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The Integration of Virtual Reality (VR) and User Experience Design (UXD) in the Design of Shared Office Spaces

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Abstract

Users' satisfaction in the design of shared office spaces is one of the important aspects that every enterprise should seek. The research provides and validates a new mechanism that could be used in the design process of shared office spaces, by integrating the tool of Virtual Reality (VR) and User Experience Design (UXD). The proposed mechanism consists of three phases. The first phase (the experiment articulation) illustrates the correlation between the satisfaction factors of users and the physical setting of shared office spaces. In the second phase (the experiment tool preparation), the research articulates the programing scripts which are necessary for the users' interaction in the experiment using the VR tool, called User Interaction Tool (UIT), where these scripts are: Mouvement Script; Rotation Script; Stretch Script; and Material Script. The third phase (the experiment implementation and tool evaluation) consists of three steps; the first one is an oriented questionnaire for determining users' needs in shared office space while establishing relative weight for every aspect, and the second step is the experiment implementation for an existing office space to explore the suggested scenarios using the proposed tool, and the third step is crucial for comparing between the existing design model and the deduced one from the proposed mechanism to evaluate the validity of the proposed tool. After testing the tool, the research finds that users' satisfaction before the experiment is about 43.352 %, while it has been raised to 86.5825 % after using the proposed mechanism. Hence, the users' satisfaction is almost doubled after using the virtual reality tool in the design process of office space design.

Key Words: User Experien

ce Design (UXD) – User Interaction Tool (UIT) – Virtual Reality (VR)

1. Introduction

Shared office spaces are considered the main unit of office buildings which have the main effect on user satisfaction, as users spend major of their time in these spaces. Many changes have occurred in the articulation of shared office spaces from closed offices to open ones [8] . Shared office design is important for productivity as it facilitates the workflow in the space while improving the users' health and energy [6] .There are some improvements in the technological tool that could be reflected in the design process of shared office spaces. Virtual reality is the most important tool which could improve the design process, as it has a sincere change in the final product by using digital models [5].

2. Research Problem

The research problem concentrates in the decreasing of users' satisfaction levels as a result of shared office spaces, as there are many problems that affect user satisfaction such as privacy, distraction, noise, etc. On the other hand, user exclusion from the design process makes the final product far away from users' needs [1].

3. Research importance

The importance of research deduced from making a design tool used in the design process of shared office spaces that could involve the users in the design process to explicit their needs and desires.

As a result, this design tool could improve and increase the user satisfaction and productivity, as well as enhancing the final product of the design shared office spaces.

4. Research objective

The main objective is to develop and validate a digital design tool -with the help of VR- that could involve users' participation in the design process of shared office spaces to increase users' satisfaction and meet their needs.

5. Methodology

For reaching out the research objective, firstly; a qualitative approach has been used to understand the virtual reality and user experience design concepts, as well as applying the UXD concept in the design process.

Secondly, a quantitative approach is used to measure users' satisfaction before and after the experiment to validate and evaluate the proposed design tool.

6. Virtual reality concept

Virtual reality is the environment created by computer with a high level of reality where user can live a real experiment virtually. From the seventies, VR represents an interaction experiment to the user, a tool that has been developed dramatically due to the recent technological improvement [4].

Virtual reality has been used in different fields, many studies and experiences made in architecture field to benefit from VR Possibilities, in which VR saves effort, time and cost. One of the most important experiment has done is the effect of interior spaces in perception of the human brain and its activity, that has been proved its success as tool [7].

The tool has been used in the final phases of the design process to represent the final product to the client [2]. In which, the user can express his opinion and make the modification to the design. There are many studies use VR in the early phases of the design process but it is not complete [2]. Accordingly, some improvements could be made for 2d&3d drawings to help enhancing the final product, however the result some is not fulfilling the user satisfaction [4].

7. User Experience Design (UXD) Concept

User Experience Design is a concept that has many sides, it includes a different specialties such as Interactive design, information engineering and visual design [10] , the design process in UXD mainly depend on the user, in which the user be a part of design process to involve his opinion, to make the final product meets his needs [8]. The effectiveness of the UXD depends on the interactive between user and the product, as the architecture product is a visual one, hence there are many interactions do exist between users and the architecture product. As a result, applying the UXD concept to the architecture product increasing the user satisfaction.

Different ways are used to apply the UXD concept on exist product, mobile phones applications, for example, is used for the interaction happen between users and the interface of the application to modify it. Otherwise, when applying the concept on the architecture product, the user needs an actual scale for the product to interact with, to hit the target as a livable space to increase users' satisfaction, this concept could be applied with the help of VR -as shown in Fig. 1[3]. VR is one of the feasible applications making simulation to the surrounding environment with actual details without manufacturing cost [9].

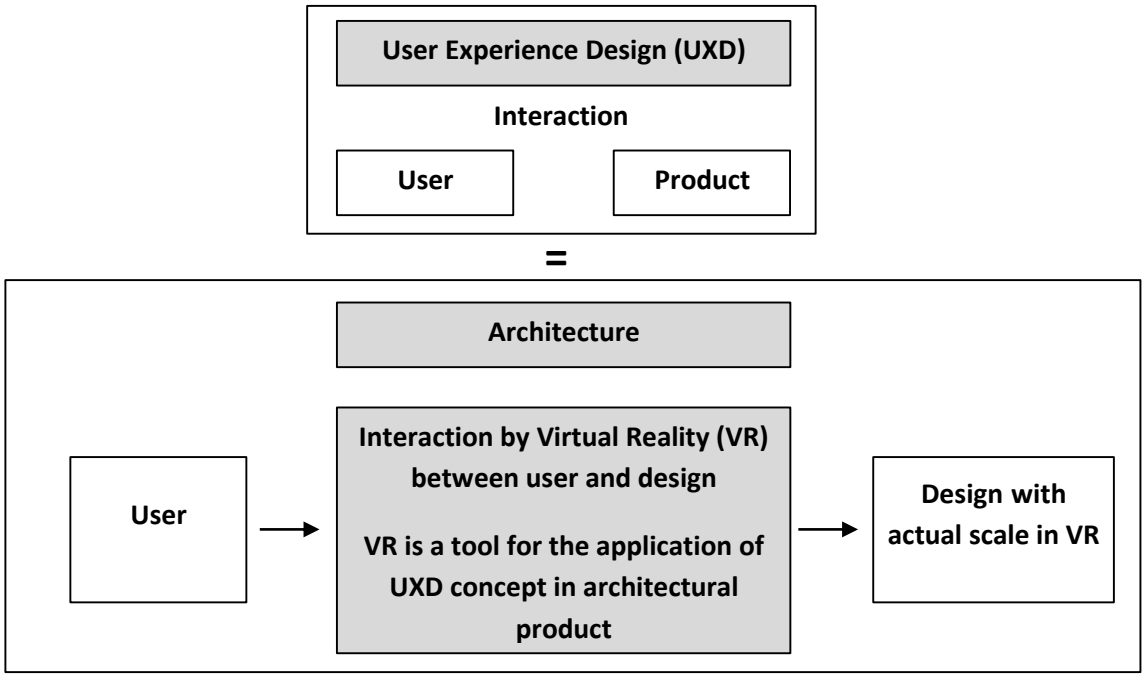


Figure 1: application of UXD concept in the architectural product

8. Factors Effecting the user satisfaction in office spaces

According to study established by the authors to define the Factors effecting user satisfaction in a given office spaces three main levels has been conclude [3] -as shown in fig. 2: the first level explains the correlation between the building and its context, the second level explains the correlation between the different floors within the building, and the third level explains the design of the office spaces while determine the relation between its physical setting altogether. The study also finds that user satisfaction mainly depends on the third level, as the user spends the major time in these spaces at that level, so the research scope will be on the third level [6].

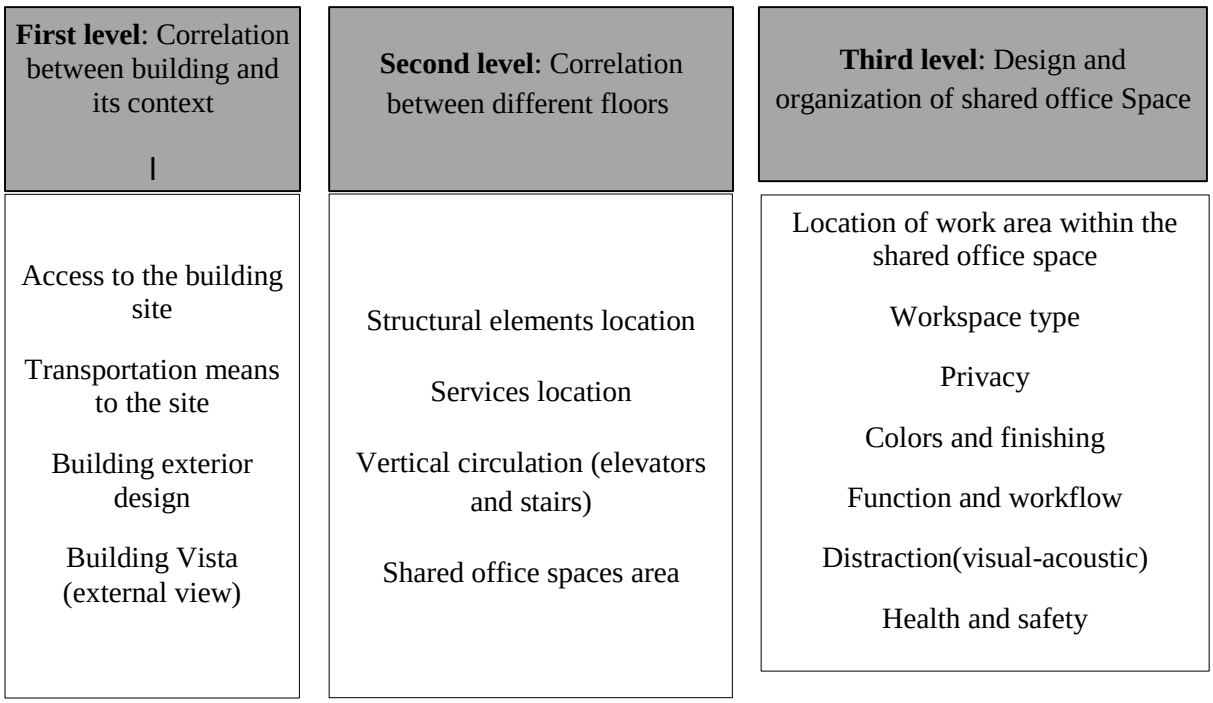


Figure 2: user satisfaction levels in office spaces design

9. The mechanism of UXD and VR

The proposed mechanism of integrating UXD and VR for the design of shared office spaces is consisting of three phases in series (fig.3): the experiment articulation, the experiment tool preparation, and the experiment implementation and tool evaluation [2].

In phase one: the experiment articulation, the research conducts a questionnaire for space users to determine their needs, and to determine the required physical elements that should be guaranteed within the VR environment. Then the experiment tool prepared based on integrating the UXD and VR tool while producing a simulation model to complete the experiment in VR environment. Finally, the third phase in which the comparison happened between the existing situation and the explored design from the experience [3].

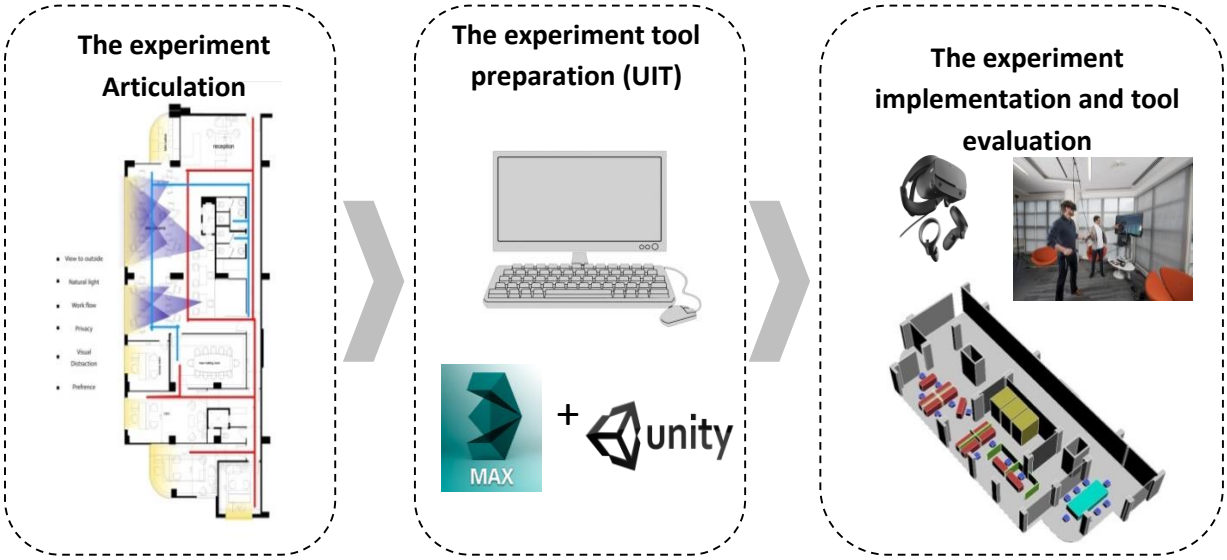


Figure 3: the three phases of the experiment

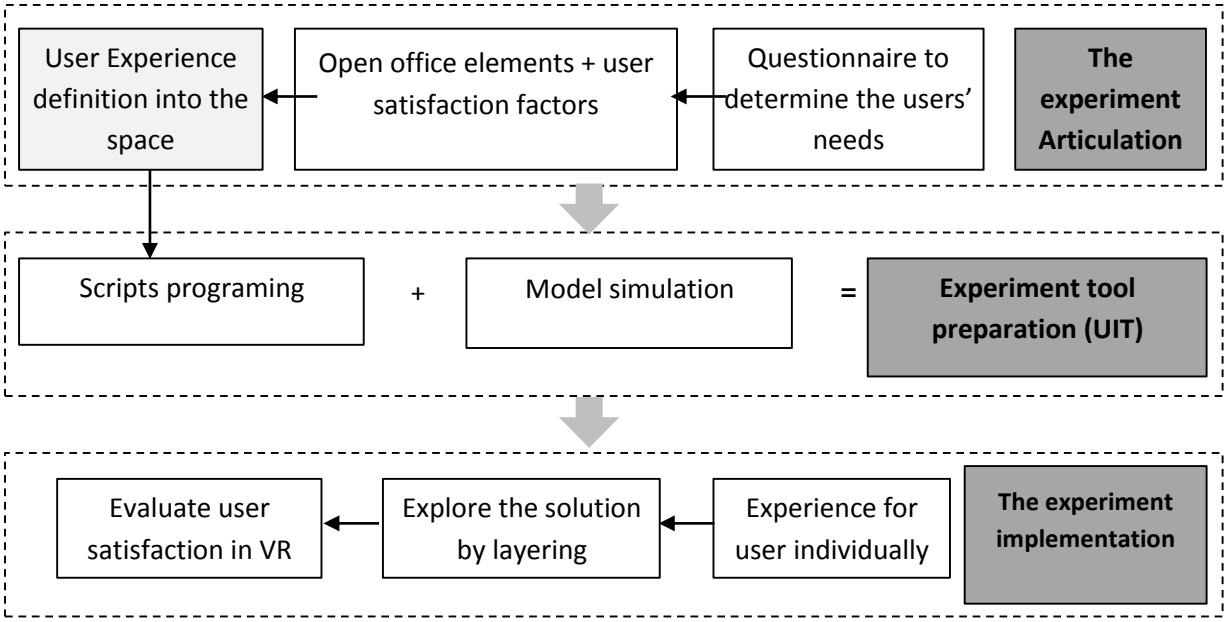


Figure 3: Experiment Design structure for shared office space

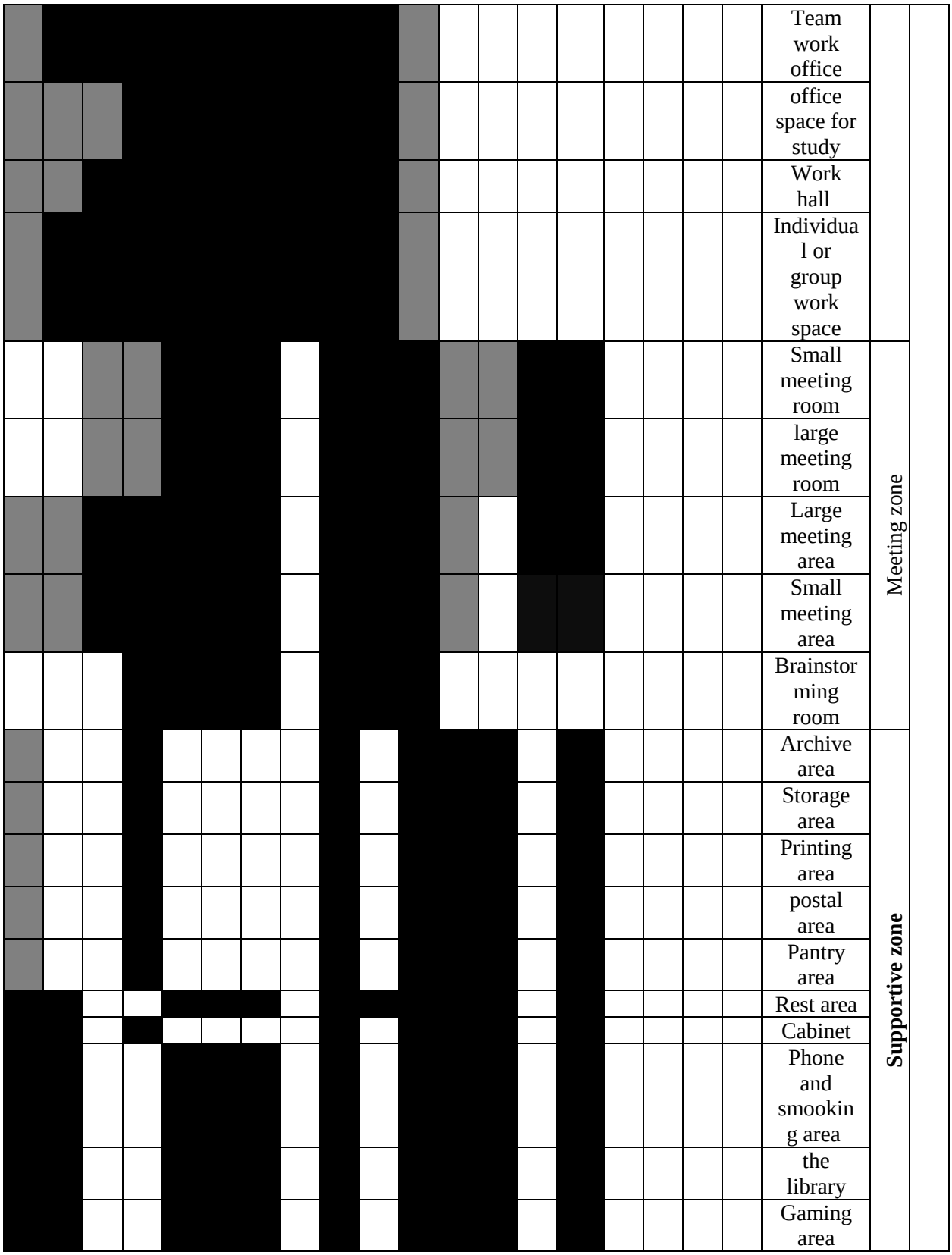
9.1. First Phase: Experiment Articulation (interaction between user and space)

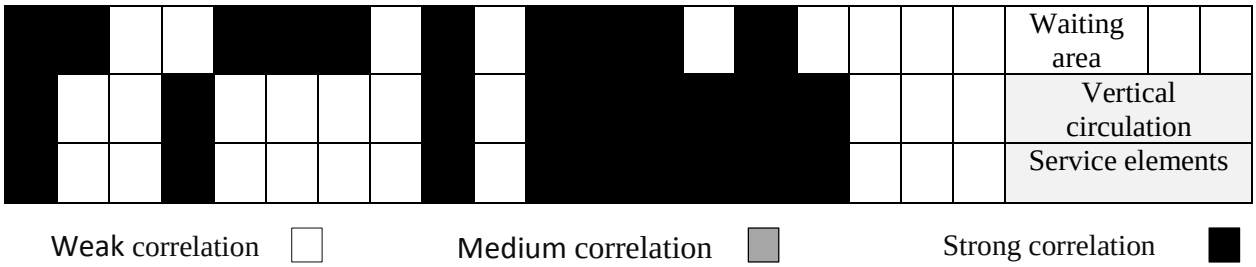
It is a vision of how the user interacts with the space in VR, and how this affecting the space design (Fig. 4). Based on the explored user satisfaction levels with the corresponding physical setting of the space articulation, it is necessary to figure out this correlation to determine the tool which help user to make the interaction, and table 1 explain this relation [1].

Figure 4: The experiment Articulation

Table 1: Correlation between user satisfaction levels and space elements

User satisfaction factors																			Open office elements		
Level 3									Level 2						Level 1						
ergonomics	Safty and health	distraction	Function & work	Color & finishing	light	privacy	Work space type	Element location in	Required work	Departments	Vertical circulation	Services location	Structure elements	Floors relation	Building exterior	Transportation to	Building site	Building and	Space limiting elements		
			■	■	■	■		■		■	■	■	■	■	■				Coloumns and walls		
				■				■	■	■			■	■	■				cieling flooring		
■	■	■		■	■				■				■		■						
																			office space division elements		
■	■	■	■	■	■	■	■	■	■	■		■							Open office	Work zone	Office spaces
■	■	■	■	■	■	■	■	■	■	■		■	■						Team work space		
■	■	■	■	■	■	■	■	■	■	■		■	■						Individual work space		
■	■	■				■		■	■	■	■		■						Private close office		
■	■	■	■	■	■	■	■	■	■	■									Shared office		


Team work office
office space for study
Work hall
Individual or group work space
Small meeting room
large meeting room
Large meeting area
Small meeting area
Brainstorming room
Meeting zone
Archive area
Storage area
Printing area
postal area
Pantry area
Rest area
Cabinet
Phone and smooking area
the library
Gaming area
Supportive zone



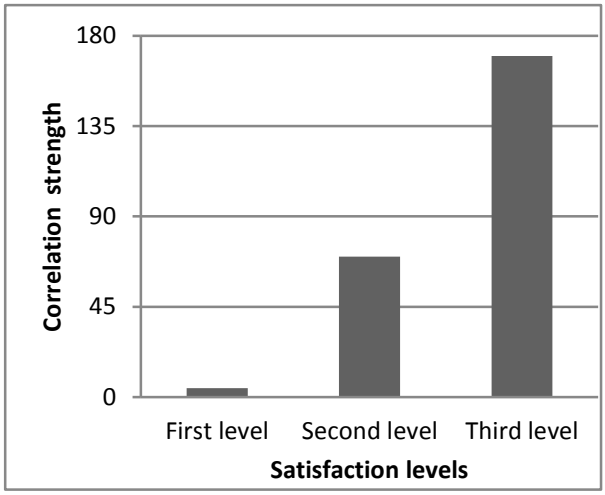


Figure 5: The correlation strength of levels of user satisfaction

Calculation the effect of each satisfaction level from the previous correlation table 1, in which the strong correlation calculated by full point, the medium correlation calculated by half point, and the weak correlation with no points. By collecting all points, the third level was the effective one in the user satisfaction [6].

Second phase: the experiment tool preparation (User Interaction Tool – UIT)

From the previous correlations table 1, the research articulates the required tools (table 2) based on the third level of user satisfaction. The deduced tool shows the main factors affecting user satisfaction, and its secondary factors.

Table 2: The Articulation of the experiment Tool

Tools	The experience definition	Secondary factors		Main factors of user satisfaction
Movement Script	Move and rotate the partition in the open space to make the work zone	Work zone location	Level ^	**location of space elements**

Rotation script				
Movement Script	Move and rotate the partition in the open space to make the meeting zone	Meeting zone location		
Rotation script				
Movement Script	Move and rotate the partition in the open space to make the rest zone	Service and rest zone		
Rotation script				
Movement Script	Move the office furniture and rotate it to the required direction	The work space location into work zone	Level B	
Rotation script				
Movement Script	Move storage furniture in the space and rotate it to the required direction	Storage location		
Rotation script				
Movement Script	Move meeting table and rotate it to the required direction	Meeting furniture location in meeting zone		
Rotation script				
Movement Script	Move the screen to suitable location	Projection screen location		
Movement Script	Choose and move the work space into the space	Work space type choise(single-double-group)		**work space type**
Movement Script	Choose partition type and stretch it to make the required hieght	Work space type choise (open-close-semiclose)		
Stretch Script				
Movement Script	Choose the rush meeting table to the required location	Choise of rush meeting location		

Movement Script	Partition type choise and its height ,compisition	Visual privacy	**privacy**
Stretch Script			
Movement Script	Choose phone area far way from work space	Acoustic privacy	
Movement Script	Choise work space direction, and its location from light source	Light type into space (direct &indirect)	**light**
Movement Script	Artificial light location choise	Artificial light location	
Movement Script	Move façade units to specify voids and natural light	Façade voids to get natural light	
		Natural light direction	
Material Script	Specify ceiling color and finishing	Ceiling color and finishing	**colors and finishing**
	Specify walls color and finishing	Walls color and ceiling	
	Specify flooring color and finishing	Flooring colors and ceiling	
	Specify spacework color and finishing	Work space colors and finish	
	Specify ceiling color and finishing	Partition finishing	
Movement Script	Move space furniture	Horizontal circulation	**function of furniture**
Stretch Script	Stretch work space in two access(x,y)	Work space dimension	
Movement Script	Furniture choise	Users relations toghther (work flow)	
Movement Script	Specify and rotate partition type and its hieght	Visual distraction	**distraction**
Stretch Script			
Rotation script	Use partiitons to decrease noise	Acoustic distraction	

Movement Script	Choose an locate natural elements	Natural elements in the space (biophilic)	**Health and safety.**
	Choose work space location	View to outside	
	Choose location of rest space and its furniture	Supportive space (spirit room – games room)	
	Choose elements which increase user foucus	User attention space navigation	
Stretch Script	Stretch work space	Work space dimention	**Ergonomics**
Movement Script		Need side table	
Movement Script	Specify Possibilities of work space to chieve User convenience	Nessecary dimention in work space (computer screen height)	
Stretch Script			

In the second phase the user interaction tool is prepared, based on the first phase (the experiment preparation). It includes two steps, the first one: an open space is prepared by make the model simulation, using 3ds max software to simulate the space with the actual scale, then importing the model into unity program to prepare it to the VR Fig. 6 [2]. The second step uses the virtual reality programming language to make the required scripts by C++ programming fig.7, to do the interactions in the open space between user and the space elements [3].

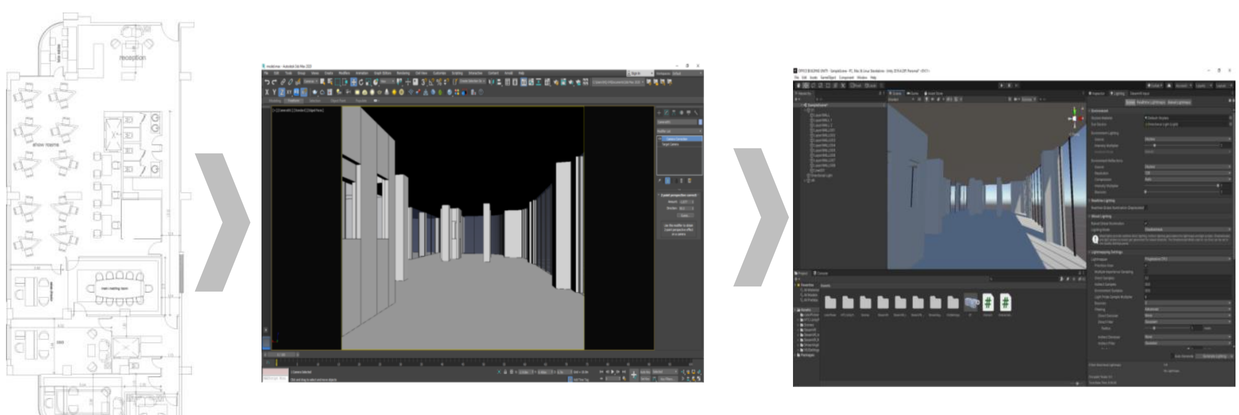
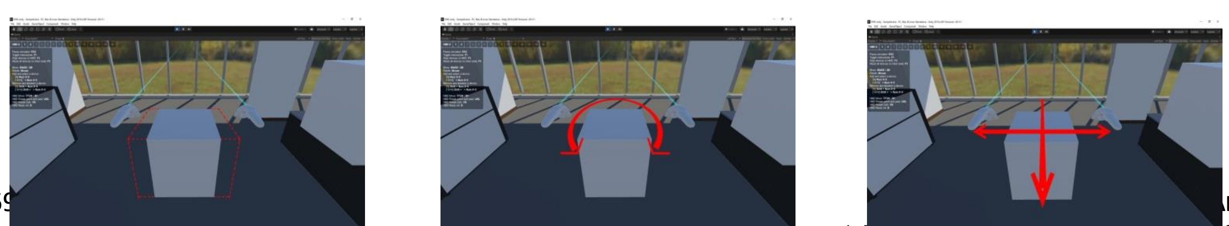


Figure 6: the preparation of simulation model from 3dmax to Unity author



Stretch Script Rotation Script Movement Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using HTC.UnityPlugin.Vive;

@ Unity Script | 0 references
public class Interact : MonoBehaviour
{
    // Start is called before the first frame update
    public Transform rightHand, leftHand;
    public int clicked = 0;
    Transform helperObj;

    Transform grabbed;
    Transform grabbingHand;
    Transform prevParent;
    @ Unity Message | 0 references
    void Start()
    {

    }
    @ Unity Message | 0 references
    void Update()
    {
        TakeInput(HandRole.RightHand);
        TakeInput(HandRole.LeftHand);
    }

    2 references
    void TakeInput(HandRole hr)
    {
        if (ViveInput.GetPressDown(hr, ControllerButton.Trigger))
        {
            if (clicked == 0)
                Grab(hr == HandRole.RightHand ? rightHand : leftHand);
            else Grab2();
```

Figure 7: part of movement script programming

9.3. Third Phase :the experiment implementation and tool evaluation

User experience design -UXD- is used to participate user in the design process of office shared spaces as where user spends the major of his work time in it. UXD depends on the visual interactive design process by applying the experiment on existing office spaces to measure users' current satisfaction-before the experiment- and the expected satisfaction after the experiment. The purpose of the experiment is to evaluate and validate a new tool to guide the user satisfaction of new office spaces while participating them on the early design phase, otherwise for further development to the existing office spaces [4].

The selected case study on an existing office located in 5th settlement in New Cairo. The office is consisting of five departments that works as a real-estate developer. The experiments is done through passing by three steps: the first step stands for conducting a questionnaire to determine users' needs for

their workspace. At the same time the conducting questionnaire measures' user satisfaction before implementing the experiment. The second step is used to participate users for allocating their needs from the workspace via VR environment. The third step investigates the concluding scenarios via the VR experience to compare it to the existing design [2].

9.3.1. The First Step : Conducting the Questionnaire

The conducted Questionnaire is a set of questions measuring users' satisfaction factor, in addition to determine the required office furniture that users need in the workspace [3]. The Questionnaire was applied on 15 users from different departments, and the result is as follows in table 3:

Table 3: users Questionnaire results

User interests			Secondary factors		User satisfaction factors
strong %١٠٠	medium %٥٠	weak %٠			
72.7%	18.2%	9.1%	Work zone location	Level A	location of item in the space
11 user	3 user	1 user			
27.3%	27.3%	45.4%	Meeting zone location		
4 user	4 user	7 user			
90.9%	9.1%	0%	Service and rest area location		
14 user	1 user	0 user			
81.8%	18.2%	0%	Work space location into work zone	Level B	
١٢ مستخدم	٣ مستخدم	٠ مستخدم			
81.8%	18.2%	0%	Storage location		
12 user	3 user	0 user			
63.6%	27.3%	9.1%	Work space type choise(single-double-group)		work space type
10 user	4 user	1 user			
72.7%	18.2%	9.1%	Work space type choise (open-close-(semi close		
11 user	3 user	1 user			
54.6%	27.3%	18.2%	Choise of rush meeting location		
8 user	4 user	3 user			
81.8%	9.1%	9.1%	visual privacy		privacy
11 user	2 user	2 user			
81.8%	9.1%	9.1%	Partition height		
11 user	2 user	2 user			

72.7%	18.2%	9.1%	(acoustic privacy)	
11 user	**3 user**	**1 user**	Phone Cell existence	
63.5%	27.4%	9.1%	**.Colors and finishing**	
10 user	**4 user**	**1 user**		
81.8%	18.2%	0%	**distraction**	
11 user	**4 user**	**0 user**		
72.6%	18.2%	18.2%	view to outside	**Health and safety.**
14 user	**1 user**	**0 user**		
63.6%	18.2%	18.2%	Work space dimensions	**Ergonomics**
10 user	**3 user**	**2 user**		

It is possible to calculate the median of each factor of user satisfaction in shared office spaces, in which strong relation scored by full point, and medium relation by half point, and weak relation with no point's fig. 8. [2]. Total User Satisfaction in Open space is 100% [1].

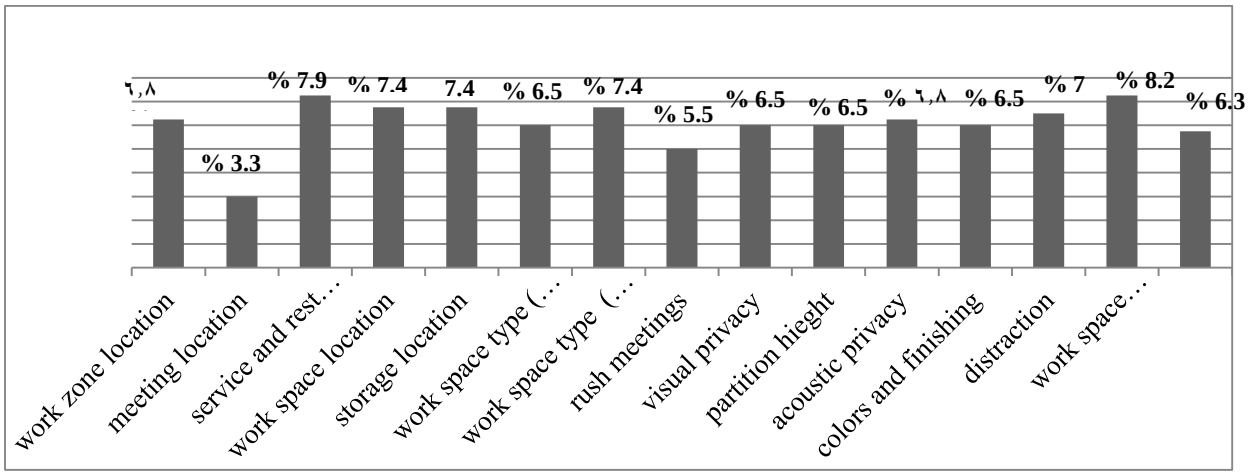
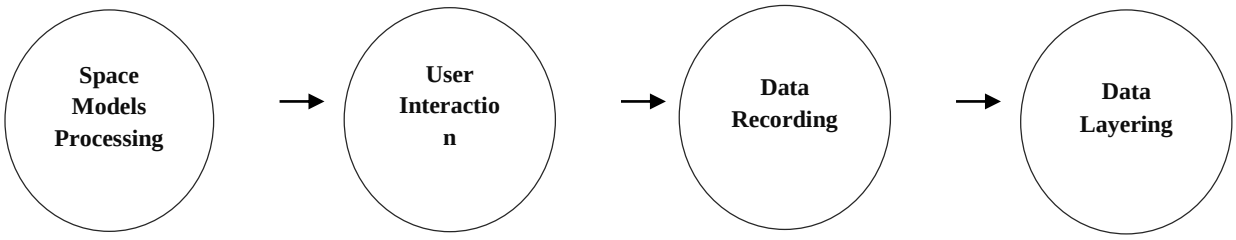


Figure 8: The weights of user satisfaction factors in shared office spaces

9.3.2. The Second Step: Experiment Implementation



In this step, the selected case study was modeled as a free space with only the structure support points (columns). Firstly, fixed zones are settled including services and facilitators, then the rest of the space is divided into different zones that have different advantages according to their location within the plan. Upon that, four users get involved into the space using the VR Tool to select the appropriate zone for them according to the workflow fig. 9. The study focuses on one department (Engineering Department) to implement the experiment [3].

Table 4: user choices to department's zones According to career hierarchy

zones	function
Zone H	Chairman
Zone I	Chairman vice
Zone A	Reception
Zone E	Rest zone
Zone G	Meeting zone
Zone B	financial management
Zone C	Marketing Management
Zone D	Engineering Management
Zone F	customers service

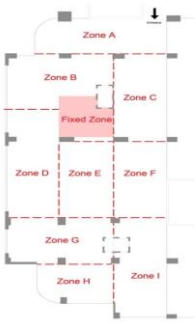


Fig. 9: user choices to department's zones According to career hierarchy

- The first user (dept. manager) got into the VR Environment and choose a workspace from the predefined zones (shown in figure 9), then he chose the suitable furniture for his workspace; a desk, a side table, a small storage, a partition, meanwhile he allocating each piece place, size direction into the workspace using the developed VR tool [6]. Observingly, the whole set of the first user was oriented to the inside view instead of to the view outside.

- The second user got into the VR Environment to select his workspace set in relation to the first user selection. He placed his workspace (with high partition) in the other side of the work-zone away from the manager, while oriented his desk to the outside view as well as picking a natural element (planting pot) beside him [6].

- The third user got into the VR Environment and select a double workspace with other user, he choose a partition with medium height between the two work space, and a storage unit beside the workspace [3].

- The fourth user share the double workspace with the third user, and choose a storage unit beside the workspace.

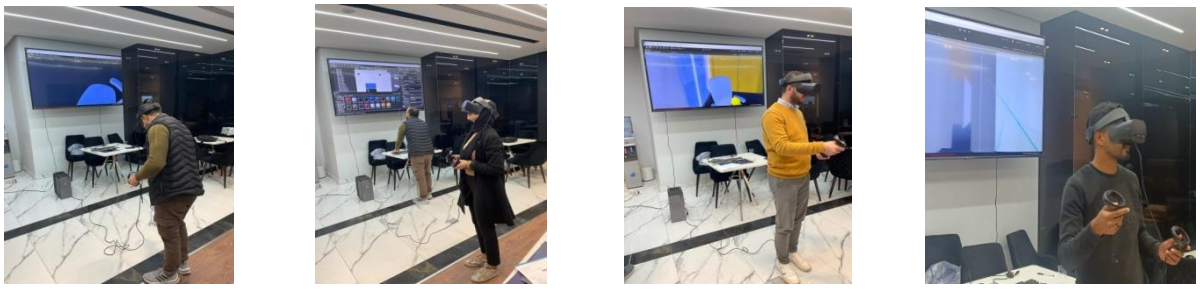


Figure 10: Users in the VR experience making their choices based on instructions

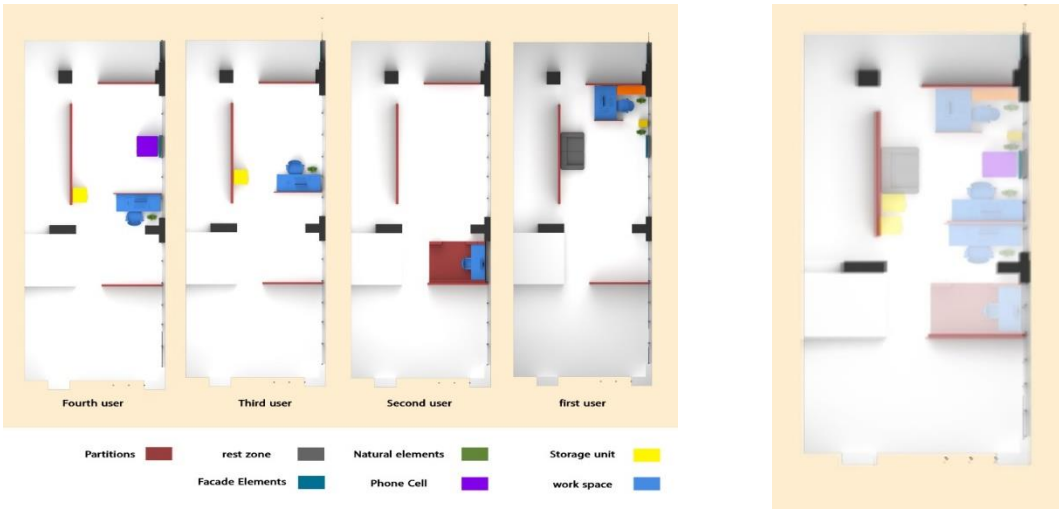


Figure 10: Layering the user's choices scenarios to investigate the experienced design solution

10. Investigating user satisfaction

The user satisfaction is investigated two times; one before and one after the experiment. Hence, two questionnaires were conducted before and after the experiment to measure user's satisfaction for comparing the concluded results to figure out and evaluate the validity of the proposed VR tool in office spaces design [1].

User satisfaction calculated by calculate each factor for four users in engineering sector. Based on each factor weight. It is possible to calculate each factor before and after the experiment by this equation:

$$\text{Factor percentage} = \frac{\text{Sum of this factor for four users*factor weight}}{\text{400 (four users)}}$$

11. The equation elaboration:

user satisfaction factors in shared office spaces based on experts designers [1], and its weights based on users interests, this weights differ from space to space depending on users demands, this study calculate each factor weight as shown in Fig 8 (based on user concern) in the target space, to use this weights in calculating total user satisfaction before and after the experience [4].

The equation which use to calculate the factor percentage based on the sum of each factor for 4 user (who made the experience) and answered the questionnaire in which asked about satisfaction before and after the experience, it is not a constant equation which can be applicated in each cases, it help to get the total satisfaction to know the used tool effective [1].

Total user satisfaction can be calculated by the sum of factors affecting on user satisfaction in shared office space:

$$\textbf{Total Users Satisfaction} = \textbf{Sum of All Factors for all space users}$$

And each factor can be calculated for 4 user by the sum of users values in the questionnaire (before and after)

For example:

$$\text{Work zone choice satisfaction rate factor (before the experience)} = \frac{\text{User 1 satisfaction rate to this factor before the experience (50 from 100)} + \text{User 2 satisfaction rate to this factor before the experience (50 from100)} + \text{User 3 satisfaction rate to this factor before the experience (25 from 100)} + \text{User 4 satisfaction rate to this factor before the experience (50 from 100)}}{\text{400 (four users)(this number can be changed by change the number of users)}}$$

Table 5: calculation the Satisfaction rate before and after the experience

Factor percentage		User 4		User 3		User 2		User 1		Factor weight	Satisfaction factors	
after	before	after	before	after	before	after	before	after	before			
(٧٥+٨٠+٨٠+ ١٠٠)*(٦٠/٤٠٠)*٦,٨ = ٥,٠١٥	(٥٠+٥٠+٢٥+ ١٠٠)*(٥٠/٤٠٠)*٦,٨ =٢,٩٧٥	60	50	80	25	80	50	75	50	%٦,٨	Work zone choice satisfaction rate	
(٢٥+٧٥+٨٥+ ١٠٠)*(٥٠+٤٠/٣,٣)*٠ =٢,٥٥٧٥	(٢٥+٤٠+٢٥+ ١٠٠)*(٥٠/٤٠٠)*٣,٣ =١,١٥٥	50	50	85	25	75	40	100	25	%٣,٣	Meeting zone choice satisfaction rate	
(١٠٠+٩٠+٩٠+ ١٠٠)*(٧٠+٤٠/٧,٩)*٠ =٦,٩١٢٥	(٥٠+٢٠+٢٥+ ١٠٠)*(٢٠/٤٠٠)*٧,٩ =٢,٢٧	70	20	90	25	90	20	100	50	%٧,٩	Rest zone choice satisfaction rate	
(١٠٠+١٠٠+٩+ ١٠٠)*(٧٠+٠+٤/٧,٤)*٠٠ =٦,٦٦	(٥٠+٢٥+٢٥+ ١٠٠)*(٣٠/٤٠٠)*٧,٤ =٢,٤٠٥	70	30	90	25	100	25	100	50	%٧,٤	Work space location choice in work zone	
(٧٥+٧٥+٧٠+ ١٠٠)*(٥٠/٤٠٠)*٧,٤ = ٤,٩٩٥	(٧٥+٧٥+٦٠+ ١٠٠)*(٥٠/٤٠٠)*٧,٤ =٤,٨١	50	50	70	60	75	75	75	75	%٧,٤	Storage location choice	
(١٠٠+١٠٠+٩+ ١٠٠)*(٨٠+٠+٤/٧,٤)*٠٠ =٦,٨٤٥	(٥٠+٥٠+٣٠+ ١٠٠)*(٢٠/٤٠٠)*٧,٤ =٢,٧٧٥	80	20	90	30	100	50	100	50	%٧,٤	Work space type (open – closed – semi close)	
(75+80+90+ 100)*6.5/400= ٥,٦١	(٥٠+٥٠+٣٠+ ١٠٠)*(٥٠/٤٠٠)*٦,٥ =٢,٩٢٥	100	50	90	30	80	50	75	50	%٦,٥	Work space type (single double – group)	
(100+90+95 +60)*6.5/400= ٥,٦١	(٧٥+٧٠+٧٠+ ١٠٠)*(٣٠/٤٠٠)*٦,٥ =٣,٩٨	60	30	95	70	90	70	100	75	%٦,٥	Partition type	privacy
(100+90+95 +80)*6.5/400= ٥,٩٣	(٧٥+٥٠+٧٠+ ١٠٠)*(٤٠/٤٠٠)*٦,٥ =٣,٨٢	80	40	95	70	90	50	100	75	%٦,٥	Partition height	
(100+100+1 00+70)*6.8/ 400= ٦,٢٩	(٠+٠+٠+٠+ ١٠٠)*٦ =٤٠٠/٨,٠١=٠,٠١ ٧	70	0	100	0	100	0	100	0	%٦,٨	Phone cell existence	
(100+95+95 +50)*6.5/400=	(٥٠+٥٠+٧٠+ ١٠٠)*(٥٠/٤٠٠)*٦,٥ =٣,٥٧٥	50	50	95	70	95	50	100	50	%٥,٥	Façade voids satisfaction rate	

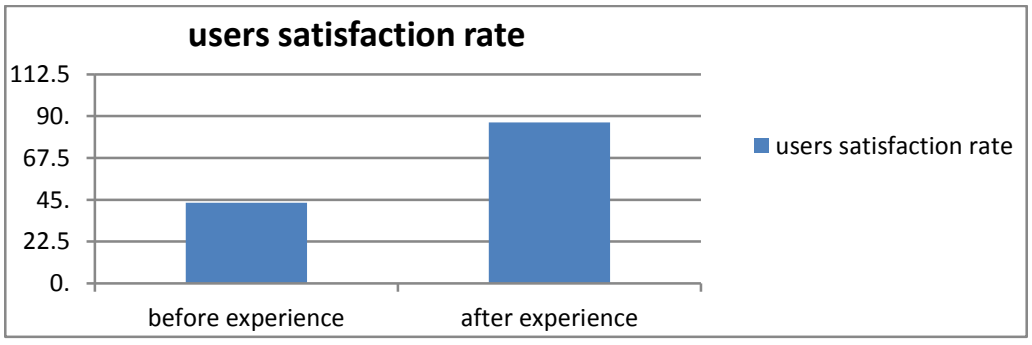
٥,٥٢٥											
(100+90+90+40)*6.5/400= 5.2	+٤٠+٨٠+٢٥) ٤٠٠/٦,٥*(٩٠ ٣,٨٢=	40	90	90	40	90	80	100	25	%٦,٥	Finishing satisfaction rate
(100+100+95+100)*6.3/400= ٦,٢٢	+٥٠+٨٠+٢٥) ٤٠٠/٦,٣*(٥٠ ٣,٣=	100	50	95	50	100	80	100	25	%٦,٣	Work space dimension satisfaction rate
(100+75+80+70)*7/400 = ٦,٠٣٧٥	+٢٥+٢٥+٥٠) ٢=٤٠٠/٧*(٤٠ ,٤٥	70	40	80	25	75	25	100	50	%٧	Distraction satisfaction rate
(75+100+95+80)*8.2/400= ٧,١٧٥	+٢٥+٥٠+٢٥) ٤٠٠/٨,٢*(٥٠ ٣,٠٧٥=	80	50	95	25	100	50	75	25	%٨,٢	View to outside
٨٦,٥٨٢٥	**٤٣,٣٥٢**	**Satisfaction rate before & after the experience**									

11. Conclusions

The study shows how user's satisfaction increases when the user gets involved into the design process of the shared office spaces. As the user could participate in the articulation of his needs and the nature of workflow which is the sincere effect on his satisfaction when achieved, using UIT tool.

The research finds that users' satisfaction before the experiment is about 43.352 %, while it has been raised to 86.5825 % after using the proposed mechanism. Hence, the users' satisfaction is almost doubled after using the virtual reality tool in the design process of office space design.

Figure 11: Users Satisfaction Rate



Accordingly, the study prove the validity of using the VR Tool with the integration of user experience design-UXD- in the design process of shared office spaces to satisfy users satisfaction. On the other hand, the study finds that: High percentage of users (90.9%) choose work-zone where users could look to facade opened to the outdoors.

- It is necessary to provide a wide selection of workspaces for users into the work area variant in groping type and privacy issues (single-double-group) or (close –open -semi close).
- It is necessary to provide offices work areas with natural elements, such as planting post, and suitable rest spaces.
- It is necessary to provide a secluded cabinet for cell phone callings to avoid acoustic distraction.
- Natural light is necessary for users in office work areas.

References

[1] Ashry,n.,Abdelrasoul,A.,&Hendy,M.(2022).Factors affecting user satisfaction in office spaces.Cairo: Engineering Research Journal,Faculty of Engineering at Soubra, Benha UNI

[2] B.H George, Sleipness .(٢٠١٧) .Using virtual reality as adesign input: Impacts on collaboration in a university design studio setting .ournal of Digital Landscape Architecture.

[3] B.H George, Summerlin .(٢٠١٨) .The current state of software amongst landscape architecture practitioners .the Education and Practice Professional Practice Network of the American Society of Landscape Architects.

[4] Drew M. Hill .(٢٠١٩) .how virtual reality impacts the landscape architecture design process at various scale .Logan, Utah: Utah state university.

[5] F Bruno, F Cosco , ML Luchi .(٢٠١٠) .Product behavior simulation in mixed reality .in procceding of ASME conf. of innovative VR .(١٧٣-١٦٥) ، united states.

[6] Gray D Moore .(١٩٨٤) . Environmental design research directions : process and prospect . praeger , new york.

[7] Javad Hatami, Maryam Banaei .(٢٠١٧) .Walking through architectural spaces : the impact of interior forms on human brain dynamics .frontiers.

[8] Jean D Wineman .(١٩٨٥) .Office Design And Evaluation .Sage Journal, environment and behavior ، .٢٩٨-٢٧١

[9] L Ma , D Chablat , F Bennis .(٢٠١٠) . Integrating Digital human modeling into virtual environment for ergonomic oriented design .In Proceedings of ASME Con. on Innovative VR .(٢١٠-٢٠٣) ،United States.

[10] Laura Klien .(٢٠٢٠) . Principal at users know.