International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 06 | June 2019 www.irjet.net p-ISSN: 2395-0072

Application of BIM as a Model for Quality Management

Akbar Shah A.A[1], Shibi Varghese[2]

[1]*Pursuing Masters in Civil Engg. from APJ Abdul kalam Technological University, Kerala, India*
[2]*Associate Professor in CE Department, M A College of Engineering, Kothamangalam, Kerala, India*

Abstract - *Quality management is an important and challenging task in every industry especially in construction industry. Due to the uniqueness of each project, the quality management plan will different for different projects. The traditional quality management systems fail to maintain the desired quality levels in project. The revolution in the IT sector and computer systems had made a powerful impact all over the world. Today the construction industry is integrated with the IT industry in order to make the construction more efficient and simple. In the quality management also we can implement certain technologies in order to effectively control the quality of project. Building Information Modelling (BIM) is one of the new tools which can be used for quality management. BIM can be used for modelling, estimating, planning, and visualizing a project. We can add any number of information into the project and store it for future use. The information provided can be extracted from BIM in a product organization product structure for its effective use. In this paper, BIM is used for the quality management of a project which is taken as a case study and finally the benefits of using BIM are discussed.*

Key Words: **Building Information Modelling (BIM), Quality Management, 4D Modelling, Visualization, Quality**

1. INTRODUCTION

Quality in construction can be defined as the attainment of acceptable levels of performance from construction activities. Or it can be defined as meeting or exceeding the requirements of client or owner. Thus, the quality management is a crucial and tedious task in the construction industry. There are generally three factors which contribute to difficulties in construction management. First, the quality control criteria for individual components are scattered in different national, industrial and local quality control codes for construction. It is also common for these specifications to cross-reference each other, creating complex dependencies between specifications[1]. Second, it's difficult to identify the responsibility for an accident because project participants form a complex web of relationships [14]. Third, the current focus of quality control is on the final component with much less attention given to quality control during the process of construction[2]. According to ISO 9001, Quality management system is defined as a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives. Quality management system consists of quality planning, quality assurance, quality control and quality improvement. Presently there are powerful tools available for the quality management in construction industry such as BIM and lean construction techniques. Building Information Modelling (BIM) can be defined as a set of information which is structured in such a way that it can be shared. A BIM is a digital model of a building in which information about a particular project is stored. It can be 3D, 4D, 5D and right up to nD (building SMART 2010). BIM is most frequently perceived as a tool for visualizing and coordinating AEC (architecture, engineering and construction)work, avoiding errors and omissions, improving productivity, and supporting scheduling, safety, cost and quality management on construction projects[2]. The 3D model can be used as a product model in which all the information about a product can be stored. The aim of 4D BIM is to visualize and simulate the sequence of construction activities. The quality management using BIM improves the quality in construction of both simple and complex projects.

1.1 Problem Description

Every construction project is unique in nature. So the quality management plan will change according to the projects. According to ISO 9001:2015 Quality planning focussed on setting quality objectives and specifying necessary operational processes, and related resources to achieve quality objectives. Quality Assurance focussed on providing confidence that quality requirements will be fulfilled. Quality Control focussed on fulfilling quality requirements. Quality Improvement focused on improving the ability to fulfill quality requirements.

Quality of construction projects is linked with proper quality management in all phases of project life cycle. Design and construction are the two important phases of project life cycle which affect the quality of outcome of construction projects significantly[5]. However, there is communication gap between the design phase and construction phase. So the design information cannot be fully utilize during the construction phase[2]. The current quality management practice in the construction industry includes issuing quality checklists, site inspection and testing, non- conformance reporting and corrective action. But there is not a systematic way of recording the inspected data hence the quality status of construction cannot be determined. The lack of collaboration and communication among the project participants is also a major issue in quality management. In order to carry out the Plan-Do-Check-Act (PDCA) cycle effectively there must be a systematic and informative

quality management model. The newly emerging technologies such as BIM and Lean construction can be used to control the quality in construction. [2] had developed a 4D BIM practical informative model for controlling the quality in construction. (Garrido et.al, 2015) suggest the use of BIM as last planner system to improve the overall quality in construction. These can be assumed as powerful tools for the quality managers to control and monitor quality in construction.

2. LITERATURE REVIEW

James L Burati *et al.* conducted studies to identify attributes for effective quality management. The study explores the evolution of Total Quality Management. They conducted in depth interviews and literature survey to find the quality management organization and methods which a are effective to quality management. Also how the organization developed and implemented the techniques. They came up with certain conclusions such as 1) the organizations which implemented TQM had shown substantial quality improvements. 2) Construction companies that adapt TQM in manufacturing used TQM in construction operation with minor modifications.3) the use of pilot projects is useful for gaining acceptance for TQM. 4) Training will not get succeeded if humanistic and technical aspects are addressed.

Batthika *et al.* developed and reviewed a computer based quality management. the paper indicates the benefits of computer based management such as providing efficient and effective computerized environment for the assisted quality management tasks, facilitating the implementation of formal quality systems pertinent to these tasks, extending and exploiting the data and tasks used in existing project management function in an integrated fashion.

Frank Boukmap *et al.* suggest an automation process for generating construction specifications. The process is developed in such a way that the system will check the applicability of the specification for a particular product and if it violates any specification it will automatically generates the results and reports.

Sacks *et al*. identifies interaction with lean construction and Building Information Modelling. He identified 56 interactions with BIM and lean techniques. The also prioritize according to the interactions. This can be used as a reference for the companies who want to implement BIM and lean techniques so that they can maximize the benefits.

Scheer *et al.* explored the practical application of BIM with scheduling and cost planning. The paper conducts a case study in Brazil. The last planner system also used along with integrated model for producing best results. The study validate that the model with lean techniques has improved transparency, visual management, reduce errors, improve communication, reduce variability and cycle time.

Lee *et al.* explores the benefits of using BIM for horizontal construction projects. The study proposes a Product, Process, Organization (PPO) model integrated with BIM in order to improve the quality in construction. The study concluded that BIM is a powerful tool for construction management. They also conducted questionnaire survey.

Chen *et al.* proposed a BIM based quality model for quality management in construction industry. They developed a 4D quality model which is enriched in product, organization process model data definition structure for quality control. The model is validated with a case study. The study concluded that it will improve the communication, better visualization of construction activities, information consistency throughout the construction process, better co-ordination and collaboration among project participants, automatic generation of engineering documents. The model will automatically detect the failed components and produce rework report as corrective action. The study concluded that the BIM based quality model will have a positive impact on the industry.

3. CASE STUDY

In order to study the benefits of using BIM based quality model for quality management, the model is implemented in an ongoing residential project. The residential building have an area of 1200 m^2. Quality control of pile foundation is studied using the BIM model.

3.1 Software tools used

1. ***Autodesk Revit architecture &structural 2018*:** it is a powerful and affordable 3D based software in which 3D model is prepared for importing the model into navisworks software. Both 3D architectural and structural models can be created using this software. The files can be saved in .rvt, .rfa formats.
2. ***Autodesk Navisworks Manage 2018:*** it is a project review software that supports intelligent 3D model based design with scheduling, visualization, and collaboration tools.
3. ***Microsoft Office Project:*** this software is used for the creation of schedules of construction activities. This can be exported to navisworks software to integrate it with 3D model for developing 4D model.

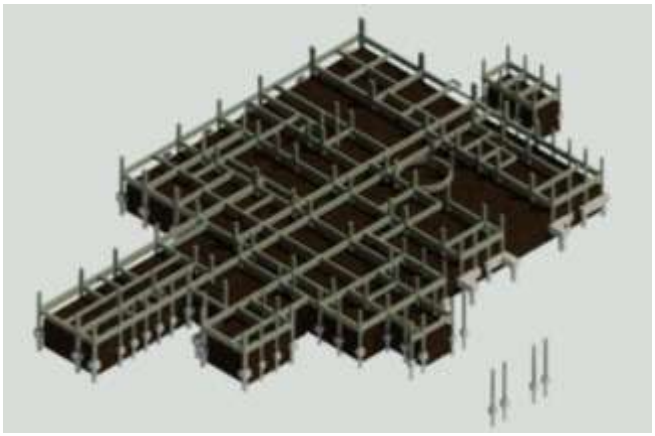

Fig-1: 3D model-Structural

Admixture used	Master flow 150 (0.6-1%)
Bottom R/F Long Steel, Sh	5T12
No. of Pile Caps	51.000000
No. of piles	1
Shear R/F Stirrups	NIL
Side face reinforcement S1	3T10
Top R/F Long steel, short st	5T12
Materials and Finishes	
Structural Material	Concrete - Cast-in-Place
Dimensions	
Foundation Thickness	700.0
Length	800.0
Spacing between piles	2500.0
Width	800.0
lapping length	0.0
pile dia	600.0
Structural Analysis	
grade of concrete	25.000000 MPa
required compressive stren	25.000000 MPa
Other	
cement amount specified	380.000000 kg/m³
concrete cover	50.0
permissible deviation in dri	7.50 cm
permissible deviation in dri	0.00 cm
pile cut -off level	75.000000
required slump	170.000000
w/c ratio	0.000000

Fig-2: Quality checklist

3.2 Discussion of Results

The study gives notion about the benefits of BIM based quality model, how it is benefitted to project team and the limitations of the model.

1. Benefits of BIM model

Quality in construction depends on several factors such as completing work on time within budget, meeting requirements, conforming to design specifications etc. In order to satisfy all the factors which are responsible for the quality, an efficient quality management system should be there.

From the case study it is understood that BIM can act as a powerful tool for quality management. The benefits of using BIM can be summarized as follows:

- *Better visualization of construction activities:* The sequence of construction activities can be simulated so that we can assess the progress of construction. Any delay in construction can be easily detected. Also we can prepare the inspection plan according to the work schedule. It will give alert to the stake holders on the date of inspection.
- *Better communication among stake holders:* One of the main disadvantages of traditional quality control methods is lack of communication among project participants. The Architectural, structural and MEP team will be in clash during the design phase. By using BIM, they can work together and solve the problems. Also the design wing can give all the necessary information to the construction wing through BIM.
- *Uninterrupted flow of information:* Information consistency is one of the main advantage of using BIM. The information can be shared from design phase to construction phase without any loss. Thus the quality requirements which the designer specifies can execute by the construction wing.
- *Gives better understanding of quality requirements:* The quality model gives a better understanding about the quality requirements so that even the person with less knowledge about quality control can simply execute the work.
- *Maintains a Strong database:* The BIM have a strong database so that all the information can be stored and preserved for present and future use. The model will be a digital model of particular project. Hence these information can be used for maintenance also.
- *Automatic detection of failed components:* We can give certain conditions for detecting the failed components. After feeding the inspected data into the model, it will automatically detect the components which are failed to meet the conditions provided. Also uninspected products can be found.
- *Saving of time and cost:* The completion of project on time within budget is one of the crucial factor which affects quality in construction. By using BIM we can detect the errors early and rectify it which will save the time. Also each construction activity can be pre planned by simulating the 4D model, thus the wastage and underutilization of resources can be avoided.
- *BIM as LPS:* 4D model can be used for developing weekly working plan or short term working plan. Thus we can assure the execution of the activity on time without any delay.
- *Clash detection:* During the design stage itself, we can detect the interference between architectural,

structural and MEP works. By working in a collaborative manner, they can come to a solution. This will ensure the smooth functioning of construction phase so the unwanted delays can be avoided.

2. Shortcoming of BIM model

One of the main problems that the quality management encounter is that people only give less priority to the quality management. The attitudinal problem will persists irrespective of the methods we are using for quality management. This is one of the limitations of quality management which we can't cure. Other limitations of BIM based quality control are:

- The development of 3D, 4D model is a time consuming and challenging task. The model should be completed before the commencement of project. High quality image rendering may take several hours.
- Requirement of skilled personnel is another disadvantage of the model. Inaccurate models will aggravate the problem and be a burden to the company.
- The BIM software's are very costly in nature. Thus it can be utilized for large construction projects only. The high quality rendering process requires heavy computer system.

4. CONCLUSIONS

Quality management is crucial and tedious task in the construction industry due to the aforementioned reasons. A systematic approach is the only way to ensure quality in construction. The information about a product including its quality requirements which is specified by the design wing should be conveyed into the construction phase without any loss. The information thus obtained should be well executed by the construction team. The executed work should be inspected by the inspection team and it should be recorded and stored for future use. The recorded data can be analyzed by a system and that system should be capable of making a decision. This process can be termed as systematic approach.

This paper attempts to study the benefits of quality management using BIM. The paper adopts a case study approach to understand the workflow of the BIM based quality model. The results obtained are summarized in the previous chapters. From the previous chapters it is clear that BIM can be perceived as a powerful tool in construction quality management. We have seen the benefits of BIM based quality model such as better visualization of construction activity, improved communication among project participants, strong database, better understanding of quality requirements, uninterrupted flow of information, saves time and cost etc. Although there are some limitations mentioned, BIM is currently one of the best tool for quality management. The job of construction managers will become easy by implementing this model at site.

So we can conclude that BIM can be justified as a quality control tool which is capable of making effective decisions. Large quantity of can be stored and maintained in the database for future use. The model can also be used to generate quality checklist for both quality assurance and quality control. In the coming years BIM will become more powerful due to the advancement in technologies.

REFERENCES

[1] F. Boukamp and B. Akinci, "Automated processing of construction specifications to support inspection and quality control," *Autom. Constr.*, vol. 17, no. 1, pp. 90–106, 2007.

[2] L. Chen and H. Luo, "Automation in Construction A BIM-based construction quality management model and its applications," *Autom. Constr.*, vol. 46, pp. 64–73, 2014.

[3] R. Sacks, L. Koskela, B. A. Dave, and R. Owen, "Sacks2010.Pdf," *J. Constr. Eng. Manag.*, vol. 136, no. 9, pp. 968–980, 2010.

[4] and K.-W. S. S.-H. Lee, S. I. Park, J. Park, "Computing in Civil and Building Engineering," *SIXTH Int. Conf. Comput. Civ. Build. Eng.*, pp. 1179–1184, 2014.

[5] E. Builder and E. Trust, "Study of Quality Management in Construction Industry," vol. 3, no. 1, pp. 36–43, 2014.

[6] C. Engineering, "Garrido2015.Pdf," pp. 604–611, 2015.

[7] Hillmer, Steven and Karney, Dennis, "In support of the assumptions at the foundation of Deming's management theory", Journal of Quality Management 6 (2001) 371–400

[8] Burati, James L Matthews, Michael F Kalidindi, Satyanarayana N "Quality Management in Construction industry", Journal of Construction Engineering and Management, Vol. 117,issue 2, pp 341-359

[9] Mireille G. Battikha, "QUALICON: Computer-Based System for Construction Quality Management ", Journal of Construction Engineering and Management, vol. 128, iss 2, pp 164-173

[10] IS 456:2000

[11] IS 2911:2010