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Issues and Future of Virtual Reality in Construction Project and Management

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Abstract - *Virtual reality (VR) and, therefore, the development of virtual environments (VEs) will build a significant impact on how construction mission stakeholders can understand and complete their tasks. VR techniques will enhance the performance and effectiveness of all degrees of a project, from preliminary abstract style through precise design, planning, and steerage, to final production touch. The capability to visualize the layout and practice the development of the facility in a very 3-D interactive and immersive encompassing will increase the information of the planning reason, improve the constructability of the venture, and reduce changes and un- successful work, which will be detected prior to the begin of production. Unlimited digital walkthroughs of the ability could also be meted out to allow for experiencing, in a very near- fact feel, what to expect, whereas creation is complete. This thesis affords a commanding read of the latest samples of flourishing adoption of VR technology as applications in the construction industry through a questionnaire survey. The results of the questionnaire show the factors which affect most for the adoption of VR in the construction industry.*

***Key Words*: Virtual Reality (VR), BIM, 3D Modelling, Construction Visualization, Construction Management, Organizational Health and Safety (OHS), COVID-19, Project Monitoring**

1. INTRODUCTION

Basically Virtual-Reality (VR) is a blend of virtual picture processing, GPU, media, sensing, and other statistics generation stream, substantially promoted the improvement of computer technology. Architecture-design approaches the use of current generation gear, which includes virtual fact (VR), which could boom performance and decrease lead instances. To date, VR uses in the creative sector, regularly for angle of visualization of Architectural design for the stockholders.

1.1 Virtual-Reality in Construction Industry:

Virtual-Reality used in the construction sector for lots of programs together with design purpose, visualization. To improve construction approaches, virtual-reality is a right path for constructing layout as it offers 3-d visualization that may be manipulated actual-time and can use to explore unique tiers of the construction activities.

1.2 Need for Study

This study will help us for understanding of VR capabilities, its benefits, its prospects in the construction sector and project management. The prime areas were about Risk, Organizational Health and safety, Safety Trainings, Implementation Cost in construction industry. Additionally, to find out awareness about VR in construction industry with its technical usability and advantages. Also, improvisation in the technology and research regarding the cost-cutting methodology for use and adoption of VR in the construction project. It will specifically helpful for construction industry in this Covid-19 Pandemic.

1.3 Objective

The main objective of this study is to learn how can we use V.R. (3-D), during the planning, Architecture Design, and visualization of a construction project even with complex building projects. Also, it helps us to improvements regarded in the adoption of technology. Further to identify most affecting factors and reasons for adoption of VR in construction industry from small organization to big organization. Also find out top ten factors which will affect the most for use of VR in construction industry.

1.4 Scope of Work

The research can help to understand the use, benefits, problems/limitations of the technology, future of the V.R. in construction, and why construction sector should adopt this technology.

1.5 Literature Review

The literature review has been done by referring to various research papers and by gathering all the important information and findings required from those research papers. Aim of literature review was to identify and shortlist factors affecting to adoption of VR in construction sector, current flows, and to find future scope of VR. There are factors divides into main seven headings. Which was (1) Introduction of VR (2) Future of VR in construction Industry

(3) Obstacles for Mass Adoption of A.R./V.R. (4) Risk (5) Most Applicable Construction Type (6) Heath and Safety Training (7) Finance. Additionally, every section or main headings are consisting of several question and factor, which is useful for collecting information in data collection stage. From literature review, the data was outdated and 100 percent applicable as technology is changing day by day. So, for that updating fresh data is necessary.

2. METHODOLOGY

In this study, a quantitative approach was used to get factual information about the awareness of virtual reality use in the construction industry. The data is collected from the data an online questionnaire survey. The whole process is shown in below figure.

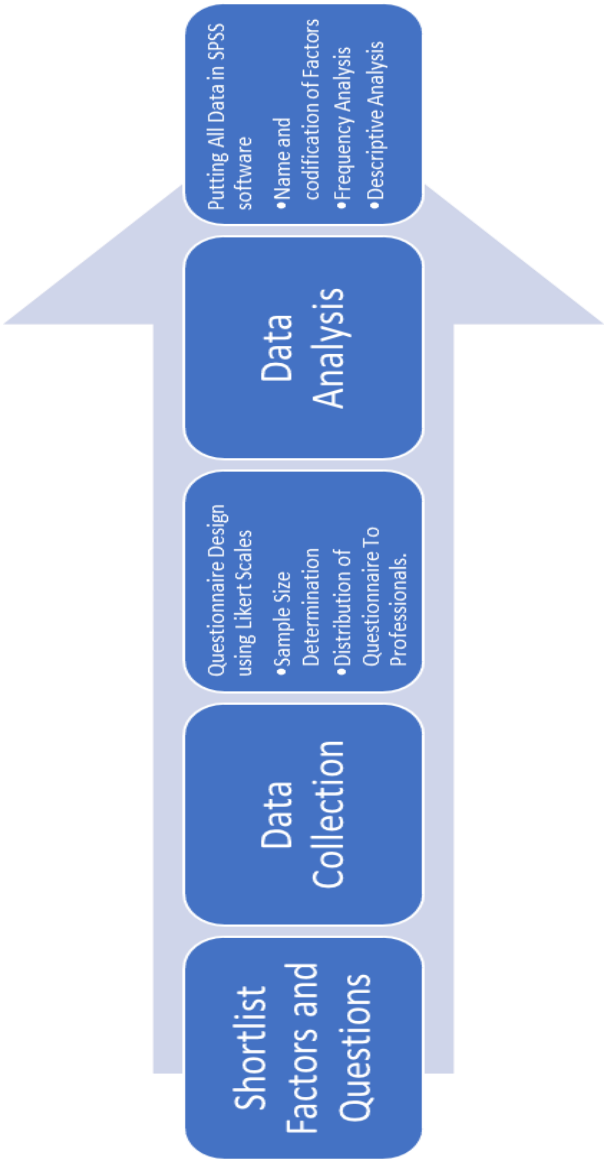

Figure 1: Methodology Process Chart

2.1 Preliminary Data Collection

The preliminary data for questionnaire design was taken by study current available literature review of research articles, paper published in various publication regarding VR in construction industry and understanding current scenario of technology enhancement and practicality in construction industry.

2.2 Determination of Sample Size

The sample size was calculated through described data below.
The Sample Size was taken 92 with Margin of Error Expected: 10%, The Confidence Level Taken: 95%, The Population Size Taken as: 2000 And Response Distribution was taken of 50%.

2.3 Data Collection

As mentioned earlier data collection was done by collecting data from online questionnaire survey using Google Forms. Which was divided into 7 parts from preliminary information to technical questions of various factors. Prime focus of questionnaire was to take response of mainly construction professionals to understand and derive conclusion of the research. Professional Included in the study were in field of Architecture, Engineering, Developer and contractor.

2.4 Data Analysis

After the data collection by the questionnaire survey, the analysis is to be done. In data collection, the opinion of professionals was collected through questions listed out in questionnaire form with help of google forms. Here data analysis is accomplished with the data collected. Collected data is compared with one and all, and the percentage of responses are found out. Data analysis is done to determine the most affecting factors for use of AR/VR in the construction industry. We have used the Graphical method with the SPSS software. Also, frequency is calculated by the software. And the closing answer will come up with maximum responses in each question, are listed in the conclusion.

2.4.1 Statistical Analysis through SPSS Statistics 26 Software

The analysis is done by the SPSS software to analyze the questionnaire responses with frequency analysis with the help of the graphical method. This analysis has determined that all the questions in survey form are given that analysis result from identifying the maximum frequencies for each question response. This will help me to find out the result of my survey. In the end, the conclusion will come for this

research study. Frequencies are identified through the sum of the total responses for each and graphical analysis is done with the SPSS software after putting the data of the responses of the questionnaire.

2.4.2 Reliability Test and Cronbach's Alpha Value Determination

The case processing summary was as shown in table below.

Table 1: Reliability Test

		N	%
Cases	**Valid**	90	100
	Excluded	0	0
	Total	90	100

As Result Cronbach's Alpha was derived as shown in table below.

Table 2: Cronbach's Alpha

Cronbach's Alpha	N of Items
0.835	27

As a result, we have got Cronbach's Alpha as 0.835, which is greater than 0.700. So 0.835>0.700 is acceptable for the analysis

2.4.3 Frequency Analysis and Descriptive Statistics Result

As final result which was derived and calculated as per Likert Scale for various subsection are as described below in the table. The questions and factors are converted into short codes of using initials for ease of data analysis. As result we get minimum and maximum values of Likert Scale, Mead, Standard Deviation and Variance.

(1) Future of VR in Construction Industry:

FOVACI1: By 2025, VR will be as omnipresent as mobile devices in the consumer market.
FOVACI2: AR/VR will be essential for understanding and demonstration of any construction project.

Table 3: FOVCI

	N	Min.	Max.	Mean	Std. Deviation	Variance
FOVCI1	90	1.00	5.00	2.8889	0.90497	0.819
FOVCI2	90	1.00	5.00	3.3444	0.98484	0.970

(2) OBSTACLES FOR MASS ADOPTION OF V.R.:

OMAOV1: User Experience
OMAOV2: Content offerings
OMAOV3: Consumer and business hesitation to embrace AR/VR
OMAOV4: Regulations and Legal risk.
OMAOV5: Financing and investment.
OMAOV6: Cost to consumers
OMAOV7: Government oversight

Table 4: OMAOV

	N	Min.	Max.	Mean	Std. Deviation	Variance
OMAOV1	90	1.00	5.00	3.2222	0.94545	0.894
OMAOV2	90	1.00	5.00	3.0222	0.84770	0.719
OMAOV3	90	1.00	5.00	2.9889	0.89310	0.798
OMAOV4	90	1.00	5.00	2.7889	1.11672	1.247
OMAOV5	90	1.00	5.00	3.5111	1.03038	1.062
OMAOV6	90	1.00	5.00	3.3000	1.05415	1.111
OMAOV7	90	1.00	5.00	2.9333	0.98071	0.962

(3) Risk:

RISK1: Consumer privacy/data security
RISK2: Product liability/health and safety issues
RISK3: Difficulty in licensing technology and IP
RISK4: Potential infringement of the third party–owned IP
RISK5: Conformity with platform requirements in publishing content
RISK6: Export control issues

Table 5: RISK

	N	Min.	Max.	Mean	Std. Deviation	Variance
RISK1	90	1.00	5.00	3.3333	0.91184	0.831
RISK2	90	1.00	5.00	3.1111	1.03255	1.066
RISK3	90	1.00	5.00	3.0111	0.91792	0.843
RISK4	90	1.00	5.00	3.2444	0.91567	0.838
RISK5	90	2.00	5.00	3.1667	0.79676	0.635
RISK6	90	1.00	5.00	3.1667	1.04128	1.084

(4) Most Applicable Construction Type:

MACT1: Residential Project
MACT2: Commercial
MACT3: Industrial
MACT4: Roads and High-Way
MACT5: Bridges

Table 6: MACT

	N	Min.	Max.	Mean	Std. Deviation	Variance
MACT1	90	1.00	7.00	4.8778	1.62029	2.625
MACT2	90	2.00	7.00	5.3889	1.27812	1.634
MACT3	90	1.00	7.00	5.1333	1.45494	2.117
MACT4	90	1.00	7.00	4.2222	1.58488	2.512
MACT5	90	1.00	7.00	4.7556	1.58866	2.524

(5) Health and Safety Training:

HSTS1: Provide a safe site-specific environment, reflecting different real-world conditions, thereby helping users learn necessary skills.
HSTS2: Apps and 3D animation help learners gain insights
HSTS3: Cost-effective as compared to standard training
HSTS4: Allow remote participation and learning
HSTS5: Improve employee knowledge retention
HSTS6: Reduced need to refer to paper manuals
HSTS7: Improve employee with highly engaging training sessions.

Table 7: HSTS

	N	Min.	Max.	Mean	Std. Deviation	Variance
HSTS1	90	2.00	7.00	4.8778	1.61334	2.603
HSTS2	90	1.00	7.00	5.3889	1.32134	1.746
HSTS3	90	1.00	7.00	4.5333	1.53022	2.342
HSTS4	90	1.00	7.00	5.1111	1.47217	2.167
HSTS5	90	1.00	7.00	5.3889	1.27812	1.634
HSTS6	90	1.00	7.00	4.9778	1.48383	2.202
HSTS7	90	1.00	7.00	5.2444	1.39269	1.940

(6) Finance:

FINACE1: Do You Want to Invest Money in This Type of Technology
MONEY_CAN_INT: How Much Money Can You Invest to Adopt This Technology?

Table 8: FINANCE

	N	Min.	Max.	Mean	Std. Deviation	Variance
FINANCE1	90	1.00	3.00	2.1111	0.90497	0.819
MONEY_CAN_INT	90	1.00	6.00	2.9444	1.47154	2.165

2.4.4 Top Ten Factors

Top ten factors are derived from all the result by highest mean value in scale of 1-5 and 1-7 separately as shown in table below.

(I) Scale 1-5:

Table 9: Scale 1-5

SR. NO.	FACTOR	MEAN
1	Financing and Investment	3.5111
2	AR/VR Will Essential for Understanding and Demonstration of Any Construction Project	3.3444
3	Consumer Privacy/Data Security	3.3333
4	Cost to Consumers	3.3000
5	Potential Infringement of The Third Party-Owned I.P.	3.2444

(II) Scale 1-7:

Table 10: Scale 1-7

SR. NO.	FACTOR	MEAN
1	Commercial Building	5.3889
2	3D Animation Help Leaners Gain Insight, Seeing Internal Operations of Machines and Understand Process Better	5.3889
3	Improve Employee Knowledge Retention	5.3889
4	Improve Employee with Highly Engaging Training Sessions	5.2444
5	Industrial Building	5.1333

From the result of top 10 factors we can have idea of factors which affect the most to adoption and current problems of

VR in construction industry as well as in construction project monitoring.

3. CONCLUSION

From this study, we can say that VR is an excellent technology for the construction sector. Before the coming of VR in the construction sector, it was used only for marketing purposes, but we can also use it for various things such as project monitoring, modification review in design, safety training, which is excellent for OHS in the construction industry. The top factors we get in results are most important as any organization wants data privacy, affordable cost of the technology, setting up setup of VR capable system, safety and safety trainings.

FUTURE SCOPE

There are many problems regarding this technology, such as less awareness in construction companies, high cost(initially), data privacy issues, less skilled persons for implementing VR in a construction project. But apart from that, there are many benefits which we should con- sider. In the market, there are applications and VR headsets such as Google Cardboard, Sam- sung VR, and many more. By which we can initially get to know about its usability. Without experience VR, it is challenging to understand its potential in construction projects and management.

The benefit of this research helps us to find factors that are most important in terms of improvement or benefit us if we adopt in the construction industry.

RECOMMENDATION

In the era of this COVID-19 pandemic, VR is a great option to review sites from home by creating a 3D cube image of the actual location. VR will be essential for the construction industry in the future. So, adopting VR as an integral part of any organization undoubtedly beneficial.

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