iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** VI **Month of publication:** June 2018

DOI: http://doi.org/10.22214/ijraset.2018.6236

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue VI, June 2018- Available at www.ijraset.com

Application of BIM for Scheduling and Costing of Building Project

Sarita D. Patil[1], Manish A. Khandare[2]
[1] *Post Graduate Student, Department of Civil Engineering, RMD Sinhgad School of Engineering (RMDSSOE), Warje, Pune, India*
[2] *Asst. Professor, Department of Civil Engineering, RMD Sinhgad School of Engineering (RMDSSOE), Warje, Pune, India*

Abstract: ***India is a rapidly developing country and its infrastructure development is at an extremely large scale. In India, Architecture, Engineering, Construction and Operation (AECO) industry is the second largest industry after agriculture industry. Indian AECO industry employs more than 35 million people, has second highest inflow of foreign direct investment after services sector, and contributes to about 11.1% of India's GDP (Mohideen 2015). Recent initiatives set by Indian government, such as Make in India, is serving to grow the AECO industry. There are many mega projects undertaken recently, e.g. high-end road ways or express ways, metro train projects and proposed bullet train project between two cities of India, i.e. Mumbai and Ahmedabad. The initiation of these projects necessitates focus on various technical and non-technical aspects along with technologies, especially the infrastructure for these initiatives (Amarnath et al. 2016). Regarding the technologies and project delivery process within the AECO industry, Building Information Modeling (BIM) is one of the most notable one, with its ability to reduce project time delays, cost over runs and litigations.***
Keywords: AEC, BIM, 3D, 4D, 5D

I. INTRODUCTION

India is a rapidly developing country and its infrastructure development is at an extremely large scale. In India, Architecture, Engineering, Construction and Operation (AECO) industry is the second largest industry after agriculture industry. Indian AECO industry employs more than 35 million people, has second highest inflow of foreign direct investment after services sector, and contributes to about 11.1% of India's GDP (Mohideen 2015). Recent initiatives set by Indian government, such as Make in India, is serving to grow the AECO industry. There are many mega projects undertaken recently, e.g. high-end road ways or express ways, metro train projects and proposed bullet train project between two cities of India, i.e. Mumbai and Ahmedabad. The initiation of these projects necessitates focus on various technical and non-technical aspects along with technologies, especially the infrastructure for these initiatives (Amarnath et al. 2016).

Regarding the technologies and project delivery process within the AECO industry, Building Information Modeling (BIM) is one of the most notable one, with its ability to reduce project time delays, cost over runs and litigations.

Building Information Modeling (BIM) has attained widespread attention in the Architectural, Engineering and Construction (AEC) Industry. Building Information Modeling (BIM) has been introduced to manage the complexity of construction projects, achieve sustainability and integrate stakeholders' requirements in terms of maximizing value with lower cost. BIM has been recognized as a facilitating tool to improve the fragmented practice and productivity in the construction industry, and lower the high construction project costs (BCIS, 2011, Cartlidge, 2011).

BIM has been widely used to manage building information throughout project life period. Particularly in quantity estimation / quantity take-off (QTO) and costing. BIM based quantity estimation process is getting more and more attention as cost estimation is cumbersome and error-prone process. There is a scope to improve the conventional estimating process even more which could be accomplished by using BIM based Quantity Estimation. This paper presents a study on comparative effectiveness offered by BIM for the traditional functions of a Quantity Surveyor though sample study.

A. Aim of the Project and Paper

The purpose of this project is to study the BIM application for Project Scheduling and Costing of Construction projects, its benefits over conventional methods and barriers in implementing BIM.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue VI, June 2018- Available at www.ijraset.com

B. Objective of the Project and Paper

The objective of this project and paper is to

1) To Study the process of BIM (Building Information Modeling) for quantity Take off in Autodesk Quantity Takeoff 2013.

2) To Study the benefits of BIM based Quantity Estimation and additional requirements if any, to be put into the model to get more benefits in terms of Quantity Take Off.

3) To compare the conventional methods and BIM based Quantity Estimatio

4) To Study the barriers of an effective implementation of BIM application for Quantity Estimation.

II. PRESENT THEORIES AND LITERATURE REVIEW

India BIM Association (IBIMA) has conducted an extensive literature survey to understand the road blocks for BIM diffusion in the global market and designed the questionnaire to realize the hurdles that Indian AECO industry stakeholders are facing for diffusing BIM technologies and workflows in AECO projects. Data collection was undertaken by India BIM Association among the Indian AECO stakeholders from February to September, 2017. Results indicates that, in India BIM is most probably adopted for design stage. BIM diffusion in construction and operation stages are yet to mature in coming days once the construction and operation teams realize the benefits that BIM can bring to them. It is very much essential to educate and train construction and operation stage stakeholders with BIM technology and processes. It is necessary to make them realized that BIM diffusion will benefit construction and operation team more than a design team.

A. BIM

BIM is an emerging paradigm which is spreading quickly in the construction industry, and a considerable number of BIM software applications have been developed, such as Autodesk Revit, Graphisoft ArchiCAD and Vico Office Suite etc.

Most of these software applications are equipped with an application programming interface (API) function, and the function can be broadened by using the specialized programs written by external application developers (Modeling 2008). Among the software, Autodesk Revit provides a rich and powerful NET API to perform automation of repetitive tasks and extension of the core functionality of Revit in simulation, conceptual design, construction and building management, as well as other functionalities (Autodesk Developer Network 2015).

B. Quantity TakeOff

Quantity takeoff is an important part of the construction process, and it is performed by general contractors, subcontractors, cost consultants, and quantity surveyors. Such tasks simply include measuring and counting the utilization of materials within a certain construction project in order to determine the associated materials and total labour usage. Time scheduling and cost estimations are both based on quantity information regarding e.g. building parts, materials, surfaces, and volumes etc. In current practice, the quantity takeoff process is typically carried out manually using a printout, a pen, and a calculator, which is an outdated method (Beyond the Paper 2006). Since the process of manual quantity takeoff is time consuming and also it depends on human interpretation, it is difficult to obtain accurate measurements and avoid errors (Monteiro and Poças Martins 2013). The development of BIM provides a better environment for quantity takeoff.

In recent years, an increasing number of practitioners have been adopting BIM, as it provides a feasible means to develop a more efficient quantity takeoff system (Firat et al. 2010). BIM enables project teams to generate cost estimates quickly and accurately, and the output can be used to assist in material ordering and cost estimation, not only early in the design phase but throughout the project lifecycle (Autodesk 2013).

For the stick-built onsite construction practice, Autodesk has developed commercial software called “Autodesk Quantity Takeoff”, which is widely used by the construction industry. It enables cost estimators to read and extract information (geometry, images, and data) from BIM tools, such as Revit Architecture, Revit Structure, and Revit MEP. After importing the data from other software, Autodesk Quantity Takeoff is able to automatically measure, count, and price building objects in minutes, and the takeoff results can be exported in different file formats such as Microsoft Excel and Design Web Format (DWF) (Autodesk 2015); however, this tool is not designed to support modular and offsite construction.

III. METHODOLOGY

The aim of this project is to study the application of BIM for scheduling and costing of construction project. For Project Case Study, a project of Proposed Construction of R & D Building for Advik Hi-tech Pvt Ltd is identified, to understand the process, benefits and

barriers of utilization of BIM in detail. The study includes the application of BIM for visualization, quantity takeoff and simulation of project schedule & cost with the 3D model.
In order to achieve the objectives, the methodology adopted is as follows.

A. Study of previous research on BIM Applications for Project Scheduling and Quantity Take Off / Costing.
B. Study of prevailing industry practices for preparing 2D/3D Drawing, Project Scheduling and Quantity Estimation / Cost Estimation.
C. Study of BIM Framework in relation with Modeling (3D), Project Scheduling (4D) and Quantity Take Off / Costing (5D)
D. By preparing of Sample model (3D) by using Autodesk Revit / Revit Architecture.
E. Comparing process of Conventional Methods of Quantity Take Off and Project Scheduling with BIM Application for Quantity Take off & Project Scheduling.
F. Study of Benefits / Advantages of Using BIM Applications for Quantity Take Off and Project Scheduling.
G. Identify Barriers of using BIM Applications for Quantity Take off and Project Scheduling

IV. SOFTWARE'S USED

The following software's are used for the sample preparation of Case Study for BIM integration 3D with 4D and 5D
A. Autodesk Revit Architecture - For 3D
B. Autodesk Quantity takeoff – For quantity
C. Microsoft Project – For scheduling
D. Autodesk Naviswork Manage – for 4D &5D

V. SAMPLE CASE STUDY

For Project Case Study, a project of Proposed Construction of R & D Building for Advik Hi-tech Pvt Ltd is identified, to understand the process, benefits and barriers of utilization of BIM in detail.

Index	Description
Size a	20m X 63m
Function	Industrial Building
Structures	RCC (G+1)
Plot Area	32000 SQM
Floor Area	2520 SQM
Other Salient Features	Building is used as research & development building.

The study includes the application of BIM for visualization, quantity takeoff and simulation of project schedule & cost with the 3D model.
ACAD 2D Plans of building are obtained from S.N.Pingle Consultants, Pune office.
From 2D drawing 3D model is prepared in Revit Architecture 2017. Student licensed version of Revit Architecture 2017 is downloaded from Autodesk's student community website to develop a 3D building model. This project focused only on civil work since during preparation of model only RCC details and architectural drawings are considered.

Fig. 1. 3D model created in the Autodesk Revit Software

After completion of 3D model quantity worked out by using Autodesk Quantity takeoff (QTO) software.

The two main elements of a cost estimate are quantity takeoff and pricing. For this project quantity worked out by using Autodesk Quantity takeoff (QTO) software. Autodesk Quantity Takeoff (QTO) can assist in combining various sources of two dimensional and three dimensional designs to create a quantity takeoff that can then be used to create a cost estimate. QTO can use various file types as its source files such as Design Web Format (DWF) or non DWF files such as PDF files, DWG files, JPG or TIF image files. Depending on the level of detailing in the DWF file that is imported into QTO, the user may be able to use the Automatic Takeoff function. Methodology adopted is as below;

A. DWF file created from CAD drawing.
B. DWF file exported to QTO.
C. From DWF file take off is taken
D. Report generated in excel and also in PDF

For this project a sample 2D drawing is taken and from that drawing DWF file is prepared. After that this DWF file is exported to QTO. From this file take off is taken for various quantities.

After taking of takeoff, unit pricing is added in respective items. We can add price differently i.e. material cost, labour cost, sub-contractor cost & equipment cost.

After completion of takeoff & pricing estimate report is generated. We can export this report in excel or in PDF also.

STEP 01 : Preparation of DWF file

STEP 02 : Export DWF file to Autodesk quantity takeoff

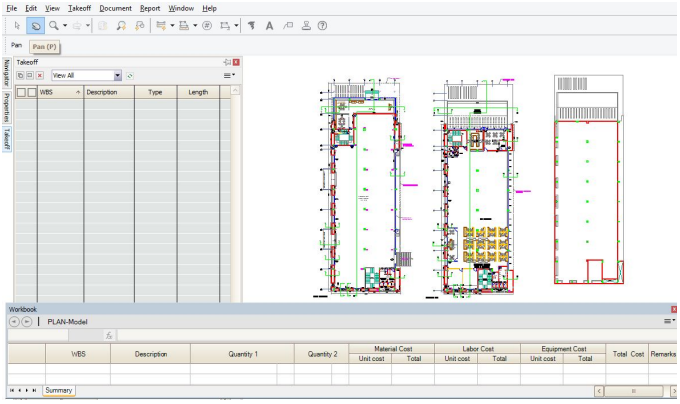


Fig. 2. DWF file

STEP 03 : From DWF file take tkeoff

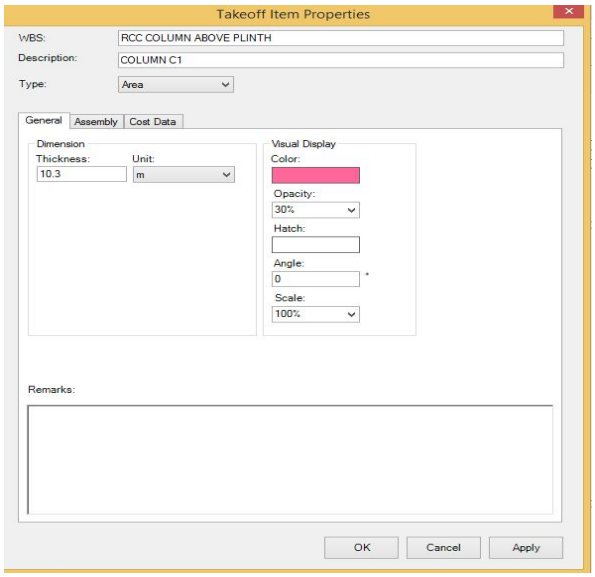


Fig. 3. General data for takeoff

STEP 04 : Prepare Report

Group (Items and Objects)

WBS	Description	Area	Thickness	Quantity 1	Quantity 2	Labor Cost		Material Cost		Total Cost
						Unit Cost	Total Cost	Unit Cost	Total Cost	
RCC COLUMNS										R$770,495.04
RCC COLUMNS.CIRCULAR COLUMN 400 DIA	COLUMN C41,42,43,44	0.113 m²	5.10 m	0.452 m²	2.307 m³	1,505.00	3,472.71	5,870.00	13,544.73	17,017.44
RCC COLUMNS.COLUMN 300X600	COLUMN C37 - 1 NO	0.182 m²	10.30 m	0.182 m²	1.874 m³	1,505.00	2,820.58	5,870.00	11,001.20	13,821.78
RCC COLUMNS.COLUMN 450X750	C8,C9	0.663 m²	10.30 m	0.663 m²	3.416 m³	1,505.00	5,140.96	5,870.00	20,051.47	25,192.43
RCC COLUMNS.COLUMN 600X600	COLUMN C15,16,21,24,27,30, 33	0.364 m²	10.30 m	2.547 m²	26.238 m³	1,505.00	39,488.12	5,870.00	154,016.78	193,504.89
RCC COLUMNS.COLUMN 600X750	COLUMN C11 - 1 NO	0.438 m²	10.30 m	0.438 m²	4.514 m³	1,505.00	6,793.61	5,870.00	26,497.35	33,290.96
RCC COLUMNS.COLUMN 750X750	COLUMN C10 - 1 NO	0.569 m²	10.30 m	0.569 m²	5.856 m³	1,505.00	8,813.34	5,870.00	34,374.94	43,188.27
RCC COLUMNS.Column in superstructure	C1 - 1 NO	0.225 m²	10.30 m	0.225 m²	2.318 m³	1,505.00	3,488.61	5,870.00	13,606.75	17,095.36
RCC COLUMNS.RCC COLUMN 300X750	C2,3,4,5,6,7,13,38,1 6,17,19,20,22,23,25, 26,28,29,31,32,35,3 4,36,39,40	0.225 m²	10.30 m	5.626 m²	57.950 m³	1,505.00	87,215.30	5,870.00	340,168.63	427,383.92
RCC COLUMNS 300X750. COLUMN IN SUPERSTRUCTURE_1	C2,3,4,5,6,7,13,38,1 6,17,19,20,22,23,25, 26,28,29,31,32,35,3 4,36,39,40	0.225 m²	10.30 m	0.225 m²	2.318 m³	1,505.00	3,488.61	5,870.00	13,606.75	17,095.36
									Total Cost	R$770,495.04

Fig. 4 Report of takeoff

To check the accuracy level of Quantity Take Off, the comparison of quantity takeoff by conventional method and by the BIM based Quantity Take Off is carried out for some of the major items.

RCC BUILDING G+1					
Sr.No.	ITEMS	Unit	Manual QTO	BIM QTO	% Difference
1	Foting Excavation	CUM	970.55	967.849	-0.28
2	RCC Footing	CUM	252.95	252.111	-0.34
3	RCC Pedestal	CUM	23.55	23.338	-0.92
4	RCC columns	CUM	110.62	111.03	0.37
5	RCC beams	CUM	158.08	156.89	-0.75
6	RCC slabs	CUM	173.15	177.735	2.64
7	BRICKWORK	CUM	437.40	436.394	-0.23
8	PLASTER	SQM	2237.26	2272	1.55
9	Painting	SQM	2237.26	2272	1.55

Fig. 5. % difference between BIM & Manual QTO

VI. 4D MODELING OF R&D BUILDING

When we link the fourth dimension i.e. time to the 3D model created in Revit then it becomes the 4D model. From 4D model we can visualize the time it takes to complete tasks within the construction process. For preparation of this, first of all from Revit model NWF file created & this file exported to Naviswork Manage. Schedule is prepared in MSP. We can export the schedule to Naviswork or in Naviswork also we can prepare schedule. For this project I had prepared a schedule in Naviswork itself. For preparation of this in timeliner we can find option add tasks, and also we can add columns like planned start, planned end, actual start, actual end etc. After preparation of schedule all activities are linked to the model. Once the linking was complete 4D model was visualized.
From drawing work break down structure (WBS) is created and schedule of project is prepared in Microsoft Project 2003.

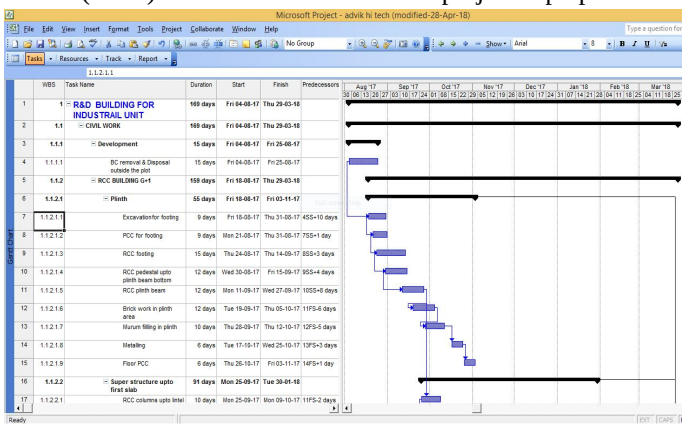


Fig. 6. MSP Schedule of Sample Project of Industrial R&D Building

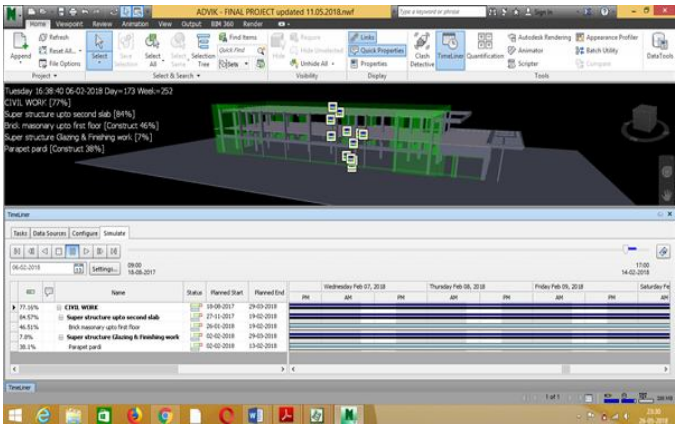


Fig. 7 4D scheduling simulation

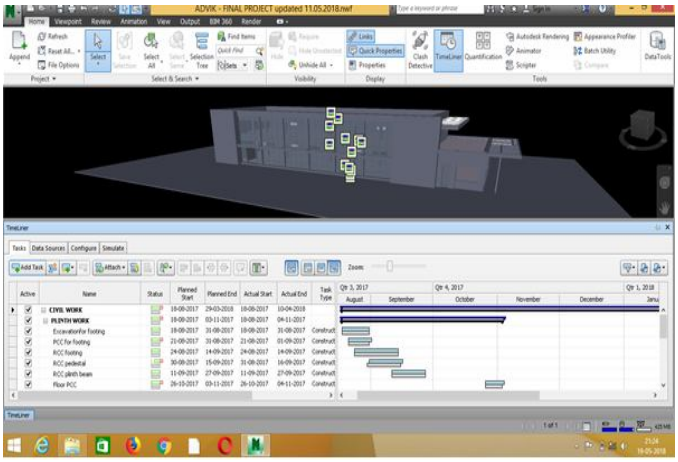


Fig. 8 4D Model of R&D Building

VII. 5D MODELING OF R&D BUILDING

Quantity surveying practice is bound to 5th dimension (5D) of BIM. The 5D BIM is an integration of the 3D BIM model and the construction schedule (4D) with contract pricing (cost) for quantity surveying applications. It stimulates the building performance with respect to its construction cost. BIM automatically generates quantities, take-offs and counts from the model which will reduce the time and costs required to prepare an estimate (Olatunji et al., 2010; Wijayakumar & Jayasena, 2013).

The model created in Revit and the cost data prepared from Quantity takeoff software is exported to Naviswork, since complete the 5D model.

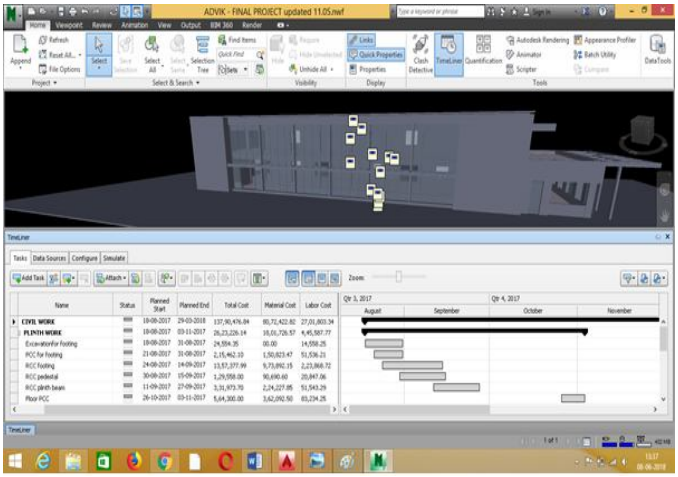


Fig. 9 5D Model Of R&D Building

VII. CONCLUSION

A. The BIM concept and technology have been applied in practice worldwide, and the great effects brought about by BIM application in the AEC industry are gradually being revealed. BIM implementation is essential to the AEC industry, and support from a national strategy is necessary in order to promote BIM.

B. For effective implementation of BIM based Quantity Takeoff, BIM Model shall be prepared for easiest possible BIM based Quantity take off. The level of detail should be determined by all participants involved in a project.

C. A comparison between the traditional estimating method and BIM based Quantity Takeoff shows that greater accuracy can be obtained through BIM based Quantity takeoff.

D. Barriers to BIM implementation have attracted widespread attention. The critical barriers are the high cost of application, lack of national standards, and lack of skilled personnel. The initial cost of investing in new technology and time for training personnel is also significant. It could be resolved if government, the AEC industry, educational institutes, and BIM providers work together to reduce BIM implementation costs, establish BIM implementation strategies, and promote BIM education. With investigation and overcoming of the identified barriers, BIM will help the AEC industry to evolve rapidly

REFERENCES

A. Journal Papers

[1] Salman Azhar, “Building Information Modeling (BIM) : Trends, Benefits, Risks, & Challenges for the AEC Industry” Leadership and Management in Engineering 2011

[2] Peter Smith, “BIM & the 5D Project Cost Manager”, 29th World Congress International Project Management Association (IPMA) 2015

[3] Saeed Rokooei, “Building Information Modeling in Project Management: Necessities, Challenges and Outcomes” 4th International Conference on Leadership, Technology, Innovation and Business Management

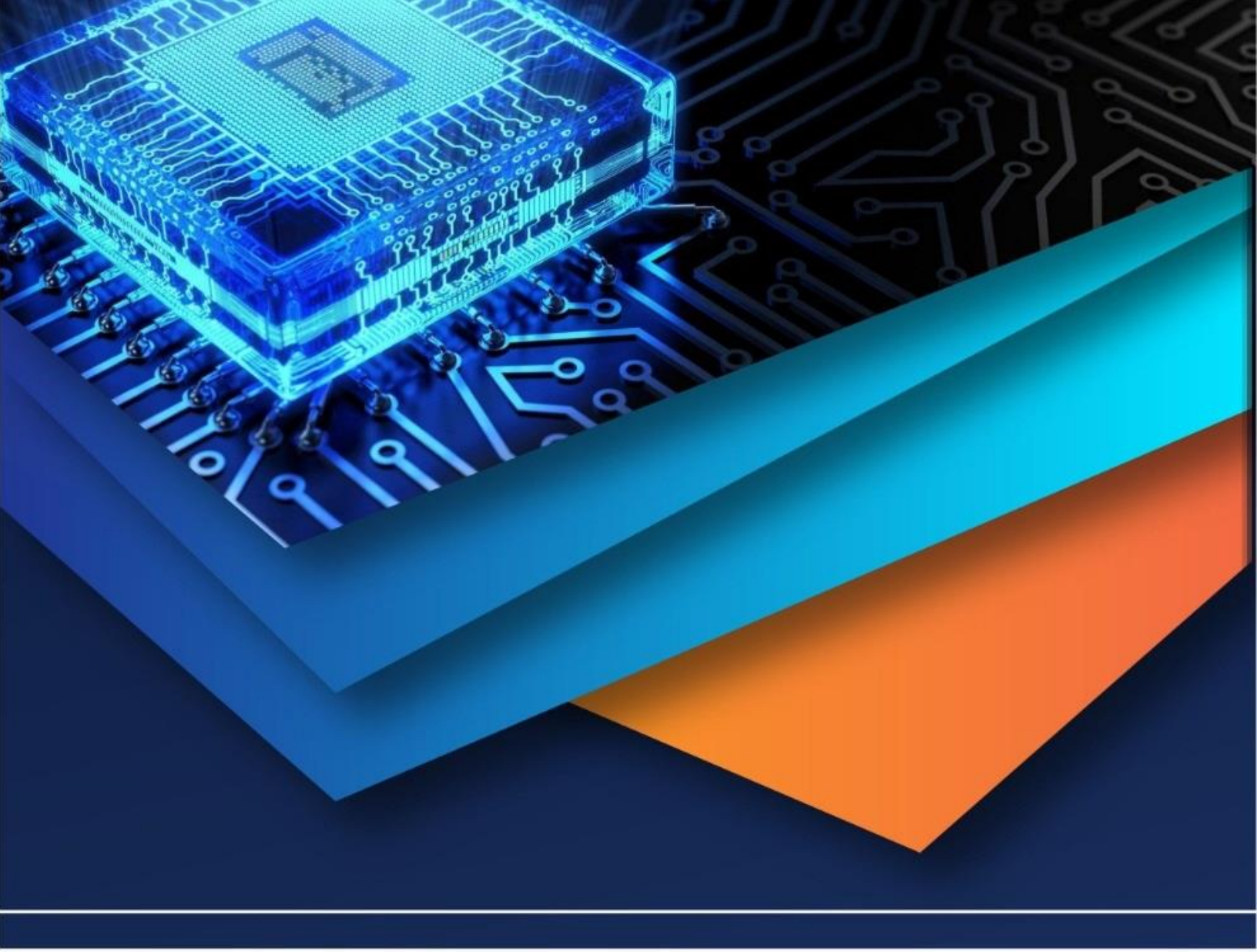
[4] Andre Monterio, Joao Pocas Martins, A survey on modeling guidelines for quantity takeoff-oriented BIM-based design article in automation in construction Nov.2013

[5] Juan Franco, Faiza Mahdi , Hussein Abaza from Department of Construction Management, Kennesaw State University., (2015) Using Building Information Modeling (BIM) for Estimating and Scheduling, Adoption Barriers, Paper published in Universal Journal of Management.

B. Theses

[6] Fredrik Kullvén & Katrine Nyberg (2014) Possibilities with BIM in relation to cost estimation and scheduling, Master of Science Thesis in the Master’s Programme Design and Construction Project Management for Division of Construction Management, CHALMERS University of Technology, Sweden).

[7] Dalu Zhang, (2012) Project Time and Cost Control Using Building Information Modeling, A Thesis submitted for North Dakota State University Of Agriculture and Applied Science.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY