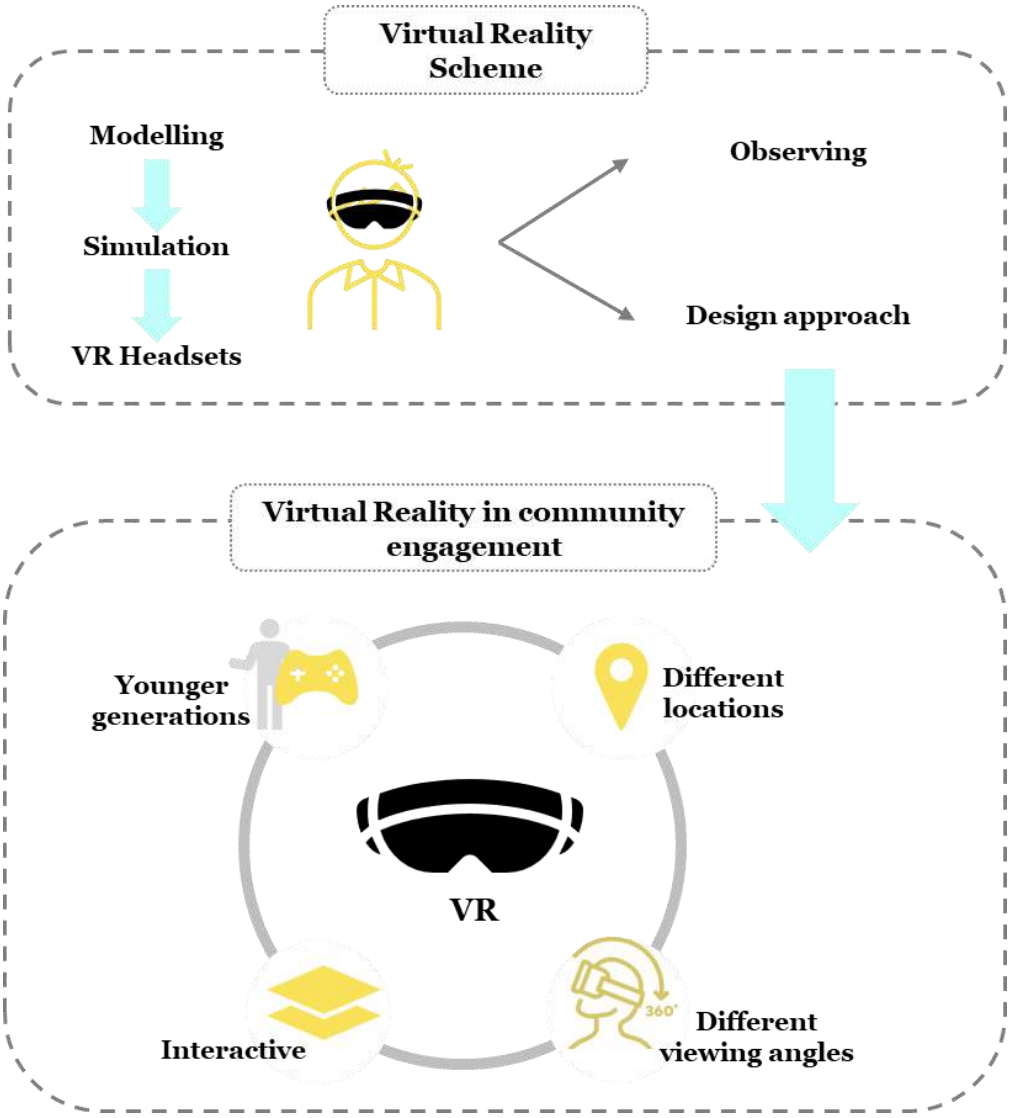

Figure 11: illustrates the virtual reality system (Source: author)

3.5 Related Work

Various studies have been to investigate the application of VR in the planning and design process and showed that there is a high potential to use it in terms of design and community engagement as it makes the process more accessible to different stakeholders and participants (Schrom-Feiertag et al., 2020). Among these studies it is pertinent to refer to the following:

Web-based virtual environment (Mahmoud and Arima, 2011), Designing a university campus public space (Figure 12). The project went through 3 phases. : The first phase was creating a web-based VR environment, by designing a 3D model for the university open space and then adding icons and animation to it. The second phase was that they invited students from the college to view these designs from a PC by opening the website and starting to have a walkthrough of the model, Third phase was that the users start to add comments on the objects of the model whether they like it or not and another option was added where students could move and rotate objects. By the end of the process, designers had the data collected already from the website and statistics based on users' comments and adjustments in the design, which ended up having a pre-design of the public space based on the users' opinions. In this process, VR worked well as a visualization tool to make the participation process easier, and the users were the designers of the space, which strengthened the relationship between stakeholders and made the process more effective by using VR as a visual interface for data entry. Virtual reality in this project was used as an observational tool in addition to adding functions to allow users to insert their opinions directly so it's also used as a data collection method.

Figure 12:Users viewing and adding comments to the design (Mahmoud & Arima ,2011)

The Regeneration of Woodberry Down experiment (Hudson-Smith et al., 2002), In this study community engagement is through an online website (Figure 13) where a forum was created with the area of Woodberry, the website included 4 main categories of information, first is for textual information about the whole process, second is the maps and images of the housing blocks, third different design proposals presented in the form of a virtual tour, last is the discussion forum by which participants use it after viewing the first three sections in order to implement their ideas and opinions, this is through various comment forms, bulletin boards and animations to ease the way of users inputs.

Figure 13: The Woodberry Down Web Site with Inset Window showing the Viewpoint (Hudson-Smith et al., 2002)

UN-Habitat Mine Craft project; This project was held by the UN-habitat using Minecraft as a tool for public participation to include the younger generations (Figure 14), It was implemented in more than 4 countries around the world, and example from these cases was in Mexico, where the UN-Habitat used Minecraft to run a public space crowdsourcing exercise, and the youth were asked to redesign a plaza, in a pre-constructed virtual environment of the existing plaza. The

Figure 14: One of the children's designs of the public space using Minecraft (Un-Habitat, 2014)

outcome was 7,429 young people participated; 1,438 ideas were submitted. Using Minecraft and virtual worlds in this way has revealed that it enhances young people's interest in urban design and planning, allows them to express themselves visually, gives them new avenues to shape policy agendas,

and aids in skill development and community networking (Un-Habitat, 2014).

Another experiment was done by.
Van Leeuwen et al. (2018), where the community engagement process was to assess three variants of park designs in a neighborhood, and participants were asked to view these designs using different participation methods, one of these methods was to use the VR headsets to move and navigate between viewpoints of the 3D proposed model and after finishing the virtual tour they were asked to vote accordingly to their preferred design, in addition to giving comments and opinions.

Figure 15: Residents viewing the variants of the park using VR headsets (Van Leeuwen et al., 2018)

Chapter Four: Case Study Application

Based on the previous literature, nowadays there is a call for having a Citizen-made design proposal to inspire urban experts, so they can create comprehensive designs that take into account citizens' opinions. In the Egyptian context, VR is not widely used in the community engagement process and still relies on conventional tools which do not directly affect the decision-making process and it is mainly focused on informing the users not being a part of the whole process. For this instance, the research focuses on investigating VR technology as a design approach in landscape design projects in Egyptian universities to promote younger generations' engagement.

4.1 Case Study Selection Criteria and Methodology

Concerning the location of the study, two locations were proposed out of which one was selected. The first proposed location was in a neighborhood in Cairo while the second location was an open space in the faculty of engineering, Ain Shams University, Cairo. The second was selected to be the area of the study due to the time limit restriction and easier accessibility of participants. Performing the study in the neighborhood would require a longer period of time than available to reach a wide range of participants. Besides, it would be easier to reach and access participants in the university than in a public neighborhood. After

selecting the university to be the location of the study, further analysis was done to choose the most suitable area in the university context.

Regarding the selection of the VR headset to be used, two options were available. These were the Oculus Quest two and the valve index headset. A comparison between both the headsets was performed and the oculus quest 2 was found to be more suitable for the case study. First, the oculus quest 2 provided higher reachability to the participants of the study. This is because the valve index headset entails that several sensors are analytically placed in a room. The headset then defines the room boundaries based on these sensors. This required that the participants be required to be present in that specific room in order to take part in the case study. On the other hand, the oculus quest required no fixed location to experiment. It was only required that users of the headset defined their room boundary in runtime based on their current standing position. This provided higher reachability as participants could take part in the case study from any location and hence allowed for a wider range of participants.

The empirical fieldwork was conducted through four different phases, first phase was the urban space selection: this was through mapping all open spaces in the university campus and observing the unused spaces, moreover, conducting an interview with the designer of the selected area to analyze its development plans.

The second phase was the design proposal of the selected area which was based on site analysis through on-site observations and the selection of landscape elements to be added to the proposed design, these elements were selected based on activity mapping of the users around the space to observe the common needs in the university campus and through literature review.

The third phase was the modeling of the Virtual environment of the space by using 3D modeling and 3D gaming software.

The fourth Phase was the implementation phase, the calculation of the sample size through observing the flow of people in the surrounding space. then inviting students through an online platform to join a workshop on redesigning an open

space in the university campus using the VR headsets this is through wearing the VR headsets and moving around the virtual space then adding landscape elements based on their needs. After applying the study with students, data was collected through an online platform that saves elements coordinates in addition to conducting a field survey with students. The following diagram shows the whole case study methodology (Figure 16).

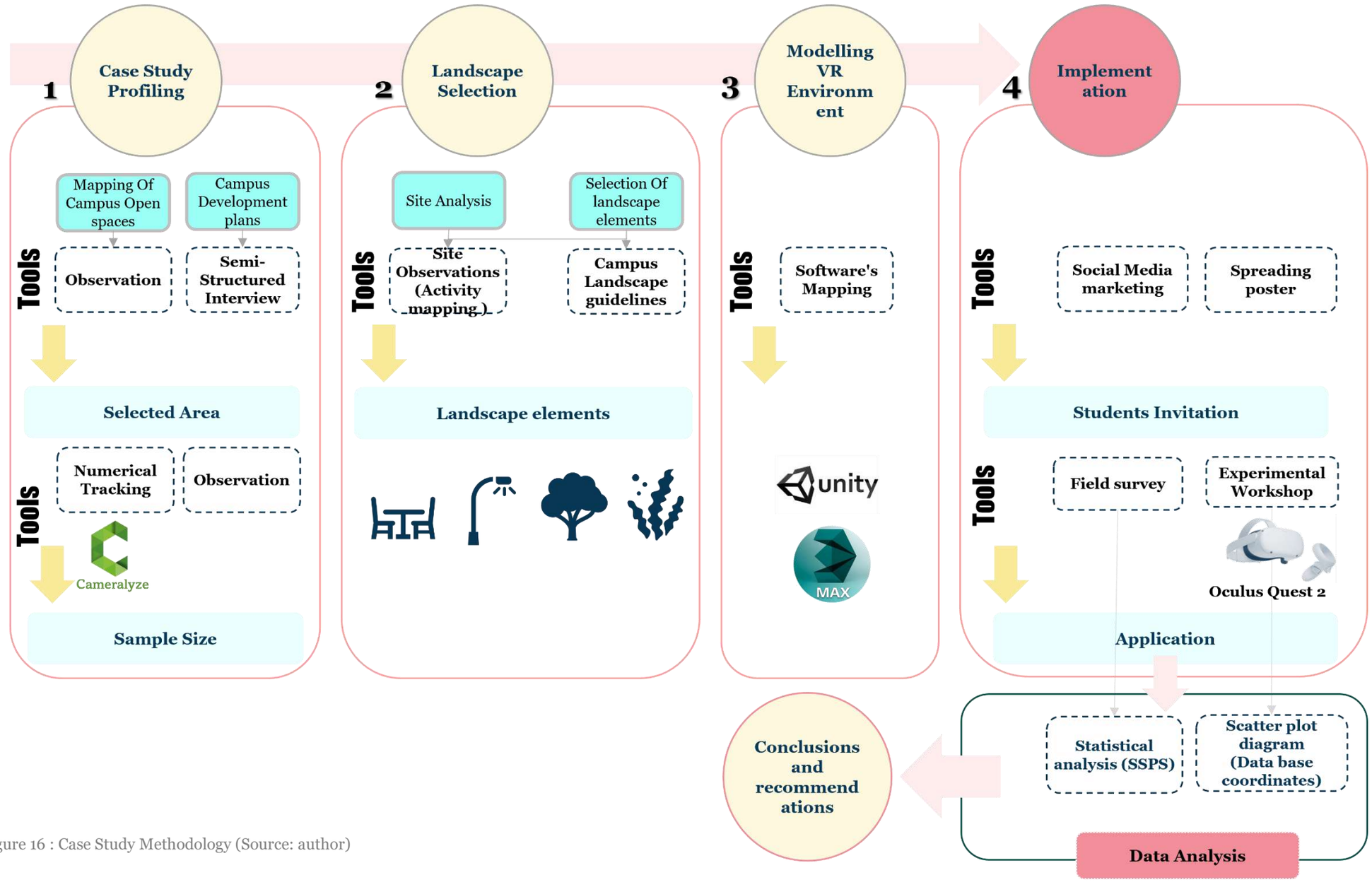

Figure 16 : Case Study Methodology (Source: author)

4.2 Phase One: Case Study Profiling

The selection criteria for urban space were based on mapping all open spaces in the university campus and identifying the spaces that are currently unused or need to be redesigned. This mapping was a result of an observational analysis that has been conducted of the campus open spaces to determine which areas were underutilized or had the potential for improvement. (Figure 17) below, shows the main open spaces in the campus. The numbers in the figure represent the common spaces that were used by students during their peak hours. (Figure 18) to (Figure 22) shows details of each of the spaces, their landscape elements, and how students utilize them.

Figure 17: The aerial image of Common campus open spaces (Source: google earth, author)

Figure 18: Photos of the space in front of the main building (Source: author)

Figure 19: Photos of the space in front of the library (Source: author)

Figure 20:Photos of the seating areas along the main spine (Source: author)

Figure 21:Photos of the space in front of the mosque (Source: author)

Figure 22: Photos of the Space between Hall A & Hall C (Source: author)

Based on this mapping it seems that most of the open spaces in the university campus are being used. This is due to the presence of landscape elements such as green areas, street furniture, benches and tables, and shading tents which allows students to interact with these spaces. These elements provide insights that students mostly use spaces with facilities that would help them in studying. The only unused space is the one between Hall A & C. For this instance, the research case study will be redesigning this space using VR headsets.

4.2.1 Development Plans of the Selected Space

In order to gather data regarding the development plans of this space, an Interview was conducted with Prof. Dr. Mohamed Fayoumi the designer of the current master plan of the study area (refer to appendix A). Based on this interview, this area was first used as a gathering area with green spaces and steps that served as seating areas. However, by that time, most of the space had become a waste area, resulting in unused space (Figure 23). (Refer to Appendix B for the interview questions).

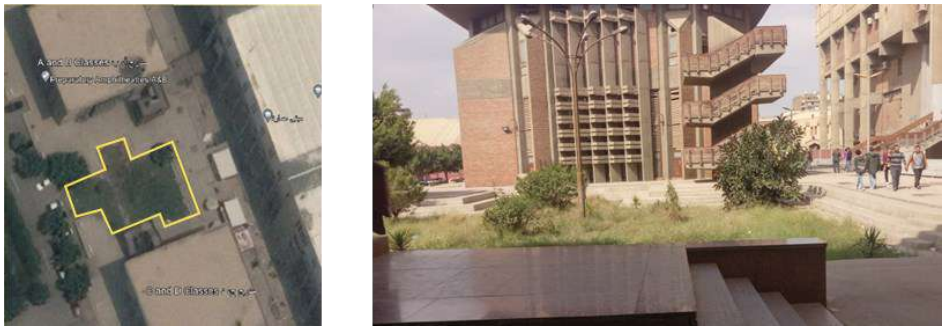

Figure 23: Study area image 2018 (Source: author)

A new development has been made for most of the faculty open spaces including the study area. Based on the development plan, this area was designed to be a service area including kiosks that can be used for multipurpose such as food kiosks, stationary needs, or any other service. But the case now is that this space is still unused, and that may be due to the lack of shading elements of the space which lead that it is most of the time a sunny space, in addition to lacking landscape elements such as seats, shading, greenery. For this instance, the research study aims to redesign the space using a different design approach that includes students and users in the design process. To achieve this goal, the researcher used VR headsets to allow students to design their own open spaces based on their needs. This approach is intended to provide a more inclusive and collaborative design process that takes into account the needs and preferences of the users who will be using the space.

Figure 24 Study Area New development site photos by the author

4.2.2 Sample Size Calculation

In order to evaluate the objectives of this research, the experimental study was carried out with a total of 44 participants. The sample size of the study was calculated by an online sample size calculator through which the total population, confidence level, and margin of accepted error were entered to get the needed sample size using (Raosoft). The information about the population size of the space users was not available as it is currently an unused space, so it had to be estimated. This estimation was based on people tracking through taking photos of the flow of students in the surrounding area along 5 days of the week at noon, this time was selected as it's the peak hour for students to take their break, A photo was taken every 5 minutes of the surrounding space along the 30 minutes break (Total 6 photos per day). Based on this average, the number of students passing by the space was ninety students. The following fig. shows an example of the people tracking software (Cameralyze) showing one slot of a day where the students count was eighty-one students. (Figure 25)

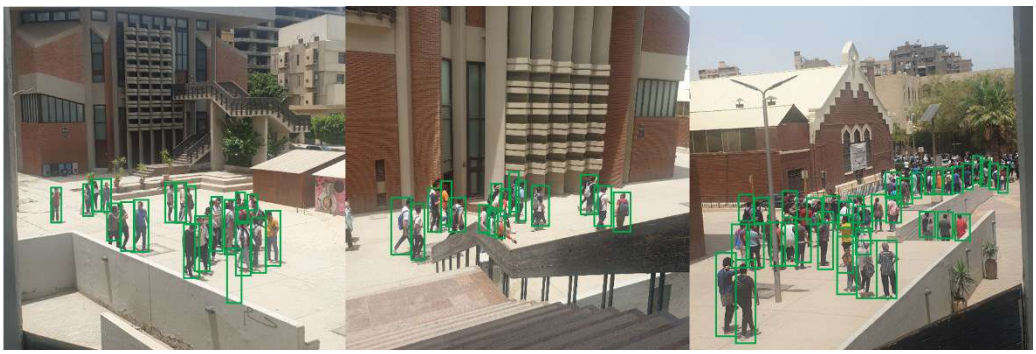

Figure 25: People tracking of one-time slot (Source: author)

4.3 Phase Two: Contextualized Design Proposal

4.3.1 Site Analysis

To provide guidance for students to redesign the space, a design was proposed based on site analysis and observations. The design takes into account various factors such as the main entrances of the space, existing kiosks' location, views, accessibility from each side, and environmental considerations. The diagram

below shows these factors and how they were incorporated into the proposed design (Figure 26).

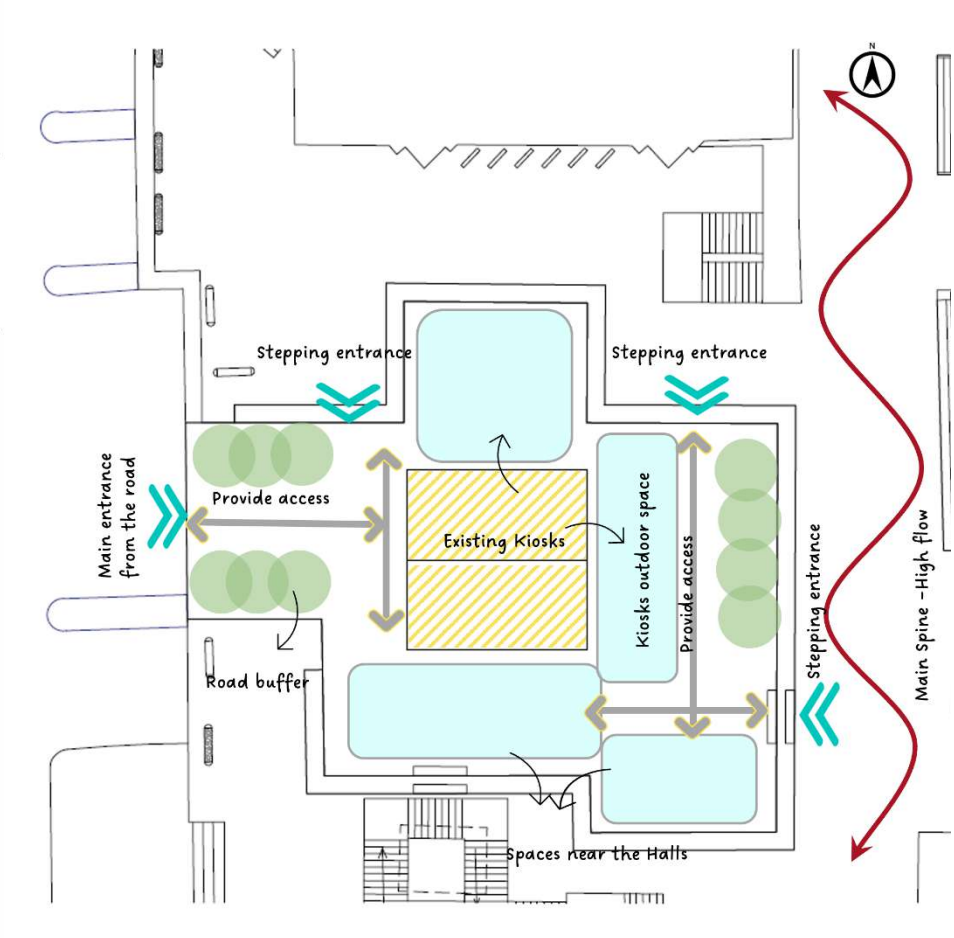

Figure 26: Study Area Site Analysis (Source, author)

Based on the site analysis, the proposed design accommodates two main zones that could be redesigned based on students' needs: Zone A and Zone B (Figure 27). The existing kiosks were kept as part of the current development plan. The design aims to provide a more flexible and adaptable space that can be customized to meet the changing needs of the students and users who will be using the space.

Figure 27: Proposed Design for the Study Area (Space between Hall A and Hall C (Source: author).

4.3.2 Selection Criteria of Landscape Elements

4.3.2.1 Guidelines for landscape design on Campus

The selection of the landscape elements was based on two main criteria. The first was from literature related to campus landscape design. The second was activity mapping for the open spaces of the faculty to determine the common activities that students do during their breaks. These criteria were used to select landscape elements that would be most useful and beneficial for the students and users who will be using the space.

Landscape serves as a foundation for a campus's outdoor environment, according to Dober (2000). He emphasized the climatological, practical, and aesthetic benefits of the landscape. Artworks and sculptures are examples of aesthetic

elements. While the climatic advantages include shade and air movement, the functional goal includes noise control and creating privacy for some spaces. Matloob et al. (2014) Concluded that campus landscape elements aim to improve safety, improved wayfinding, more attractive scenery, and an inviting atmosphere. According to research, there are four main elements of campus landscape design that are connected to campus sustainability:

-Ease of movement around the space

-Sense of identity and sense of belonging

-Accessibility

-Quality of the Public realm

According to (Lau, Gou, and Liu, 2014), the goal of landscape design is to create natural settings and sensory connections for restoration; the goal of spatial design is to organize easily accessible spaces to provide a good sense of orientation and for various activities; and the goal of green design is to construct an eco-system that includes sustainability features as well as physical comfort. These design ideas will provide users with a wide spectrum of comfort, from physical delight to emotional relief, further promoting well-being on the campus. Based on that the common landscape design elements in campus are described in (Figure 28).

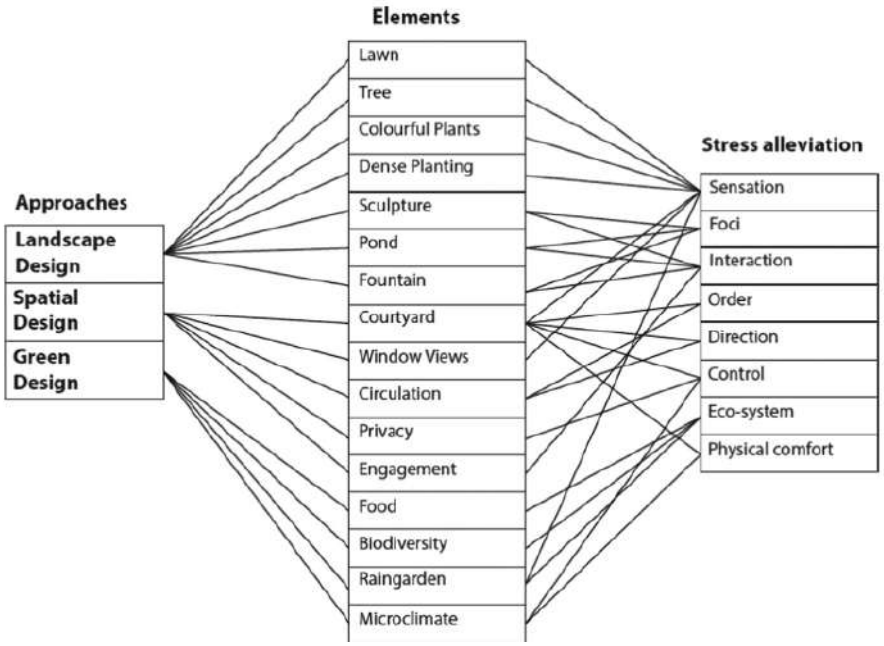

Figure 28: Framework for healthy campus open space design (Lau, Gou, and Liu, 2014)

4.3.2.2 Activity Mapping

The Second criterion was activity mapping which was conducted as part of the Urban Space project, revealed that the main activities in these spaces are studying whether individually or studying, and working in groups, reading, writing, drawing specially for architecture students, eating, and socializing. This reflects the need for these tables and chairs, drawing tables, trees, and tents for

shading, and street furniture such as basket bins, light poles, and electricity sockets. (Figure 29) shows the activity mapping of different campus open spaces

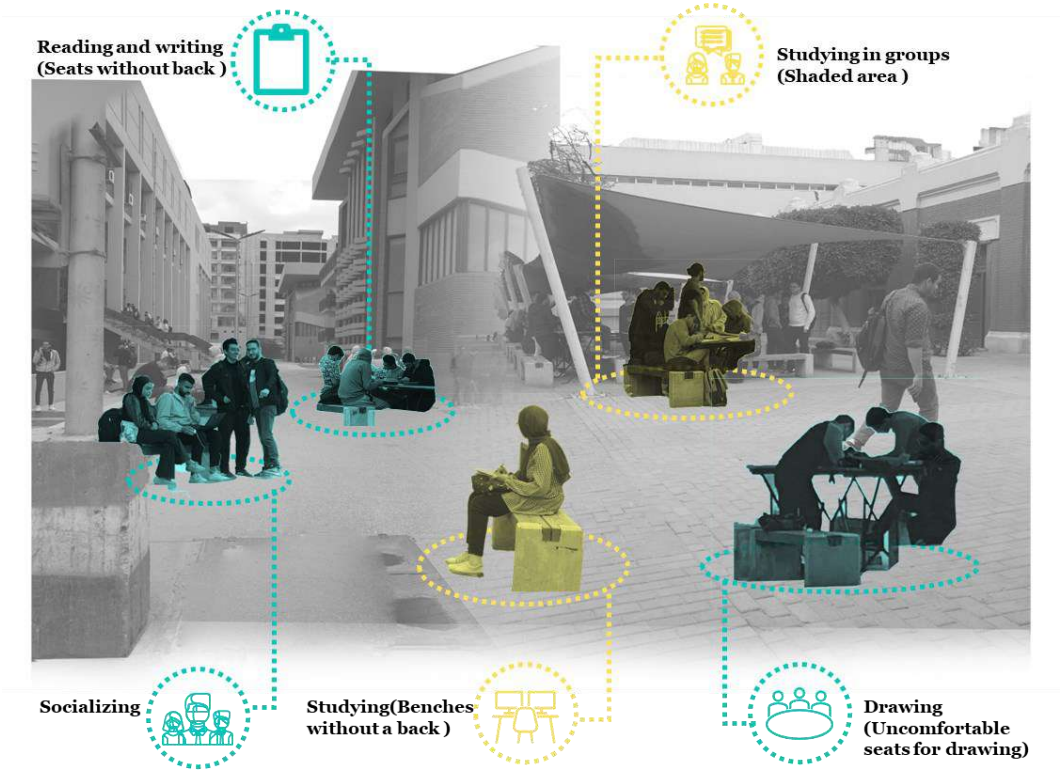

Figure 29: Collage describing Activity Mapping in different faculty open spaces (Source: author)

From the previous two sections, the selected design elements to be implemented in the design were divided mainly into four main categories: (Seats-Shading elements-Shrubs-Physical elements), the design of these elements was based on the existing landscape elements in the new university campus development in addition to new elements according to the activity mapping and guidelines, the landscape elements are presented in (Table 1).

Table 1: Selected landscape elements (Source: author)

Seat	Wooden Bench 	Table and chairs 	Wooden seat and table 	Assembled bench 
Shading Element	Tree 	Shading Tent 		
Shrubs	Red shrub 	Green Shrub 	Purple Shrub 	
Physical Elements	Light Pole 	Trash bin 		

4.4 Phase Three: Modelling of the VR Environment and Testing

After analyzing the space and proposing the design based on the physical and environmental aspects, the next step was the modeling of the VR environment by which students will interact with, the next steps were followed:

1-Building the space model through 3D modeling software and 3D game development software. These were Autodesk 3Ds Max and Unity, respectively.

The selection of these software's was because it provides a variety of functions and modules library for multi specifications of the gaming development, provides good visualization and light rendering of 3D objects, thus a major advantage for modeling 3D spatial geometry, easiness of using these softwares and the availability of tutorials and information about them which fits in the time plan of the research study.

3Ds Max is a program used to design 3D models and images. In this case study, a 2D model of the university's plan was obtained and imported into 3Ds Max. The 2D model was then extruded to generate a 3-dimensional model of the plan. Unity is a 3D game development program used for interactive, real-time 3D games. The 3D model produced from 3Ds Max was imported into Unity to start the creation of the virtual reality game.

2- A fixed number of each of the landscape elements were added to the boundaries of the model. Using the programming language C#, a script was added to each of the elements to make them interactable. This enabled the users to grab the objects, move them and place them in their desired locations. Then these elements were arranged around the space so that users could grab an object and add it to the study area. (Figure 30) and (Figure 31) shows the different views of the model that the users see when wearing the VR headset.

Figure 30: Study area modeling (Source: author)

Figure 31: Study area with landscape placed in it (Source: author)

3- Adjust the scene's lighting and materials for each component through the material editor.

4- Next, and through the unity software library, a character was added to the project. This character, along with a respective C# script, was used to enable the users to walk through the game model and rotate around.

After the model was complete, a testing phase was carried out with a random sample of users to gain insight into the overall model and determine whether it was visually appealing and understandable. Comments on this initial trial model

indicated that although grabbing and moving things worked well, there should be an unlimited number of landscape elements available to allow for a more creative arrangement of the objects inside the study area.

5 Based on this feedback, a further step was taken. The fixed number of landscape elements was removed, and a set of buttons were added to the model. Each button corresponded to a specific landscape element. Button scripts were programmed and added to their respective buttons. Upon clicking on a button, a new instance of the respective element was spawned and made available for the user to move, grab, and place. This gave users the option to insert an unlimited number of objects, hence allowing for a wider range of designs. (Figure 32)and (Figure 33) shows the updated scene views to the users based on the testing phase.

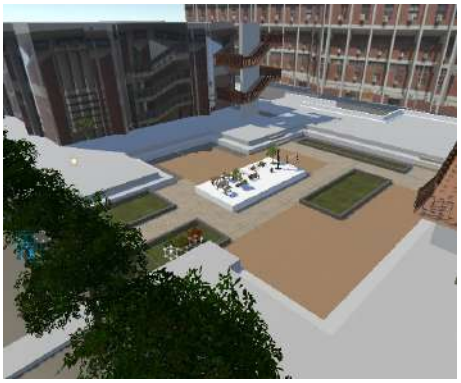

Figure 32: Shows a bird's eye view of the final scene (Source: author)

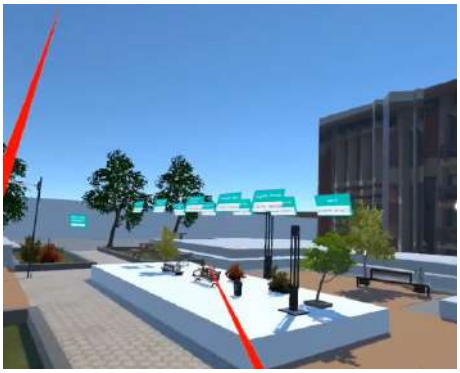

Figure 33: landscape elements with selection buttons (Source: author)

4.5 Phase Four: Implementation and Field Work

4.5.1 Procedures for the Application

After Having the model ready to be applied, the last phase was the implementation to allow users to be a part of the whole landscape design process and illustrate their needs using new technology (Virtual Reality) .and this will be done on 2 Main phases:

Phase One: community engagement workshop using VR headsets, where users will start allocating the landscape elements using VR and controllers based on their needs to redesign the two main zones (Zone A and Zone B) (Figure 34), These data will be collected in the form of x, y, z Co-ordinates, and then it will be used to generate a design. This process could help in forming different design proposals based on the users' opinions.

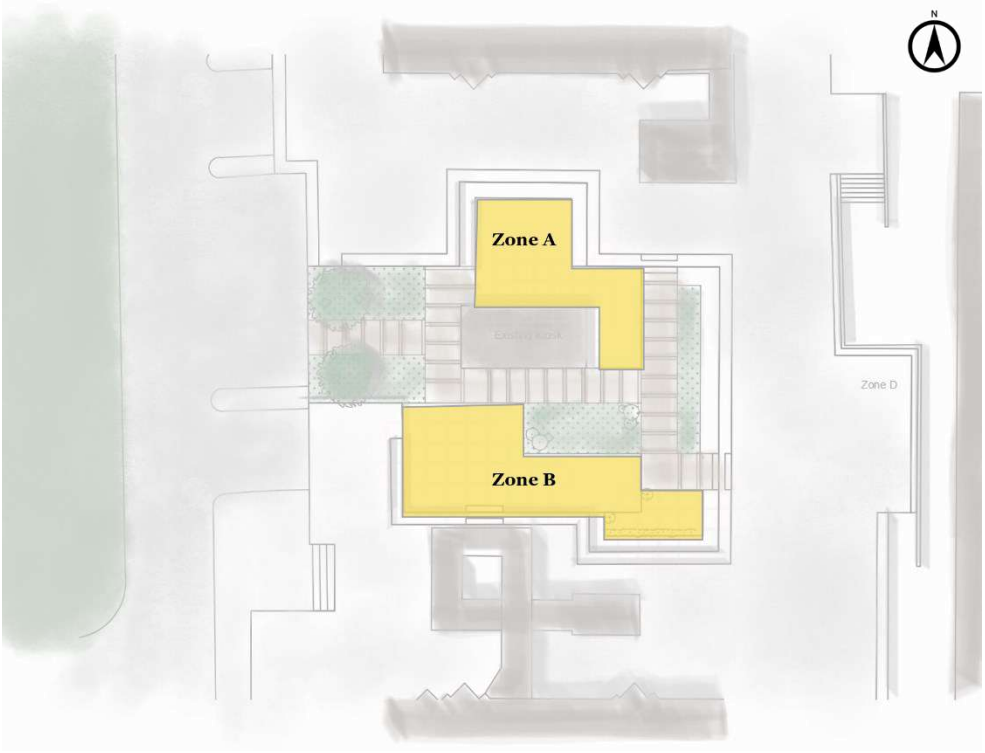

Figure 34: Proposed zones to be redesigned (Source: author)

Phase Two: Field survey: After conducting the workshop from phase one, a field survey was conducted with the participants in order to collect their opinions regarding the whole process. The survey was descriptive-analytical, and it collected information that describes the users as well as exploring their perceptual views towards Virtual reality and new technologies.

4.5.2 Phase One: Community Engagement Workshop

First, to invite students to the workshop, an online booking platform was created using Rally website to allow students to book slots in order to be involved in a workshop titled '' Be a part of the virtual world '', and this link has been sent to all students from different departments, in addition to a poster with a detailed description was added to illustrate what the process will be briefly and that they will redesign an open space in the university whether individually or in groups based on their needs with the VR headsets (Figure 35) and (Figure 36). The workshop was held in different locations in the faculty based on the participants' location for 5 days from 7-05-2023 to 11-05-2023.

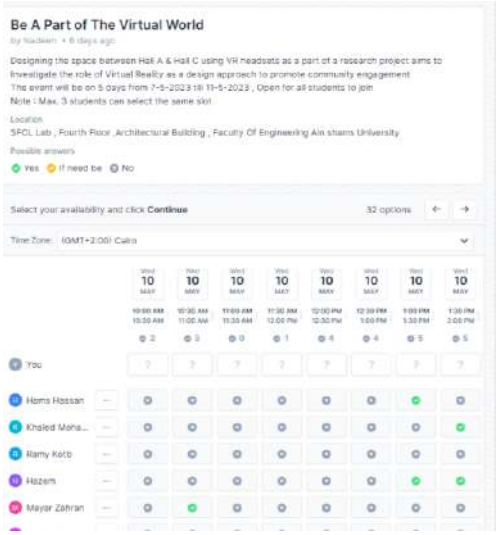

Figure 35: Students' Booking slots (Source: author)

Figure 36: Community engagement workshop poster (Source: author)

As previously mentioned, a proposed design was done to limit the variables of the study and the no. of open spaces that participants will design. However, students were asked to redesign two main zones, A and B. And place the landscape elements based on their needs. To achieve this, a small introduction to students was done about the importance of community engagement, why this workshop is done, in addition to public spaces design considerations, landscape design elements that could be implemented, and an illustration of what they are

required to do, this was in the form of a PowerPoint presentation. Following this the participants were asked to brainstorm, considering problems and challenges they face in the study area. It was assumed that participants are not always familiar with the software and may not be proficient with using this kind of technology. The participants were briefed about VR technology, its controllers, how to navigate and move around space and explain why it is useful to use this kind of technology in community engagement. The end of the presentation included a demo video for the study area being redesigned with the VR headsets to help illustrate the power of the software and encourage participants to explore and be creative.

Results were conducted by saving the X and Y coordinates of each landscape element added by participant trials, by using Firebase form to implement this script in unity. By the end of the workshop, an Excel sheet with each landscape element coordinates was collected, In addition to images of the 3D visualized designs of the participant's trials. (Figure 37) Shows the users' participating using VR headsets. (Refer to Appendix E for participants' photos).

Figure 37: Users' participation using VR headsets (Source: author)

4.5.3 Phase Two: Field Survey

Following the workshop, a field survey was done in order to get the participants' perspectives and opinions on the entire procedure, The survey was divided into Four main sections:

1-General information about the demographics of the participants such as gender, age, whether they are students or employees, department, and knowledge background. Moreover, the trial starting and ending time.

2-Assess the VR content and visualization in terms of interactivity: this section focuses on the visualization of the VR in terms of the ability to move around the space, visual experience, in addition to the ability to get used to grabbing objects in the virtual environment. The main questions were:

- Rate your Overall Experience of Using VR headsets in designing a space and getting used to it.
- From a scale of 1 to 5 rate your navigation and movement through the space
- On a scale of 1 to 5 rate your experience using the controllers of VR to move around the model
- From a scale of 1 to 5 rate your experience moving and grabbing objects in the space

3-Assess the effectiveness of using VR to visualize needs: this section focuses on the user perspective on VR and how it helped in visualizing their needs:

- Rate your experience with using VR headsets to help you describe your ideas and needs.
- From your point of view, which of the following is comfortable for you to use when participating in a design project (Using 3D Shots-Using Animated Video-Using 3D Game-Text Information), and each of these was explained in detail with examples, to help users understand it.

4-Advantages and disadvantages of using VR: By which users were asked to give positive and negative feedback about the whole process from their point of view.

Chapter Five: Results & Discussion

This chapter focuses on the results of the empirical study, which was conducted in two main phases, which are the community engagement workshop and the field survey after the workshop. ending with a discussion of the analysis with regard to the literature.

5.1 Phase One: Community Engagement Workshop Results

Results from the students' designs were collected by first dividing the whole study area into a grid of 3*3 m. This is based on the space needed to create a cluster of an outdoor seat area. The coordinates that were allocated by the participants during the workshop were collected, then analyzed by plotting it on the layout of each zone, then percentages of each landscape element were calculated using a matrix to determine the commonly selected landscape element in each square of the grid in each zone (Figure 38).

A matrix method was used to analyze each zone to determine the percentage of allocated elements. this was done by categorizing the landscape elements based on the function as follows:

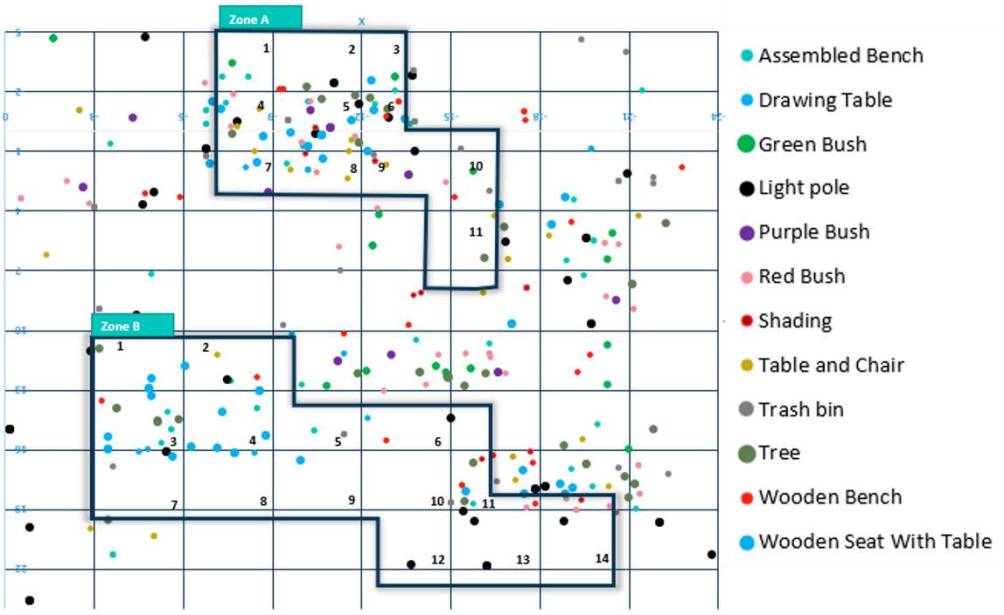

Figure 38: Community engagement Workshop results coordinate (Source: author)

- Seats: Assembled bench, Wooden bench, and table, Table and chair, Wooden bench, and Drawing Table
- Shading elements: Tree or Shading tent
- Shrubs: Green shrub, purple shrub, red shrub
- Physical Fixtures: Light pole and trash bin.

Zone A: This zone was divided into 11 modules, In the first category (seats), Results showed that in Zone A, the majority of the participants selected the wooden table and seat to be placed in this space with a percentage of 35%, and 24% selected the table and chair, As for the rest of seat typologies options, all of them are more or less represented evenly with a percentage 14% as shown in (Figure 40). The next step was to define the spatial allocation of these elements, the common module that the wooden seat with a table was placed in was module number 5 as shown in (Figure 39) Matrix of each seat typology in zone A is shown in Appendix C.

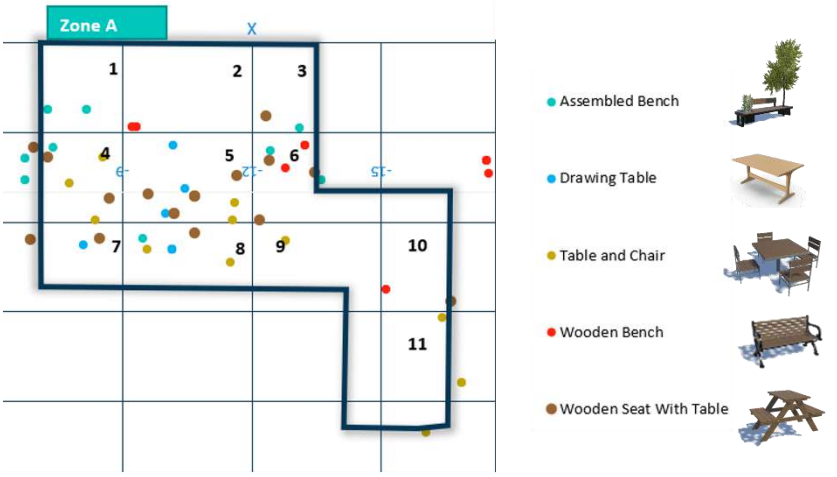

Figure 39: Zone A, Different seat distribution (Source: author)

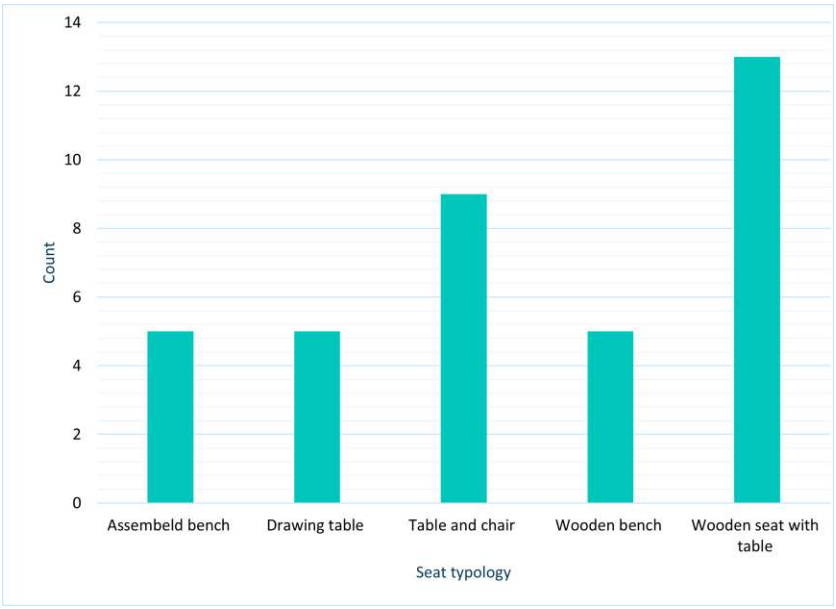

Figure 40: Seats typology score (Source: author)

Second category Shading element:

The results showed that participants prefer to insert trees in the space rather than the tent as a shading device, in addition to that, during their trial, most of the participants mentioned that they need a shaded area in this space, this was reflected also when participants started placing trees out of Zone A and along the pathways, as they needed an additional shading element. Most participants

selected trees with a percentage (80%) and (30%) only selected the shading tent as shown (Figure 42). , the common module that the tree was placed in was module number 5 (Figure 41).

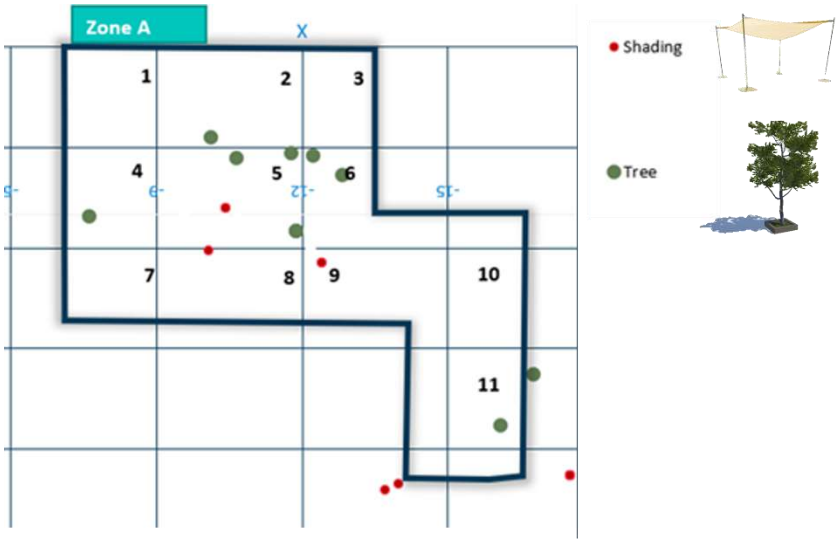

Figure 41: Zone A, distribution of trees and shading tents (Source: author)

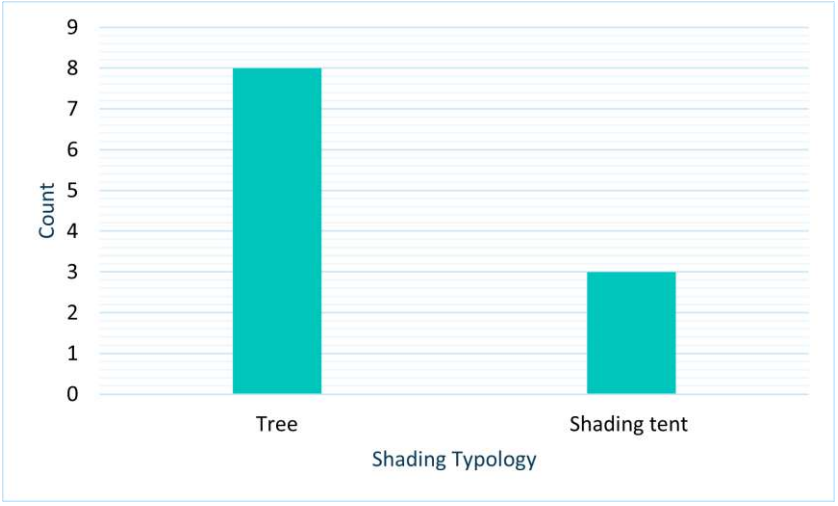

Figure 42: Zone (A) Shading typology score (Source: author)

Third category green shrubs:

Most of the responses have shown that the majority of the participants selected the red shrub with a percentage of 50%, and spatially allocated in module no. 5,

the least selection was to the green bush with 21%. as shown in (Figure 44) and (Figure 43).

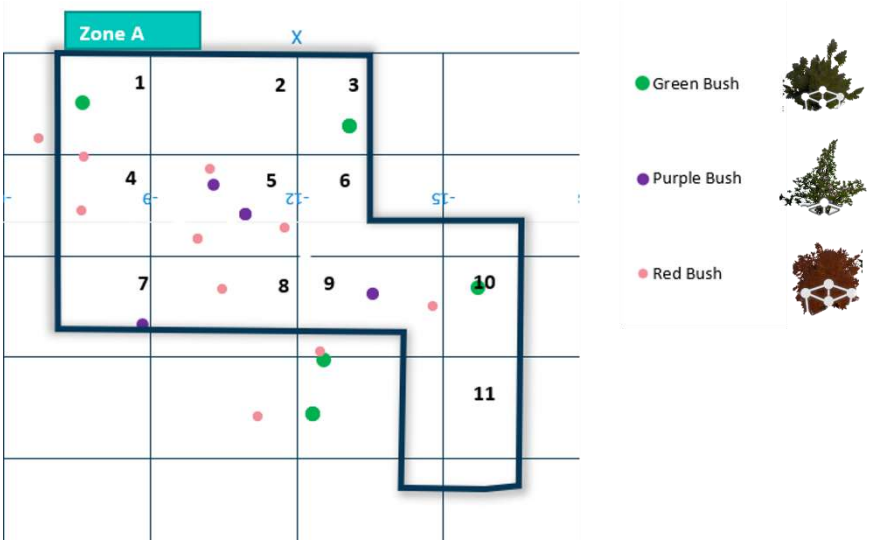

Figure 43: Zone A, Shrubs spatial allocation (Source: author)

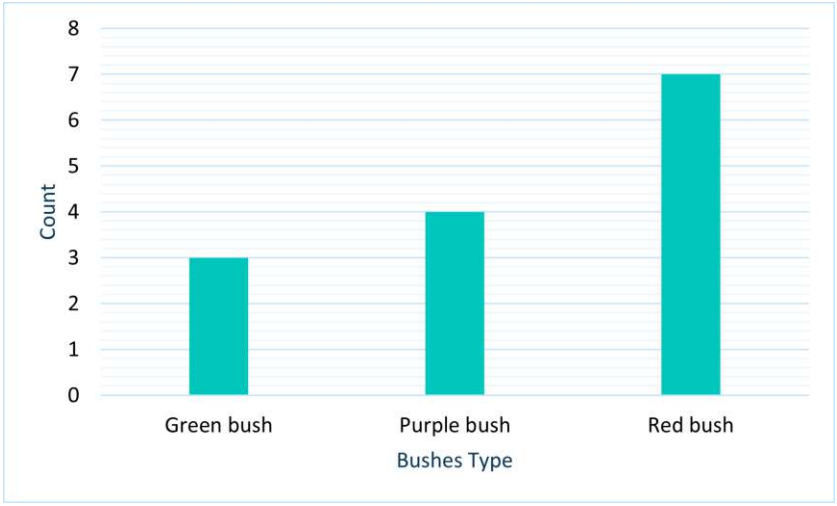

Figure 44: Zone (A) Bushes typology score (Source: author)

Fourth Category: Physical fixtures

This section was mainly to determine the preferable allocation of light poles and trash bins based on the user's allocation, shows that most of the participants

allocated the light pole in module no. 5, and trash bins along were almost distributed equally in modules 5, 9 and 10 (Figure 45).

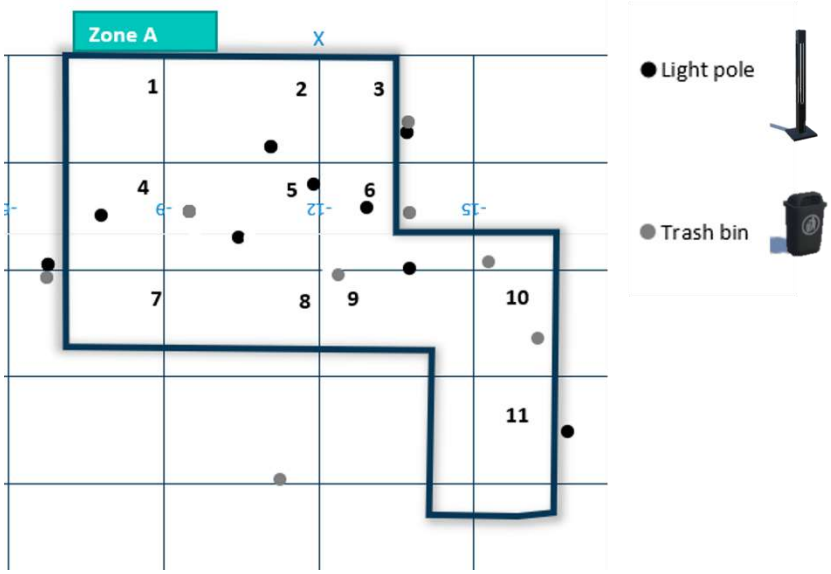

Figure 45: Zone A, Light pole, and trash bin spatial allocation (Source: author)

These results show that participants were able to allocate the landscape elements based on their preferences, ending up giving the designer different alternatives of locations for the same landscape element. For example, according to Zone A results the following alternatives could be concluded: In module number 5; a cluster could be formed using the wooden seat and table, trees for shading with red bushes, basket bins could be added, and this cluster could be duplicated through the rest of zone A. Another alternative could be using tables and chairs with trees, and purple bushes, or maybe using both alternatives in a way that satisfies all the participants' needs. But it could be concluded that these kinds of matrices and spatial allocation of landscape elements helped in excluding some of the elements, as no one chose them, which also helps in the final design.

Zone B: This zone was divided into 14 modules, In the first category (seats), Results showed that in Zone B, the majority of the participants selected the wooden table and seat same as Zone A but with a percentage of 46%, and 20% selected the assembled bench. as shown in (Figure 47). The next step was to define the spatial allocation of these elements, the common module that the

wooden seat with the table was placed in was module number 4 as shown in (Figure 46), Matrix of each seat typology in zone B is shown in Appendix C.

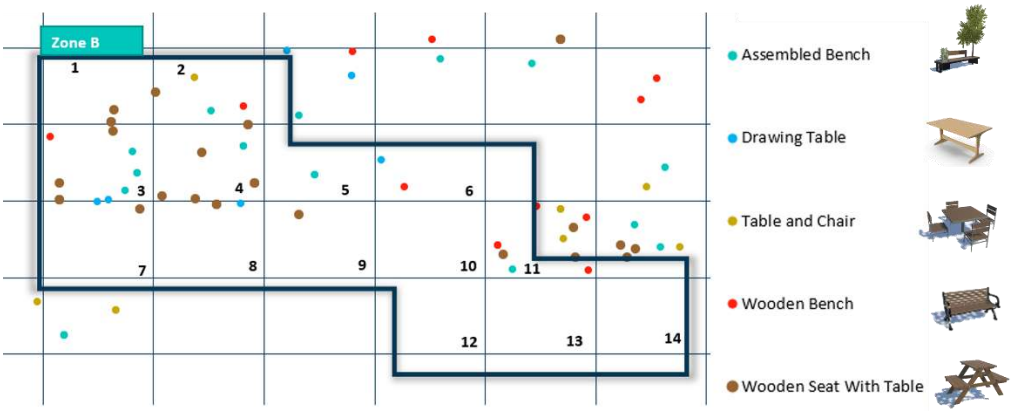

Figure 46: Zone B, Different seat distribution (Source: author)

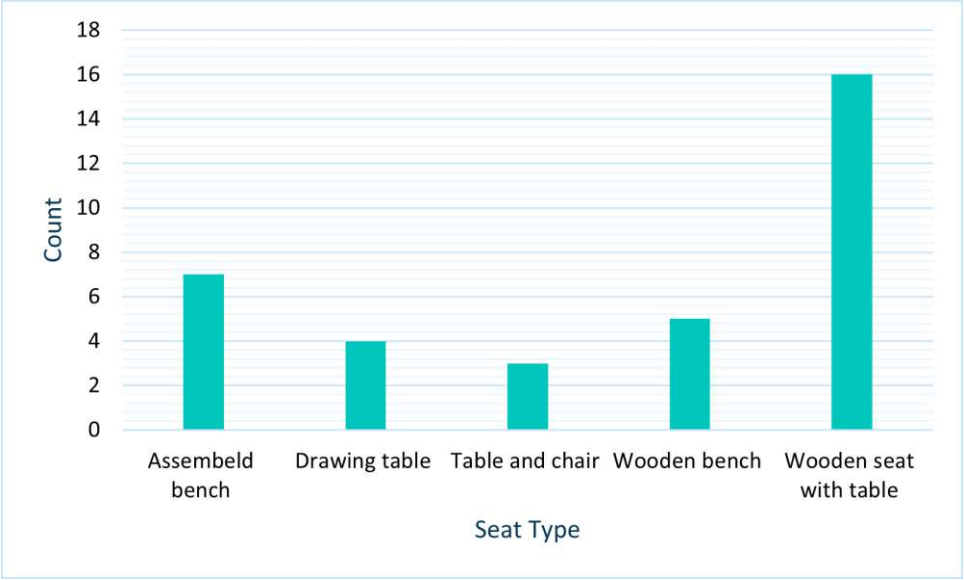

Figure 47: Seats typology score in Zone B (Source: author)

Second category Shading element:

The results showed that participants prefer to insert trees in the space rather than the tent as a shading device, in addition to that, participants started placing trees out of Zone A and B, as they needed an additional shading element in the surrounding area. All of the participants selected trees as a shading element specifically in module number 3 (Figure 48).

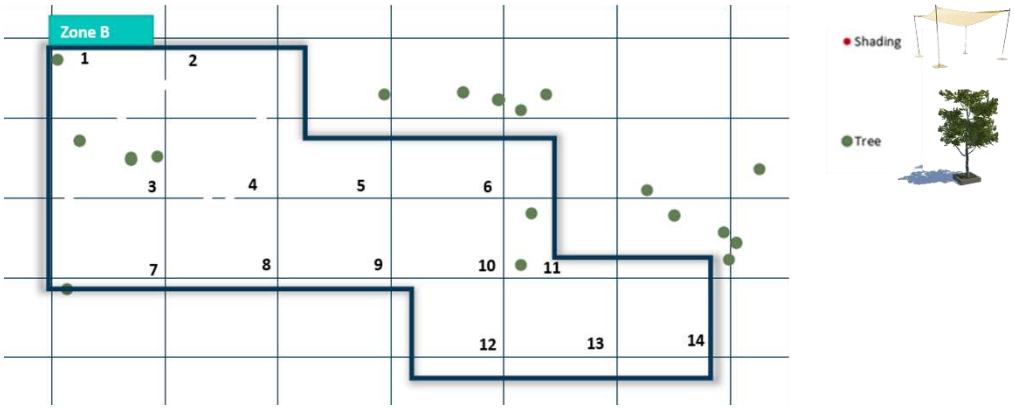

Figure 48: Zone B, distribution of trees (Source: author)

Third category green shrubs:

The results showed that most of the participants started to add the shrubs in the surrounding space with different variations but not in zone B, this reflects how the use of the VR allowed users to start designing the space according to their preferences. (Figure 49).

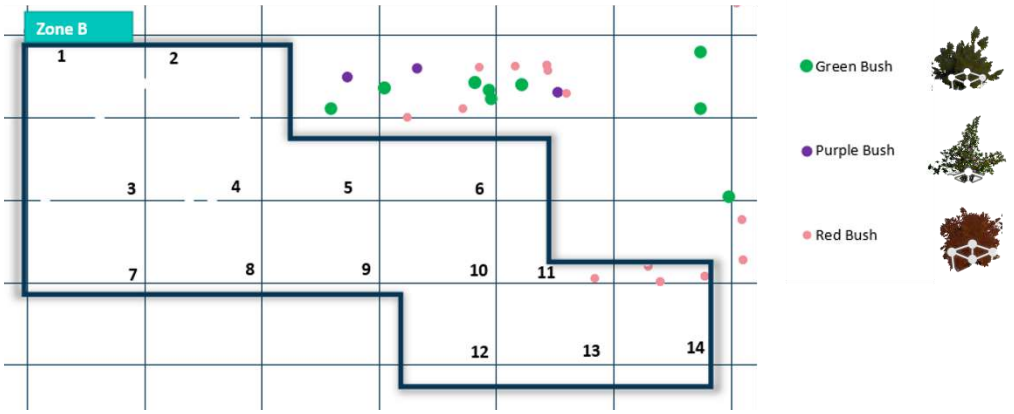

Figure 49: Zone B, Shrubs spatial allocation (Source: author)

Fourth Category: Physical fixtures

This section was to determine the preferable allocation of light poles and trash bins based on the user's allocation, results showed that there was no specific module to add light poles or trash bins but they were distributed along the space (Figure 50).

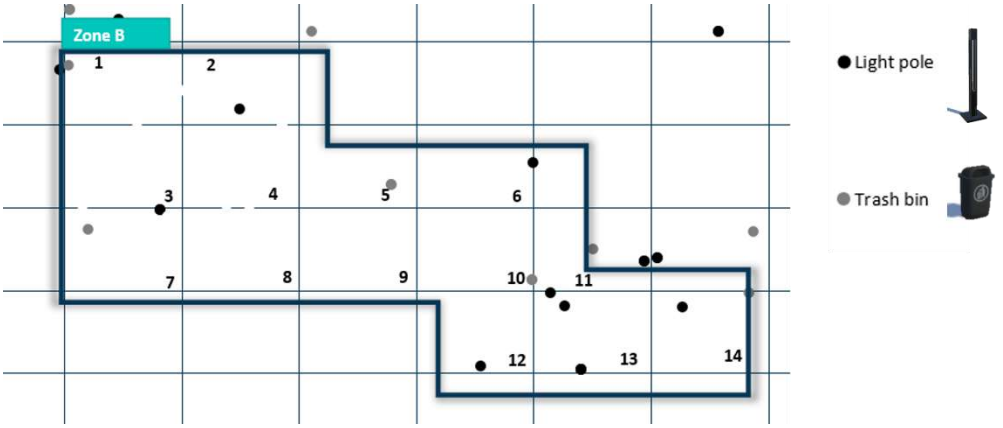

Figure 50: Zone B, Light pole, and trash bin spatial allocation (Source: author)

According to these results, it was observed that most of the participants were focusing more on designing one zone whether zone A or zone B, and this reflects the ability of the users to stay in a virtual environment and their ability to start designing in it with a limited project scale. Moreover, not all participants were designing zone A and B only, while they started adding landscape elements in the surrounding areas such as along the pathway, some of the participants added benches along it. This reflects that sometimes the users of the space have another perspective on it, which could change the designer's opinion and proposal. The use of the VR headsets helped the participants to be able to visualize the space, Hence, enhancing their responses. (

Figure 51)Shows different designs resulting from the participant's allocation of elements using the VR headset. (Refer to Appendix F for more participants' designs)

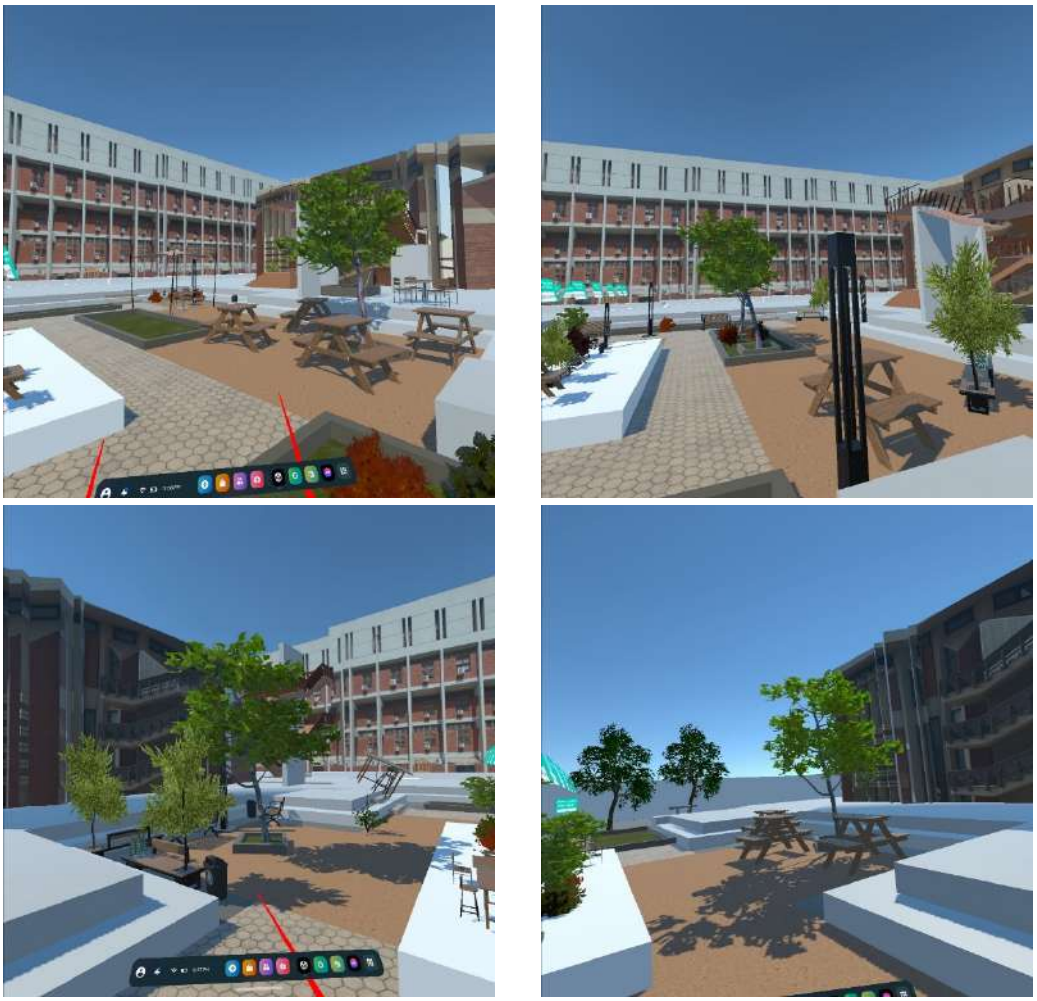

Figure 51: Example of different participants' designs (Source: author)

5.2 Phase Two: Field Survey Results

This part of the chapter focuses on the second section of the empirical case study in the thesis; the field survey. After finishing the trial with the VR headsets, A field survey was conducted with students and employees who were involved in the research study to investigate the role of VR to promote community engagement. The gender distribution of the respondents to the workshop invitation was that the majority of the respondents were female where their percentage was 61% and male percentage was 39% As shown in (Figure 52). (Refer to Appendix A for the affiliation of workshop attendees).

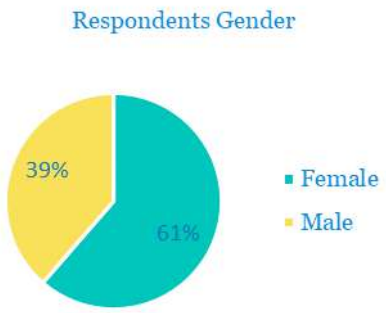

Figure 52: Gender distribution (Source: author)

The overall sample of the study was 44, General categorization of people results show that the majority of participants were students with a percentage of 77% and 23 % were employees (Figure 53), Students percentage was divided into 2 main categories students with urban or arch. Background, and students from other disciplines.

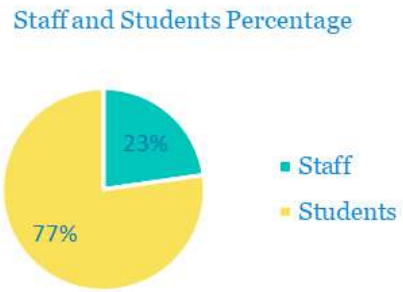

Figure 53: Staff and students' distribution (Source: author)

This part was divided into two main sections, one section was to assess the use of VR headsets in terms of visualization and interactivity of the users, and the second section was to assess the impact of VR on the community engagement process, and how it affected the ability of users to visualize their needs.

5.2.1 Assess the VR Content and Visualization in Terms of Interactivity

This section was divided into four main questions:

First question: participants were asked to rate their overall experience with the VR headsets from 1 to 5 whether they enjoyed the overall experience or not to assess how they perceive being in a virtual environment, the scale bar was as follows 1 was the least enjoyable (Very Bad), 2(Bad), 3 (Intermediate), 4 (Good) and 5 means that it was very good experience. The results were that no one chose the least rating, and it was mainly divided between intermediate, good, and very good as shown in (Figure 54). The majority of the respondents gave a high rating which reflects that they enjoyed using VR, where (52%) of the respondents gave a rate of 5 and (39%) gave a rate of 4, while only 9%of the participants found some difficulties in using the system and gave a rate of 3 (Figure 55)

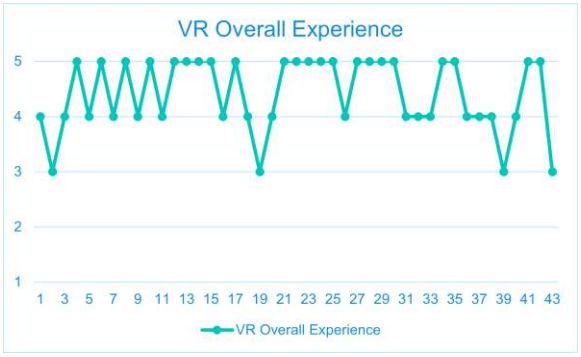

Figure 54: Respondents rating for VR experience (Source: author)

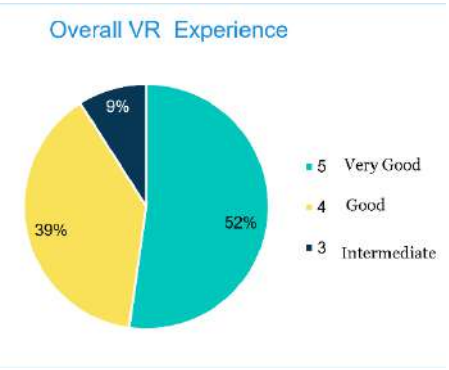

Figure 55: Percentages of VR experience ratings (Source: author)

The next three questions were to assess the visualization and controllers of the VR, and this was through a scale bar. The scale bar was divided as follows 1 was (very hard), 2(Hard), 3 (Intermediate), 4 (Easy) and 5 means that it was very easy. The second question was to rate the ability to navigate and move around space in the virtual environment. This question was to assess the ability of users to get familiar with the movement virtually and recognize the surrounding environment as a real one, and the ability to relate what they see virtually to what they see in reality. All the respondents were between 2 and 5, and no one chose

rate 1 (Figure 56). Most of the participants' responses varied between 4 & 5, where the percentage of giving rate 5 (Very good) was 32%, and 4 (Good) 39%, and the least percentage was rate 2 (Bad) 4% (Figure 57)

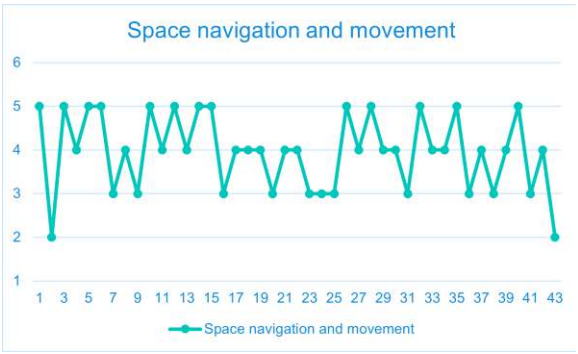

Figure 56: Space Navigation Rating (Source: author)

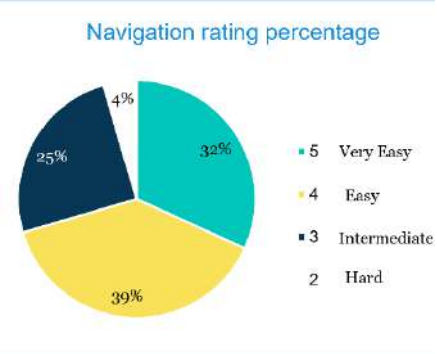

Figure 57:VR Navigation Rating Percentage (Source: author)

The third question was related to the experience of using VR headsets in terms of controllers, to assess the ability to use these controllers to turn or move around the space and get used to the function of each button. In this question responses varied between all scales (Figure 58). Regarding the controllers, most of the responses were between 3 to 5, where 40 % of the respondents with rate 5, 33% with rate 4, and 23% rated 3. The least percentage was with bad ratings, where 2 % rated bad and 2% rated very bad (Figure 59).

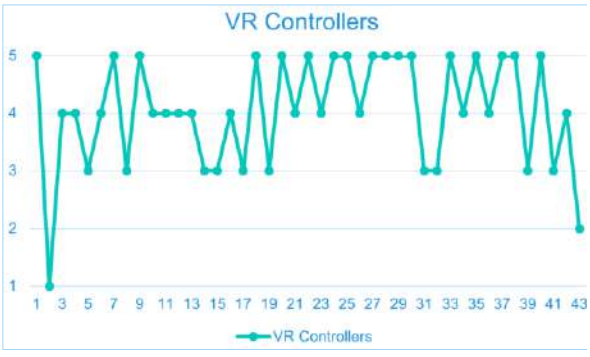

Figure 58: VR controllers Rating (Source: author)

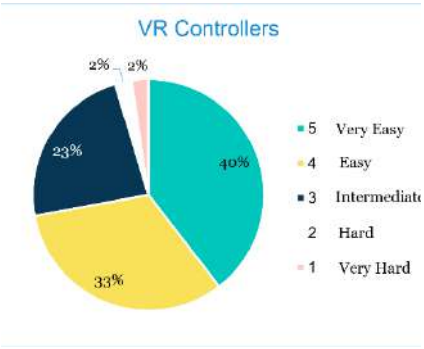

Figure 59:VR Controllers Rating Percentage (Source: author)

The fourth question was to assess the ability to grab and allocate objects based on their needs, and this was to analyze the visual quality of the space and

landscape elements as well as the ability to move them. The following graph shows the respondent's rating based on their ability to move and grab landscape elements, it shows that responses varied between rates 2 and 5, and no one chose rating 1 as shown in (Figure 60). where shows that most of the responses were between intermediate, good, and very good. The majority of participants had some difficulties while moving and grabbing objects using VR headsets and controllers in the virtual environment, where rated 37% rated 3, 30% rated 4, and 26% rated 5 (Figure 61).

Figure 60:Ability to move and grab objects (Source: author)

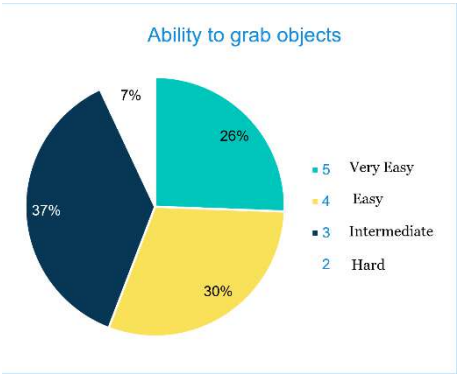

Figure 61:Ability to grab objects rating percentage (Source: author)

5.2.2 Assess The Effectiveness of Using VR to Visualize Needs

This section focuses on the user perspective on VR and how it helped in visualizing their needs and ideas, in addition to their ability to communicate their main issues. The first question was to rate their experience with using the VR headsets to illustrate their needs, using a scale bar from 1 to 5, 1 was (Very Bad), 2(Bad), 3 (Intermediate), 4 (Good), and 5 means that it was very good and helped in describing needs. (Figure 63) shows that most of the responses varied between intermediate and very good. Results were as follows, 50% of the participants responded with 5, 0% responded with 1 the majority of the rest of responses varied between 3 and 4 (Figure 64)

Figure 63: Ability to describe needs rating (Source: author)

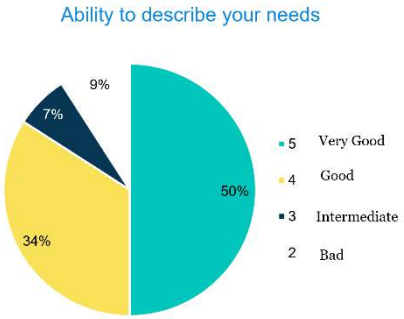

Figure 64: Ability to describe needs rating percentage (Source: author)

The second question was to ask the participant, The preferable participation tool from their point of view in a landscape design project, before asking this question, during the survey participants were asked if they were involved previously in a participation design process, but the responses were mostly no, then they were given 4 choices to select one or more from them, before answering the question, the participants were given a detailed explanation of every participation method in the choices and how the participation process would be implemented if using this method. Choices were (Using 3D Shots-Using Animated Video-Using 3D Game-Text Information). With regards to 3D images, they would be given a set of 3D shots with different design proposals, and they could comment on them. Second, proposing the design to the participants through an animated video after the final design and they could give their comments on it. Moreover, using the 3D game as the workshop implemented in this study, the last choice was the text information through a questionnaire, each question is to ask the participants to select the most suitable landscape element by choosing from the images of different typologies.

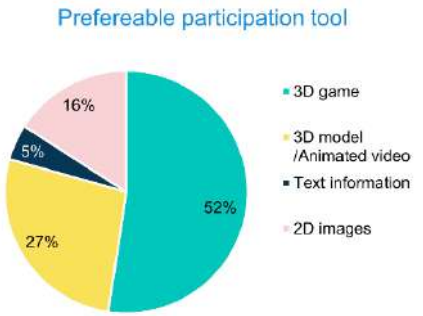

Figure 62: Preferred participation tool (Source: author)

The results showed that more than half of the participants selected the 3D game, using VR with a percentage of (52%), then the next option was the animated video with a percentage of (27%) and a 3D model of the space (Figure 62).

5.3 Discussion

5.3.1 Integrating Virtual Reality into the Design Process

At first, during the trial phase when the study was conducted with three participants, to examine the model with the VR, Participants faced some difficulties to understand the process and the VR navigation including its controllers, based on this a demo video was prepared with the next 41 participants, where they saw a similar example of what they will do and a more detailed illustration of the controllers, which made their experience during the study better and easily getting familiar to the tool this was emphasized by (Zhang, Shen and Liu, 2020) in the case study of Tokyo Bay zone which resulted that the user movement and experience in the virtual environment after a scripted video was with a better understanding than the one with the free navigation without an illustrating video, which affected the participant's responses.

It was concluded that in phase one (Design workshop) when implementing the VR headsets in the design process and allowing the users to use it to design the space based on their needs. Users are not just adding their designs and opinions, The Spatial allocation of objects is also known based on their needs, which paves the road for the designer to design considering the spatial allocation from the community engagement process, this also helped in giving different alternatives of the spatial allocation of the same object and landscape elements clustering, for example: in Zone A based on the highest percentage first alternative could be: wooden seat and table, trees for shading with red bushes, basket bins could be added, module no. 5 with having Table and chairs surrounding it, this cluster could be duplicated through the rest of zone A. This could be reflected that the result of this process showed the designer different design proposals that could actually be merged to form one final design according to user opinions. According to Portman, Natapov, and Fisher-Gewirtzman (2015) the use of VR benefits both,

the users as it creates a sense of place for them when using a more interactive tool to be a part of the design process, and the urban designers and stakeholders, where it gives them a better understanding of community needs. Although a proposed design was given to the participants and an illustration was given that they will design zones A & B only, some of the participants started to design the surrounding spaces and pathways from their perspective, which reflects that when being in a virtual environment it showed them a different perspective of the space and allowed them to add other ideas in addition to the designer perspective, This overcome the limitations of using a 3D model or animated videos in a participation tool to show the participants different alternatives of a design.

5.3.2 User Perception of Virtual Reality

From the comments of the participants during the workshop: ‘’ I want to add 4 tables and a tree in the middle ‘’, ‘’ I want to add here a bench in front of the existing steps so we could sit in a group”, These comments ensure that being in a virtual environment enabled the participants to recognize the space and visualize their needs. This was reflected in the way they oriented the selected landscape elements based on their real-life problems when using this space. According to Dannevig, Thorvaldsen, and Hassan (2009) study, when comparing the use of VR and a traditional tool to present to the community a new building development in As, Norway, it was concluded that the use of VR in presentation helped to enhance the understanding of participants when being involved in an architectural project as it provided a more accurate presentation and made both the community and professionals understand the visual impact of such design proposal and better to engage the participants with the immersive environment which evokes stronger reactions.

Furthermore, allowing users to allocate the elements based on their needs helped in achieving a higher level of participation at in co-creation level, this was a recommendation of a study done in the southeast of the town of Suwalki by (Szczepańska, Kaźmierczak and Myszkowska, 2021), where development of an

area there was done with the involvement of the community in it using VR to view the design, respondents suggested that it would be better if there is a possibility to add or remove elements based on their recommendation after viewing the design. The use of virtual reality in allocating the landscape elements helped the users to better understand the spatial orientation of the space, in addition to being aware of the space scale. (Figure 65)shows different participants' interactions when designing the space, whether working in groups or individually.

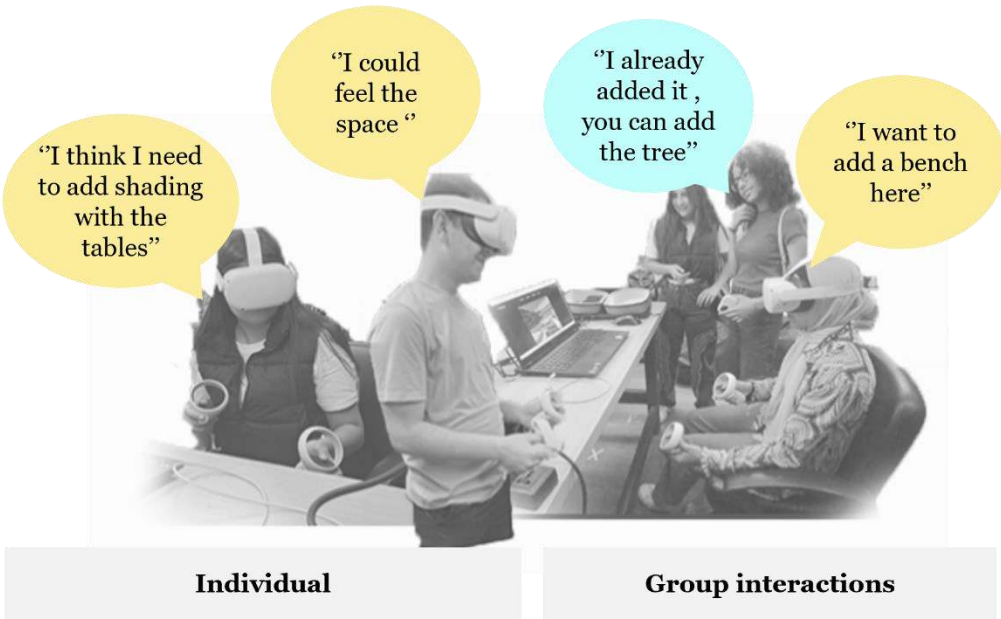

Figure 65: Different participant's interactions (Source, author)

5.3.3 Virtual Reality Interactivity And Visualization in Community Engagement

Reviewing the relevant literature showed that virtual reality (VR) techniques in urban design have gained a lot of attention specifically in the field of community engagement. The field survey was divided into two sections. Regarding the first section of the questionnaire focuses on assessing Virtual reality (VR) technology in terms of user experience and visualization, Based on the discussion with the users after the study, first when using VR headsets it's challenging to think and move in a virtual environment but it's more enjoyable for them to use it in a participation process, as it feels like being through a game and designing it which

was an interesting process for them, In addition to the feeling of the space and ability to perceive it. This was shown in the case when Hill (2019) conducted a study with students to test the impacts of integrating virtual reality into the landscape architecture design process, along the study students reported that they had a better understanding of space designs when viewing it in a virtual environment and it was successful when designing in the 3D as it expresses their ideas clearly.

The overall experience differs based on the ability to stay in the virtual environment or not and the ability to use this kind of technology and getting used to it. The majority of the respondents gave a high rating between 3 and 5 with a mean value of (4.43), and they commented that they enjoyed the experience and was fun using it, this was also concluded by (Schrom-Feiertag et al., 2020) in the study of implementing VR to support citizens engagement in street design. No one responded with one or two which reflects that most of the users enjoyed using VR but with different variations, From these variations, the technology knowledge and the ability to get familiar with using VR. As per the discussion with the participants, most of the participants who gave a rate of 3 (Intermediate) couldn't stay in the virtual environment for a long time because of the feeling of dizziness and motion sickness when wearing the headsets for a long time, this was also concluded in (Hill,2019) and in (Szczepańska, Kaźmierczak and Myszkowska, 2021).

Moreover, some of the respondents who require vision correction had some problems with sight as it requires them to wear glasses. In addition to this, some difficulties were related to the way of using the controllers as one of the users commented ''Controllers need more time and practice to get used to it '', however, they commented that being in a virtual environment is a good experience as they feel the real environment and the real scale of objects, but it needs more practice. The ones who gave a rate of 4 or 5 in the overall experience saw that it is like a game, and it is interesting to be able to move virtually in addition to recognizing the space and being able to add their own needs. And this is because being in an

immersive virtual environment gave the sense of objects scale as in the real world and helps in the perception of the urban space's physical attributes which helps users to recognize and understand the use of the space and the possible activities, they can do it within it which is aligned with (Gómez-Tone et al., 2021). The two questions regarding the navigation and the ability to grab objects gave insights about the interaction of users with the space and with the landscape elements, where the mean value of the navigation was 3.95, and for the ability to grab objects was 3.75. based on the users' comments, this kind of technology is not hard but needs more time to get familiar with it and to be able to recognize how to move and grab objects, other respondents mentioned that after 10 minutes of being in the virtual environment, they got used to it, then they started to design the space. According to (Schrom-Feiertag et al., 2020) Utilizing VR requires time since each participant's VR equipment has to be customized, in addition to exploring VR itself takes time, where along the study users wanted to stay longer in the VR environment which reflected their acceptance of the tool but the need for more time to get used to it.

Based on the research findings, it could be concluded that there is a strong correlation between the ability to navigate in the virtual environment and use the controllers with the overall experience rating as shown in (Table 2)based on the comments after the field survey that the main difficulties of this technology were the ability to get familiar to use the controllers and maybe this could be solved by having another workshop or having enough time to practice the participants on how to use it, in addition to their ability to perceive the space and navigate through the virtual environment. it was assumed that there could be a relation between the time the participants spend in the VR environment with their overall experience, but the results showed that it's not an aspect as some of the participants who stayed 10 minutes weren't able to stay more time than this because of the dizziness and other difficulties. other participants who stayed the same 10 minutes were completely satisfied with the experience and were satisfied with the design and landscape elements they selected, so they didn't stay longer.

Table 2: Correlations between the overall VR experience with controllers and navigation (Source: author)

		Total Time	VR Controllers	VR Navigation	VR Grabbing Objects	VR Experience Rate
Total Time	Pearson Correlation	1	-0.044	-0.166	-0.179	-0.129
	Sig. (2-tailed)		0.775	0.281	0.245	0.404
	N	44	44	44	44	44
VR Controllers	Pearson Correlation	-0.044	1	0.171	-0.171	.334*
	Sig. (2-tailed)	0.775		0.268	0.267	0.027
	N	44	44	44	44	44
VR Navigation	Pearson Correlation	-0.166	0.171	1	0.103	.321*
	Sig. (2-tailed)	0.281	0.268		0.506	0.034
	N	44	44	44	44	44
VR Grabbing Objects	Pearson Correlation	-0.179	-0.171	0.103	1	0.144
	Sig. (2-tailed)	0.245	0.267	0.506		0.352
	N	44	44	44	44	44
VR Experience Rate	Pearson Correlation	-0.129	.334*	.321*	0.144	1
	Sig. (2-tailed)	0.404	0.027	0.034	0.352	
	N	44	44	44	44	44

*. **Correlation** is significant at the 0.05 level (2-tailed). varies between +1 and -1, where +1 is a perfect positive correlation, and -1 is a perfect negative correlation. 0 means there is no linear correlation at all.

N is number of cases that was used in the correlation

Before the study, it was expected that there is a need for a design background in order to get familiar to the space and be able to redesign it, but the results showed that there is no correlation between the design background and the whole VR experience, as it's more related to how a user could recognize the tool. Furthermore, there was a slight relation between the design background and the ability of users to visualize their needs with a correlation coefficient of (0.154) as shown in (Table 3), where the users with a design background were more aware of the design elements and what to select to be added in the space, this was reflected on specifically two students with a design background when designing the space they started to redesign a full zone with all the landscape elements not just adding their needs. Figure 66 shows an example of a housing department student design of the space using VR headsets. But still, this could be overcome

by having more sessions about the design process and the design of a space with the participants before the VR trial. According to the study of (Zhang, Shen, and Liu, 2020), it was concluded that using VR is considered a good presenting technique for planners or designers to explain design concepts to the users of the space, regardless of the participant's level of professional experience.

Table 3: Correlation between the ability to visualize needs and design background (Source: author)

		Needs	Design Background
Needs	Pearson Correlation	1	0.154
	Sig. (2-tailed)		0.320
	N	44	44
Design Background	Pearson Correlation	0.154	1
	Sig. (2-tailed)	0.320	
	N	44	44

*. **Correlation** is significant at the 0.05 level (2-tailed). varies between +1 and -1, where +1 is a perfect positive correlation, and -1 is a perfect negative correlation. 0 means there is no linear correlation at all.

N is number of cases that was used in the correlation

Figure 66 : Images from a housing department student design through the VR (Source: author)

5.3.4 Virtual Reality in Community Engagement

In the second section which is related mainly to the participation process and how they were able to visualize their needs, according to the first part of the questionnaire, Users had a better experience when being fully immersed in the space, this gave them the sense of being in a real environment and enhanced their understanding of the space and the ability to move within the space with different

view angles, which reflected that they were able to visualize their needs and illustrate it in a different way, even when they wanted to insert more elements in the space they were able to do so. Moreover, comments and discussions during the workshop when users are still wearing the VR headset, gave another perception about their opinions, for example from the student's comments:" I added the seat and basket bin, I need to add a shading for it '' -A housing department student, '' This tool is very interesting, as a designer I could feel the space ''-Junior urban design department student, '' I could recognize now the areas that need to be shaded, how about adding here trees and scattered benches below it '', This reflects their ability to illustrate their needs according the main issues they face with the current design and the ability to imagine the space. This aligned with the result of (Bourdakis, 2004), where users could comment on the design during the process, and respondents showed that it enhanced their communication. Furthermore, some of the participants worked in groups, which gave added value to the VR, where the ones who worked in a group, started to discuss together what they want and interact with each other to reach a design that satisfies all of them, this overcomes the issue of when using the VR, it won't allow participants interact together.

In general, most of the responses showed positive insights regarding the ability of users to illustrate their needs with a mean value of (4.3) which is considered a high value as it made the human scale easy to be perceived than that of the traditional methods such as 3D images or animated videos and allowed the users to experience the space from different viewing angles.

Besides the ability of users to illustrate their needs, using VR helped in engaging younger generations, which most of the time are not involved in a participation process, this was elaborated by (Meenar and Kitson, 2020) when involving the youth in their study. On the other hand, when trying to apply this study to older generations which are from Generation X (1965-1980) and part of Generation Y (1981-1996) it was found that there are some difficulties in understanding the technology and cannot cope easily with the VR, but it's not impossible to apply it,

could be applied with more practice and sessions to teach them about the tool. In addition to this, the study was conducted in three different locations in the same faculty, which helped to reach more target groups and users, this could be replicated in the design projects, as it doesn't require a specific space to conduct the study and allowing citizens to interact and move freely, This was aligned with the study of (Fares, Taha and EL Sayad, 2018). Although most of the respondents rated the experience with a high rate and enjoyed being a part of the process, some of the respondents mentioned that they would recommend also using 3D models and 3D shots. Moreover, some participants recommended using both tools, where the study could be on two steps, the first step is to view the design through VR and illustrate their needs in it as it's a more interactive tool and better in visualization, then the second step is to view the final design after the user input to see how it will look like and give some insights about it. This was emphasized by (Schrom-Feiertag et al., 2020) that the VR tool could be used as an additional method for participation but not as the only option for participation.

Chapter Six: Conclusions and Recommendations

6.1 Conclusion

The research aims to solve the problem of the lack of using of collaboration and co-creation tools that promote community engagement in the Egyptian context. The main objective was to investigate the integration of new technologies, specifically virtual reality, in community engagement to enhance the decision-making process within the Egyptian context. Moreover, the question that the research aims to answer is how the use of VR promotes community engagement in the Egyptian context.

Community engagement when applied in a design process minimizes the gap between the citizens and the designer and creates a more responsive design as it takes into consideration the main issues and problems which users face, followed by providing solutions to it according to the user needs, in other words, community engagement allows the co-creation process, which is the engagement of both stakeholders and end users in the decision-making process to create an integrated design and a shared governance model, focusing on the urban spaces design, when designing with the users of the space this would overcome the issues

of having a final design based on the designer analysis only or previous design experience and not according to the actual user perspective. In the Egyptian context, the community engagement concept has been developed since 1998 by the GIZ initiative for upgrading projects, since that time it became a more familiar concept till it reached its point now that the strategic plans are currently being prepared with the implementation of the different participatory planning process, but still, this process relies on the conventional tools such as community meetings, questionnaires, workshops, in addition to when representing the ideas to the users with the current methods of visualization such as three-dimensional images, or using two-dimensional plans and maps, are not easily understood by the users and these tools are considered to be ineffective to illustrate the design and transfer data to users. Nowadays several tools are currently being developed to contribute to the community engagement process. And there is a shift to use new technologies to enhance the participation process. Using digital technology in community engagement lowers participation barriers between citizens and stakeholders, and advances equity, and inclusivity. From these technologies that gained traction was the use of virtual reality, which is a fully artificial environment that allows users to observe and interact with virtual objects and their surroundings via input devices, in addition to the experience of living immersible in a simulated space with independent anchoring. Furthermore, visual communication is an important aspect of the participation process because it allows the user to better perceive the given information to him, and the way of visualization of VR and its process set it apart from other tools as it could be used for designing planned or unplanned realities that still do not exist, moreover, it provides a better visualization of data which is easier to the participants to understand than that of the conventional tools.

To answer the main research question and reach the main objective, the research was divided into two parts; the first part was reviewing Literature and theoretical background about community engagement and the Virtual reality concept, and the second part was an empirical study, where a case study was done to apply virtual reality concept in the community engagement process, by conducting a

workshop in an open space of a university campus in Cairo, where students and employees were invited to start using VR headsets to redesign the open space by replacing the landscape elements according to their needs in the space, then a field survey was done after it to examine the user perception to this tool. Results of the first part were collected by having numerical data of coordinates of each landscape element according to the participant's allocations to it, the second part which was the field survey was analyzed using statistical analysis (SPSS). From the design workshop results, it was concluded that the use of virtual reality in the community engagement process gained positive responses from the participants, where it facilitated their understanding of designing a space, and allowed for a higher level of participation as the participants were designing the space not just being informed with the design, in addition to giving the designer different design alternatives according to the user needs and the user perspective, this answers the first and second research question which were how virtual reality could be used as a design approach? and How Virtual reality models can be used for community engagement. The field survey results showed that participants enjoyed using this tool even if it was their first time using it as it allowed them to feel the space and sense the real scale of objects, in addition to giving more opportunities to engage the younger generations in the participation process, Although the workshop went smoothly, some limitations of it were regarding the time needed to apply the study, where the participants needed more time to get familiar with the technology, this reflects on the third and fourth research questions which are How could the public perceive these new technologies? And What are the pros and cons of VR tools? Moreover, using virtual reality allowed for applying the community engagement process in three different locations and with different timings which overcome the conventional tools drawback of requiring a fixed time and location, in addition to the flexibility of the participants to work in groups which allowed for more interactivity and collaboration between them. From the participant's perspective, using VR in the design process made the human scale easy to be perceived, and experience the space from different viewing angles. This responds to the Fifth research question which was: Does

immersive VR technology provide cognitive benefits in the decision-making process?

According to the research and the applied case study, it's concluded that the use of virtual reality and co-creation technologies in the community engagement process was appreciated by the participants, where the majority of participants responded positively to their experience in using VR, especially in visualization and immersion as it provides more interactive participation medium and allows the users to be fully immersed in the design, which creates a feeling of realism. Although using VR was well appreciated by the participants, some drawbacks of the tool should be considered, where the use of VR requires enough time for the participants to get familiar with it, in addition to the exclusion of some age groups as it requires technology skills. Moreover, some participants reported the issue of motion sickness and dizziness when wearing VR headsets, but it's still a preferred tool for the users of the space to take part in the decision-making process.

The overall results showed that there are possibilities of integrating new technologies such as virtual reality in the community engagement process, as it enhances the decision-making process by providing different design alternatives according to the user perspective, in addition to solving issues and problems of a specific space design based on the user solutions and needs. This integration increases user interactivity and allows the users to be more engaged when being a part of the space. on the other hand, using VR has some drawbacks such as time, technology background and feasibility needs to be considered when applying this tool. Furthermore, using virtual reality in the community engagement process could be applied to small-scale projects and its feasibility to be applied to large-scale projects needs to be tested in further studies.

The following diagram summarizes the overall study outcomes and conclusions (Figure 67):

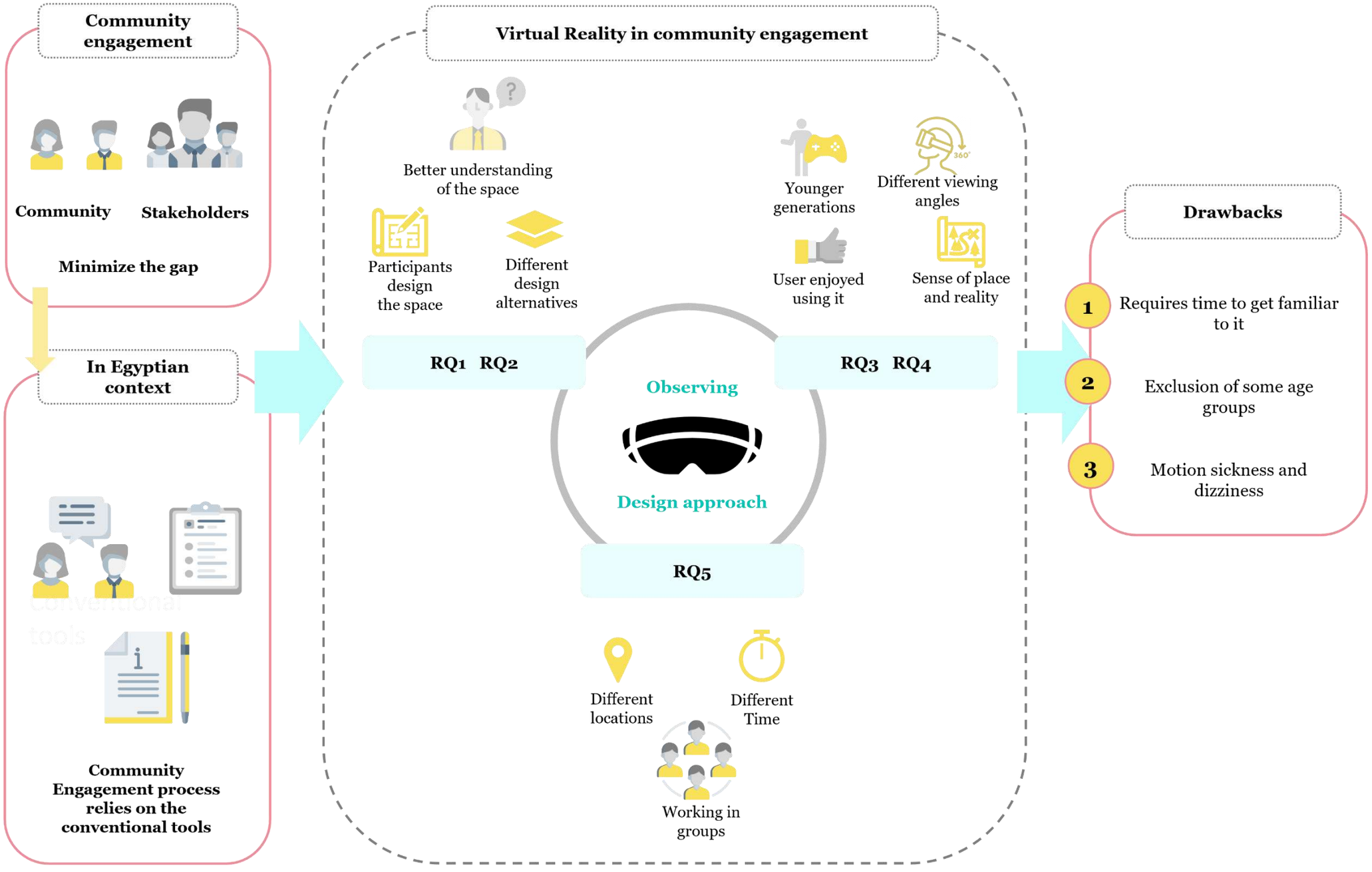

Figure 67: Conclusion and outcomes (Source: author)

6.2 Limitations

Some limitations affected both the data collection and analysis :

1-One of the main limitations of the study is the time limit to apply the case, where it requires more time to conduct a workshop and users need more time to get familiar with the tool

3-Technology limitation, where there could be other additional settings in the model to make it more interactive, such as adding a commenting tool in the model so users can add their insights through VR headsets in the model.

2-Technology background, some of the employees who started using the VR had some issues with understanding it

3-The study was conducted in May 2023, which was the end of the semester, it was difficult to apply the study with a wider number of students as they had submissions and exams

6.3 Recommendations

After reviewing the literature, conducting the study, and analyzing the results, a set of recommendations could be provided for future research. First, it is recommended that the study is performed on a wider time and in three phases. The first phase would be the conduction of a workshop where participants are given demo tries where they get used to moving around and grabbing objects in the virtual world, in addition to having volunteers in the workshop could educate the users about the tool and enhance their understanding before they try it to overcome the technological gap between users and VR. This is to allow the participants to get used to the tool and make their experience easier. The second phase would be one where the participants design the space based on their needs using the VR headset. Finally, the third phase would be one where all the participants are shown the final design concluded by the designer that takes into consideration their different needs. This is to fully immerse the users in the process and show them the results of their input. Second, due to the high cost of the hardware used in the case study, it is recommended that the study is performed in collaboration with technological or educational institutes that could provide the latest required technology.

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List of Appendices

Appendix A-Affiliations of Interviewer and Participants

1-Prof. Mohamed El Fayoumi: Professor at the urban design and urban planning department at the Faculty of Engineering, Ain Shams University. And the designer of the current development plans of the campus open spaces including the study area.

2-Workshop Participants:

- Students from different departments of the faculty of engineering at Ain Shams University
- Employees working in the architectural building (Near the study area)
- Staff from the urban design and urban planning department and architectural department.

Appendix B-Interview Questions with the design expert of the study area

Q1: What is the development history of the campus open spaces?

Q2: According to what was the current food kiosk planned?

Q3: What was the use of the study area (Space between Hall A & Hall C)?

Q4: Are there any other development plans for the study area?

Appendix C-Grid results of the community engagement workshop

1-Zone A seat distribution matrix

Zone A	Seats				
Grid no.	Assembled bench	Drawing table	Table and chair	Wooden bench	wooden seat with a table
1	1	0	0	0	0
2	0	0	0	2	0
3	1	0	0	0	1
4	1	0	3	0	2
5	0	3	2	0	4
6	1	0	0	2	3
7	0	1	0	0	1
8	1	1	2	0	1
9	0	0	1	0	0
10	0	0	0	1	1
11	0	0	1	0	0
Total	5	5	9	5	13
%	14	14	24	14	35

2-Zone A Shading distribution matrix

Zone A	Shading	
Grid no.	Tree	Shading tent
1	0	0
2	1	0
3	0	0
4	1	0
5	3	1
6	2	0
7	0	0
8	0	1
9	0	1
10	0	0
11	1	0
Total	8	3
%	80	30

3-Zone A, Matrix of each shrub typology score

Zone A	Shrubs		
Grid no.	Green bush	Purple bush	Red bush
1	1	0	0
2	0	0	0
3	1	0	0
4	0	0	2
5	0	2	3
6	0	0	0
7	0	1	0
8	0	0	1
9	0	1	1
10	1	0	0
11	0	0	0
Total	3	4	7
%	21	29	50

4- Zone B seats distribution matrix

Zone B	Seats				
Grid no.	Assembled bench	Drawing table	Table and chair	Wooden bench	Wooden seat with table
1	0	0	0	0	2
2	1	0	1	1	2
3	3	2	0	1	3
4	1	0	0	0	4
5	1	0	0	0	0
6	0	1	0	1	0
7	0	0	0	0	1
8	0	1	0	0	2
9	0	0	0	0	1
10	0	0	0	0	0
11	1	0	2	2	1
Total	7	4	3	5	16
%	20	11	9	14	46

Appendix D - Survey Questions

Be A Part of The Virtual World

Designing the space between hall A & hall
C as a part
of a research project aims to investigate the role of Virtual Reality as a design approach to promote community engagement

* Indicates required question

Personal Information

1. Name *

2. Year *

Mark only one oval.

- ◯ Freshmen
- ◯ Junior
- ◯ Sophomore
- ◯ Senior 1
- ◯ Senior 2
- ◯ Employee
- ◯ Staff
- ◯ Other: _____

3. Age

Mark only one oval.

- ◯ 20-30
- ◯ 30-40
- ◯ 40-50
- ◯ 60-70

4. Department Name *

Mark only one oval.

- ◯ Architecture Engineering
- ◯ Urban Design & Urban Planning
- ◯ Housing and Urban Planning
- ◯ Landscape Architecture
- ◯ Environmental Architecture and Urbanism
- ◯ Employee
- ◯ Staff
- ◯ Other: _____

Timing of the trial

5. Start Time *

_____

Example: 8.30 a.m.

6. End Time *

_____

Example: 8.30 a.m.

Assess the content and visualization of the VR Experience

7. Rate your Overall Experience of Using VR headsets in designing a space and getting used to it *

Mark only one oval.

Very Bad
1
2
3
4
5
Very Good

8. From a scale 1 to 5 rate your navigation and movement through the space *

Mark only one oval.

Very Bad
1
2
3
4
5
Very Good

9. From a scale 1 to 5 rate your experience using the controllers of VR to move around the model *

Mark only one oval.

Very Hard

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Very Easy

10. From a scale 1 to 5 rate your experience moving and grabbing objects in the space *

Mark only one oval.

Very Bad

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Very Good

Assesses the effectiveness of virtual reality tool for community engagement

11. The use of VR headsets to help you describe your ideas and needs *

Mark only one oval.

Very Bad

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Very Good

12. From your point of view , which of the following is comfortable for you to use when participating in a design project *

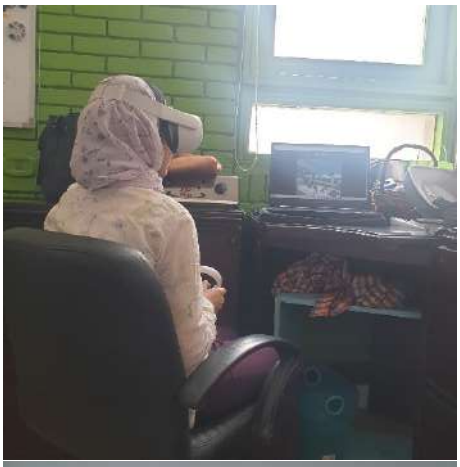
Tick all that apply.

- ☐ Using 2D images
- ☐ Using 3D Models
- ☐ 3D Game
- ☐ Text information
- ☐ Other: _____

13. Based on your experience , mention one positive and one negative thing on the overall study

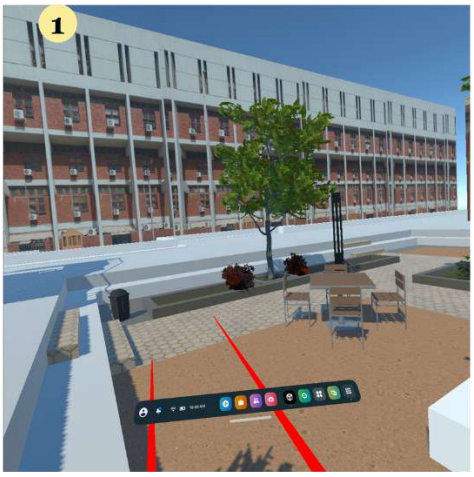
_____

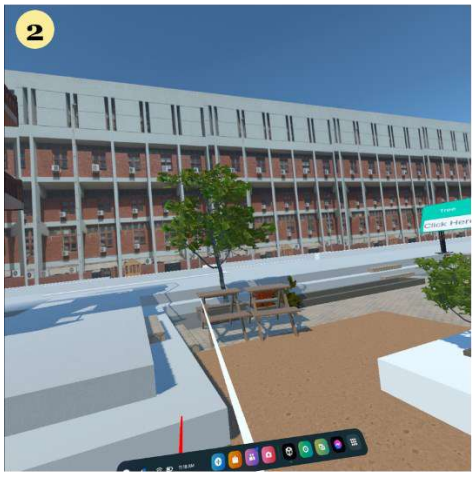
Appendix E-Participant's photos during the study




African
Cities Lab
Happy Days
are
BEER
Again!

Appendix F-Participants Designs with the VR



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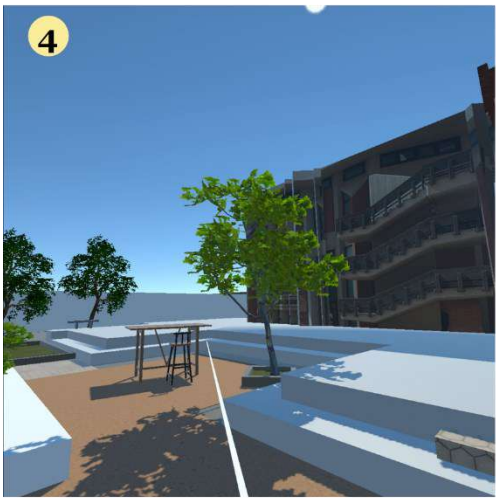
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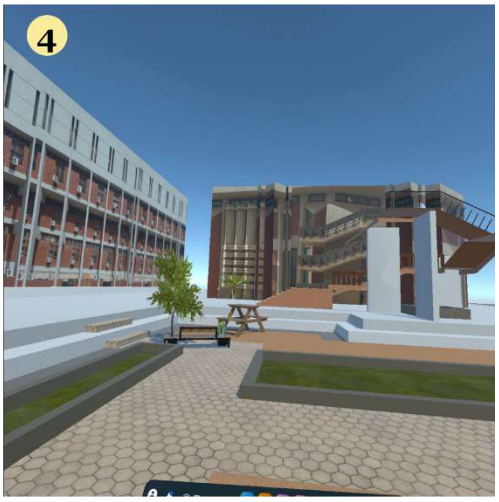
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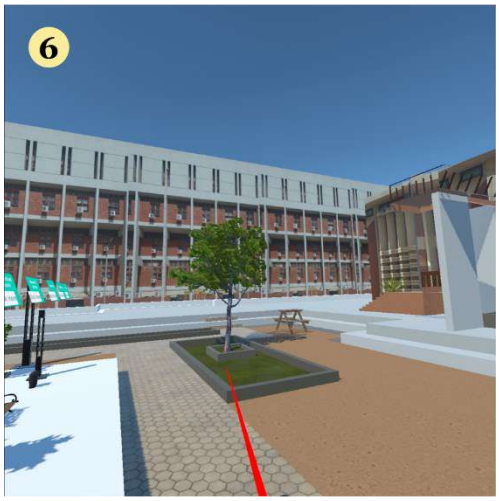
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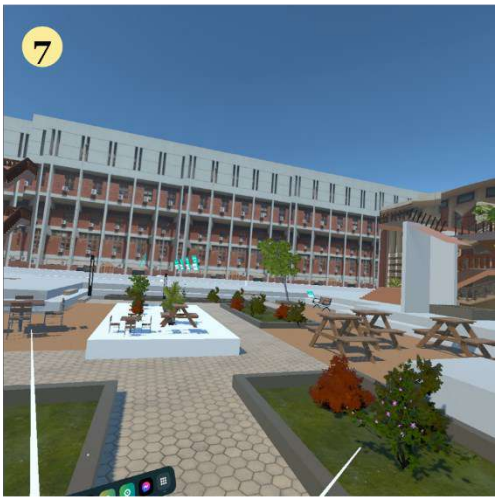
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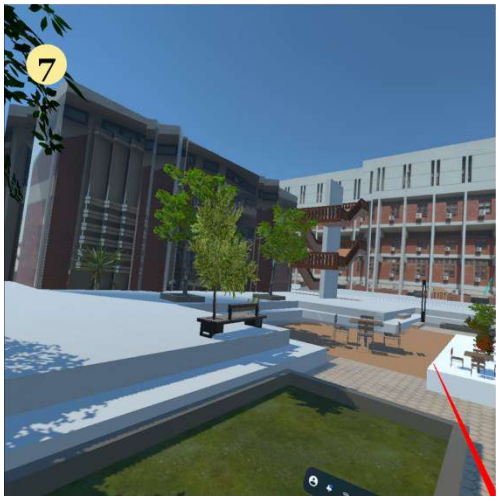
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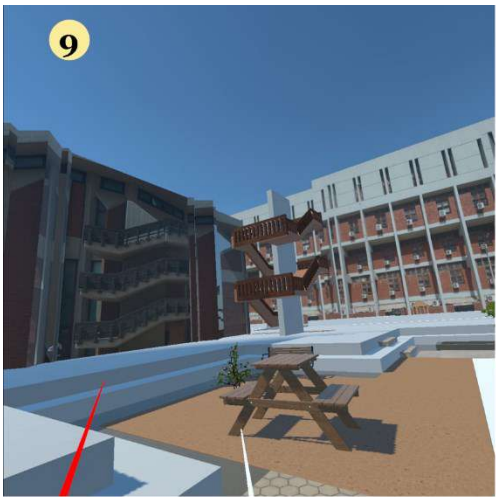
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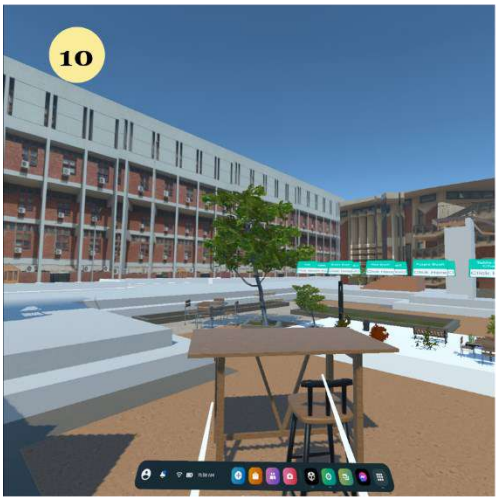
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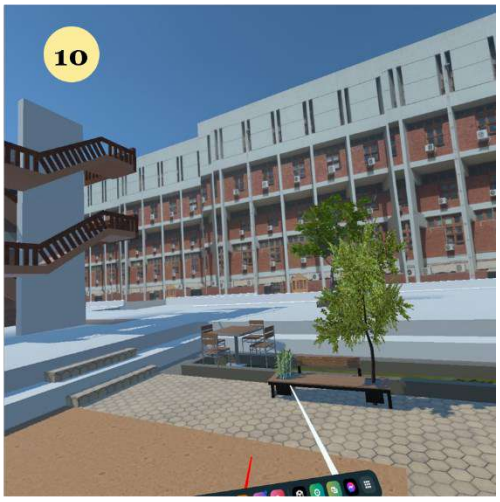
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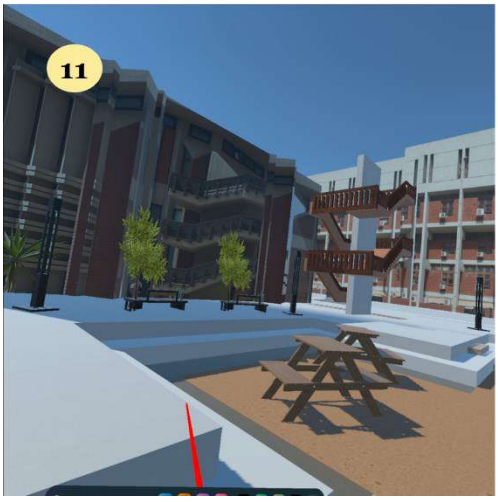
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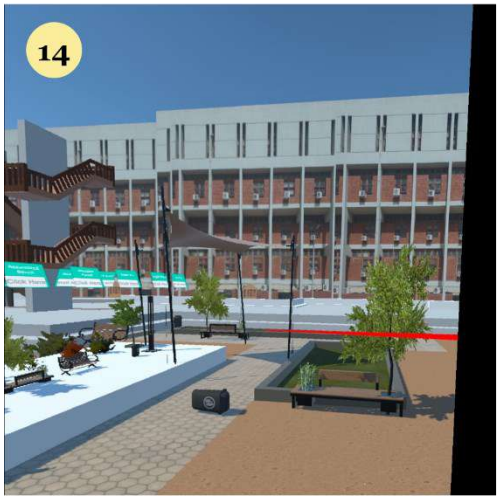
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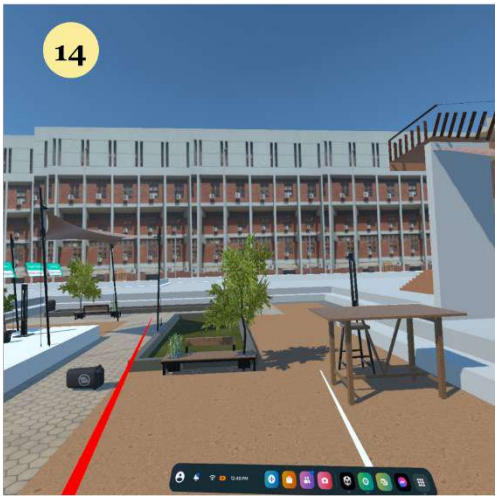
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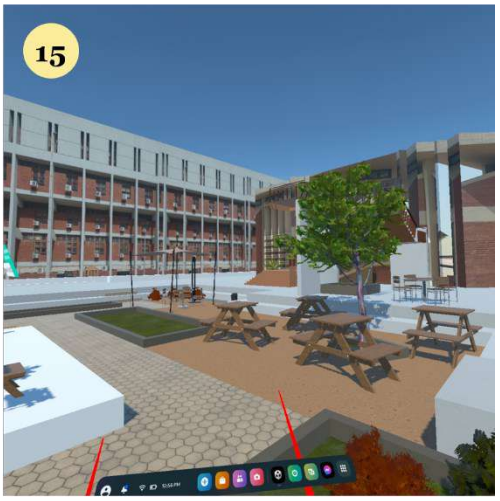
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الواقع الافتراضي كمدخل للتصميم لتعزيز المشاركة المجتمعية

نادين اشرف احمد

ملخص البحث

تعد المشاركة المجتمعية جانبًا مهمًا يجب مراعاته في التخطيط الحضري وعملية التصميم ، فهي تعزز الكثافة التنموية المناسبة والأراضي المزودة بالخدمات. في مصر ، ساهم هذه الأدوات في الغالب في إعلام المواطنين ولكن لا يتم إشراكهم في عملية التصميم بأكملها مما لا يسمح بالإبداع المشترك بشكل أفضل ، بالإضافة إلى وجود عيوب أخرى مثل متطلبات الوقت والمكان المحددين. بالتركيز على المساحات الخارجية ، وهي أماكن يتجمع فيها الناس ويتفاعلون معًا ، هناك مشكلة كبيرة تتعلق بإشراك المستخدمين في عملية التصميم ، مما يتسبب في حدوث صراع بين أصحاب المصلحة الحكوميين والمستخدمين العامين. نتيجة لذلك ، يتناقص عدد الأشخاص الذين يستخدمون هذه المسافات. يتم حاليًا تنفيذ تقنيات جديدة لتعزيز عملية المشاركة المجتمعية ، من هذه التقنيات هي تقنية الواقع الافتراضي (VR) والتي يتم استخدامها الآن على نطاق واسع في التصميم الحضري وعملية التخطيط الحضري ، نطاق البحث هو تسليط الضوء على دور تقنية الواقع الافتراضي كنهج تصميم من شأنه ليساهم في عملية المشاركة المجتمعية في السياق المصري. يتوفر تطبيق أدوات الواقع الافتراضي في مصر في مجالات مختلفة مثل التصميم الداخلي والسياحة والتراث الثقافي والتعليم وما إلى ذلك ... ولكن تم العثور على فجوة في استخدام الواقع الافتراضي كأداة نهج تصميم لتحسين المشاركة المجتمعية في السياق المصري من خلال البحث تم إجراء الاستدلال الاستنتاجي من خلال البحث التجريبي ، حيث تم إجراء دراسة حالة للتحقيق في دور الواقع الافتراضي في تعزيز المشاركة المجتمعية في السياق المصري ، وقد تم تحقيق ذلك من خلال تطبيق ورشة عمل لإعادة تصميم مساحة في الحرم الجامعي باستخدام نظارات الواقع الافتراضي. قد ركزت أسئلة البحث على مشاركة المجتمع وعملية تطبيقه باستخدام مفهوم الواقع الافتراضي وكيف يؤثر على عملية التصميم بأكملها.

الكلمات المفتاحية: إشراك المجتمع ، المشاركة ، الابتكار المشترك ، الواقع الافتراضي

إقرار

هذه الرسالة مقدمة في جامعة عين شمس للحصول على درجة العمران المتكامل والتصميم المستدام. إن العمل الذي تحويه هذه الرسالة قد تم إنجازه بمعرفة الباحث سنة ٢٠٢٣ هذا ويقر الباحث أن العمل المقدم هو خالصة بحثه الشخصي وأنه قد اتبع االسلوب العلمي السليم فيٌ االشارة إلى المواد المؤخوذه من المراجع العلمية كل في مكانه في مختلف أجزاء الرسالة.

و هذا إقرار مني بذلك ،،،

التوقيع : 

الباحث : نادين اشرف احمد

التاريخ : ٢٣ / ٧ / ٢٠٢٣

الواقع الافتراضي كمدخل للتصميم لتعزيز المشاركة المجتمعية

مقدمة للحصول على درجة الماجستير في العمران المتكامل والتصميم المستدام

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لجنة الحكم

التوقيع

أ.د. .....
أستاذ.....
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جامعة .....

تاريخ المناقشة : .....

الدراسات العليا

ختم الإجازة

أجيزت الرسالة بتاريخ :.....

موافقة مجلس الكلية .../.../...

موافقة مجلس الجامعة .../.../...

جامعة عين شـــــمس

٢٠٢٣ / ٧ / ٢٣

جامعة عين شمس

الواقع الافتراضي كمدخل للتصميم لتعزيز المشاركة المجتمعية

رسالة مقدمة للحصول على درجة الماجستير في العمران المتكامل والتصميم المستدام

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يوليو ٢٠٢٣