



Investigating the Role of Building Information Modeling with the Virtual Reality Technology in Design of Sustainable Construction

Masood Jamali

EasyChair preprints are intended for rapid dissemination of research results and are integrated with the rest of EasyChair.

April 12, 2022

Investigating the role of Building information modeling with the Virtual reality technology in Design of sustainable Construction

Masood Jamali

Master of Civil Engineering (Construction Technology and Management). (E-Mail: Masood_jamali14@yahoo.com)

Abstract. The construction industry has one of the most negative and destructive effects on the environment. That is why Building Information Modeling has been created for the construction industry to seek and solve this issue and construction problems. Technology in the construction industry is one of the solutions to this crisis. Technologies that in all stages Construction Supervisor of the work of the designer, structural engineer, calculator, project manager to optimize the project in all stages is made. Advanced structural information modelling technology is one of these new technologies that can accurately perform the initial design of the structure by modelling all the information on the structure several times. Match the flow of changes in documents and documentation during the implementation of the structural project. This research work shows the importance of using Building Information Modeling and sustainable construction to reduce the negative and destructive effects on the environment, considering Building Information Modeling as well as essential reality and improved reality technology. Due to its emergence as well as virtual reality in Iran, recognition of its capabilities and applications in the context of the criterion that has been discussed and examined is satisfactory.

Keywords: Sustainable Structures, Structural Information Modeling, Virtual Reality, Augmented Reality and Environments.

1. Introduction

Today, the continuous increase in the population and the problem of energy shortage in society have led to wasteful consumption of energy. Fossilization and sustainable development (Sliamani, 1387) Green standards or sustainable standards, Ihram is formed by nature and instead of being hostile to nature, it controls its energies and, in 1 as one, Structures are used (Kargar, 1394.) Structuring of building information, a tool in the construction industry with a computer display of the physical features and characteristics of the structure, Shares a repository of knowledge to make decisions at appropriate times. The goal of technology is augmented reality, which emerged in the 1960s with the creation of a three-dimensional image that can be created at any moment. Provides simultaneous interaction for the user, enriching the real world (Squark, 2014). It can be pointed out that in designing the model of building information about intelligent management, which leads to a reduction in time and wastage of materials in the construction industry, there can be 2 that in Fossil fuels have a great impact on fossil fuels, and in terms of virtual augmented reality The standard is also called a virtual replica, due to the removal of the replica, which is made of cardboard and wood. It can help conserve biological resources. It can also be influenced by the modelling of structural information. Or the intelligent management and its presentation with virtual augmented reality also pointed to the attraction of each employer. Examining library documents and initial studies can reveal the importance of the issue of environmental protection and a sustainable criterion with attitudes in line with the environment and ihram to nature can play an effective role in protecting the environment. Among these are structured information modelling, virtual reality, and reality. In addition, given the benefits they have,

they can be effective in this regard. The use of these components together can have a significant impact on the process of preserving the environment as well as reducing the damage caused by the construction industry should be based on the environment. The purpose of this study is to investigate the benefits of information modelling. The structure is designed to reduce environmental damage.

2. Research background

1. Table 1 (Research Background) examines several articles by keywords. The results from rows 2 and 4 show: When modelling structural information takes place, As a result of creating more and more harmony between engineers, designers and engineers of structures, facilities and mechanics. The use of meters and BIM estimation eliminates manual errors as well as the use of the program. Scheduling in a project where all of these events take place in a BIM suite and if with other benefits Lets point out BIM can be used as an energy analysis, which helps us level. Consumption reduces the energy of the structure and the use of fossil fuels, which in turn reduces this. Greenhouse gases (methane, carbon dioxide, etc.) can be used to cause less damage to the environment. Row 1-6 shows: in virtual reality and augmented reality as a way to present the work has been transformed into criteria that allow it to be analyzed and evaluated before the project is implemented. It has been decided that the same thing has led to the elimination of the problem and the solution of this problem can be solved before the implementation. Many things, such as reducing waste, help materials, and as a result, reduce waste. Materials can reduce the level of environmental damage in the production of structural materials. Row 3 also indicates the great importance of the environment that the construction industry with the advent of modernism has had a great impact on the environment. Sustainable standards in structures and landscape standards can be maintained in areas such as energy conservation and protection from the world's natural resources, protection from air pollution, protection from the ozone layer, physical and mental health and the future of Barshit will help communities (Rahaii et al., 2013).

Table 1: Research background, authors.

#	Research Name	Author	Conclusion
1	virtual reality: Opportunities and Challenges in Construction.	Hasanzada, almira, 2018.	In this research virtual reality and space, The other is considered as one of the components that appear Digital technologies came into play and They created new concepts and somehow Except for culture-building technologies in Construction Were introduced, and virtual reality technology They have many capabilities to know the purpose Use the category to select this article Virtual reality relative to its engagement with Users.
2	Modeling Building information (BIM) Green.	Badar shah, rawanshah Mahdi, 2019.	Benefits of using BIM in project marketing Project, how to return the formality of green supplies, Use of cutting fabrication systems and how Development of green construction in the country.
3	the environment And sustainable measures in design Buildings the future.	Rahayee Omaid, Qayeem muqami farhad, 2021.	For the trader to be in line with the goals of Sustainable development of slow orientations and structures Has the least pollution for the environment It is necessary to observe two principles in it Be: First, flexible and capable transactions Comply with environmental conditions and the needs of residents and Secondly, the materials used in it must be native and Can be returned to the environment.

4	introduction to Application of modeling Information Build (BIM) In management Construction projects.	Satooda Bidkhi, Amir Husain. 2019.	BIM as a practical tool for management The project will be progressing and developing Analyses such as sustainability seem to Structures, green construction and sustainable development, etc. Other extensible aspects of this technology.
5	Landscape trading, Sustainable trading, Nature and Construction Green.	Kargar, Ali. 2021	Utilizing sustainable transactions in buildings and Landscape trading can take place in the following areas: Energy conservation, conservation and protection of resources Natural world resources, immunity from air pollution, protection of Ozone, physical and mental health and the future Help communities.
6	Capability check Perception of the environment in Reality system Virtual based Components of perception.	Kamali Tabriz, Sina. 2019.	Virtual reality in general on emotional levels, Interpretation and valuation are reliable and only At the cognitive level, it can give true perception Optimal simulation. Reality technology Virtual can research in education discussions And purposefully design transactions.
7	BIM-based environmental assessment in the building design process.	Farshid Shadram and Marcus Sandberg. 2021.	They say that climate-changing is a big problem in the world. The construction industry is one of the biggest users of natural resources and the construction industry spends so much natural energy, it is the reason that the environment gets so much effect by the construction industry. In this research work, the researcher tries to find more beneficial BIM for the construction industry to find the advantages of BIM for the environment and worked for future developments.
9	BIM for sustainability Analyses.	Salman Azhar and Justin Brown. 2020.	They say that Construction uses 40% of total energy in the USA and 30% of energy is used by the greenhouses and gas stations, this is the reason that the demand for natural energy is very high in the United States of America. BIM can make a very good decision for the future development for the sustainable development of the United States of America. Building information modelling can perform the 3D models which can easily help the construction industry to create a very high demand for natural energy users in the state.

10	BIM for environmental impact assessment in early design phases.	Marie-France stendah and Marie-Claude Dobios. 2022.	The researchers say that the construction area or the construction field is the biggest user of natural energy in the world. Building information modelling can provide the relationship between engineering design and engineers, so they can easily incorporate the future demand of energy in the nation and the world. They say that the easiest way to create a very safe environment is building information modelling to create sustainable development for sustainable construction and save energy.
----	---	---	--

3. Research Methodology

The research method of this research was descriptive-analytical and also this article is based on two sections. Part I Documentary study, library, keyword analysis and description, including environment, criteria Sustainable, virtual reality and augmented reality is the basis on which this type of research allows researchers Gives good communication and interaction with the subject. In the second part, the results of library studies and articles are stated in the findings section.

1.3. Basics of Theoretical

1.1.3. Sustainable Construction

A stable standard dates back to the 19th century. Pioneers John Ruskin, William Morris, and Richard Latabi are considered stable standard movements. Ruskin in his book "Seven Standard Torches" says that To achieve growth and prosperity, one can establish the harmonious order found in nature. Goal From the design of sustainable structures to reduce its damage to the environment in terms of energy and utilization of resources it is natural that it includes the following rules: A) A steady decline in non-renewable resources

B) Development of natural environment

C) Elimination or reduction of toxic substances or harmful to nature in the construction industry) 2015.

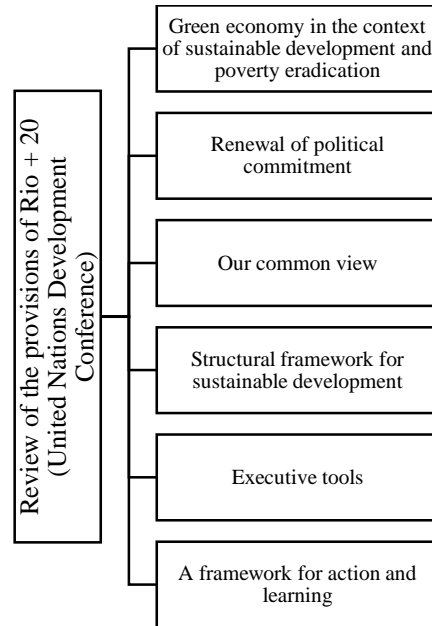


Fig 1: Review of the provisions of the Rio +20 United Nations Conference on Sustainable Development, Amin Mansour, 2012.

2.1.3. Sustainable Construction patterns

Since constructive buildings today create a large part of the environmental pollution, this is unstoppable, a sustainable measure can be an idea with thinking, design and planning precisely in line with the lowest impact on the environment, which has three main pillars. Therefore, sustainable criteria for creating a healthy environment based on resource efficiency, protection from non-renewable resources, Reduction of renewable energy consumption and improvement of quality of life in line with meeting daily and health needs Humans will help (Zandieh and Parvinejad, 2010). The overall goal of sustainable design is to reduce the adverse effect of the structure on the environment through proper productivity. It is from energy and natural resources. A sustainable design while pursuing aesthetic values, It is environmental, social, economic, moral and spiritual (Zandieh and Parvinejad, 2010). The sustainable design aims to meet the needs of today without harming the resources of future generations, with key points in this design have low energy, high flexibility and high efficiency in the use of resources. (Richard Rajirz). The main point is the choice of materials and type of performance of a structure under construction and the structures should be up to 80% and more be self-sufficient in providing the energy they need. (Yan Kapliki). Sustainable design means maximum efficiency with minimal tools in ecology (more is less). (Norman Faster). Sustainability can be considered as one of the key aspects of our profession because 50% of energy in Europe in The construction part is completed. (Toomass Hartzig). Sustainable design can be defined as ecological design. Sustainable design can be defined as a kind of design. Which are in perfect harmony with the Earth's ecosystem during their cycle of life. (Kan Yang).

4. Building information modeling system

Before the 1980s, standard drawing and construction were generally done by hand and on paper. A skin was forming. From 1980 to the late 1990s with technological developments and the advent of computers, A major shift from the old ways of drawing to computer-aided design took place. Complication of drawing; Involvement of more people in the project and system-related challenges. Different constructs, the need for more complete and integrated programs and software, this flow to the system Modeling of structural information and newer areas of managing the life cycle of the structure has advanced (Latifi Oskooi, 2011). Structural information modelling does not only include three-dimensional information, but before projects start, engineers help design simulations through analysis and simulation. And provide optimized imagery and better quality construction documentation. Finally, information modelling Construction by reducing construction costs, compatible with the building environment and environmental friendliness. It helps in the cost.) (Javaherpour et al., 2015.) The possibility of examining different design scenarios virtually for all groups (Darby, 2006). It allows us to complete Observe the stages of construction, which is what causes us to easily understand the stages of construction. You can also use BIM to communicate between structures, standards and facilities, and then assess the interference relationship and eliminate it, which can be removed before the performance. First-year, first issue, summer 2021, 100 time management as well as refinement have an impact on the use of materials. For example: in some, We have witnessed the fact that during the implementation of the sewerage facility and its guidance to the network Municipal sewage has dealt with the structure of the floors and to eliminate its interference, it has started to destroy a part of the structure. They also demolish some of the pre-built walls to do so. This causes the waste of materials as well as a waste of time, as has been said. These interferences can be addressed before implementation.

1.4. Applications of building information modeling system

In object modelling system information modelling according to performance and structural systems definition, they are an intelligent, context-oriented and meaningful model and can be used by using applications: Routine, Archie cad, and Bentley come into play. While the two-dimensional and three-dimensional views of the project and the table its specifications are at the disposal of the designers and with changes in one menu, other features that the software in it allows us to change and update ourselves automatically. View one of the applications Is for modelling structural information by combining standard design, mechanical installations, facilities Electrical, construction and construction documents are used. View other programs for the modelling system Structural information is provided to designers in the design, modelling, presentation and integration of information. They help in a single model) (Latifi Oskooi, 2019).

2.4. Applications of building information modeling in project management

Digital representation of the physical and functional properties of a structure and a source of shared knowledge for information Structure is a reliable basis for decision making that can be used to control conflicts, analyze, and estimate time.

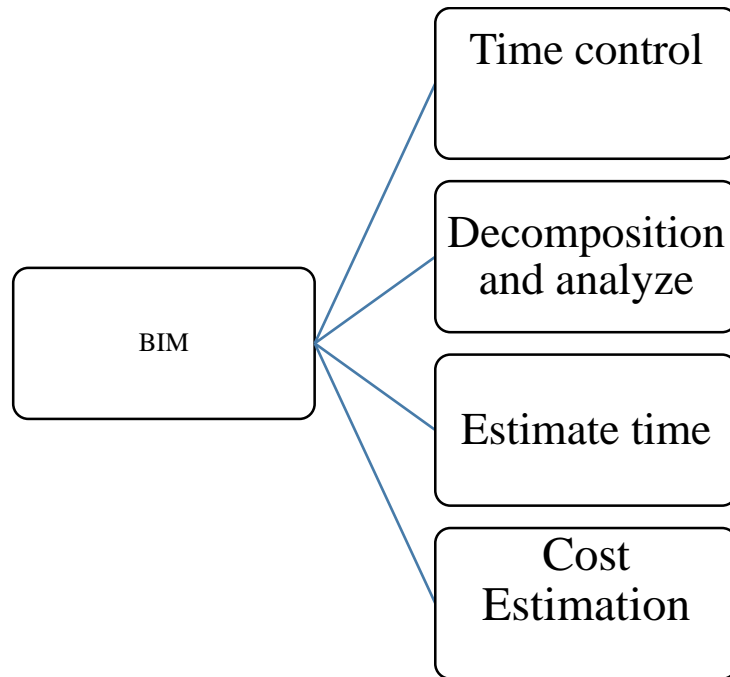


Fig 2: Applications of BIM in Project Management.

A) Interaction control: Controlling interactions by gathering information from different disciplines and examining inconsistencies. Performs geometric designs by modelling structural information, recognizing interferences in modelling information of different disciplines causes the interferences to be corrected at the design stage. (Kurdish), 2008 et al.)

B) Analysis: For the analysis of the energy consumer, help can be obtained from modelling information, if possible. Analyzes and examine a structure during its installation and heating period.) 2008. Al ET Eastman)

C. Time Estimation: After the fourth, it is often called the time in which the information modelling objects are constructed. They are connected at once, which depicts a graphical view of the project schedule. This simulation provides the possibility of predicting and detecting programming errors early. This possibility can also be used to optimize the supply and procurement aspects and as a solution to the problem. Find the most useful solution to be used (2008, Al ET Eastman.)

D) Cost Estimation: The fifth dimension often includes cost estimates that can include three-dimensional design components. Attached to the price list. Price lists can include labour costs and the cost of equipment and more machines and details to estimate cost. This exact cost estimate will make this possible. The project can be evaluated from an economic point of view (2008), Al ET Eastman.

The design of traditional structures was mainly based on two-dimensional plans, including plan and mean and sections. But Structural information modelling provides maps of the spatial dimensions of space (length, width, and depth). With several dimensions including time and cost, which are recognized as the fourth and fifth dimensions, respectively. Have combined; Therefore, modelling structural information in addition to

geometry also covers other issues. Gives, including spatial relations, light, and geographical information (Javaherpour et al., 2015).

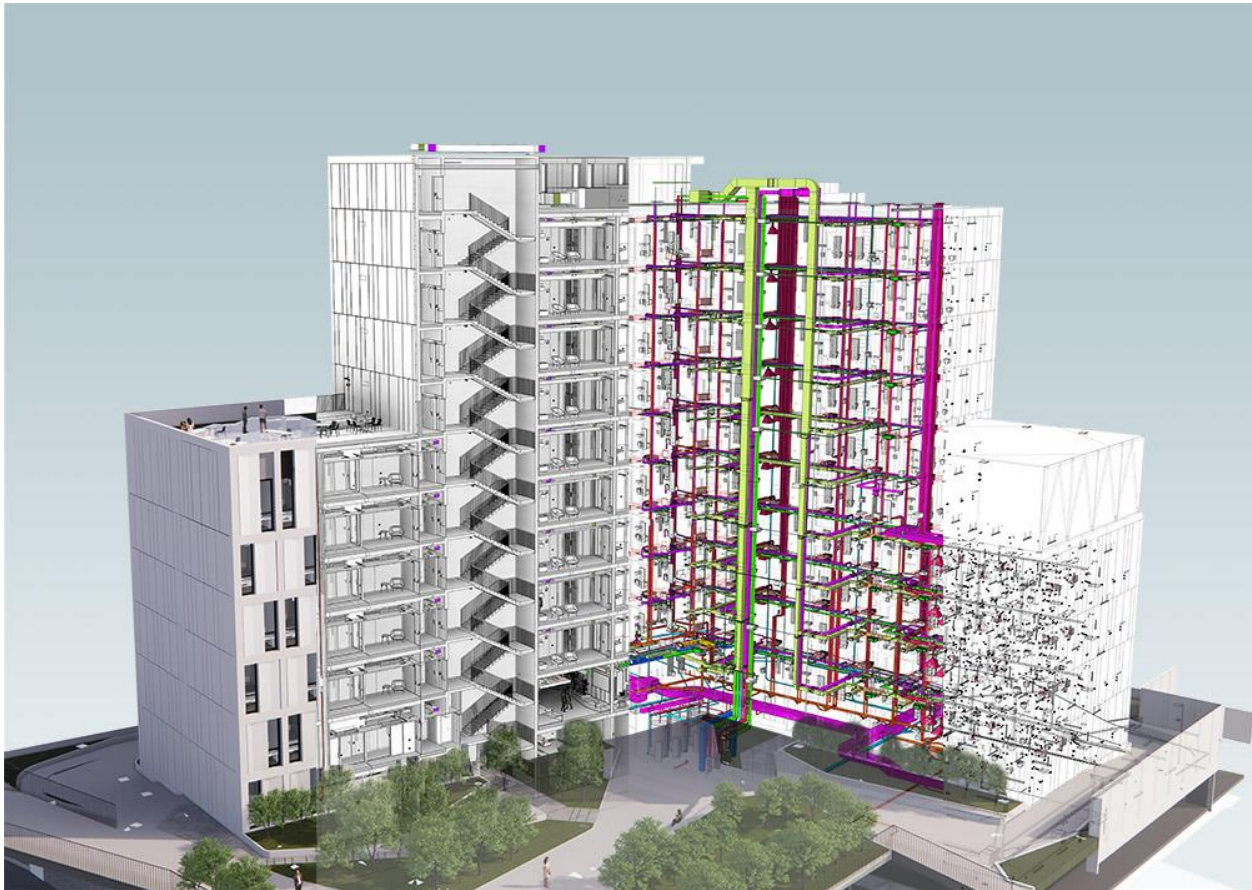


Fig 3. BIM Building Information Modeling.

3.4. Building information modeling capabilities

Building information modelling capabilities can be categorized as follows) URL1 :)

2D model: presentation and work presentation

3D model: Mathematical representation of any 3D surface such as length, width, and height of an object.

4-dimensional model: Adding the fourth dimension means scheduling to the three-dimensional model. In any modelling model, the 4-dimensional structure information communicates between the 3-dimensional elements and the project delivery timeline, and in this way, it provides users with the possibility of virtual simulation of the project in a four-dimensional environment.

5D model: Adding the fifth dimension means cost estimation data to the 3D model.

6-dimensional model: When the project is ready to be delivered to the owners, this model contains the component information.

Related to the structure such as product details and data, methods of maintenance and operation, photographs, and Warranty data are links to product analytics sources, contracts, and construction information. Energy Analysis: Can link structural information modelling to energy analysis tools for evaluating the energy is specified during the design process. Collision Identification: Designs generated by different organizations can be compared Gathered to enable the identification, study and elimination of geometric collisions between architectural and structural systems.

4.4. Virtual reality

The origins of virtual reality go back to the time when 360-degree images began to appear. The root of virtual reality is the use of computer modelling and simulation that enables people to interact with or even interact with a three-dimensional artificial environment through other senses. First-year, first issue, summer 2021, 102 for this reason, this technology is based on the knowledge that is the ultimate development and advancement of information technology in space. Three-dimensional is virtual reality named (Faryabi and Javanmard, 2014). Virtual reality one is a new technology that allows the user to interact with an interactive computer simulation environment. Virtual reality can be a physical presence in one place and in a real-world or virtual world. Simulate. Most virtual reality environments are primarily visual experiences that can either they can be seen through a computer screen or a magnifying glass device. In the virtual environment, there is a time when the user's movements are captured by motion sensors and the setting of the scene on the stage is done in real-time at the same time (Hassanzadeh Vahtaheri, 2016).

5.4. Virtual reality in empathy

Virtual reality on a benchmark makes it possible for designers to be able to work in an environment they have designed to intervene and move, and if necessary, manipulate this three-dimensional environment. This feature can be used by increasing the perception of customers in the sales department and by creating an interactive and dynamic environment that creates the right of choice for students and clients (Golzarian, 2016). Virtual reality is a type of virtual augmented reality that is a 360-degree (panoramic) image. It is created a fact of what is modelled on the computer, and Standard software such as Lumion is created by virtual reality headsets as well. Applications are observable. Virtual reality creates an artificial environment that combines the world the fact and the information generated by the computer is made up, or in other words, can be said to be a computer simulation environment that can make a physical presence in a place and a real world. Or simulate a virtual world by some software, such as A unit is created that in Unity software does this with the help of Palin Voforia. It is more than eighty per cent perceptual, which is why vision has a great effect on perception. Taleo Del et al., 1398.) As it was said in virtual reality, in which reality is what it is found that this type of display and its communication is used by specialized heads. The sense of sight causes an increase in the level of perception and also about the aspect of innovation that leads to the creation of it increases the sense of belonging, it also increases the sense of belonging, as described in Figure 4, the process of perception visually paid.

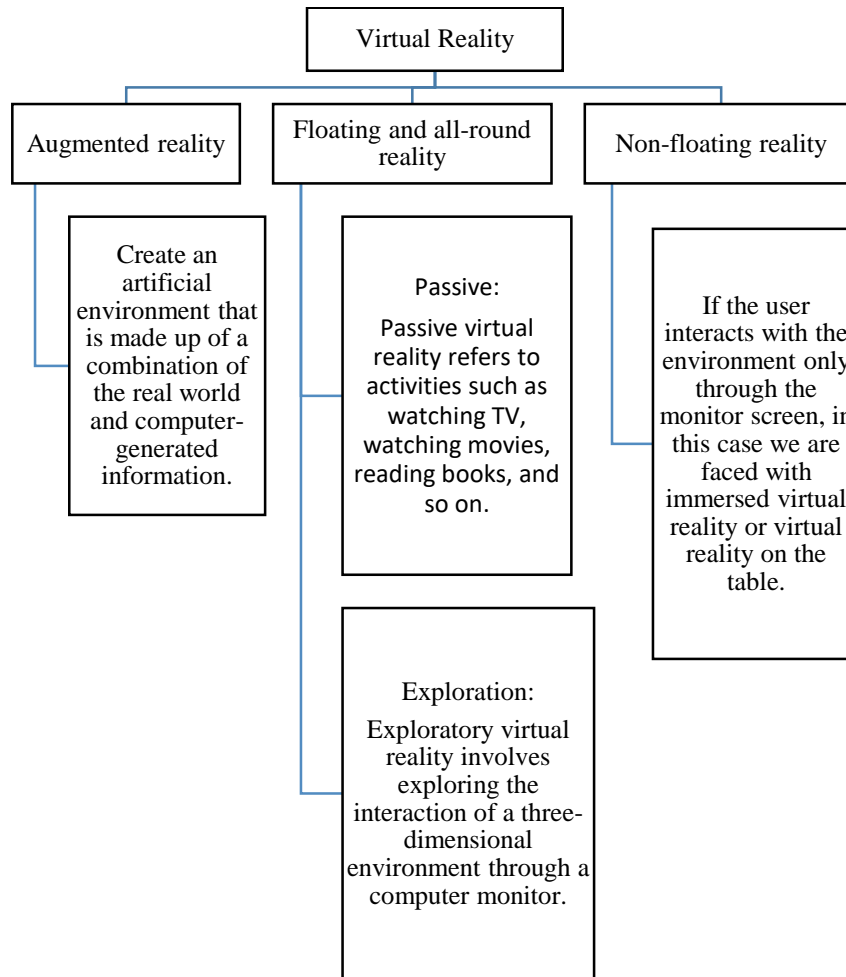


Fig 4. Virtual reality in proportion to the amount of user engagement with the virtual environment.

5. Results

The increasing expansion of cities and the industrialization of lives have many negative consequences, including Air pollution and the environment, depletion of natural resources and an energy crisis. Construction and related industries It is mentioned as one of the polluting factors of the environment, among which a criterion Sustainable pursuit is a way that by increasing efficiency and optimization in terms of materials, energy and space expansion, Reduce the negative effects of structures on the environment. The goal of a sustainable standard of alignment with nature is the environment and not the enemy. In the first part of the research, try to describe the relationship by describing the keywords. And the interaction of all researchers with the subject and in this section about the benefits of information modelling Structure, virtual reality as well as augmented reality to examine some of the factors influencing these components of the environment has been addressed.

1.5. Factors influencing building information modeling on the environment

The development and advancement of technology have a great impact on the quality of all aspects of life. Among them is the modelling of structured information, which can be considered due to its many advantages. It was used for more growth and stability criteria.) That in Iran in terms of understanding each of the challenges And the needs of the industry to take the necessary measures to prepare a document for the development of information modelling technology Construction on the horizon of 1404 countries in the Deputy Minister of Housing and Construction and Office of National Regulations and Construction Control Ministry of Roads and Urban Development in July 1397 this document has been extracted. Modelling of structured information with Three-dimensional imaging of project designs, control of their interactions and presentation of an executive image of the program Scheduling, as well as accurate cost estimation and estimation, can be an effective tool for project managers in to control the project as well as increase productivity, reduce losses and waste of materials.

Table 2: Factors influencing the modeling of construction information on the environment, authors

Sustainable Construction	Light analysis) Optimal use of energy (Solar).	The orientation of the sun and the better and more use of its light by the openings lead to a reduction in the use of artificial light, which reduces energy consumption.
	Rainwater collection and harvesting	Instead of draining rainwater, it can be collected and stored using a suitable collection system. Yard irrigation was used. If necessary, it can be done with the appropriate method of earth drainage also used.
	Prevent material loss	Building information modelling allows us to complete all construction steps before implementation and fix the problems to fix these problems before making the reduction loss of materials is effective.
	Reduce greenhouse gas emissions	The process of producing building materials leads to an increase in greenhouse gases such as methane and the carbon dioxide that structural information modelling can also be analyzed pre-construction leads to the elimination of interference and also reduces the loss of materials this can reduce greenhouse gas emissions.

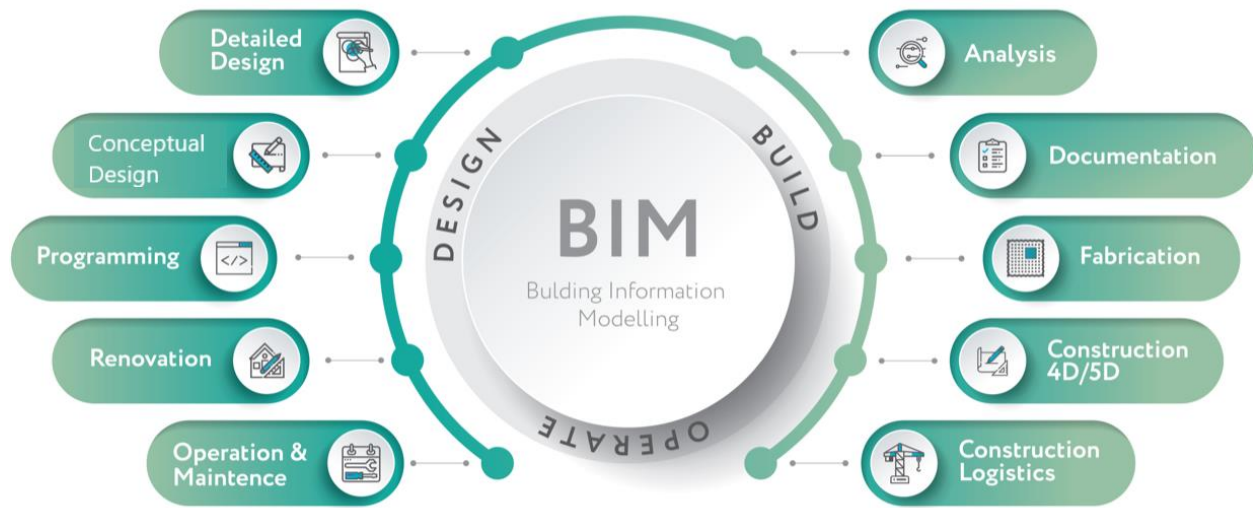


Fig 5. BIM Details.

2.5. Factors affecting virtual reality and augmented reality on the environment

It can also be pointed out that this growth of technology has led to virtual reality. The transformation has become one of the fields of deeper research and study in the field of standard engineering. Products Structural materials cause serious damage to the environment, which is virtual reality as well as reality. Additions, however, allow us to analyze and evaluate a building before it is built. And if there is a problem, it can be solved, in addition to preventing the passage of time. Also, help prevent material waste. Reduce material waste by reducing material production. Structural and thus can reduce the level of environmental damage as well as the reality Virtualization and augmented reality have become the ways of presenting work in a standard that can be absorbed. Help each employer. One of the main components in project delivery is the mock-up these mock-ups are made mostly of cardboard and wood. With the help of reality that some people add to it the virtual mock-up also says that by removing the mock-up, a large number of trees can be cut down the supply of the replicas of this replica (cardboard, paper and wood) was prevented. To understand each employer, they have to take a large number of renders from different angles that take a long time. This was done by using virtual reality or 360-degree panoramic photos. Eliminating these single-frame renderings also reduced project delivery time and energy usage.

6. Conclusion

- Rapid urbanization and energy crises in the world need to provide appropriate solutions to reduce the negative effects of construction more and more satisfactorily.
- In general conclusion, applying a stable criterion in structures and a landscape criterion is the way of achieving an efficient criterion. It can do so in many areas, including energy conservation, conservation and resource conservation.
- Natural protection from environmental and air pollution, protection from ozone depletion, physical and mental health and future Barshit help communities. Unfortunately, today we have witnessed the issue that a stable standard alone has not been able to solve all the environmental crises, but has removed part of it.

- In this research, expressing the benefits of structuring information, virtual reality and augmented reality to their impact on the Reduction of damage caused by the construction industry to the environment has been mentioned.
- They can also He pointed out that the use of these components in structures could lead to further realization. And better achieve the goals of sustainable architecture to preserve natural resources.

References

1. AIA (2017). AIA Contract Documents: Integrated Project Delivery (IPD) Family, www.aiacontracts.org/contract-doc-pages/27166-integrated-project-delivery-ipd-family.
2. AISC (2017). AISC Design Guide, 30 vols. AISC Chicago, IL. www.aisc.org/publications/design-guides/.
3. Akinci, B., Boukamp, F., Gordon, C., Huber, D., Lyons, C., and Park, K. (2006). "A Formalism for Utilization of Sensor Systems and Integrated Project Models for Active Construction Quality Control." *Automation in Construction*, 15(2): 124–138.
4. Akintoye, A., and Fitzgerald, E. (2000). "A Survey of Current Cost Estimating Practices in the UK." *Construction Management & Economics*, 18(2): 161–172.
5. Alberti, L. B. (1988). *On the art of building in ten books*. MIT Press, Cambridge, MA.
6. ANSI/X3/SPARC (1975). "Interim Report: Study Group on Database Management Systems 75-02-08." *FDT: Bulletin of ACM SIGMOD*, 7(2), 1–140.
7. Ashcraft, H. W. J. (2006). "Building Information Modeling: A Great Idea in Conflict with Traditional Concepts of Insurance, Liability, and Professional Responsibility." Schinnerer's 45th Annual Meeting of Invited Attorneys.
8. AIA (2017). AIA Contract Documents: Integrated Project Delivery (IPD) Family, www.aiacontracts.org/contract-doc-pages/27166-integrated-project-delivery-ipd-family.
9. AISC (2017). AISC Design Guide, 30 vols. AISC Chicago, IL. www.aisc.org/publications/design-guides/.
10. Akinci, B., Boukamp, F., Gordon, C., Huber, D., Lyons, C., and Park, K. (2006). "A Formalism for Utilization of Sensor Systems and Integrated Project Models for Active Construction Quality Control." *Automation in Construction*, 15(2): 124–138.
11. Akintoye, A., and Fitzgerald, E. (2000). "A Survey of Current Cost Estimating Practices in the UK." *Construction Management & Economics*, 18(2): 161–172.
12. Alberti, L. B. (1988). *On the art of building in ten books*. MIT Press, Cambridge, MA.
13. ANSI/X3/SPARC (1975). "Interim Report: Study Group on Database Management Systems 75-02-08." *FDT: Bulletin of ACM SIGMOD*, 7(2), 1–140.
13. Ashcraft, H. W. J. (2006). "Building Information Modeling: A Great Idea in Conflict with Traditional Concepts of Insurance, Liability, and Professional Responsibility." Schinnerer's 45th Annual Meeting of Invited Attorneys.
14. Bernstein, H. M., Jones, S. A., Russo, M. A., Laquidara, D., Messina, F., Partyka, D., Lorenz, A., Buckley, B., Fitch, E., and Gilmore, D. (2010). *Green BIM: How Building Information Modeling is Contributing to Green Design and Construction*. McGraw Hill Construction, Bedford, MA.
15. Bijl, A., and Shawcross, G. (1975). "Housing Site Layout System," *Computer-Aided Design*, 7(1): 2–10.