QUALITY MANAGEMENT IN CONSTRUCTION INDUSTRY USING BUILDING INFORMATION MODELLING (BIM)

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Abstract: the potential of Building Information Modeling (BIM) is to support a change of the processes of design and construction has been evident in the construction industry. Although BIM is helpful for improving design quality by eliminating conflict also reduce rework, there has been very less research into using BIM throughout the project for construction for quality control and efficient information utilization. Due to the consistency of design data with quality and construction process with quality control and the potential of BIM implementation in quality management lies in its ability to present multi-dimensional data including design data and time sequence. This paper explains and discusses the benefit of 4D BIM for a quality management based on construction codes

***Keywords*- Building information modeling (BIM), Quality Management, construction management**

I. INTRODUCTION

Due to globalization of construction sector, construction projects increasingly utilize multinational, increasing the need for high quality and efficient communication alternatives. Parallel to this, visualisation is receiving increasing attention within the construction industry. However construction companies generally have not gained full advantage of the available visualization tools due to lack of sufficient experience and assistance in the successful implementation of the technologies.

Today many construction companies face many challenges and problems, such as “workmanship defects”, delay, and “cost overrun in complementing their projects in all over the industry .the globalization and competition are the most important reasons that each construction company needs to improve and correct its system for achieving its objectives by management tools. As the results of studies in 776 projects across seven industries in different countries have showed construction and engineering companies were successfully achieve their goals because of being subject to particularly through planning, analysis and controlling by project management. Successful project management can be defined as having achieved the project objectives as on time, within cost, and quality (scope) to meet client's requirement. Quality is the most significant factor in the success of construction projects. But numerous reports have criticized the construction industry, especially in terms of productivity, quality and quality system and the majority of project managers focus on the cost and time instead of quality for construction projects, but the scholars emphasize more attention should be towards quality . Nowadays, quality has not just implicated on products and services in the organizations, it can be related to the process, system, and management as well. Quality of construction project is a general philosophy by which process are carried in a total quality infrastructure. The total quality infrastructure consists of several key pieces. The first, and one of the most important, is the quality system as a business management tool. In 1987, the first edition of quality system was introduced by the International Organization for Standardization (ISO) to aim quality and customer's satisfaction improvement.

QMS is included systematic approach, documentation, guidance, and audit that can be a part of every project management processes from the moment the project initiates to the final steps in the project closure phase as well. The traditional approach to the construction process is similar to a relay race with the assumption that the project life cycle is divided into a series of sequential and separate operations undertaken by individual parties

ISO 9001 can improve the efficiency of the processes of the organizations by generic guidance and documentations, and continual improvement through “Plan-Do-Check-Act” (PDCA) methodology to achieve successfully the satisfaction of customer and quality objectives. Unfortunately, most construction companies in developing countries believe establishing QMS is just wasting time and money for consultancy, training, periodical internal and external audit, and certification fee, without any benefit, and it is just useful to have its certification as a market tool. Therefore, the managers often focus on the certification as the primary objective and requirement more than value in the projects, and this kind of the notion can cause inefficient operation and lack of an effective QMS. Some studies showed that lack of support from Top management is the most barrier to implement QMS in construction industry. Also, the lack of enough evidence concerning how QMS actually affects on organizational practices and performance (lack of awareness in benefits of QMS) is a big problem to motive owners and managers of construction companies in implementing QMS. Thus, this study was carried out with the aim of evaluating the impact of Quality Management by using Modern Tools and Techniques for implementation and comparative study of Conventional Methods of Quality Management over the using of Modern tools like Navisworks for Quality Management. Find out effectiveness of Navisworks software for the quality management by considering main elements of construction project (cost, time, quality/scope) in selected construction project.

Sr. No.	Activity	YES	NO	N/A
1.	The building is set out correctly on the site(demarcation w.r.t. layout plan/)			
	Materials and products match what was specified in plan			
	Centre line Plans and material specifications are followed.			
	Materials are installed to manufacturers' instructions so you get the warranty.			
	Footings need to be straight and correctly positioned, though the finish doesn't have to be smooth			
2	**Concrete slabs**			
	The concrete is laid on top of several things put in beforehand. There is a layer of compacted base course, plumbing pipes and pipes taking electrical and other cable, in-floor heating and polystyrene insulation if required.			
	There are additives that can be applied to the concrete to reduce cracking during or following curing; the concrete can be coloured, polished and/or ground.			
3	**Concrete Formwork**			
	Before concreting commences ensure proper access for workers involved in placing, compacting and finishing concrete.			
	Presence of experienced supervisor keeping a continuous watch for any dangerous situation.			
	Adequate supply of spare props, clamps, bolts, wedges and skilled workers at site.			
	Alignment, camber, level and plumb (verticality) maintained while concreting is in progress.			
	Effective depth between top and bottom reinforcement not disturbed.			
	Cover of concrete around reinforcement steel maintained as specified.			
	Grout loss due to movement at joints and corrective action taken against it.			
	Loosening of wedges and fixings due to vibrations transmitted to the formwork and corrective action against it.			
	Spilt concrete and/or grout cleaned immediately.			
	All wooden spreaders, to hold vertical form faces apart, removed after placing concrete.			

Table No.1.1 ISO Checklist

II. LITERATURE REVIEW

Several case studies, international journals are studied to understand BIM technology. Through literature survey it can be concluded that BIM technology should be implemented in construction industry

1) Mehmet F. Hergunsel has studied visualization, 3D coordination, cost estimation, prefabrication, construction planning and monitoring, and record model. The 3D management used to notice and get rid of deal clashes and conflict. BIM based 4D preparation helps understanding of the construction mechanism and schedule progress that in turn results improved construction planning. The record model can be generating as the final growth of the construction as the as-built are completely updated in the Building Information Model. Prototype 4D Building Information Model was created and studied. The BIM-based schedule was incorporated to the 4D model. The project concluded with an analysis on the use, advantages and setbacks of BIM and its tools.[1]

2) In research paper of P.M Diaz done analysis is intended to show the communication of BIM and project manager‘s roles on construction projects. It insists on the implication of proper information and understanding of project managers to get succeed in BIM, 3D, 4D BIM and BIM based scheduling techniques are examined. The use of the term 4D to refer to the fourth dimension time is also discussed. The paper also review the issue regarding the BIM performance, static design and intrinsic problems related with an attempt to assess the advantages in a purely quantitative way, The studies show both the BIM advantages and disadvantages. And BIM can be regarded as a decision-making tool in spite of it being technical equipment also BIM should be incorporated in the construction course.[2]

3) Su-Ling Fan, Miroslaw J. Skibniewski, and Tsung Wei Hung, has written in paper , that BIM and 4D modelling have both freshly inward extensive attention from the architectural, engineering and construction (AEC) industries. Research efforts to engagement have established that BIM and 4D technologies are able to provide sooner and more efficient communication of information between involved project parties and yield improved and inventive solutions stemming from better design along with other benefits. These papers describe the results of research determined on capturing the effects of BIM during the construction phase of the project. Four factors counting requests for information, rework, change orders, and schedule compliance are discussed based on personal interviews with contractor employees experienced in the use of BIM. Eight case studies were conducted to discover the effect of BIM during the construction stage with respect of these four factors.[3]

III METHODOLOGY

There are a variety of gears and techniques are available for the quality management of construction work. Up till now there are many difficulties to implement quality management system in construction firms. Conventional methods of quality management are quite mind-numbing and one way or another difficult to apply. To achieve the fulfilment of customer and quality objectives of construction firm need to use modern technologies and tools for the quality management. In this study How Revit , MSP and Naviswork like modern tool is effective for quality management is evaluate by comparative study is doing on traditional methods of quality management with the Naviswork modelling. For quality management and scheduling technique following case study from data collected is analyzed and compared in Naviswork.

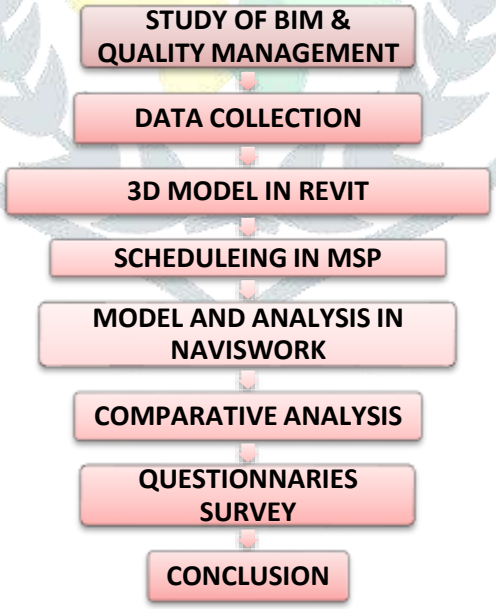

Fig 1: Flow chart of methodology

The objective of this research was to develop a complete, educational and sensible 4D BIM-based application for the purpose of construction quality management and to examine how it can fit into the current construction practice. Also, the research recognized possible problems with using Naviswork technology with current quality management methods, and proposes solutions. Throughout the research, quality models that controlled process, organization, and invention information were built using national, industrial and local quality standards and codes. Then, a scheduling model and the quality model were integrated into a virtualized 4D BIM-based application to identify quality control criteria and responsibility assignments in the construction process.

This application includes inspection and testing, analysis during the construction phase, and feedback of inspection results.

A case study approach was adopted to explain the dynamic quality control model that was developed from a complete review of the site investigation. In the case study, the inspection data was collected from the project general contractor and CAD drawings and the construction schedule were obtained from the project owner and from contractors.

STEPS FOR DESIGN OF BUILDING MODEL:

STEP1: Collection of AutoCAD 2D drawings of the project from site and project manager.
STEP 2: Creation of 3D model by importing 2D drawings in REVIT software.
STEP3: Conversion of the REVIT 3D model into Naviswork format by using an extension tool in REVIT.
STEP 4: Preparation of work breakdown structure for the project and creation of task schedule using the quantity data from REVIT in Microsoft project.
STEP 5: Creation of 5D model by importing and attaching 3D model and the MSP schedules (time and cost) in Naviswork software.
STEP6: Simulation and visualization of 5D model in Naviswork software.

DEVELOPMENT OF MODEL IN 3D USING REVIT:

Autodesk Revit Architecture is a credentials software application created by Autodesk for architects and building professionals. The tools and description that make up Revit Architecture are purposely designed to support building information modeling (BIM) workflows. With use of BIM as altered to computer-aided drafting (CAD), Revit Architecture is capable to provide active information in bright models also allows multifaceted building structures to be precisely designed and predictable in a short amount of time. Each quick model created with Revit Architecture represents an entire project and is stored in a single database file. This allows changes made in one part of the model to be automatically propagated to other parts of the model.

SCHEDULING USING MICROSOFT PROJECT (MSP):

Microsoft Project is accessible in standard and expert editions, depending upon the project needs and management level. The format of a Microsoft Project file is .mpp. It is one of the most commonly used PC-based project management equipment, and is designed to help managers in tasks such as: Devising plans, Setting practical goals, major resources, Assigning tasks, Recording progress and finances, monitor workloads, Scheduling meetings.

The software has an user-friendly help wizard that guides the user throughout the path of the assignment from formation to resource classification, assigning tasks and obtaining final results.

DEVELOPMENT OF MODEL IN 4D USING NAVISWORK:

Autodesk Naviswork Manage software is a broad review solution for analysis, simulation, and coordination of project information. Multidisciplinary design data can be combined into a single incorporated project model for interference management and clash detection. Naviswork Manage helps design and construction professionals predict and avoid possible problems before construction.

4D Scheduling Simulate building schedules and analyze project performance, and helps to decrease delays and sequencing problems. In project we used the scheduling for developing construction sequences that link model geometry to times and dates import times, dates, and other task data from project management software to actively link schedule with project models; and set up planned and actual times to visualize deviations from the project schedule.

With the use of cooperation Toolkit we communicated design intent and encourage teamwork with the ability to add mark-ups to viewpoints with advanced redlining tools. The software's object simulation character help you create animations of objects for clash and interference analysis. You can create communication scripts that link animations to specific events, triggers, or key comments, and link animations to tasks in a 4D schedule or improved construction planning.

CLASH DETECTION WITH NAVISWORK SOFTWARE:

Naviswork provides a stage for integrate all of the trades, even those with different 3D programs, into one system in order to build a comprehensive and interactive, three dimensional model of each project we perform.

Naviswork predict clashes by combine all of the trades in the virtual world, allowing us to revise plans and schedules to resolve conflicts before construction begin. This saves thousands of man hours that would be spent working through these issues in the field. Doing it right the first time, with a complete 3D representation of the project, preserves valuable resources of time and money. With Naviswork, a 3D model of the entire project is given a virtual walk through.

QUALITY MANAGEMENT SYSTEM:

The quality of a invention is reflected in its ability to induce confirmed or oblique needs and internal characteristics of a finished product in addition to its external design. Therefore, construction product quality can be defined as: the degree to which the stated or implied needs and the internal characteristics are guaranteed during the process of construction. This research defines quality as compliance with construction codes and specifications.

During the last decades construction industry has been heavily criticized for its performance and productivity in relation to other industries, it appears that the construction industry is going through an powerful stage of introspection, which is exacerbated by bigger industrial and social change. These changes are varying the stroke of the environment within which construction operate. in addition, such changes extensively affect the way business is carried. No organization operating in the construction industry, whether huge or tiny, personal or civic, can afford to disregard its altering environments if it is to stay alive.

lots of of the organization practice use to carry construction organization are being challenged. The industry's clients are moving ahead. Clients require better service quality, quicker buildings and innovation in technology. It is no disaster that the construction industry has turned to the manufacturing sector as a point of reference and source of innovation. Successful concepts derived from manufacturing, such as Total Quality Management (TQM), Reengineering and Lean (or Just-in-Time) Production, are being adopted and integrated into the construction industry. Implicitly, the successful execution of these concepts is deeply reliant on a society of teamwork and cooperation at both intra- and inter-organizational levels in construction.

Quality Management has more and more been adopt by construction companies as an initiative to solve quality evils and to meet the needs of the ultimate client, if yet an business wanted to take up the concept of QMS (Quality Management System) in the construction industry. on the other hand, implementing QMS ideology in construction industry is above all tricky because of the many parties involved.

IV.DATA COLLECTION:

SITE DETAILS

- Name of site : 18 latitude
- Location of site : Punawale, Mulshi, Pune
- Site Engg: Manoj Gawade
- A proposed commercial building having 7 floor and102shops is taken for case study location is in Punawale.
- Design Team: Sanskrit construction
- Owner and Developer :G. D. Square and akshaychordiya
- Architect: Rajas Designers
- Cost of project : 16 Cr
- Structural Engineer : Structus Consultantss
- Builder :G. D. Square and akshay chordiya
- Area: 92000 sq.ft.
- Commercial building having No. of Towers: 1, No. of Floors: 7 Floors, No. of showroom:6.
- Present condition of the project : under construction
- No. of Towers: 1,No. of Floors: 7 Floors, No. of showroom: 6

Fig 2: 3rd eye view of actual site

Fig 3: First floor slab

Fig 4: layout plan

Fig 5: center line plan

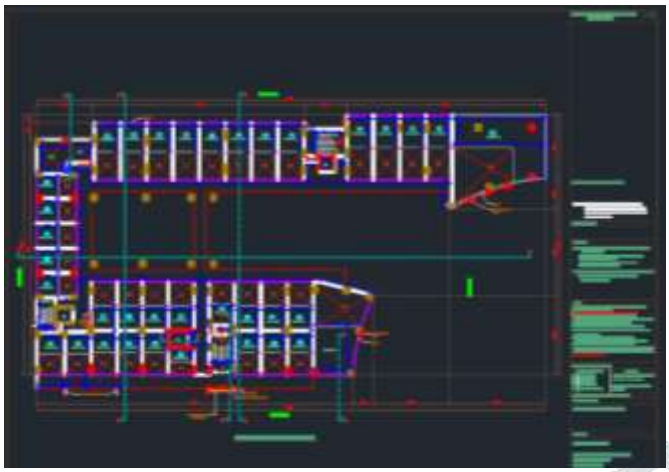

Fig 6: 2nd floor plan

Fig 7: plinth beam layout

18 latitude by G. D. Square and Akshay Chordiya

18 latitude is spread across beautiful 92000 sq.ft., of which nearly 50% is reserved for greenery and open spaces. The landscape is designed in a contemporary resort style, with the lush tropical planting to cool the environment and provide beauty.

Fig 8: Site Condition

V.RESULTS AND DISCUSSION

LOD 300 REVIT MODEL:

LOD 300 MODEL PREPARED IN REVIT SOFTWARE:

Using Autodesk Revit software 3D model of building is prepared in LOD 300.

Following are image of model, framing of model, development of model and final LOD 300 model.

After 3D modelling proceed to scheduling in Microsoft Project software. And then 4D model in Autodesk Navisworks will work out.

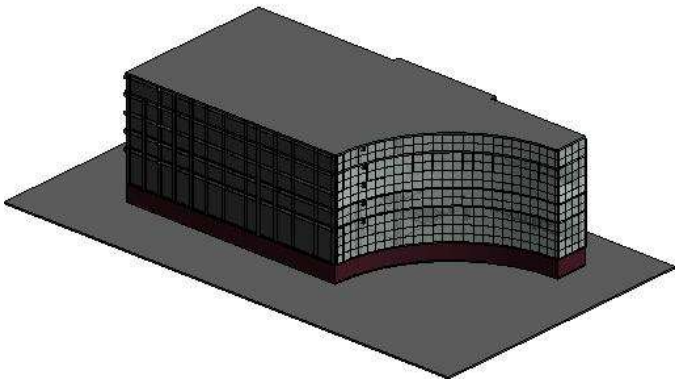

Fig 9: 3D Model

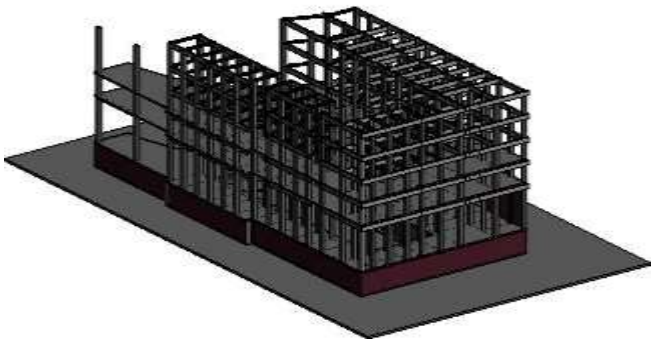

Fig 10: 3D Model LOD 300

Naviswork modelling: LOD 400 MODEL

3D model from Revit software and Schedule from MSP is imported to the Naviswork and 4D model is done in Naviswoks. In this software simulation is workout

Fig 11: SCHEDULING IN MSP

Fig 12: BAR CHART IN MSP

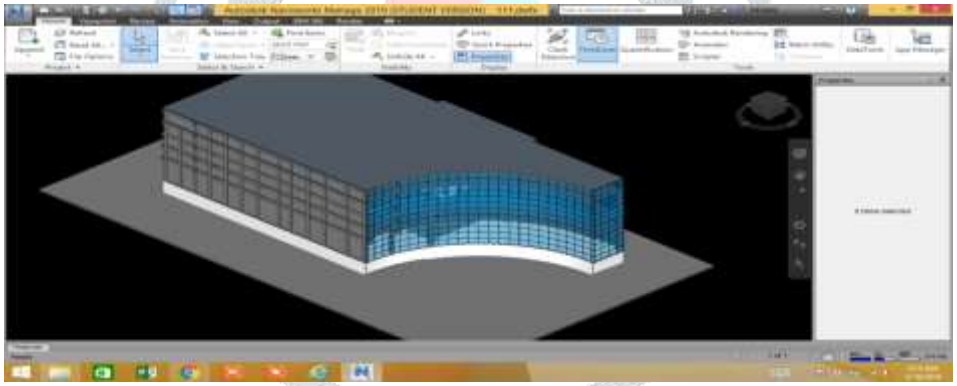

Fig 13: LOD 400 MODEL

Fig14: LOD 400 MODEL + SCHEDULLING

CLASH DETECTION TEST FOR QUALITY

In this step clash detection test is ran for column level and zero clash observed, hence it can be approved **for further construction in this way the quality management can be achieved**

GRAPHICAL REPRESENATATION:

It is observed that by using BIM technology we can save total 102 days of construction of building.

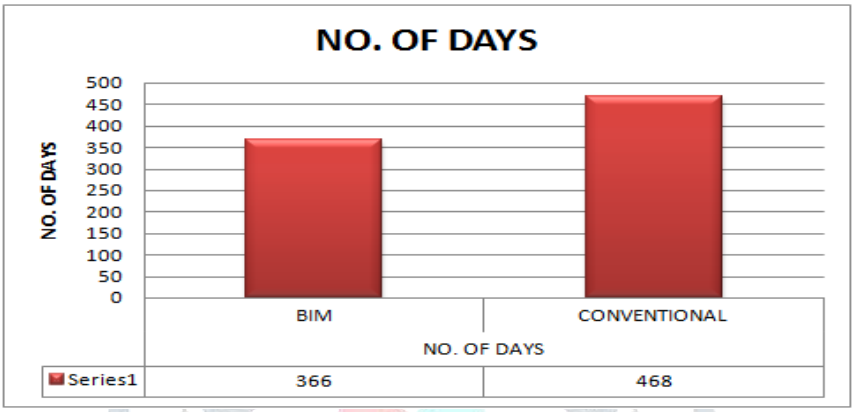

Fig 15: 4D PARAMETER

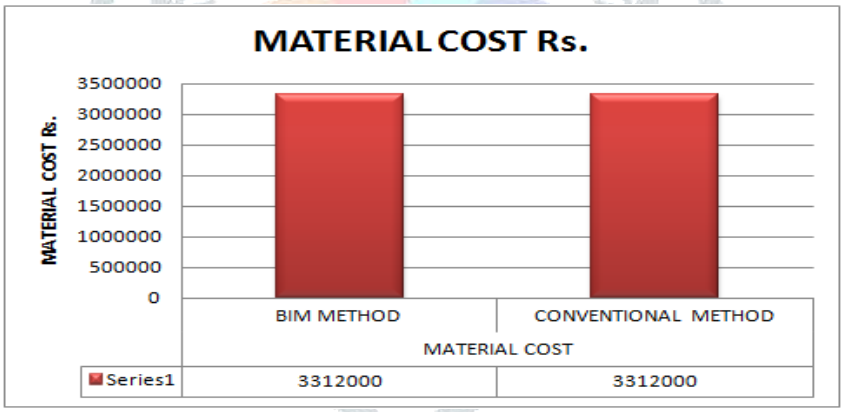

Fig 16: 5D PARAMETER

ANALYSIS OF QUESTIONNERIES

2D is inefficient to true BIM workflow in the working drawing phase than 2D CAD

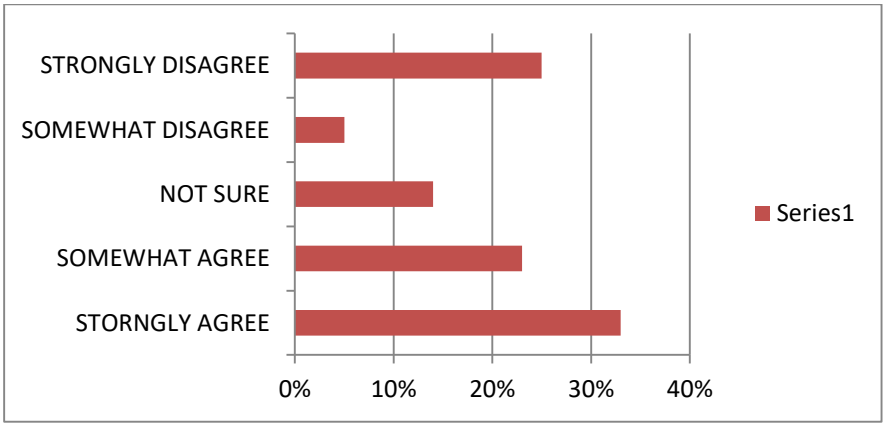

Fig 17

Adopting BIM workflow will lead to better architectural works.

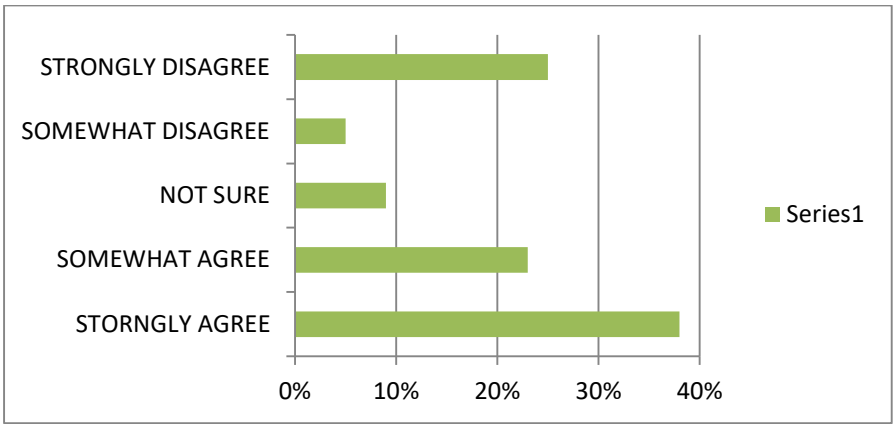

Fig 18

What difficulties you observe regarding quality management and quality improvement as per ISO standards?

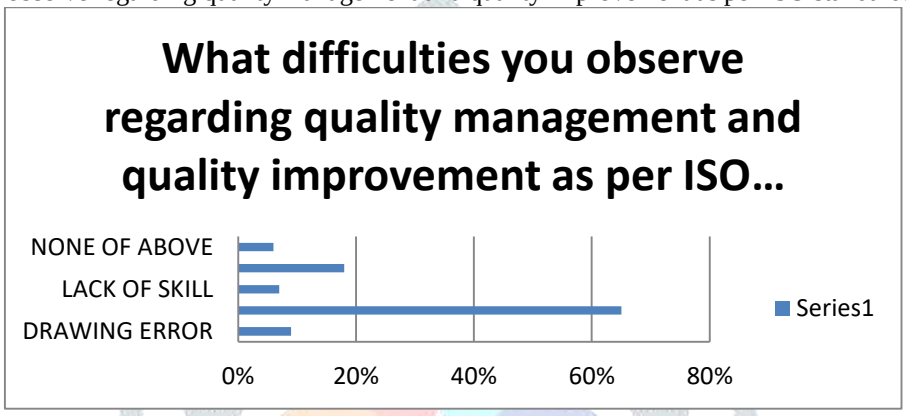

Fig 19

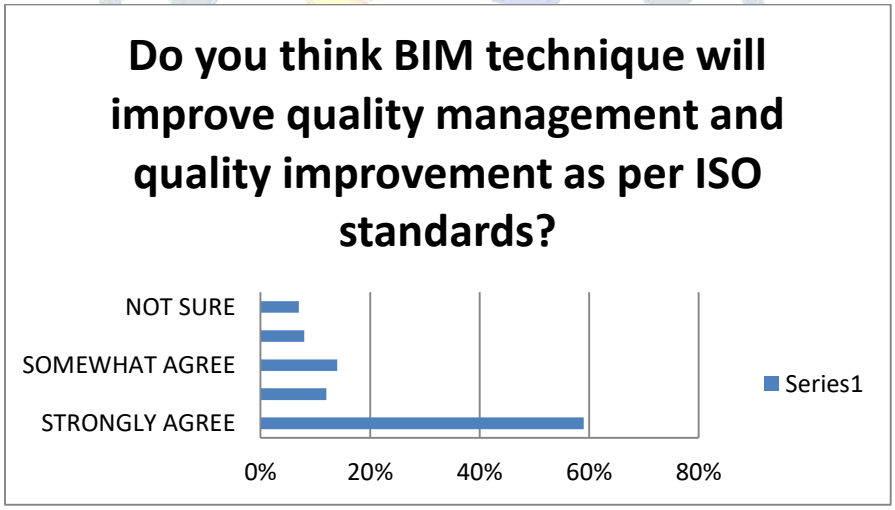

Fig 20

VI.CONCLUSION

In this paper the BIM method is used for effective construction management, the quality management improvement is studied and it is observed that using clash detection effective coordination of various parties can be maintained. Furthermore the number of schedule days can be reduced to 25-30% by reduction in planning, analysis and design days

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