

Facilitating public participation in urban development projects using virtual reality
tools Case Study; Central Tehran (Jomhuri Eslami St.)

Seyed Yousef Mousavi¹ ,Ali Khaleghy²

Received: 23 -October-2020

Accepted: 21- December-2020

ABSTRACT

The process of participation, as a public culture, is not well established in the way citizens think or act. Due to the importance of citizen participation in urban development projects, a lot of research has been done to increase participation. The purpose of this study is to facilitate citizen participation in urban development projects. But what distinguishes this study from other studies is the use of new tools and up-to-date technologies such as virtual reality. In this regard, the simulated environment of the study area is accomplished in a specialized virtual reality laboratory environment And individuals were tested as a sample. People's unfamiliarity with the virtual environment made it difficult to feel close to the real environment, but the attractiveness of the virtual environment made people move in the experimental environment and increase their excitement. Finally, it was found that the tested individuals feel satisfied and answer the relevant questions well, which showed a desire to participate in the project. In conclusion if some of the most important weaknesses of virtual reality are eliminated, for example, if we increase the sense of immersion or combine virtual reality with augmented reality, this will increase the efficiency of this tool in increasing the participation rate.

KEYWORDS: Public Participation, Urban Development Plans, Virtual Reality, Tehran city center.

Reference to article:

Seyed Yousef Mousavi ,Ali Khaleghy (2020), Facilitating public participation in urban development projects using virtual reality tools Case Study; Central Tehran (Jomhuri Eslami St.) Journal of Research In Urban Planning and Architecture - Environment Identity (JRUPA-EI) NO.1 (4), Autumn 2020.P.59-72.

http://www.ei-journal.ir/article_130828.html?lang=en

¹ Masters of Urban Desing, Faculty of Architecture and Urban Studies, Tehran Art University, Tehran, Iran Yooosof.moosavi@yahoo.com 59
(Author)

² Master of Urban Planning, Faculty of Architecture and Urban Planning, Tarbiat Modares University, Tehran
[.ali.khaleghy1987@gmail.com](mailto:ali.khaleghy1987@gmail.com)

1.INTRODUCTION

Citizen participation is a tool to strengthen urban management in today's advanced societies and is one of the indicators of life quality in different societies. The diversity and complexity of urban issues, along with administrative and managerial problems, necessitate citizen participation in urban problems. One of the main problems of citizens' non-participation is the increase in costs as well as the low efficiency of urban projects, It is possible that the plans are fully prepared and approved by experts and officials, but during or after the implementation, faces the strong resistance and opposition of the users of that plan, ie ordinary citizens (Abdolmutallab, 1392: 44). Another problem is that in many designs or plans their main features, defects, and characteristics is unknown until they are finally implemented on ground. In the simulated environment in virtual reality glasses, different possibilities and conditions can be applied in the design, and by placing different people, including experts and citizens, in the simulated environment of the design, different perceptions and cognitions can be achieved to implement The plan is very useful. In the simulated environment in virtual reality glasses, different possibilities and conditions can be applied in the designs and plans, and by placing different people, including experts and citizens, in the simulated environment of the planned or designed area, different perceptions and cognitions can be achieved which are very useful for the implementation of the plan. finally, by evaluating the changes made by users, an optimal option can be selected for the said cases, this issue will make the citizens satisfied with the suggestions and features of the plan after the implementation, and also this Satisfaction increases people's sense of belonging to the environment due to their participation in its design and construction, and as a result, causes the citizens to take care of that project (Ghaedi, 2012: 193).

In this study, we try to build and design spaces, software and facilities, suitable for both groups of citizens and city officials, to create a pleasant participation experience for citizens and also the possibility of reviewing the plan before implementation for officials and presence and interaction in cyberspace.

1- Theoretical framework of research

Today, participation is one of the most important issues in the development of the city. Expressing the Necessities Policies and methods to enable people to participate in the change of societies will be a very fundamental and effective way for all experts, stakeholders, planners and implementers in performing their duties. What has made the issue of participation in development theories important today is the approach of development theories to human, social and cultural goals. In a partnership system, the relationship between the manager and the managed is a dynamic two-way relationship because partnership means participating and having a company. This reciprocal relationship includes all the achievements of civilization and human experience, from commitment and a sense of responsibility for one's actions to respect for the rights of others and the belief in the equality of human beings. In other words, participation is a social

action and is based on a reciprocal relationship. And social action is an action that one person does something according to the expectations of other people. Therefore, in order to fully understand social action, we must: First, recognize the external socio-economic and cultural factors that affect the action of individuals, Therefore, in order to fully understand social action, we must: First, recognize the external socio-economic and cultural factors that affect the action of individuals, second, the factors that are relevant to the individual and are important from the individual point of view should be paid attention, and Finally, the impact of these factors on the structure of urban management should be examined and be evaluated. (Habibi, 2005: 18) With the expansion of cities and the complexity of urban life, planning for the city has become more important than before and in today's planning system, participation is one of the most important pillars (Stauskis, G, 2014: 2). The presence of citizens in the field of decision-making and their closeness and coordination with officials and, and achieving their wants and needs as soon as possible in accordance with living conditions and social and economic characteristics, is possible through the process of participatory urban planning. (Berger, M, 2014: 6)

The growing importance of the role of people in the management of societies and the growth of democratic systems has led to attention to the idea of public participation (Armstein, 1969: 216). Public participation is now an integral part of the planning process in most democratic countries, and the need for public participation has often been a legal necessity in planning laws (Oosthuizen, 1989: 296). At the beginning of World War II, market mechanism tools replaced traditional planning methods, and planning was attacked and criticized from various aspects (Klostelman, 1983: 6). After the Second World War, planning and preparing plans became popular in the industrialized countries. The purpose of planning at this time was to allocate land for the construction of settlements, activities and communication lines. This was done through land use zoning and the implementation of special criteria. (Shokouei, 1997: 148-143). Rational planning was formed in the late fifties with the aim of controlling balanced growth and optimal distribution of resources (Ennis, 1997: 195). Also in the sixties, with the emergence of shortcomings in the method of physical and rational planning in practice, systems planning theory was formed with emphasis on the collection of comprehensive information, modeling and the use of quantitative tools (Bucek, 2000: 3-16). In the sixties and seventies, participatory planning became the center of world change due to the direct involvement of people in the decision-making process. This theory was the result of many conflicts between classical theories such as: physical planning, rational planning and systems planning (Klosterman, 1983: 216). The field of planning should be directed more towards the people, voters and citizens (Sharifian Thani, 1997: 55-42). Participatory planning can be effective in understanding the functional aspects of the city and recommending appropriate action to organize the urban situation. . From the point of view of realistic planning, it is more appropriate to do such planning at the level of the neighborhood unit. (Mazini, 1378: 1914).

2-1- Utilization of technology to facilitate urban participation

Due to the increasing facilities and facilities provided by the advancement of technology as well as new urban theories such as smart city in which traces of the use of new applications and technologies can be seen, new facilities and equipment can be used to increase urban participation. , Such as mobile applications, Google services, virtual reality tools, etc., As mentioned earlier, virtual reality glasses can have a huge impact on urban participation, in simple terms, they allow citizens to see and comment on the designed future of their city. Or if they wants to change it to their liking, it will increase participation, interest and attractiveness for citizens, as well as a sense of belonging to citizens, because in a way, part of the design and planning of the city has been left to them. (Schubler, 1996: 25).



Figure (1) street view service from Google



Figure (2) Google scanners

2-2- How to use virtual reality tools to facilitate citizen participation

The type of use of virtual reality tools in facilitating participation can be very wide and diverse. First, the types of uses of this tool in facilitating participation are introduced and then the research strategy in using this tool is introduced. Virtual reality tools include augmented reality and virtual reality, augmented reality and holograms as well as 360 and 3D photos and videos. In this research, the main focus is on the virtual reality itself, the difference between virtual reality, augmented reality and The mixed reality is described in following sections (WhitticK, 1979: 850).

2-3- Use of augmented reality to facilitate urban participation

Using this type of technology, new dimensions can be added to urban participation and make it a much more exciting and attractive process. For example, you can define a code for any idea or change that is going to happen and stick it on the wall where it is visible to everyone, then citizens can scan that code with their phone, They can see all the changes in the design through thier phone's camera and even express their opinion, for example, by moving the furniture in the designed plan on their phone screen or leaving a comment, through which the planner or designer can view the results and make necessary changes (Falksm, 2000: 35).



Figure (3) use of augmented reality in urban plans

This is actually the tool used in this experiment. by using virtual reality, citizens can be completely in the designed environment and also interact with it to a large extent, for this purpose, kiosks can be prepared and then the designed environment model is fully prepared, then the user enters the environment by placing the glasses and can apply his comments in it to the extent that the planner let him do changes. In addition, the other two cases, namely mixed reality and 360-degree photos and videos, have not been defined and retold separately because they are very different from the subject under discussion. (Howard and Gaborit, 2016: 2).



Figure (4) use of virtual reality in facilitating urban participation

In the discussion of facilitating public participation using virtual reality tools, the most important studies and researches in this regard have been presented separately from national and international experiences:

2-4- Research background in the field of virtual reality

One of the most important sources that has dealt with the science of virtual reality and has provided a citable reference in this field is the valuable book "Understanding Virtual Reality, Principles, Application and Design" by Arsherman and Craig (2003). This book, while fully introducing virtual reality, discusses the main systems that enable users to interact with the virtual world. In this regard, new tools that can be used in virtual reality have been introduced and the possibilities, capabilities and limitations of each have been discussed. This book also classifies the key components of experiencing a virtual environment into the four general categories of creating a virtual world, immersion (physical and mental), sensory feedback, and interaction, and introduces and examines these elements (R Sherman and B Craig, 2003,14).

Also among the researches related to the scientific use of virtual reality in the field of urban affairs, the article of Betty et al. (1998) entitled "Modeling of virtual urban environments" should be mentioned. In this article, he classifies the key activities of virtual reality in three general formats of display, modeling and communication. He also sees the real power of interaction in cyberspace as the result of a wide range of actions that can be taken by users, and addresses four key types of operators: motion operators, decision operators, analytical operators, and applying Changes operators (Batty et al., 1998: 10). Other important sources related to virtual reality include Al-Kadmani (2002) entitled "Tools and methods of visualization in urban planning, from freehand sketches to virtual reality." In this article, he argues that conventional visualization tools in urban planning can range from very simple to very complex: including 3D digital modeling, urban simulation, and virtual reality as It mentions the upgraded version of simple volume mackets. He also believes that two types of communication media, namely super media (hybrid media) and the Internet, have taken all the recent advanced tools (including virtual reality) with a new look and presented them at a higher level. In this way, they have been able to create a variety of unique tools (Al - Kodmany, 2002: 190).

Also other people and experts such as Thomson et al. (2006) Al-Arabi (2002) and J. Park et al. (2008) in their research, while discussing the practical use of virtual reality technique in urban studies and urban design research, to analyze the advantages, possibilities and potentials and disadvantages of this technique in These areas have been addressed. Using the findings of the above studies, in the present study, it is possible to benefit from the maximum potentials of this technique as much as possible to avoid the research results from the harms caused by the disadvantages and weaknesses of this approach.

2- Research methodology

۳-۱- Data collection methods

Due to the subject and limitations of this research in order to collect data and information needed to conclude and answer research questions and due to the nature of these questions, which are generally qualitative, for this purpose, tests and questions have been prepared that are generally answering the research questions and will be evaluated qualitatively. In general, according to the evaluation and trying to identify and prepare a process for using virtual reality tools in urban participation, after collecting and asking the tested people, research questions will be answered and the desired process will be prepared.

3-2- research tools

In general, the tools used in this research are divided into two categories of hardware and software tools. In general, hardware includes computer systems, laptops and glasses used in this research and The software also includes game-engine softwares, modeling and rendering softwares, each of which is discussed in detail below.

3-3- Hardware used in research

These hardware can generally be divided into two groups: computer hardware, which are components and graphics systems, etc., and the second group includes virtual reality glasses.

3-4- Virtual reality glasses

Due to the great variety of these glasses and also the limitations of the Iranian market, OSVR, one of the best virtual reality glasses, was used in this study.

3-4-1- OSVR Virtual Reality Headset

OSVR headset is currently one of the cheapest headsets among the mentioned titles, this lens has all the features of advanced headsets and the only difference can be considered in the controller of this headset, which is a game controller and the user can use to move and interacting with the environment. Currently, due to the availability of this headset in the virtual reality laboratory and the lack of other options, this headset has been selected for the research and will be used (EnniS, 1997: 155).



Figure (5) Virtual reality glasses

3-4-2- Computer hardware used

One of the most important parts of the graphics card is the graphics card, which has a great impact on the smooth processing and display of cyberspace to the user, so the existence of a powerful computer system for this process is essential for this purpose. Used to be able to meet research requirements. In general, as mentioned, one of the most important components in the computer system is its graphics, which in this type of research that requires the use of virtual glasses, graphics with a system of more than 4 GB of memory and GDDR5. (Falksm, 2000: 45).

3-4-3- Virtual reality softwares

The software used in this section is generally divided into two categories: modeling software and model rendering or model preparation software, which softwares selected for this research will be reviewed in the following.

3-4-4-2- D image editor and materials creation

Photoshop software, developed by Adobe, is commonly used to edit images. Everyone who deals with computer graphics needs this software in some way. Photoshop today is the most popular software among users that supports layers, filters, text, 3D objects, movies, and more.

3-4-5 - 3D modeling

Modeling means producing a three-dimensional model of objects. A three-dimensional model is actually a mathematical representation of an object. Modeling can be compared to sculpture. Like a sculptor, a three-dimensional modeler must consider all the components, compositions, and angles of the object. 3D models are smaller components and elements (vertices, edges, procedures, and polygons) that can be modified and used in a variety of ways. The most popular 3D modeling softwares are AutoCAD, Sketch up, 3Ds Max Maya Blender, Zbrush and cityengine. It should be noted that all these softwares have almost the same capabilities and can be used in this research, although due to the nature of this research that requires urban modeling, to achieve this, sketchup software And cityengin have been used in combination with each other (Falksm, 2000: 47).

3-5- Technique used in research

In this research, according to its objectives, modeling and testing techniques have been used. In general, these modeling and tests include a schematic model prepared from the area of Ferdowsi neighborhood in which people are tested And interact in that environment. In a way, a hypothetical project can be included in the model so that people can comment on it and even change it if they wish. It should be noted that It was not possible for the tested subjects in the virtual environment to change the designed features because this requires HTC Vive glasses which have a controller, and at present, the tested subjects can only move inside the environment and view the designed project from different perspectives and finally, comment and even answer the desired changes in the questions asked after the test.

4- study area

In this section, Ferdowsi neighborhood is introduced and recognized in terms of managerial and social aspects. other aspects that were not needed for research are not mentioned.

4-1- Introducing and determining the boundaries of the study area

A neighborhood that today is known as the National Garden and sometimes called Ferdowsi is located in District 12, which is limited to Enghelab Street from the north, Imam Khomeini Street from the south, Saadi Street from the east and Vahdat-e-Islami Street from the west. This neighborhood is considered one of the old neighborhoods of Tehran and has been part of the Dolat neighborhood.

This area has the most famous embassy buildings and cafes, which may be due to the history of formation of Lalehzar Street. at a time when Nasser al-Din Shah was dreaming of building another Champs Elysees (after his first trip to Paris) in Iran. Also, the neighborhood has two main axes called Ferdowsi and Lalehzar, the first of which is the exchange bourse and the second is the electrical appliances exchange.

These two axes are very crowded and the dominant use in the edge of these two axes is commercial and administrative, whose level of performance is more in the macro area and beyond the region and neighborhood. The dorsal parcels of these two axes are a mixture of residential-commercial and workshop, and the further we get from the main axis and the closer we get to the inner tissue, the

greater the residential dominance. Most of the activists in these areas (people who work in this area) live outside of District 12. Hence, they refer to these two axes daily. The passages in this area have a good geometric design, but their capacity does not meet the volume of vehicles passing through this area.

These two axes are very busy and the dominant use is the edge of these two commercial and administrative axes, whose level of performance is more in the macro area and beyond the region and neighborhood. The dorsal parcels of these two axes are a mixture of residential-commercial and workshop, and the farther we get from the main axis and the closer we get to the inner tissue, the greater the residential dominance. Most of the activists in these areas (people who work in this area) live outside of District 12. Hence, they refer to these two axes daily. The passages of this area have a good geometric design, but their capacity does not meet the volume of vehicles passing through this area.

It should be noted that this area is not like Tehran Bazaar, which deals entirely with economic issues in any type and manner, nor like Baharestan, which is an office environment, nor like the north of Shemiran Gate, which has a residential texture. Rather, mixed areas are mentioned, each of which attracts its own population that has different and sometimes conflicting needs, expectations, and lifestyles. This (existence of different social and cultural strata) also leads to the fact that it prevents the homogeneity of life and the formation of certain ghettos. Evidence of this is that in this area, we see more women commuting than just doing big business. Another important point about this area is the difference between day and night residents. This means that due to the administrative and commercial position of District 12 in Tehran, this area also receives many employees and workers from other parts of the city and even people from the surrounding cities who leave the area when workshops and shops are closed. Another important point is that there is activity in this area during most of the day and night. It can be boldly claimed that this range has 18 hours of effective activity (from 6 am to 12 pm). It is worth mentioning that the existence of different people from different social strata on a daily basis who interact with each other causes very different social interactions.

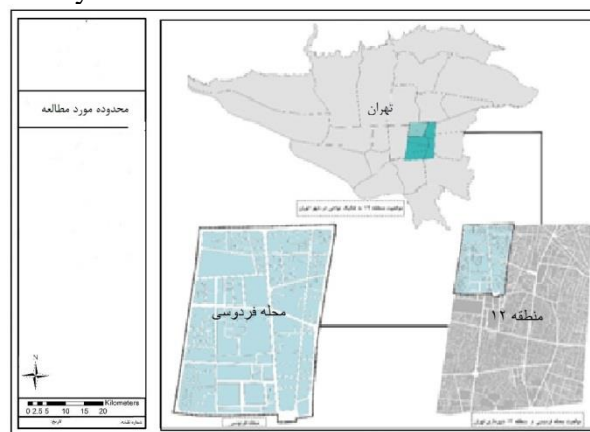


Figure (6) Geographical area of Ferdowsi neighborhood

5- Analysis of data, tests and research findings

Due to the limitations of this study, the experiments performed mostly to examine the experiences and problems faced by the participant in the experiment and to provide an answer or solution for them, as a result, in addition In the following questions, the main focus is more on understanding the experience of the person and the obstacles and opinions about the experiment. In other words, the researcher has tried to observe the tested subjects and interview them to be able to reach the test results, so the questions are completely qualitative and are more interviews. The questions are as follows:

- Express your opinion about the project implemented on Jomhuri Eslami Street.
- Express your experience of being in a virtual environment of Jomhuri Eslami Street project and enumerate its positive and negative points.
- In your opinion, what changes can be made and what can be done to promote urban participation using the virtual reality tool?

It should be noted that these questions are general and may be related to the different experiences of the person being tested. The purpose of these experiments is to understand the experience of the participants and to find the problems in implementing the research idea.

5-1- first test

After the initial explanation, the first person entered the virtual environment in order to get acquainted with the environment and use virtual reality glasses, and spent about 20 minutes in this environment. The results of this experiment are as follows:

- One of the most important results of the first test is to create a feeling of dizziness and headache in the person being tested, which is usually due to spending a lot of time in the virtual environment, ie 20 minutes. Be used. Another result of this experiment is that despite the attractiveness of the virtual environment for the test subject, this person has difficulty communicating with and moving in the environment in the first few minutes, and this shows that To what extent are people unfamiliar with being in cyberspace environments to participate in urban projects and therefore not be able to move or interact as they should and perhaps do.

- Also, another point that the person mentioned after the test is the lack of facilities to interact with the environment. As mentioned before, the possibility of interacting with the environment increases the sense of immersion and thus a better understanding of the environment by the person being tested.

- Another case that the test subject mentioned is the possibility of different movements on foot, such as normal people and even flying in a virtual environment, which allows the person to examine the desired plan or problem from different aspects and as a result Understand it better.

- One of the other cases mentioned by the test subject is the comfort of the test environment in terms of performing the test in a closed space or suitable weather. Virtual is for the participation of individuals. Because due to the use of virtual reality glasses that may cause fatigue and perspiration, appropriate and

comfortable air is one of the key points to attract people to this type of participation.



Figure (7) The person being tested

5-2- Seceond test

The second person entered the virtual environment after initial explanations in order to get acquainted with the environment and use virtual reality glasses, and spent about 15 minutes in this environment. Results:

- One of the problems that the second person also encountered was the inconvenience in establishing communication and also moving in the virtual environment, although this was partially solved after a few minutes in this environment, but due to the repetition of this problem, it can be understood that People are generally not very familiar with virtual environments and their glasses, which is one of the weaknesses and shortcomings that, if not addressed, can be one of the main obstacles to achieving public participation using virtual reality tools.

- From other points of view, the person being tested is the visual appeal and beauty of the virtual environment, which itself causes the person to move along the street and around the design, which is one of the positive points of this test. It should also be noted that this person also felt dizzy and had a headache after the test, which resolved after a few minutes.

- Another case that the test subject mentioned is the impossibility of interaction and change of elements located in the virtual environment, which is also mentioned for the second time, so it can be understood that the interaction of the person in the virtual environment is one of the key points to achieve Participation is public and must be responded to in different ways. Also, the test subject in this regard referred to changing the material of the paving area or changing the location or type of furniture, which again was not possible due to the limitations of this project and the lack of necessary facilities and reduced the person's interaction with the environment.



Figure (8) The person being tested

5-3- third test

The third person, after the initial explanation, entered the virtual environment in order to get acquainted with the environment and use real virtual glasses, and spent about 10 minutes in this environment. The results of this experiment are as follows:

- The third person, according to the background and familiarity with the virtual environment, already has a lot of trouble communicating or walking in this environment and moves freely in the environment.
- Another topic proposed by this plan was the unwanted nature of the virtual environment and as a result the change in the sense of immersion within this environment.
- Another case has been mentioned, the lack of modeling of the surrounding environment of the design is completely created, which has caused the person to come to the environment to some extent from the created design, it is necessary to mention that the surrounding environment is the person. They tested the back environments of Jomhuri Eslami Street and outside this street.
- In another case, it was mentioned that the possibility of repairing the environment and changing or personalizing the desired design has been tested by the user or the person, which has been repeated several times by the tested people.
- One of the interesting points of this test was the lack of headache or dizziness in the person after the test, which could be the main reason for having previous experience in using virtual reality tools.
- Another very important point that the person mentioned after the test was the implementation of this experiment in the design environment, on Jomhuri Eslami Street, which in fact has made it possible for the person to use the virtual environment in which he is present and has a theory. To use. And have a better partnership with project planners.

6- summary and Conclusion

Examining the results of the tests, it can be said that many of the questions in this study have been well answered and the test results relatively meet the needs of the research, although if the number of tests increases, the test results are more valid and accurate. However, due to the limitations of this research, this number of experiments has been sufficient. It seems that by providing a diverse and reliable environment for users, we can increase their desire to participate in the polls. The simulated area was close to reality, but according to users, they

had difficulty interacting with the environment completely. It seems that this factor is due to the lack of components such as immersion in the modeled environment, the appropriateness of the test environment and proper explanations about how to use the device and virtual reality glasses before entering the virtual environment are important points of these tests, which, due to the unfamiliarity of users with cyberspace, if they try this space a few more times, these problems will be solved. This research is in fact a basis for other research on the use of virtual reality in urban management. It seems that by using a combination of two tools, virtual reality and augmented reality, it is possible to achieve very good results in solving urban problems. Also, this platform that has been prepared can be considered for the use of city managers so that they can see the plans once before implementation and realize their strengths and weaknesses.

7-References

- 1- Aghazadeh, Ahmad, (1931), Principles and rules governing the process of citizenship education and the study of developments and characteristics of such training in Japan, Quarterly Journal of Educational Innovation, Fifth Year, No. 17
- 2- Imam Jomeh, Farhad and Ashtari, Kiana, (1933), "Sociological explanation of the status of civil rights in the executive organizations of Arak urban society", Social Research Quarterly, Year 6, No. 19
- Ismailzadeh, Hassan, (1931), "Good governance and adherence to human rights with the grounds for realization.
- 4- Abdolmutallab, Abdullah, (2013), "Citizenship Participation, Tehran, Shahr Publishing Institute
- 5- Fathi, Soroush and Mokhtarpour, Mehdi (1931), "Urban Development, Urbanization and Citizenship Rights", Iranian Journal of Social Development Studies, Third Year, No. 4, pp. 105-89.
6. Ghaedi, Yahya, (2012), "Educating the Future Citizen", Quarterly Journal of Educational Innovations, Fifth Year, No. 11.
- 7-Roupé, M ,2013, Development and Implementations of Virtual Reality for Decision-making in Urban Planning and Building Design, 10-100.
- 8-Stauskis, G. 2014, Development of methods and practices of virtual reality as a tool for participatory urban planning: a case study of Vilnius City as an example for improving environmental, social and energy sustainability Stauskis, 1-13.
- 9-Omar El, H. 2011, Public Participation in Urban Development Process through Information and Communication Technologies, 1-28.
- 10-Jiang, L, 2016, Developing an online Virtual Reality application for e-participation in urban sound planning, 1-11.
- 11-Howard, 2016, Using Virtual Environment Technology to Improve Public Participation in the Urban Planning Process, 1-28.
- 12-Hanzl, M, 2007, Information technology as a tool for public participation in urban planning: a review of experiments and potentials, 1-19.

13-Münster, S, 2017, How to involve inhabitants in urban design planning by using digital tools? An overview on a state of the art, key challenges and promising approaches, 1-15.

14-Changfeng, Implementation of Web-based Virtual Reality Technology in Public Participation, 1-9.

15-Berger, M, 2014, Augmented Reality at the Service of Participatory Urban Planning and Community Informatics – a case study from Vienna, 1-25.