

**REPUBLIC OF TURKEY  
YILDIZ TECHNICAL UNIVERSITY  
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**5D BUILDING INFORMATION MODELING BASED  
CONSTRUCTION QUALITY LIFE CYCLE INSPECTION PLAN  
TO IMPROVE PERFORMANCE OF CONSTRUCTION PROJECTS**

**SARMAD FARAJ ISMAEL AL-HUMAIRI**

**MSc. THESIS  
DEPARTMENT OF CIVIL ENGINEERING  
PROGRAM OF CIVIL ENGINEERING**

**ADVISER  
ASSIST. PROF. DR. ZEYNEP IŐIK**

**İSTANBUL, 2017**

REPUBLIC OF TURKEY  
YILDIZ TECHNICAL UNIVERSITY  
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

5D BUILDING INFORMATION MODELING BASED CONSTRUCTION  
QUALITY LIFE CYCLE INSPECTION PLAN TO IMPROVE  
PERFORMANCE OF CONSTRUCTION PROJECTS

A thesis submitted by Sarmad Faraj Ismael Al-humairi in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** is approved by the committee on 28.03.2017 in Department of Civil Engineering, Civil Engineering Program.

**Thesis Adviser**

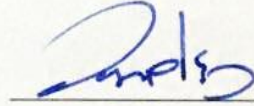
Assist. Prof.Dr. Zeynep IŞIK  
Yıldız Technical University

**Approved By the Examining Committee**

Assist. Prof.Dr. Zeynep IŞIK  
Yıldız Technical University

Prof.Dr. Yusuf ARAYICI  
Hasan Kalyoncu University

Assist. Prof.Dr. Cenk BUDAYAN  
Yıldız Technical University



## ACKNOWLEDGEMENTS

---

I gained from numerous years of interest in examining field that the ideal approach to catching feeling of learning is to be a specialist. In any case, this adjustment in the example of life was an uneasy and full with testing.

It was an establishment to work under the supervision and exhortation of Assist. Prof. Dr. Zeynep Işık who made it feasible for me. I express my earnest gratefulness for her backing and energy all through my time at Yildiz Technical University to tote an essential comprehension of Building Management. I might likewise want to thank for her direction, inside, and out remarks. Uncommon thanks are stretched out to all my kindred graduate understudies, for their liberality, supportive examination and consolation I got from them in the early phase of my exploration.

I welcome all my lab mates who were exceptionally kind to me as a nonnative and constantly prepared to relinquish their significant time because of me. They truly helped in interpreting my conceptual.

Finally, I might want to express my most profound appreciation to my folks, siblings and sisters and all relatives for their backing and tolerance. The last but by no means the least, the commitment and comprehension of my mom who might not be conceivable to depict with words are completely welcomed.

March , 2017

Sarmad Faraj Ismael AL-HUMAIRI

## TABLE OF CONTENTS

---

	Page
LIST OF ABBREVIATIONS.....	vii
LIST OF FIGURES .....	viii
LIST OF TABLES.....	ix
ABSTRACT.....	x
ÖZET .....	xii
CHAPTER 1	
INTRODUCTION .....	1
1.1 Literature Review .....	1
1.2 Objective of the Thesis .....	2
1.3 Hypothesis .....	3
CHAPTER 2	
BUILDING INFORMATION MODELING.....	4
2.1 Definitions and Concepts.....	5
2.2 BIM: 3D,4D and 5D .....	6
2.3 Roots of Building Information Modeling .....	8
2.4 The Benefits of BIM and Its Related Problems .....	9
2.5 Contemplations and Limitations of BIM .....	15
2.6 Basic Steps to Effective BIM Achievement .....	18
CHAPTER 3	
QUALITY MANAGEMENT IN CONSTRUCTION MANAGEMENT.....	21
3.1 Concept of Quality.....	21
3.2 Quality Management in Construction Management Methods.....	23
3.3 Special Nature of Construction Projects .....	25
3.4 Partial Completion and Receipt .....	26
3.5 Basic Principle of Total Quality Management .....	28
3.6 Problems of Quality Management in Construction Projects .....	30
3.7 Quality Management of Iraq Construction Projects .....	30

3.8 Summary .....	32
 CHAPTER 4	
BUILDING INFORMATION MODELING IN QUALITY .....	33
4.1 BIM for the Construction Industry .....	33
4.2 Sorts of Construction Firms .....	35
4.3 Steps to Develop a Contractor BIM.....	37
4.4 4D models and Its Relations with Construction Planning .....	39
4.5 Advantages of 4D Models .....	40
4.6 The Relation of BIM and Quality Management .....	41
4.7 Lijuan Chen & Hanbin Luo Research Objective and Methodology.....	42
4.8 Definition of POP Model & 4D Model .....	45
4.9 Conclusions Based on Previous Studies .....	47
4.10 Summary .....	48
 CHAPTER 5	
PROPOSEL 5D MODEL FOR QUALITY MANAGEMENT .....	49
5.1 Cost Valuation Provides For (5D) and Its Effect on Quality.....	50
5.2 Construction Quality Management Life Cycle Inspection Plan with 5D BIM .....	51
5.3 Proposal Concept Model.....	52
5.4 Role on Research: Model Analysis, Simulation, and Work Processes (The Model) .....	56
5.5 Benefits of The Model .....	57
5.6 Summary .....	58
 CHAPTER 6	
BUILDING INFORMATION MODELING CASE STUDY .....	61
6.1 Background on Related Work.....	62
6.2 Methodology and Hypotheses .....	63
6.3 Building Information Modeling(5D) for Existing Buildings(Case Study). 63	
6.4 5D Model-Based Building Quality Control.....	64
6.5 Description of Project .....	65
6.6 Case Study Form with BIM .....	69
6.7 The benefits applied Model on this project when.....	69
6.8 The Main Significant Goals of Proposed Model .....	74
6.9 Summary .....	75
 CHAPTER 7	
DISCUSSION AND CONCLUSION .....	77
7.1 Discussion.....	77
7.2 Conclusion .....	80

7.3 Main Results and Contributions .....	82
7.4 Recommendations for Further Studies .....	83
REFERENCES .....	84
CURRICULUM VITAE.....	89



## LIST OF ABBREVIATIONS

---

BIM	Building Information Modeling
LC	Life Cycle
IQD	Iraqi Dinar
AEC	Architecture, Engineering and Construction
FM	Facility Management
IFC	Industry Foundation Classes
AIA	American Institute of Architects
AGC	The American Institute of Architects
CAD	Computer-Aided Design
IPD	Integrated project delivery
QMC	Quality Management in Construction Projects
CQIS	Construction Quality Integration System
TQM	Total Quality Management
CM	Construction management
POP	Process, Organization, and Product
CQIS	Construction Quality Integration System
NCR	Nonconformance Report
CE	Cost Estimation
API	Autodesk Revit application programming interface
LOD	Level of Development

## LIST OF FIGURES

---

	Page
Figure 2.1	"BIM model creation processes in new or existing buildings" ..... 7
Figure 2.2	Relation between building life cycle ..... 8
Figure 4.1	"Percent of Firms in each major construction sector, 2004" ..... 36
Figure 4.2	"Typical Organization of a Project team for a building project"..... 36
Figure 4.3	The flow steps of BIM project (2DModel) ..... 38
Figure 4.4	Steps flow for a project (2&3D Model) ..... 38
Figure 4.5	"4D View of construction Vancouver construction center" ..... 39
Figure 4.6	"A snapshot of a 4D model and photos from the project site" ..... 40
Figure 4.7	"4D snapshots of a campus wide project showing various construction activities occurring throughout the campus to landscape, road, and facilities" ..... 40
Figure 4.8	The execution of construction quality management inspection plan using BIM quality model ..... 44
Figure 4.9	Product template, Organization template, Process template, BIM-based construction quality model ..... 45
Figure 4.10	Workflow of BIM-based construction quality model ..... 46
Figure 5.1	BIM Relationship of any Project..... 52
Figure 5.2	Process chart of 5D model..... 54
Figure 5.3	Relationship between project parts..... 56
Figure 6.1	Picture for the project (case study)..... 67

## LIST OF TABLES

---

	Page
Table 3.1 Systems and specifications adopted in the quality management and control in construction projects in Iraq .....	31



**5D BUILDING INFORMATION MODELING BASED  
CONSTRUCTION QUALITY LIFE CYCLE INSPECTION PLAN  
TO IMPROVE PERFORMANCE OF CONSTRUCTION PROJECTS**

Sarmad Faraj Ismael Al-HUMAIRI

Department of Civil Engineering

MSc. Thesis

Adviser: Assist. Prof. Dr. Zeynep IŞIK

BIM procedures are built up for new structures. Therefore, there is little concern about old structures, revamped or deconstructed with BIM yet scientists and researchers are encouraged to engage in the application of modeling built on the former buildings and to discover the benefits.

Because of fast advancements in BIM research, included partners request an innovative outline of BIM usage and exploration in existing structures. This thesis introduces a survey of BIM and recent academic papers on the topic. Results demonstrate that there is a rare BIM usage for the buildings, because of difficulties such as (1) high demonstrating/change exertion in incorporating information (2) upgrading data in BIM (3) treatment of unverifiable information, articles and relations in BIM based existing structures.

The research includes a short presentation portraying the origination and development of BIM. Development industry experts will reflect, with the advantage of the knowledge of the past, on the procedure changes that will have happened in the future. They will have probably found it as a different faction to recognize definitively between such influences as BIM, incline development, and execution - driven configuration. Without each other, these methods could, hypothetically, flourish all alone. Their effects, in any case, are corresponding in essential ways, and they are being received at the same time.

A framework can be more than just a pretty picture. The 3D visualization allows project stakeholders to better understand the building as it comes alive before their eyes. A 4D

model looks just like a 3D model, but it contains even more information about installation rates, productivity rates, crew sizes, and costs. And a 5D model looks just like a 3D model, but it includes component pricing and budgeting reports for the job. When these all put together and the iterative effect of 3D-4D-5D BIM is observed. As the model grows in complexity, it becomes the data-rich font of project knowledge. Each stakeholder can approach the model with different questions and what-if scenarios and receive near-instant analysis of the situation.

The employment of a unique Leveraged Integration process allows us to progressively increase the intelligence of the construction data model and support informed decision making.

**Keywords:** 4D&5D; BIM for quality management; Management of building information models; International BIM developments; building life cycle (LC) and Existing Buildings (case study)



**İNŞAAT PROJELERİNİN PERFORMANSINI ARTTIRMAK  
AMACIYLA DÜZENLENEN 5 BOYUTLU YAPI BİLGİ  
MODELİNE DAYANAN YAPI KALİTESİ YAŞAM DÖNGÜSÜ  
DENETİM PLANI**

Sarmad Faraj Ismael Al-HUMAIRI

İnşaat Mühendisliği Bölümü

Yüksek Lisans Tezi

Danışman: Yrd. Doç. Dr. Zeynep IŞIK

Yeni yapılar için yapı bilgi modeli (BIM) prosedürleri oluşturulmuştur. Bu nedenle, BIM modeli ile yenilenen veya incelenen eski yapılar hakkında fazla endişeye yer yoktur, ancak bilim adamları ve araştırmacılar, eski binalar üzerinde oluşturulmuş modelleme uygulaması ile meşgul olma ve bunların faydalarını keşfetme konusunda teşvik edilmektedirler.

Yapı Bilgi Modeli (BIM) araştırmasında kaydedilen ilerlemeler sayesinde, bir inşaat projesine dahil olan ortaklar Yapı Bilgi Modeli (BIM) kullanımının yenilikçi bir taslağını ve mevcut yapılardaki keşfi istemektedirler. Bu tez, Yapı Bilgi Modeli (BIM) anketini ve konu ile ilgili yazılmış güncel makaleleri içermektedir. Araştırma sonuçlarına göre, binalarda Yapı Bilgi Modeli (BIM) kullanımına oldukça nadir rastlanmaktadır. Bunun sebebi de, (1) toplanan bilgiyi birleştirirken gösterilen açıklama/değiştirme gayreti, (2) Yapı Bilgi Modeli (BIM) verisini bir üst seviyeye taşıma sorunsalı, (3) Yapı Bilgi Modeli (BIM) kullanılmış mevcut yapılardaki parça ve ilişkilerin, doğrulanamayan bilginin işlenmesi gibi zorluklardır.

Araştırma, Yapı Bilgi Modelinin (BIM) oluşumunu ve gelişimini kısa bir biçimde sunmaktadır. Kalkınma endüstrisi uzmanları, geçmişten bu yana elde edilen bilgilerden de faydalanarak, gelecekte ortaya çıkabilecek prosedür değişiklikleri üzerine kafa yormaktadırlar. Yapı Bilgi Modeli (BIM) prosedürü, gelecekte farklı bir alt grup olarak uzmanların karşısına çıkacaktır. Bu durumda, Yapı Bilgi Modeli (BIM), eğitim geliştirme

ve yürütmeye dayalı kurulum gibi etkenler belirlenir. Bu yöntemler, birbirleri olmadan, varsayımsal olarak tek başlarına gelişebilirlerdi ve etkileri, her durumda, önemli bir şekilde iletilir ve alınır.

Bir yapının iskeleti aslında güzel bir görünüşten çok daha fazlasıdır. Yapının 3 boyutlu görseli, binanın nasıl olacağını gözler önüne serdiği için, hissedarların yapıyı daha iyi anlamsını sağlar. 4 boyutlu model, 3 boyutlu model gibi gözükmeyle beraber; montaj maliyetleri, verimlilik oranları, ekipteki insan sayısı ve maliyetler hakkında bilgi içerir. 5 boyutlu model de, aynı 3 boyutlu model gibi görünür ancak işle alakalı bileşen fiyatlandırmayı ve bütçe raporlarını bünyesinde barındırır. Bunların hepsi bir araya geldiğinde, 3-4-5 boyutlu Yapı Bilgi Modeli'nin (BIM) tekrarlayan etkisi gözlemlenebilir. Bahsi geçen bu model karmaşıklıkça, projenin zengin veri kaynağı haline gelmektedir. Her bir hissedar modele farklı sorularla ve çeşitli varsayım senaryoları ile yaklaşabilir ve hemen durumun yaklaşık bir değerlendirmesini elde edebilir.

Eşsiz bir Kaldıraçlı Bütünleştirme sürecinin kullanılması, inşaat sektöründeki paydaşlara yapı veri modelinin işlerliğini artırma imkanı sağlar ve bilinçli karar verme sürecini destekler.

**Anahtar Kelimeler:** 4 Boyutlu & 5 Boyulu; 4D & 5D; Kalite yönetiminde Yapı Bilgi Modeli (BIM); Yapı Bilgi Modellerinin yönetimi; Uluslararası Yapı Bilgi Modellerindeki (BIM) gelişmeler; Yapı yaşam döngüsü (LC); Mevcut binalar (vaka çalışması)

### INTRODUCTION

#### 1.1 Literature Review

The importance of the construction sector in everyday life to man and in the national economy can be noticed for all countries. This derives from that the achievement of quality in the industry has economic effects leading to reduction in the production costs through removal of defects, debugging costs, re-implementation of some of the rejected works, achievement satisfaction of users and reduction in maintenance costs during the period of use, thus contributing to the increasing age of economic facilities. The executing agency also gains the confidence of its business and increases its share of the labor market allowing them the possibility of competition and continuation [1].

The BIM process is usually done by the three-dimensional modeling of real-time and of the most appropriate cost as well as a dynamic program to maximize capacity in the field of design and building. The process of an informational model of the building, which includes spatial connection, geographic data quantities and properties of building elements, can also contain all the pieces (such as furniture and fixtures) directly linked to choice and request or inquiry about their prices to see the total cost with the rest of the materials used [2]. This method is more active and more effective than traditional methods in the query and cost control of construction projects. It removes many of the obstacles and surprises that arise during the implementation period as it can be verified during the design phase and prevents them so as not to hinder the work later. In addition, any changes will be made during the real process of construction in the informational model of the building and keep it asymptotic to the truth as possible, which later helps in the maintenance and management of the building. In addition to controlling each object individually, the modeling process defines the object's links [3].

If for example, what has been associated with a particular object has changed the last object in some way, both objects will change depending on the relationship between them. The program rejects this change if it is opposed to the logical relationships in the model between objects.

## **1.2 Objective of the Thesis**

This thesis has been written to provide support for the project's decision-making processes, to have the parties commit to the project objectives by means of using the building information model, to visualize design solutions, to assist design and the coordination of designs, to increase and secure the quality of the building process and the final product, to make the processes during construction more effective, to improve safety during construction and throughout the building's lifecycle, to support the cost and lifecycle analyses of the project, to support the transfer of project data into data management during operation [4].

Construction modeling aims to support a design and construction lifecycle process that is of high quality, efficient, safe and in compliance with development. Building information models are utilized throughout the building's lifecycle, starting from initial design and continuing even during use and facility management (FM) after the construction project has been concluded.

This thesis provides support for investment decisions by comparing the functionality, scope and costs of the solutions. Lifecycle analyses for the purpose of comparing solutions, design and objectives of facility management follow-up have been made. Design visualization and analysis of the construction feasibility have been performed. Quality-assurance and data exchange have been enhanced making the design process more effective and efficient.

The assets increase total earned costs by using 5D models, savings of up to 10% of the contract value through clash detections and up to 7% reduction in project time, additionally creating a good quality in the implementation of the building.

### **1.3 Hypothesis**

The initial research hypotheses state that 5D technology can be valuable to construction management practices, and have a benefit although 5D/BIM modeling is saving time and cost. It also considers that 5D modeling is of interest at the design stage, especially for early analyses of constructability issues. Finally, the research claims that 5D Level of Development (LOD) specifications have to fit the targeted project stage and remain flexible enough to enable both processes with 5D models, from construction sequence to constructability analyses of details.



### **Building Information Modeling (BIM)**

BIM is most of the time seen as an execute for envisioning and planning Architecture, Engineering and Construction (AEC) (design, building, and development) works, shunning blunders and oversights, correcting efficiency, invigorating booking, security, expense, and quality administration on development projects and ventures. It consolidates all the construction parts, including dimensional surfaces, ownership of land connections, monarchy, and amounts. BIM can furthermore invite and keep up data caught amid the entire life and health of building ventures from outline to support and can be connected to the several domains [5]. Despite the fact that BIM is considered accommodating in enhancing plan quality by disposing of contentions and decreasing revamp, there has been a consequential examination into utilizing BIM all inside the endeavor for advancement of quality control and capable data use. Given the consistency of arranging the data with quality information and improvement functionality of quality control management, the ability of BIM execution in quality organization is arranged in its competence to display involving several dimensions or aspects specific to information plan and time succession [6].

As with the traditional issuing of information, BIM is equally subject to a quality assurance to ensure the data is correct and appropriate [7]. This review process usually takes two forms: 1) Virtual design reviews: Performed throughout the design process, where the design team regularly shares its work to ensure that the design is fully coordinated. 2) Formal design team reviews: The model is reviewed as a whole. Comments are electronically recorded within the model environment, thus ensuring that feedback remains connected while keeping a right choice. Like any new process, change takes time, especially in an industry as fragmented as construction. However,

the streamlined and cost-effective design process of BIM offers cost reduction, time implementation reduction and quality improvement. If those construction companies commit to BIM, the benefits will be greater [8].

In this chapter, we'll audit building data displays and its related innovations, potential advantages, expenses and necessary foundation. It likewise talks about the current and after time impact of BIM on controllers; legitimate exercise connected with the development business; and makers of building items. The substantial arrangement of BIM contextual investigations portray the different devices and procedures of BIM, the parametric displaying of structures, and interoperability issues too.

## **2.1 Definitions and Concepts**

In the previous decades, there was a developing enthusiasm for the development part in utilizing (BIM) 2D due to numerous advantages and asset funds amid outline, arranging, and development of new structures. Advancement of 3D displaying began in the 1970s, in light of the early PC supported outline (CAD) endeavors in a few industries. While numerous businesses created coordinated examination devices and item based parametric demonstration (the fundamental idea of BIM), the development segment was bound for a long while to the general 2D outline [9]. BIM display was presented in pilot ventures during the mid-second millennium to bolster building configuration of modelers, what design is. In this way, real research patterns concentrated on the change [6].

BIM is the process of creating and managing building data during its life cycle, this kind of modeling involves designing objects (opaque and unknown, general or specific products, solid or vacuum forms (such as the shape of the room) those objects carrying geometric properties, relationships, and attributes associated with them. In modeling informatics system, one must allow design tools to extract different projections of a building for productive purposes and other uses. These projections are automatically consistent with each other in the sense that all objects differently match projections regarding size, shape, and location in which each object are defined only once, as is the case in reality. Browsing automated elevations eliminate many errors that occur from the usual fee for each unit on the way home [10].

BIM is a magnificent tool for data management capable of implementing information technique and project management. It is a new in-depth intelligence for building

information technology, and hierarchical matters connected with its execution and the significant effects that viable utilization of BIM can give individuals from an undertaking group [11]. This study indicates how planning, development and working structures with BIM vary along with proceeding with the same exercises in a customary way or utilizing representation by hand or utilizing a PC.

BIM is a window for the new look of the building, how it works and the ways it's constructed. BIM is a term to describe Construction Information Modeling, instead of the object (building information modeling). It mirrors the conviction that BIM is not a sort of programming but rather a human activity that includes a large operation in the changes of the construction sector eventually [12].

## **2.2 BIM: 3D, 4D and 5D**

BIM approach "offers integrated data management, component libraries, and general functionalities. Widespread differentiations of BIM are 3D (spatial model with quantity takeoff), 4D (plus construction scheduling) and 5D (plus cost calculation) BIM" [9].

Diverse BIM creation forms for structures appear in Fig.2.1. For time structures, BIM is made in a procedure for life cycle (LC) stages (case I). Since not all Architecture, Engineering and Construction/Facility Management (AEC/FM) partners in the building utilize BIM - in some cases LC- yet, some make secluded BIM exclusively for an assigned, single reason. In existing structures – people rely upon the accessibility of previous BIM. It can redesign (case II) or be made once again "(case III). In Europe, more than 80% "of private structures were constructed "before 1990" and primarily do not have any "documentation in BIM" [9]. Consequently, if executed step by step, basically manual figuring out procedures ('focuses to-BIM', 'sweep to-BIM') (case III) helps recovering building data.

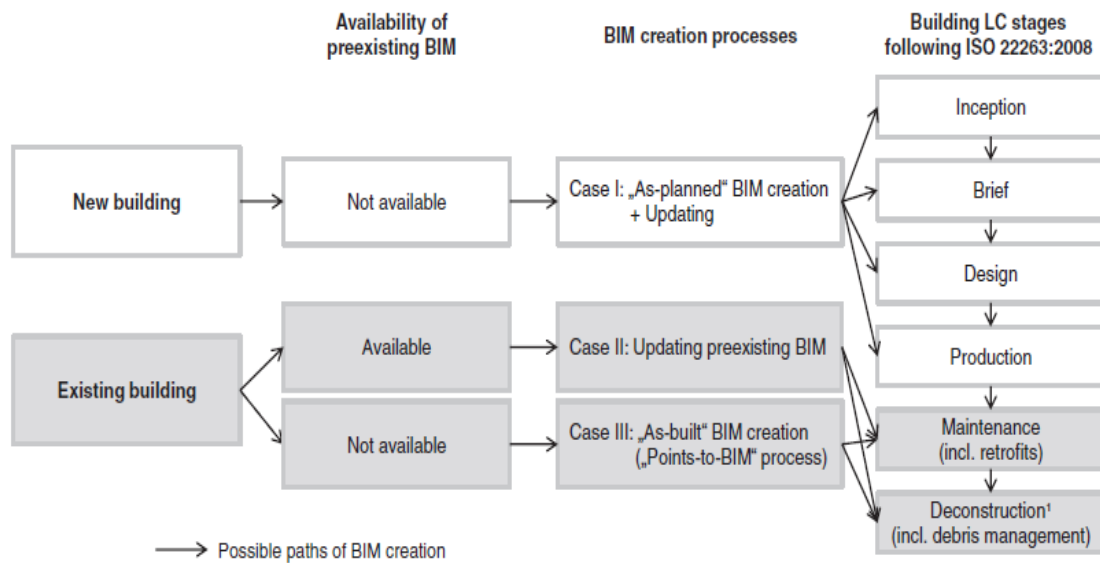


Figure 2.1 "BIM model creation processes in new or existing buildings" (Source: Volk. R et al.; 2014).

As portrayed in Fig. 2.2, BIM, in a more extensive sense, can be separated into interrelated practical, enlightening, specialized and hierarchical/lawful issues. Contingent upon the partners' requirements and the task prerequisites, a BIM layout is utilized to bolster and carry out master administrations for structures; for example, vitality or natural examinations. In this manner, two sorts of master programming may associate with a BIM layout: (1) information implementation giving administrations of import, information catch and observation, information handling or change of caught information into BIM or (2) information yield applications giving reports or specialized investigations, for example, auxiliary and vitality examinations or conflict discoveries [9]. Because of various outline, design, development, upkeep, and deconstruction administrations amid "building Life Cycle, potential applications and required functionalities of BIM" structures and bases are complex. Contingent upon the partners and undertakings' prerequisites, BIM with e.g. engineering, "constructional", funneling and "electrical" [9], auxiliary, manufacture or observing usefulness is required.

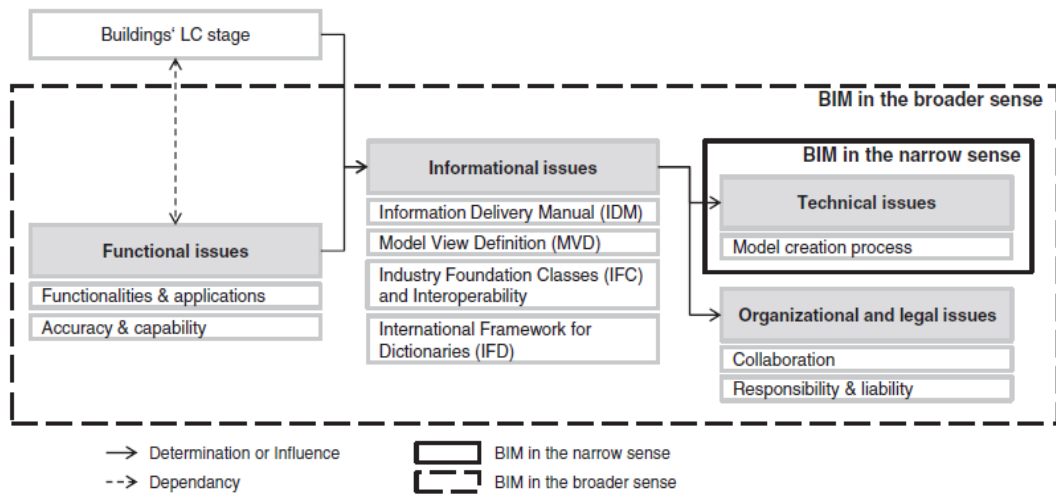


Figure 2.2 Relation between building life cycle (Source: Volk. R et al.; 2014).

Functionalities are latent "in 3D, 4D or 5D BIM (e.g. quantity takeoff, scheduling or cost calculation) or they are attached to BIM as independent expert applications. Expert functionalities use the underlying BIM data to support, extend, calculate or simulate specific business requirements (e.g. perform structural analysis). Results are either reintegrated into BIM or reported separately. Functionalities are based on process maps, which describe the logical flow of information and activities as well as the stakeholders' roles within a particular functionality." [9]

### 2.3 Roots of Building Information Modeling

Phil Bernstein, an architect, a fellow of the American Institute of Architects Strategists and an expert in the industry, was the kickoff of BIM abbreviation for "Building Information Modeling" in English, then Jerry Mazarin aided circulation and unified the term with a "common name for the digital representation" construction process [13]. After that, Graffy proposed that companies should offer different terms to be adopted such as "virtual building", "the company Autodesk," Building information modeling "to assist the exchange of information and combined work in digital form." [14].

According to those and others, the first real application of the concept of information modeling as the default building is Graphisoft ArchiCAD, the first appearance being in 1987.

BIM "covers relationships spatial analysis, geometry information, geographic information, quantities and properties of building components" [15]. (e.g., manufacturers, details). The whole life cycle of the building can be represented in a modeling information manner, including the construction and the facility operations. This method works from modeling to facilitating a variety of tasks such as extraction and classification of quantities and specifications of the materials used. It can also work part-time for everyone in the team, as a distribution site for buildings and internal brushes, coordinating the functions of different people working separately in the same centralized model. Systems and stages and groups can be displayed in proportion to the entire group, installations scale facility. It also includes necessary information from the building, such as sensor measurements and control signals from the building regulations [9].

#### **2.4 The Benefits of BIM and its related Problems**

BIM approach can backup and progress much commercial activity. A marked improvement has been achieved compared to traditional 2D CAD or the hand drawing in order to explain how BIM is considered helpful to the project from its start. Well-known owners must determine whether any of the specific areas and a number of floors, under quality control and specific requirements like calculated cost and time can a given building meet the budgetary necessities of a proprietor. On the off chance that these inquiries can be replied with relative assurance, proprietors can then continue with the desire that their objectives are achievable, given that a specific configuration is altogether an over spending plan after a lot of time, and exertion has been exhausted and is inefficient [16].

Building up a preceding schematic model, produces an itemized construction model considered as more cautious assessment of the proposed plan to figure out if it meets the building's useful and maintainable prerequisites. Early assessment of configuration options utilizing investigation/reproduction instruments expands the general nature of the building. Prior and "more accurate visualizations of the 3D model design" created by the BIM programming is outlined straightforwardly as opposed to being produced

from various 2D dimensions. It can be used to imagine the outline at any phase of the procedure with the wish that it will be dimensionally predictable in each perspective [17].

In the case of lack of high corrections when making modifications to design, on the off chance that the objects utilized as a part of the configuration are planned by parametric tenets that guarantee appropriate arrangement, the 3D model will be constructed decreasing the client's need to oversee plan alteration.

With produced and consistent 2D graphics conforming to the Design [24], "Exact and predictable drawings can be separated for any arrangement of articles or specified perspective of the task. This significantly decreases the measure of time and number of mistakes connected with creating development drawings for all configuration disciplines. At the point when changes to the outline are required, completely predictable drawings can be produced when the configuration modifications are entered" [12].

BIM advancement empowers contemporary work by various arrangement corrections. "While collaboration with drawings is furthermore possible, it is normally more diffraction and monotonous than working with one or more sorted out 3D models in which change - control can be all together supervised" [12]. This condenses the setup time and altogether diminishes arrangement missteps and avoidances. It similarly gives earlier learning into diagram issues and shows open entryways for a setup to be continuously advanced. This is significantly more fiscally keen than holding up until a diagram is about to be completed and a short time later, applying regard assembling just after the noteworthy arrangement decisions have been made.

Subtle productions, regular 2D graphics at any stage of design, and, reliable graphics can be extricated for any arrangement of articles or fixed perspective of the undertaking. This, to a large extent, lessens the measure of time and magnitude of blunders connected with producing development graphics for all outline disciplines. At the point of modification of the configuration in demand, completely reliable layouts can be created when the outline modifications are entered. BIM innovation encourages synchronous work by numerous configuration disciplines [18].

However, cooperation with graphics is likewise conceivable; it is inalienable, entails more diffraction and tediousness than dealing with one or further planned 3D layout that

can be very much overseen. This abbreviates the outlined time and lessens plan mistakes and oversights. It likewise gives prior understanding into outline issues and introduces open doors for a configuration to be ceaselessly moved forward. This is a great deal more financially savvy than holding up until a configuration is almost finished and afterward applying esteem building simply after the real plan choices have been made.

BIM gives prior 3D representations and quantifies the territory of spaces and other accessories, taking into account prior and more exact cost gauges. For specialized structures (labs, healing facilities, and so forth.), the purpose of the configuration is frequently characterized quantitatively, and this permits a building model to be utilized to check for these necessities. For subjective prerequisites (this space ought to be close to another, and so forth.), the 3D model can bolster program assessments [19].

For any phase of the configuration, BIM innovation can separate an exact bill of amounts and spaces that can be utilized for cost estimation. In the early phases of an outline, cost appraisals are constructed basically in light of the unit cost per square foot. As the configuration advances, more definite amounts are accessible and can be utilized for more exact and determined cost gauges. It is conceivable to keep all gatherings mindful of the cost suggestions connected with a given outline before it advances to the level of itemizing required for development offers.

At the last phase of the configuration, an appraisal taking into account the amounts for every one of the articles contained inside the model takes into account the readiness of a more exact last cost gauge. Therefore, it is conceivable to settle on better-educated outline choices on costs utilizing BIM instead of paper - based framework [20].

Connecting the building model to vitality examination devices permits the assessment of vitality use amid the early plan stages. This is unrealistic in utilizing customary 2D devices which require a different vitality investigation performed toward the end of the configuration procedure, consequently lessening the open doors for modifications that could enhance the buildings' vitality execution. The ability to connect the building model to different sorts of investigation apparatuses gives numerous chances to enhance building quality. Development arrangements utilizing 4D layout presuppose connecting evolution schema to the 3D objects in an outline, with the goal that it is conceivable to reproduce the development procedure as well as the building's presentation and view

how this would look anytime. This realistic reenactment gives extensive knowledge into how the building will be developed from time to time, uncovers wellsprings of possibilities and issues and open doors for conceivable changes (view, group, hardware, space conflicts, wellbeing issues, and so forth.) [21].

This kind of examination is not accessible from study offer records. It does, notwithstanding, give included advantages if the model incorporates impermanent development questions, for example, shoring, framework, cranes, and other real hardware so that these items can be connected to calendar exercises and reflected in the coveted development arrangement [22].

Since the virtual 3D building model is the hotspot for every one of the 2D and 3D drawings, plan blunders brought about by conflicting 2D drawings have opposite effects. Moreover, because frameworks from all orders can be united and looked at, multi - framework interfaces are effortlessly an examination of both efficiency (for hard and delicate conflicts) and outwardness (different sorts of mistakes). Clashes are recognized before they are identified in the field. Coordination among taking interesting architects and temporary workers is upgraded and mistakes of exclusion are fundamentally lessened. This speeds the development procedure, decreases costs, diminishes the probability of lawful debate, and gives a smoother procedure to the whole venture group [21].

The effect of a recommended outline modification can be looked into the building model, and modifications to alternate articles in the configuration will naturally overhaul. A few redesigns will be made naturally taking into account the set of parametric standards. Extra cross framework overhauls can be checked and redesigned outwardly. The outcomes of change can be precisely reflected in the model and every single resulting perspective of it. Moreover, plan changes can be determined more rapidly in a BIM framework since alterations can be shared, pictured, evaluated, and determined without the utilization of time - expending paper exchanges. Redesigning in this way is to a great degree blunder - inclined in the paper - based frameworks [19].

On the off chance that the configuration model is exchanged to a BIM manufacture device and point by point to the level of creation items (shop model), it will have an exact representation of the building objects for creation and development. Since segments are now characterized in 3D, their mechanized manufacture utilizing

numerical control hardware is encouraged. Such computerization is a standard practice today in steel creation and some sheet metal work. It has been utilized effectively as a part of precast segments, fenestration and glass manufacture. This permits merchants worldwide to expand on the model, to create subtle elements required for manufacture and to keep up connections that mirror the outlined goal. This encourages the offsite creation and decreases expense and development time. The precision of BIM additionally permits bigger segments of the configuration to be manufactured offsite than would regularly be endeavored to utilize two-dimensional drawings, because of the possible requirement for location changes (revamp) and the failure to anticipate careful measurements until different things are built in the field [23].

The confrontation could predict that enhanced procedures in every period of configuration and development will decrease the number and seriousness of issues connected with customary practices. Clever utilization of BIM, notwithstanding, will likewise bring about noteworthy changes in the connections of venture members and the legally binding understanding between them. (Conventional contract terms are custom fitted to paper - based practices.) What's more, prior cooperation between the engineer, temporary worker, and other configuration controls will be required, as information given by authorities is of more use amid the outline stage. (This is not steady with the present configuration - offer - fabricate plan of action). While BIM offers new strategies for a coordinated effort, it acquaints different matters with deference with the advancement of viable groups [24].

Choosing the techniques, enhanced procedures in every period of configuration and development will lessen the number and seriousness of issues connected with customary practices. Savvy utilization of BIM, as it may, will likewise bring about huge changes in the connections of undertaking members and the authoritative assertions between them. (Customary contract terms are customized to paper-based practices.) Moreover, prior coordinated effort between the drafter, temporary worker, and other outline orders will be required, as information given by experts is of more use amid the configuration stage. (This is not steady with the present configuration - offer - manufacture plan of action.) While BIM offers new techniques for a coordinated effort, it acquaints different issues with deference in the advancement of successful groups [17].

Deciding the techniques, that will be utilized to allow satisfactory sharing of model data by individuals from the venture group is a huge issue. If the engineer utilizes customary

paper - based drawings, then it will be vital for the temporary worker (or an outsider) to assemble the model so it can be utilized for development arranging, assessing as well as coordinating and so on. Making a model after the configuration is finished, adds cost and time to the venture; however, it might be legitimized by the benefits of utilizing it for development arranging and nitty-gritty-outline by mechanical, plumbing, different subs and fabricators, plan change determination, acquisition, and so forth. On the off chance that the individuals from the undertaking group use diverse demonstrating devices, then apparatuses for moving the models starting with one environment then onto the next or joining these models are required. This can include multifaceted nature and acquaint potential blunders with the venture. Such issues can decrease by utilizing Industry Foundation Classes (IFC) benchmarks for trading information. Another methodology is to utilize "a model server that speaks with all BIM applications through IFC or exclusive benchmarks. That will be used to permit adequate sharing of model information by the members of the project team as a significant issue. If the architect uses traditional paper - based drawings, then it will be necessary for the contractor (or a third party) to build the model so that it can be used for construction planning, estimating, and coordination etc. Creating a model after the design is a complete addition of cost and time to the project, but it may be justified by the advantages of using it for construction planning and detailed design by mechanical, plumbing, other subs and fabricators, design change resolution, procurement, etc. If the members of the project team use different modeling tools, then tools for moving the models from one environment to another or combining these models are needed. This can add complexity and introduce potential errors to the project. Such problems can be reduced by using IFC standards for exchanging data. Another approach is to use a model server that communicates with all BIM applications through IFC or proprietary standards" [12].

Some of the contextual analyses exhibited in this study give foundation to this issue. Legitimate concerns display challenges, as for who claims the numerous outline, manufacture, examination, and development datasets, who pays for them, and who is in charge of their exactness. Practitioners through BIM use on ventures are tending to these issues. As proprietors take in more about the benefits of BIM, they will probably require a building model to bolster operations, support, and ensue redesigns. Proficient gatherings, for example, the American Institute of Architects (AIA) and The American Institute of Architects (AGC) are creating rules for an authoritative dialect to cover

issues raised by the utilization of BIM innovation. The utilization of BIM will likewise empower the coordination of development learning prior to the configuration procedure [16]. Incorporated outline firms manufacturers equipped for organizing all periods of the configuration and fusing development information from the start will have most advantages. Contracting game plans that require and encourage great joint effort will give focal points that are more prominent to proprietors when BIM is utilized. The most critical change that organizations face while actualizing BIM innovation is utilizing a common building model as the premise of all work forms and for cooperation. This change will require time and training, as is valid for every single huge change in innovation and work forms [22].

## **2.5 Contemplations and Limitations of BIM**

BIM can enhance the correspondence and coordination between the diverse partners of a venture. BIM's advantages range from basic enhancements in effectiveness and coordination to more noteworthy customer fulfillment [25].

When deciding the techniques, each association at present using "2D or 3D computer-aided design (CAD) drafting"[8] programming can be characterized by a cost component versus buying, keeping up and updating programming authorization to have a useful and focused business sector. Present patterns demonstrate that the expense of BIM programming bundles has a tendency to be more costly than available CAD programming bundles accessible. With the presentation of BIM programming, the prerequisites on equipment have expanded essentially. At present, CAD programming can be worked (with constraints) for a larger part of expert portable workstations. However, through a presentation of BIM programming, devoted high-particular workstations, proportionate to those in demand by cutting edge displaying and execution programming, are desired [18].

Programming and program prerequisites are in front of equipment accessibility. With BIM programming, it is a key to realize precisely what specifications of the equipment enhance execution and what components have no significant impact by any stretch of the imagination. More points of interest on the equipment necessities for BIM programming might be found in the getting started areas.

The expense of traineeship, with modern programming, is an awesome interest to prepare staff rapidly so that a venture can be supported. It is not sensible to accept

experts with CAD capabilities with the ability to understand new BIM programming rapidly or without particular preparation. According to key contrasts amongst BIM and CAD, preparation ought to be viewed as a prerequisite for all experts required with outlining and creating documentation [26].

BIM gives the capacity to each group to be required in the outline and demonstrates the process, giving them full observation of the finished item. Interest in preparing for early adopters gives them an aggressive edge with activities that have obviously indicated necessities to be recorded using BIM [16].

Transference from formula to modeling, at the point when "moving from a CAD-based drafting environment to a BIM-based displaying environment", is an adjustment in the work process encompassing what was applied to be straightforward drafting undertakings; for example, duplicating markups or getting red lines. These assignments now require a more elevated amount of talented configuration drafter who has a comprehension of the venture and the materials utilized. The expenses connected with preparing and keeping up a gifted outline modeler are higher than a designer with no information of the exchange. A few organizations may even be constrained to stay out of the BIM world through and through because of the time and information concentrated nature of BIM. The move from customary CAD will likewise put an expanded level of obligation on the designer to guarantee that all framework segments are facilitated with the other configuration experts; for example, design and building administrations that site issues are decreased to a base. Organizations have a couple of various plans of action to consider when pondering staff preparing regarding BIM [27].

First: The primary choice includes the preparation of current originators to attempt the greater part of their configuration work in the BIM environment [22].

Second: It includes over-skilling of the majority of their drafting staff to a higher specialized level in order to embrace outline obligations [19].

Third: It is a blend of the initial two where there is a particular arrangement of tenets and rules for print-ups with the goal that configuration profit margins can be deciphered into the model plainly and productively [24].

Regardless, the BIM procedure takes into account facilitated conveyance before the configuration procedure so the twofold potential taking care of or update is avoided.

This advantage exceeds the expense of any extra preparation to up-aptitude staff regardless of what is the plan of action for the conveyance of BIM ventures.

Interoperability between Software Platforms, - one of the greatest issues with early connectors of BIM is the issue of between item similarities. Because of the new nature of the business sector, producer of the each product is accomplishing something other than what is expected with its product. "This interoperability test can make it troublesome for ventures to work if diverse colleagues own distinctive programming bundles" [28].

This interoperability issue is not constrained to various programming stages; because of the fast advancement of the BIM programming industry, more up to date adaptations of projects inside the same stage can have interoperability issues. "This interoperability issue is not limited to different software platforms; due to the rapid development of the BIM software, newer versions of programs for the industry within the same platform can have interoperability issues" [29].

One contrasting option to the present items' particular models is a merchant autonomous, impartial document group. One such document arrangement "is the Industry Foundation Classes (IFC)" position, which catches "both geometry and properties" of the smart buildings (objects with related usable metadata) and their connections inside "Building Information Models", hence encouraging the sharing of data crosswise over generally incongruent applications [29].

Advancement, since an objective of BIM is to relegate limitations and parameters to wise items to enhance proficiency, there is a possibility to repress advancement, which would conceivably generally happen without the computerized forms and shared learning that BIM now gives. Those organizations actualizing BIM ought to see the "parameters and metadata" requirements as a worldwide "database that" permits planners to spare time connected with overhauling and arranging particular item information dully on various tasks, thus expanding the measure of time spent on framework outline and advancement [29].

## 2.6 Basic steps to effective BIM Achievement

BIM usage assesses appropriate arranging, persistence, and whole responsibility of all levels of the association. While acquainting BIM with an association, continuing with just a base measure of information is a typical mix-up and can be unreasonable.

Developing a BIM Action Plan, building up a strong BIM activity arrangement ought to be the initial move toward earning your association and it works in a BIM domain. Without this arrangement, setting it up is difficult to remember what data is required for it to be fruitful. The arrangement ought to comprise two noteworthy segments: examination and execution [30].

Analysis, a main share of the arrangement ought to center on data about "gathering about current" strategies, "methods and business" procedure. The move to a "BIM" work process is a noteworthy movement for any association on "all levels"; overall, it is an incredible time to look deep into your work process to discover any wastefulness that can be altered [29]. The examination segment of a BIM activity arrangement ought to include:

- Existing identification and analysis of operations; it is vital to direct a nitty-gritty examination of existing inner and outside business procedures to build up a gauge where to begin to accomplish the objectives built up later in the arrangement. This investigation ought to incorporate a definite audit of how activities are at present handled through the association from beginning advertisement through consummation.
- Technology analysis, a point-by-point innovation examination distinguishes existing equipment and programming advancements and their related costs used by the association. A survey of the current archive and information administration ought to likewise be incorporated into the investigation.
- Value Analysis, the move "from a CAD-based" association to a "BIM-based" association conveys a critical cost sway on three noteworthy fronts:

"Hardware": Present "BIM" programming which "requires a higher"-execution "workstation" when contrasted with a "CAD" programming on a similarly measured task. "This BIM" usage "may require" a noteworthy redesign "of current" frameworks to guarantee productive work process [29].

Software: BIM programming should obtain the best asset for data on the best form of programming and backing to buy the numerous affiliates out there. With affiliates, examination of subtle elements of needs and marketable strategy to distinguish the right course to take - whether it is a solitary permit or an out and out membership with specialized backing is possible [21].

Workforce: Educating and preparing representatives to utilize BIM programming and the new related conveyance forms, which costs cash. This expense will most straightforwardly identify with preparing, however, there will likewise be a provisional loss of profitability while existing procedures are transitioned to another technique. Once the previously stated examinations have occurred, the following stride is to build up a generally staged technique for execution. The execution ought to include:

Timeline: A point-by-point timetable is required to guarantee the general system executed in an auspicious and sorted out procedure [27].

Staff alteration: A variation to a BIM transport process addresses a noteworthy change to a present CAD work process and along these lines a change to individual agent parts. The best change is to move a long way from unadulterated" drafters with the BIM" technique focused on building an assignment "in the virtual environment", the people who are interfacing "with the model require more trade" figuring out how to be successful [29].

As a rule, two new parts will characterize inside the Association: a BIM organization director and task BIM administrators. A BIM organization director will lead the charge for the organization and be the controlling power behind usage, models improvement and programming choices. On every undertaking, a BIM task director ought to be relegated by who is in charge of venture related BIM choices, interfacing with other undertaking colleagues, BIM administrators, and support of the model [19].

Preparation Plan: Preparing a BIM stage is best finished by utilizing an "in the nick of time" strategy. A ton of the ideas required with BIM are altogether different when contrasted, and a customary CAD work process in this way is best known to take a shot at a genuine task. A demonstrated technique for achievement is to have various days of preparation comprising of large portion of a day for classroom guidelines taken significantly after a day of real work venture with the educator accessible for hands-on instructing. The preparation ought, to begin with just a little gathering of representatives

on a solitary venture so they can streamline the BIM work process preceding getting the whole association up to speed [28].

It is in a likely manner, good for not exactly a lone delegate, to get the start and finish planning and a short time later, go about as the BIM executive of the association. This individual can then be the "go-to individual" for help and can lead the establishment of models. Compelling BIM executions inside an association starts with the basic vision of advancement and buys in from all people of the affiliation. Senior power needs to support the change and surrender a little, to begin with reaping future prizes. Diverse affiliations are at all periods of the BIM execution process - from mulling over it, starting to realize and to completely working in a BIM work process. Moreover, various close-by and neighborhood BIM and Integrated Project Delivery (IPD) bundles meet all an ideal opportunity to discuss BIM-related subjects. It is basic to interface with industry partners to share triumphs and dissatisfactions to better the general business. The way to accomplishment in any BIM undertaking is shared exertion among all colleagues, which incorporates yet is not restricted to the venture proprietor, the configuration group, general contractual worker, subcontractors and merchants/suppliers. Data information must stream unreservedly between the majorities of the BIM venture colleagues to get greatest focal points in a BIM venture. The venture proprietor assumes a focal part in driving the dialog and basic leadership process concerning applying BIM to his/her anticipation [31].

Use open BIM resources to help grasp more advanced BIM thoughts and practices. Set aside enough resources for certification that your affiliation is buying programming and is partaking in a business methodology that will meet your present and future business needs and open doors. With a sharp execution of BIM advancement, your gathering starts to make aptitudes and strategies, build trust in the item and pace the future work for potentially favorable circumstances. For your affiliation, it will mean new opportunities to give the most raised measure of things [25].

### Quality Management in Construction Projects (QMC)

The construction project considered as one of the oldest industries known to man, that has flourished since the ancient historic covenants has advanced degrees and achieved excellence in construction and its methods. The ancient monuments; pyramids in ancient Egypt, Roman theaters, ancient Babylon, the Great Wall of China and other testaments to the greatness of these projects and prosperity in the past as well as its products have been and continue to reflect the extent of civilization [32].

This study aims to review the reality of quality management in the construction sector and rates compared with the supposed situation are provided in order to identify points of weaknesses in it, try to make some proposals and recommendations which will help to improve quality management and development in the sector construction, this is done through a review of the systems and specifications for industry construction. This will include study and definition of the concept of quality and its applications in civil engineering projects and then examine the reality of quality management in the construction industry and finally, a presentation of the results and proposals.

It was clear from the research that the quality management in construction projects with some of the defects, dereliction, is fit to find some solutions and proposals that can contribute to avoiding some of them.

#### 3.1 Concept of quality

"Quality" is derived from the Latin word "*qualitatem*". Quality in general means the person or the degree of its goodness. The clear meaning of the word quality is a bit trickier; the explanation of quality meaning is different with respect to different people. Everyone has a different opinion about the sense of quality. The concept of a quality

varies with time; ideas about quality during these days are different about last century [33]. In general, quality has multiple definitions; it can be identified as below:

- Quality is appropriate for use or purpose.
- Quality is conforming to the requirements and specifications.
- Quality is to satisfy the customer.
- Quality is the overall product attributes and characteristics that satisfy customer needs and expectations.
- Quality is the degree of excellence. The quality, in essence, is the goal to achieve product or service quality requirements.

Therefore, the basic qualities of construction works and construction means that to be available in this business are mainly safety, durability factors and the possibility to use such that are appropriate. With the purpose of which is the course of their investment and to gain the confidence of its users and their satisfaction.

The meaning of quality and its concept is somewhat vague and often associated with the opinion of the customer or the user according to his need and purpose of the product as well. Therefore the content quality in construction can be associated with primarily aspects and concepts of the following [34].

- 1- Performance: is the construction good enough to do the required purpose?
- 2- Economic: does the construction represent value for investment?
- 3- Age: is the construction firm and able to cope with the times?
- 4- Aesthetic: is the construction's appearance with modern style and commensurate with the facilities around it?
- 5- Depreciation and economic power: is the construction a good investment?

In other words, the quality management and the quality of construction related to several factors and expectations surround the most important of the construction process; perfection, durability, and reliability. To achieve quality in the construction industry, it should be seen as a construction project with a range of activities such that beginning and end user need your sense of satisfaction and contentment. It is also worth mentioning that the QMC industry is the responsibility of several parties of the construction project (owner- designers – executor - supervisor) [35].

### 3.2 Quality Management in Construction Projects Methods

There are four levels to provide (QMC) methods reviewed in the following: examination or inspection, quality control, quality assurance, and total quality management" [36].

**Examination or Inspection;** It involves all activities related to the measurement, test and determines the features and characteristics of the product or service comparing it with the specific requirements of the activities in the construction projects represented by the inspection, testing of materials, the work carried out and compared with the specifications. Mismatches in works or materials must be replaced and reimplementation of the nonconforming work must be decided [37].

**Quality control;** It involves the activities and practical techniques used to achieve the quality requirements. The quality of construction projects settings include the following:

- Establishing specific criteria for the implementation (construction process) through schemes and technical specifications and terms that describe each part of the construction process [38].
- The accuracy of measurement for ensuring criteria during the implementation of matching construction work, drawings, specifications and technical conditions.
- Corrective action for measurements to decrease the minimum allowable limits, which do not affect the safety, durability and functionality of the good aspects of the construction work implemented.
- Planning to improve standards and to increase congruence with it by taking advantage of the negatives and errors, which appear in the course of implementation to avoid in subsequent stages of construction projects [39].

**Quality Assurance;** All plans activities necessary to achieve sufficient confidence that the quality assurance process, product or service will be satisfied. The quality assurances in construction projects have a wide meaning of the application of standards and procedures, which ensures that the product will achieve the required specifications. The assurance achievement includes the following:

- Approval or certification from the third-party, which means there is a participation (other than the owner and executor) that examines the level of work performed and evaluated in each phase of the construction project (for example, the study must be

audited by a third-party to take the responsibility for giving approval, amended or rejected) [37].

- System checks by ensuring its ability to achieve the required quality level and extent of compatibility with construction work conditions and with the available resources.
- Advanced planning for quality requires an efficient and experienced management for frameworks quality of construction work and develop executive programs and the practical steps to perform during the phases of the construction project in order to reach the required quality level.
- Comprehensive manuals on quality explain the importance of achieving the quality of the construction work, concepts, and related activities.
- The use of quality costs of expenses spent on account activities, businesses (audits, the development of plans and specifications) related to quality assurance is compared economically with the results in the event of failure and each phase of the construction project.
- Involves operations and productivity, any interest in supporting the implementation process works like (materials, equipment, calculate costs and develop plans).
- Adopts the failure modeling analysis of the method by studying the circumstances surrounding any failure occurring in the construction work by identifying the causes and effects to be worked on making the necessary correction and avoiding it in other works.
- Adjusts the statistical processes by conducting tests in the course of doing the work in order to determine the number of distractions that occur in every phase of the construction project, so it is early treatment before the defects exceed the allowable limits [34].

**Total quality management;** It is an integrated management approach to satisfy customer needs and achieve continuous improvement through involving employees at all levels appropriate and effective use of technologies and methods of cost suitable to solve problems [40].

For construction projects, the total quality management is to achieve a better use of available resources through the quest for continuous improvement and requires the application of the principles of quality at all levels of the business management. Though the overall quality management process includes the following:

- Seeking to improve the permanent work for the development of codes and standards and dissemination quality by securing the necessary resources for the implementation of construction projects requires quality concepts.
- Involves the participation of suppliers and customers by identifying their opinions about the points related to quality by discussing and motivating them to perform their role in improving the quality of construction projects.
- The participation of all operations whether it is productive or not because all of them have the quality effects of construction work.
- Scale to measuring achievements, any tracking of the implementation of plans and work to improve them on an ongoing basis ratio.
- Teamwork (teamwork). This means that all the construction project parties (owner, designer, executor, and supervisor) that work together as a team has a common goal to implement construction project with high quality.
- Post staff. To contribute the achievement of quality in the performance of their businesses by explaining quality concepts by motivating them to implement the business with high accuracy [35].

### **3.3 Special nature of Construction Projects**

Stages of the construction project; Construction Projects typically pass a series of stages like decision stages, where the employer studies the need for the project and identifies requirements related to the project by choosing advisers to assist the completion of a preliminary assessment of the project.

The economic feasibility of the project and the extent of the effect of its presence in economic and social areas is studied. The owner of the project at this stage does several and the most important arrangements to identify and an authorized project manager should be by him with special works on the project team.

While the stage of study and design is defined as the stage of transforming the aspirations of the employer, ideas and requirements relating the project to specific proposals through completing the preliminary design of the project and determining the legal and regulatory requirements related to the project such as building foundations and regulations, as well as, the specifications and requirements for materials construction

methods used and the key depending on the function and nature of the project. This stage also needs the cost plan to be prepared by the architect of the quantities in coordination with the design team. Finally, the contracting and implementation stage, which means the method or the way through the choice of the contractor who will carry out the project, preferably the appointment of the main contractor after the completion of the preliminary design and the cost plan for it whenever the appointment of the contractor was an early contribution with respect to the quality of the project more effective [41].

At this stage of the project, the contractor receives the site to complete the project work planned in the previous stages. Included in this area of work are three main components, namely:

- Preparation of information and documents control to be relied upon in the course of implementation.
- Materials used for the completion of work on the project and in compliance with specifications.
- Complying with the special requirements which include:

Made quality (quality of work of the project): The program schedule which relies on the coordination of project activities and work and helps control the completion of these works at the right time in order to complete the project on time.

Cost; must be controlled according to the requirements of the employer and compared with the plan so that the total cost of the project remains controlled [42].

### **3.4 Practical completion and receipt**

It is the operation in the project where the contractor is sufficient to allow the owner acknowledge the project. The owner of the project can conduct a preview of the work and the issuance of the list of defects in which the contractor must repair in order to receive a certificate of practical completion (Provisional acceptance) which determines the start of the period of liability for defects (Guarantee from six months to a year) depending on what is contained in the contract. The contractor shall be responsible, for all defects that appear repaired and then gets a certificate for fixing these flaws [43].

After receipt of the project from the contractor, the owner must supply and not just turn around, adding investment to achieve the economic objective and become a legal, financial responsibility for the safety of the building occupants.

The responsibility of the owner is that he must provide security and safety procedures on an ongoing basis, provide the correct usage of instructions. And they should believe in continuous control for the entire project to detect defects that appear during direct investment, making the necessary maintenance as soon as possible [39].

The major development in the quality assurance systems in recent years essentially happened, applied to manufacturing, but these systems and their applications are still new in the field of construction. Although they can be compared to the building process of manufacturing, there remain points of several differences between construction projects and manufacturing projects with respect to quality and application of systems and these differences are:

- The construction project is the product in the construction industry, and that's when it comes to investment. The majority of construction projects are single, non-recurring, and they result in the manufacturing projects.
- Each project in the construction industry has a special task force and the movement sometimes occurs for some staff of the draft elements to another, which reduces the possibility of taking advantage of these elements' previous lessons in the process of improving quality in the long term [40].
- In the construction industry, there is a long period after the end of the study and design in order to build a construction process during which the project is active until a resolution is taken for non-investment. Often, the study is done by the implementing agency which makes the design team of defects or deficiencies, making it benefit from appearing in the course of the construction or invest far while in manufacturing the tests, the effectiveness of the design process and corrective actions can be quickly applied.
- These special characteristics of the construction project would lead to administrative difficulties in its implementation, which requires additional efforts and achieve the performance requirements of the project including quality the time and cost [35].

### **3.5 Basic principles of total quality management**

Total quality management (TQM) in the “construction industry” [34] was a new principle, limited to be applied only in industrial projects. Then construction companies in the United States started to apply it after seeing the success of the industrial enterprises by the application of the concept overall quality, which depends on the pursuit of two ground principles; the customer satisfaction and continuous improvement. We will clarify these principles (achieved in the light of the conditions of employment and in the construction industry conditions) and how to work with them later on.

The basic function of the construction industry is to offer customers projects, facilities and services ready to use and check their requirements and any construction company willing to continue to work on it will complete its work at a cost of competition.

TQM is a management philosophy based on identifying customer needs and requirements, accurate working to secure the environment and the circumstances of the appropriate action to achieve these needs and requirements at the least possible cost, through quality assurance at every stage of the construction process [39].

Because of the fact that the construction project is the idea that it is ready to use, therefore the quality of the final product will be satisfactory to the customer. It is possible for the customer to be internally or externally not a part of the company producing the products or service but influenced by or use them as they become ready. The internal customers understand people or groups within the producer receiving products or information from other people or groups within the party itself, although satisfying them is an essential part of the process to provide external customers with a quality product [44].

Each party in the production process has three roles: a resource, an outlet for the process, and a customer. This triple role concept exists at all levels and stages of the construction process, described in the following manner:

Architects and engineers can be considered as customers for the owner and implementers of the study process and design meanwhile supplying drawings and specifications to the contractor. The contractor is a customer of drawings and specifications set by architects and engineers, a part of the process construction as well as lists of origin or ready-made service for the owner.

The success of the entire process is highly dependent on the design submitted by architects and engineers like the possibility of controlling the quality of the final product level in the project. Construction decreases with the progress of the project, and this confirms the importance of focusing on the customer's requirements and the needs of internal and external since the planning stages of the project [46].

In order for TQM to achieve total quality management, it must do two functions; the first one is the increasing improvement of the existing methods, procedures and to maintain the improvements through the production process control; the second directing effort and focus to obtain technological progress in the field of building and engineering operations through creativity and innovation.

All engineering work (draft) consists of operations from which to complete the work, as each stage of the construction process of the engineering project makes part of the process itself.

Each process can be divided into stages (i.e., dividing each stage to the partial phases) so the transition from one stage to another with a change in the current situation to achieve improvement is continued by improving the methods and procedures that govern the process of change and then achieve better customer satisfaction in the next phase. Thus, every phase is linked to the previous stage (supplier) and subsequent phase (the customer) for the completion of the construction process in the framework of the working team through all stages and to achieve the quality level of customer satisfaction.

During the implementation of each process, the transition from one stage to another should seek to narrow the gap between the needs of the customer and what has been implemented, including the current situation by applying the analysis process problems and by deeming loop "planning - implementation - check - the interaction." This is a regulatory action for the growing improvement of the methods and procedures by focusing on correction and prevention of defects and is accomplished by removing the underlying causes of problems, moreover, the establishment of standards and adjusting them continuously [41].

### **3.6 Problems of Quality management in construction projects**

Through a review of some research on the quality management in construction projects in various countries around the world, a number of problems of quality management in projects of construction are shown. The most prominent of these problems are as follows:

- \* Insufficient commitment by the senior management of companies and organizations in the construction industry to make effort required to implement a successful quality management.
- \* Lack of effective communication and adequate coordination between the elements of the team in the project construction (owner - designer - executor - supervisor) besides the lack between senior management and work sites.
- \* The lack of efficiency in the work and training frameworks [40, 45, 46, 34].
- \* Lack of codes and general specifications that must be followed during the construction process [47], insufficient attention to quality by working in construction projects[47].
- \* Instability of work in the construction industry influenced by the size and stability of the national economy and that is related to the availability of materials.
- \* The lack of planning for the application and to effectively manage the quality.
- \* Difficult access to the labor market in the construction sector and regardless of the availability of necessary conditions and capabilities to achieve the required quality.
- \* Lack of integrity among workers and those in charge of conducting laboratory tests and absence of quality requirements.
- \* There is a lack of full awareness for using equipment and techniques.
- \* Insufficient preparation for the construction drawings, specifications that do not match tenders, even the lack of competence of the companies contractors who carry out construction projects.

### **3.7 Quality management of Iraq construction projects**

To study the reality of quality in the construction industry in Iraq, a survey has been prepared for the systems specifications adopted in the management and quality control in construction projects.

Many sites that belong to engineering projects are visited by viewing the content of documents and papers of some projects. Interviews are conducted with managers, the architects of the implementation and the resolution of some contractors, some private engineering offices are visited and some institutions and companies working in the field of construction collect the information of our surveying.

Table 3.1 was prepared, from which can be seen what comes out of it: a lack of codes used during the study and design stage for most types of construction projects, where the source code for the facilities are done only in Iraq. This implies that quality management and control in the contracting phase are limited to a specific set of laws and decrees. In the implementation stage, the quality management and control are according to the Iraqi manual and conditions book and general terms and specifications issued by the Ministry of Planning.

Table 3.1: Systems and specifications adopted in the quality management and control in construction projects in Iraq

Systems and specifications adopted in the quality management and control			
Project Type	The study and design phase	Contracting stage	The implementation phase
Reinforce concrete Structural construction projects	Iraqi and US code	Decrees, laws and the terms of a private group contracting the two-part first and second	Iraqi specifications booklet general conditions of the two-part Construction issued by the Ministry of Planning
Roads, bridges and rail projects	Iraqi and British code	Decrees, laws and the terms of a private group contracting the two-part first and second	-
Water and sanitation systems	-	-	-
Electricity networks	-	-	-
Phone networks	-	-	-
Shipping ports	none	-	-
Civil air transport aircraft	Iraqi and US code	-	-
Military projects	US code	-	-
Steel Structures	British code	-	-

The study and analysis of this survey have benefits in the formation of an idea about the reality of quality management in the construction projects, to provide some suggestions and recommendations, which will help to avoid some of the quality management obstacles and improve the construction industry.

### **3.8 Summary**

By studying the reality of quality management in construction projects all around the world and research in various aspects and scrutiny of the means and methods relating to quality control used in industry, Iraqi construction systems as well as contractual procedures, relate to quality management projects. Iraqi construction has shown that the quality management in the Iraqi construction industry suffers from some deficiencies and they need a new formulation to ensure a quality of high level in their projects in order to keep development with their counterparts in developed countries.

### **Building Information Modeling in Quality**

This thesis is another way to deal with a construction outline, development, and office administration called building information modeling (BIM). It gives a profound comprehension of BIM innovations, the issues connected with undertakings usage, and the significant effects that proficient utilization of BIM can give to all individuals from a task group. The theory clarifies how outlining, developing, and working structures with BIM varies from seeking after the same exercises in the conventional way utilizing drawings, whether paper or electronics. BIM is starting to change the way structures look, the way they work, and the courses in which they are assembled. All through the study, we have purposefully and reliably utilized the expression "BIM" to portray an action which means building information modeling. This mirrors our conviction that BIM is not a thing or a sort of programming but rather a human action that includes wide process changes in development at last [48].

This chapter investigates and examines the upsides of "4D BIM" for a quality application in light of development rules, by building an item to the pattern, association and procedure information introduction framework by reviewing the work of two scholars in 2014 called "BIM-established construction quality management model and its applications".

#### **4.1 BIM for the Construction Industry**

Utilizing BIM innovation has significant focal points for development that spare working period and cash. An exact constructing style advantages all individuals from the undertaking group. It considers making arranged development controls efficient that spare duration and cost, and even decrease mistakes and clashes. This part clarifies how

a temporary worker can get these advantages and what changes to development procedures are alluring [49].

The critical point is that contractual workers are paid in early date inclusion in development tasks, or search out proprietors that demand precocious investment. Temporary workers and proprietors ought to likewise incorporate subcontractors, processing, and placing in their BIM endeavors. The conventional configuration - offer - fabricate approach that restricts the contractual worker's capacity to contribute their insight to the venture amid the outline stage when they can include a huge worth. While a portion of the potential estimation of a temporary worker's learning is lost after the configuration stage is finished, noteworthy advantages to the contractual worker and the task group can even now be acknowledged by utilizing a building model to bolster an assortment of development work forms. These advantages can in a perfect world be accomplished by building up a layout indoors with the cooperation of subcontractors and fabricators; having an advisor to build up a model is likewise conceivable.

The level of the point of interest of the data in a building layout relies upon what capacities will be utilized for. For instance, for exact expense assessing, the layout should adequately detail to give the amounts of the material expected for cost assessment. For 4D CAD plan examination, a lesser point by point model is sufficient, however, it must include transitory works (framework, removal) and offer how the development will be staged [50].

A standout amongst the essential advantages is gotten from close temporary worker coordination that can be accomplished when the greater part of the significant subcontractors take an interest in utilizing the building layout for specifying their bits of the work. This grants exact conflict recognition and amendment of conflicts before they become issues in the scope. It empowers expanded offsite construction, which diminishes field cost and time and enhances exactness. With whosoever, these employments of a building layout is examined in subtle element and cases are shown for the situation ponders in Chapter 6.

Every temporary worker which mulling over the utilization of BIM innovation ought to know that there is a noteworthy expectation to absorb information. The move from drawings to a project data layout is not a simple one in light of the fact that verging on each procedure and business relationship is liable to some change to abuse the open

doors offered by BIM. Unmistakably, it is essential to arrange these progressions precisely and to acquire the help of specialists who can manage the exertion. Toward the end of the section, we give proposals to making the move and recognize what issues can be expected.

Without proprietor or planner - driven BIM endeavors, it is fundamental that contractual workers set up an administration in the BIM procedure on the off chance that they are to pick up the upsides of their own association and better position themselves to profit by broad BIM appropriation [51].

## **4.2 Sorts of Construction Firms**

There is a colossal scope of development organizations, from substantial partnerships that work in numerous nations and offer a wide assortment of administrations to little endeavors that have singular proprietors who take a shot at once or anticipate at once and give an exceedingly particular administration [52].

When we look at the building business, the scope of temporary workers is additionally colossal with respect to the administration they offer. The majority of the business comprises contractual workers who begin with a fruitful offer, self - play out a portion of the work, and contract subcontractors for particular administrations. A few temporary workers confine their administration to dealing with the development procedure. They contract subcontractors for all development work. At the flip side of the range is configuration - assemble firms that assume liability for both the outline and development forms yet subcontract the heft of the development work. Temporary workers end their obligations when development is finished, yet they are certain that this offers administrations in the turnover and administration periods for the completion process of the building (construct - work - keep up). Figure 4.1 describes the rate of firms in every real area of the development business in 2004. It shows a greater part of all organizations in the specialty of trade classification.

Homebuilders "differ from most other construction companies in that they act as developers: buying the land and applying for zoning changes, planning and constructing the infrastructure, and designing as well as building the homes that are sold. Homebuilders range in size from large public firms that build thousands of homes each year to individuals that build just one home at a time"[50].

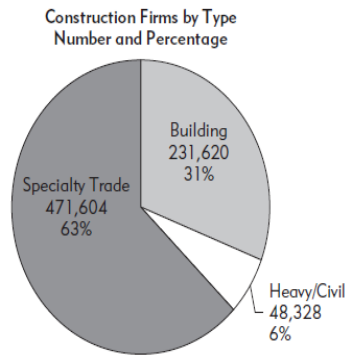


Figure 4.1 "Percent of Firms in each major construction sector, 2004"(Eastman, 2008).

There are numerous sorts of subcontractors that have practical experience in one zone or kind of work, for example, "electrical, plumbing, or mechanical" itemizing. The general contractual worker chooses these subcontractors taking into account focused offers, or they are pre-chosen in view of past business connections that have exhibited viable joint effort. The particular development information of these subcontractors can be exceptionally important within the outline, and a considerable lot of them perform plan and additionally development administrations. The rate of work done by subcontractors fluctuates generally relying upon the kind of work and contract relationship [51].

Normal undertaking group association is represented in Figure 4.2. There are numerous alternatives for the association of the task group. One is for the proprietor to procure a development director construction management (CM), who then prompts the proprietor or outline on the development of the task. However, once in a while risk is accepted connected with cost overwhelms.

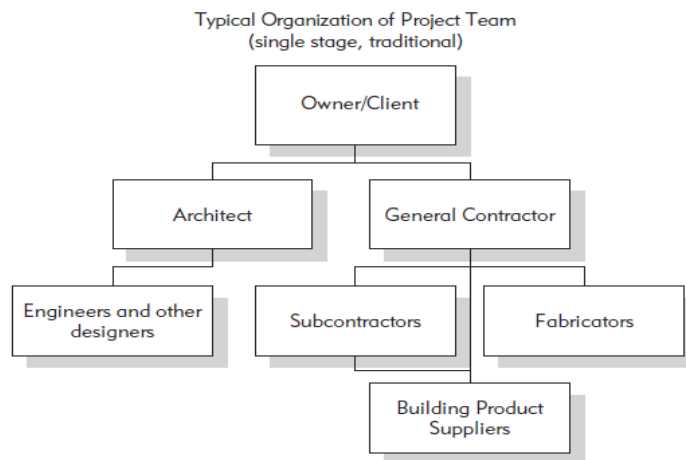


Figure 4.2 "Typical Organization of a Project team for a building project"(Eastman, 2008).

### 4.3 Steps to Develop a Contractor BIM

While the utilization of BIM innovation is expanding quickly, it is in the early phases of usage and contractual workers are presently using a wide range of ways to deal with utilizing this innovation. Most outline groups do not make models for each venture, which has prompted contractual workers in taking responsibility for the demonstration process. Notwithstanding when the compositional utilization of BIM gets to be typical, contractual workers should display extra segments and include development – particular data to make building models valuable to them. Therefore, numerous driving - contractual workers are making their building models starting with no outside help to bolster evaluating, 4D CAD and so on. Figure 4.3 demonstrates a typical work process of a contractual worker making a building data "model from 2D paper" graphics. A reminder that, at times, the temporary worker is "building a 3D model "that is just a "visual representation of the task". It does not contain parametric parts or relations between them. In these cases, utilization of the model is constrained to conflict discovery, representation, and visual arrangement, for example, 4D, in light of the fact that the "3D models do" not characterize one discrete quantifiable part to bolster amount departure or exchange coordination. In different cases, contractual workers may manufacture a crossover "3D/parametric model" that incorporates some BIM parts, which empower "some coordination" and amount departure. At the point where temporary workers do deliver a full building model, they can influence it for various purposes.

Another methodology for actualizing BIM is outlined in Figure 4.4. For this situation, the venture group teams up on a model – 3D, BIM, or crossover – in a domain that is suited to their practice. On the other hand, if a particular association works in 2D, the contractual worker or advisor can change over the 2D to 3D/BIM so that their work can be gone into the common model. Regularly, the contractual worker or the advisor deals with the joining of these different models, which are produced freely by various individuals from the venture group, and then converted into a cooperative model. The common model can be utilized by the task group for coordination, arranging, amount departure, and different capacities. While this methodology does not exploit every one of the devices which a full highlighted assembling data model backing does, it reduces

expenses and time contrasted with conventional practices. The mutual 3D model turns into the premise for all development action and considers much more prominent precision "than 2D drawings". As the practice and utilization of BIM increments, new procedures will develop. The contextual investigations in Chapter 6 highlight an assortment of routes in which contractual workers are adjusting their work procedure to influence BIM. In the accompanying segments, we talk about particular displaying techniques [51].

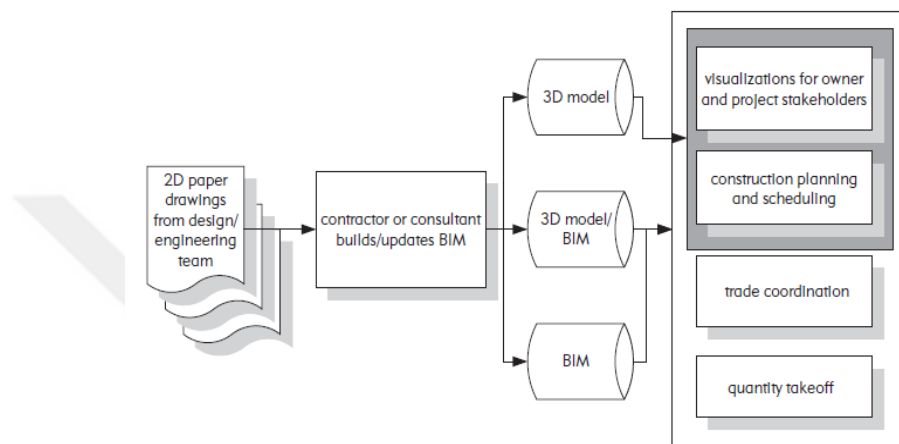


Figure 4.3 The flow steps of BIM project (2D Model)

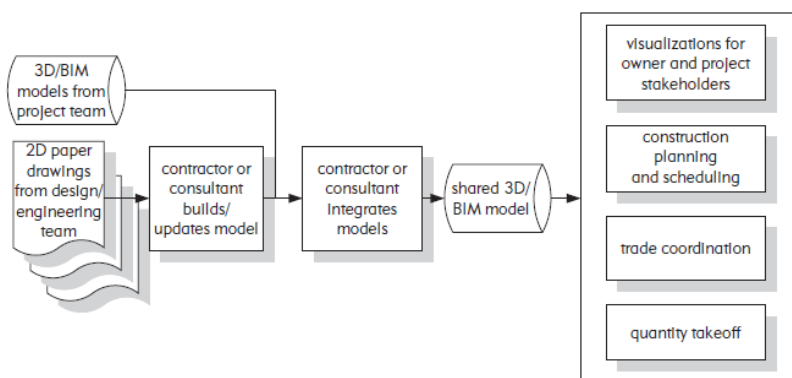


Figure 4.4 Steps flow for a project (2&3D Model)

Homebuilders give a decent case of how a configuration - construct exertion can profit by the utilization of BIM innovation. At the point of creating plans for model homes, a building data model can give quick input on the amount and cost ramifications of a configuration change. At the point where a purchaser demands plan adjustments to a model home, this capacity can give quick visual and cost input and permit the planned purchase to rapidly achieve a concurrence with the developer. This sort of quick

reaction to customers' needs is of incredible quality, particularly for development organizations that give redid building choices taking into account methodical techniques for development [51].

4D "computer aided design" instruments permit the temporary worker to reproduce and assess the arranged development succession and offer it with others in the venture group. Objects in the building model ought to bunch as indicated by the periods of development and connect to suitable exercises in an undertaking plan.

#### **4.4 4D models and its relations with construction planning**

(4D) models at first were produced "in the late 1980s" by substantial associations required in building complex foundations, power, and process ventures. As the AEC business embraced 3D instruments, development associations fabricated manual 4D models and joined depictions of every stage or period in the undertaking. Custom and business devices advanced in the "mid to late 1990s"[22], encouraging the procedure by physically making 4D models with programmed connections to 3D geometry, elements, or gatherings of substances for development exercises (see Figures 4.5, 4.6 and 4.7). BIM permits schedulers to make, survey, and alter 4D models all the more regularly, which have prompted the execution of better and more dependable timetables. The accompanying areas examine the advantages of "4D models" and the different alternatives schedulers out there while delivering them.

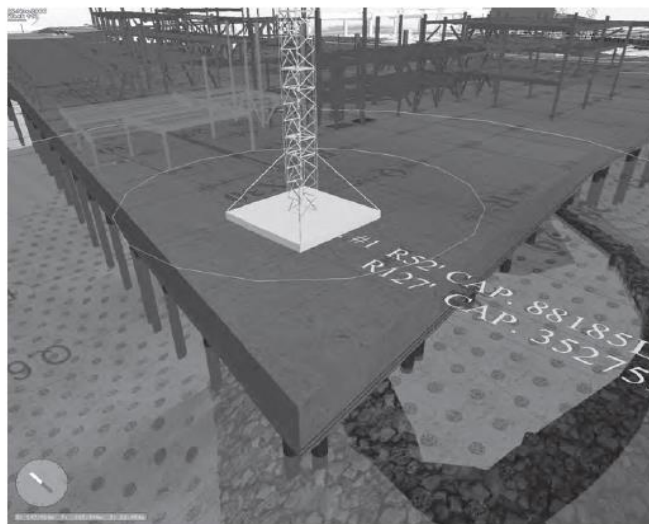


Figure 4.5 "4D View of construction Vancouver construction center" (Eastman, 2008)

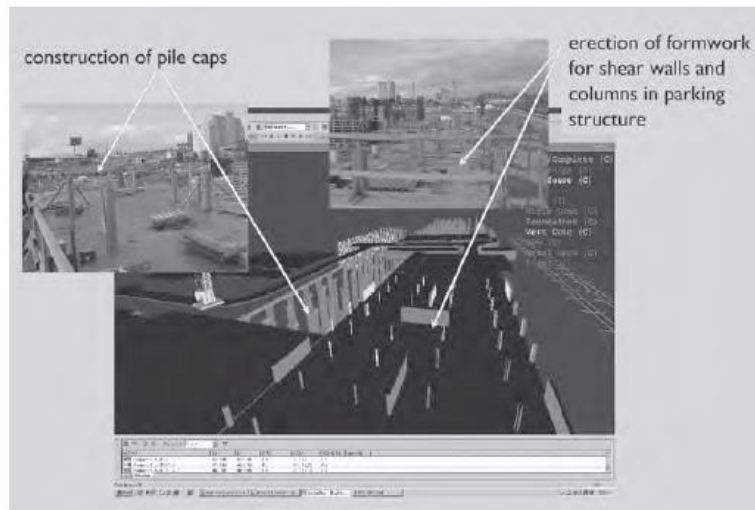


Figure 4.6 "A snapshot of a 4D model and photos from the project site"(Eastman, 2008)



Figure 4.7 "4D snapshots of a campus wide project showing various construction activities occurring throughout the campus to landscape, road, and facilities"(Eastman, 2008)

#### 4.5 Advantages of 4D Models

4D reenactments work fundamentally as specialized instruments for uncovering potential bottlenecks and as a technique for enhancing joint effort. Contractual workers can audit 4D reenactments to guarantee that the arrangement is attainable and proficient as could be expected under the circumstances [52]. The advantages of 4D models are:

**Communication:** Organizers can outwardly convey the arranged development of all partners in the task procedure. 4D model exemplifies the transient and spatial parts of a timetable and this relates more than conventional graph course of events.

Multiple stakeholder inputs: 4D models are regularly utilized as a part of group discussions, such as how a task may impact activity, access to a successful facility, or other basic group concerns.

Site logistics: Organizers can oversee set down ranges, access to and inside the site.

Trade coordination: Organizers can facilitate the normal time and space stream of exchanges on the site and in addition, the coordination of work in little spaces.

Compare schedules and track construction progress: Venture chiefs can look at changed timetables effortlessly, and they can rapidly distinguish whether the undertaking is on track or behind the calendar.

Most importantly, 4D CAD needs a fitting 3D model of the building to be connected to a venture timetable that gives beginning and end dates for every item. [12]

4D Layout Procedure: Schedulers can look over an assortment of apparatuses and procedures to fabricate 4D models:

1. Manual strategy utilizing 3D or 2D instruments
2. Manufactured 4D highlights in a 3D or BIM instrument
3. Send out 3D/BIM to 4D instrument and import plan

#### **4.6 The relation of BIM and quality management**

As mentioned earlier BIM can generate and maintain information produced during the whole life cycle of a building starting from design to maintenance, preparation of schedules and estimates, tracking and managing changes, and managing site logistics and all those can be applied to various fields.

BIM has introduced a way to increase the overall quality of the project. It enhances venture quality in the following ways: 1) proficiency, exactness and enhancement in the design assessment [55, 56]; 2) diminishes mistakes due to better coordination amongst archive and the entire team, thus minimizing clashes [53, 54]; 3) easily conducts simulation, optimization; 4) eliminates costs of operation, maintenance, and times [57]; 5) is programmed to save building records as well as producing exact and reliable data.

However, there are no special directives on how to use BIM to enhance quality [58]. Given this, the chapter will view a paper proposing a "4D BIM-based application for quality management in the construction phase", which can benefit the project by

ensuring information consistency from the design through the construction phase. BIM is a parametric modeling effort that provides tabular views of components and characteristic interactions with their elements such as, name, type, attributes relationships and metadata" [6].

#### **4.7 Review on some scholar research of BIM on CQM model**

There are a few surveys known into using BIM all within the errand for advancement quality control and successful information use. The capacity of Building Information Modeling (BIM) to reinforce a change of the design and improvement methodology has been obvious in the advancement business. This part is an audit of an examination and a 4D BIM examination benefits quality control in the light of improvement codes, by building the model in a thing, affiliation, and strategy process, organization, and product (POP) data definition structure. A logical examination is given to favor the use of the proposed 4D BIM application for quality control in the midst of time improvement of the Wuhan International Expo Center [6]. It presented a research paper to develop a "practical 4D BIM-based application for the purpose of construction quality management and checking on how it could suit the current construction practice" [6]. In addition, to highlight the possible issues of using BIM technology with existing quality management procedure, it provided a solution. During the research, quality models with all related process, organization, and product (POP) information were passed using national and local quality standards and codes of China. The model was integrated into a virtualized 4D BIM-based application to distinguish quality control criteria and assignments in the development procedure; this will be seen through examination and testing, investigation amid the development stage, and criticism of review results. The case study approach was explaining the dynamic quality control model that was developed from a review of literature and site investigation by deriving a construction quality integration system® (CQIS) and the CQIS is the foundation of the research. In this model, all the needed data were collected from a project general contractor and CAD drawings, together with the schedule. The study was divided into four parts: (1) part one concerned the examination of a value of quality control methodologies in foundation through questionnaires on the site; (2) part two is about the creation of the 4D BIM model by Autodesk Revit® and Navisworks®; (3) part three is about the figuration of the method to coincide the quality data structure with BIM based on

theory; (4) part four includes the evolution the 4D BIM application workflow for quality management.

The foundation work at the Wuhan International Expo Center was chosen for the support of the proposed model. The foundation was chosen due to completing the project with no delay caused by lack of quality.

The quality control process expressed by the quality management plans was due to field monitoring, which depends on the construction drawings and standard specifications, which monitors the quality of the material, testing, and equipment. Upon completion of the work, the acceptance of the work will be due to approved construction documents [59].

For the contextual investigation model, agendas as electronic layouts are utilized for quality control in the light of national, industry and privately based quality control codebooks for China. Development quality acknowledgment is isolated into the unit (sub-units) extend, the portion (sub-fragment) extend, the sub-venture, and the assessment parcel. An assessment parcel is made out of a specific number of tests that are duplicated in the same conditions and pooled in an endorsed way to test. The grouping of acknowledgment is the other way from conventional acknowledgment techniques - from the base parcel to the entire undertaking. The investigation parcel is the smallest unit and can be considered as a development item equivalent to a segment in a BIM model [50]. Fig.4.8 "shows the overall process of quality inspection plan utilizing a BIM quality model. First, the quality control plan is developed based on the work plan, the inspection plan, and project characteristics. Second, the corresponding quality checklist is retrieved from the 4D BIM-based quality construction models, according to work classifications and the process of construction activities, when requested by a contractor. Third, the inspection is conducted by recording the field measurements and test results required in the checklist. Fourth, an objective comparison between design requirements and construction results is automatically generated. Fifth, decisions are made on whether to accept and proceed to next process or to reject this lot and issue a nonconformance report (NCR) with specific requirements from the BIM-based quality model. Finally, the inspection work results in feedback, and it is reflected in the model. Subsequently, the model and the inspection plan are updated. Quality management is a precise and complex process, which requires knowledge and work experience. The mobility of construction practitioners and the lack of accurate

understanding of quality codes leads to negligence or failure to conformity with quality requirements. Therefore, research and development of a construction quality management model are necessary for barrier-free quality data circulation between different trades at all stages of the project. The integration of 4D BIM and construction quality codes provide accurate and consistent data for the whole process, allowing the participants to fully understand the quality requirements" [6].

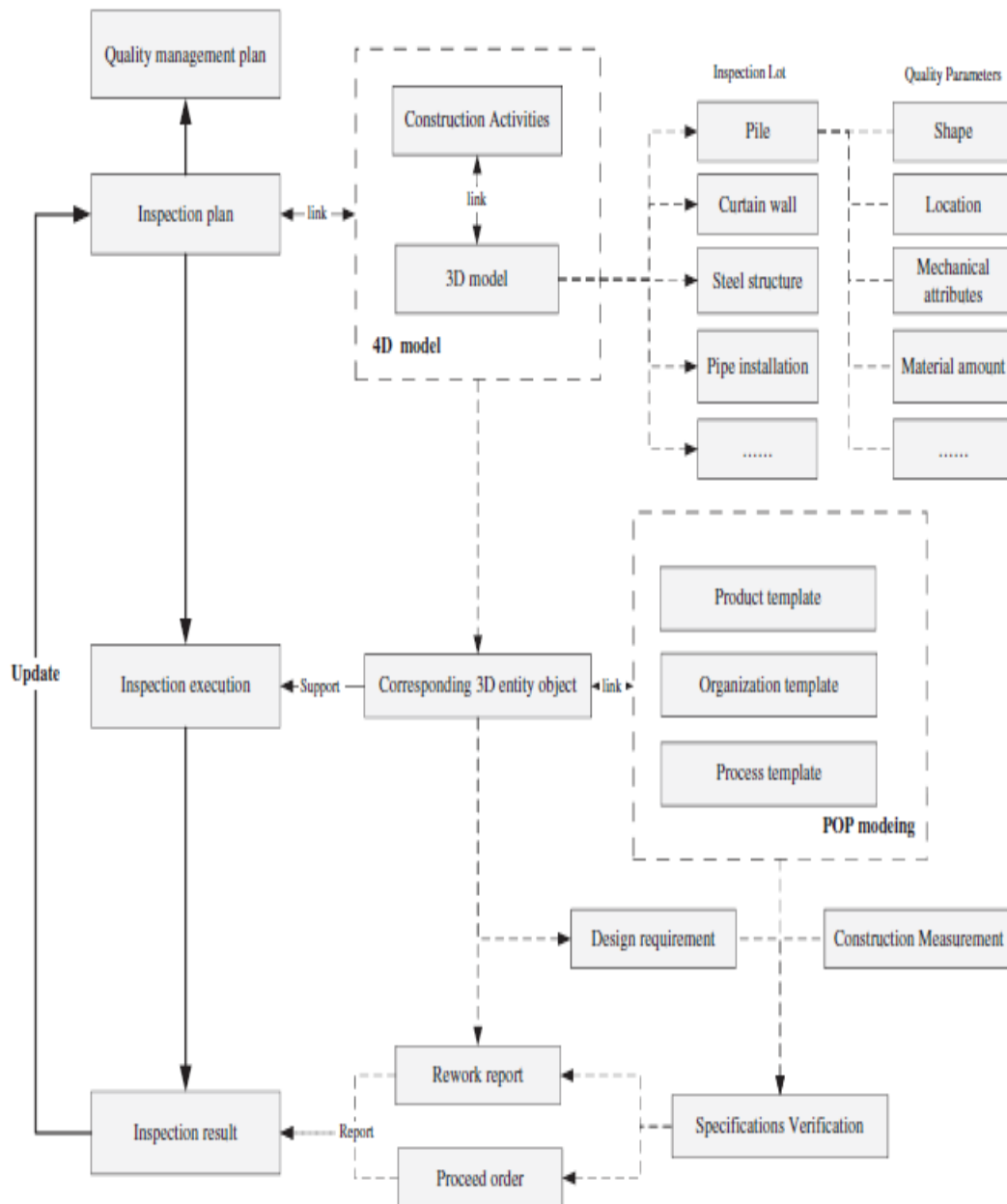


Fig 4.8. The execution of construction quality management inspection plan using BIM quality model (Source: LiJuan Chen & Hanbin Luo; 2014)

## 4.8 Definition of POP model & 4D model

4D modeling is an example of "product process modeling and organization process modeling." [6]. The earlier work of developing an electronic agenda database is refined to structuralize codes and will be utilized as the establishment of this examination. The quality model incorporates more than 300 sorts of control items and more than 1000 control formats, covering control codes and norms for the entire quality control process in the development business.

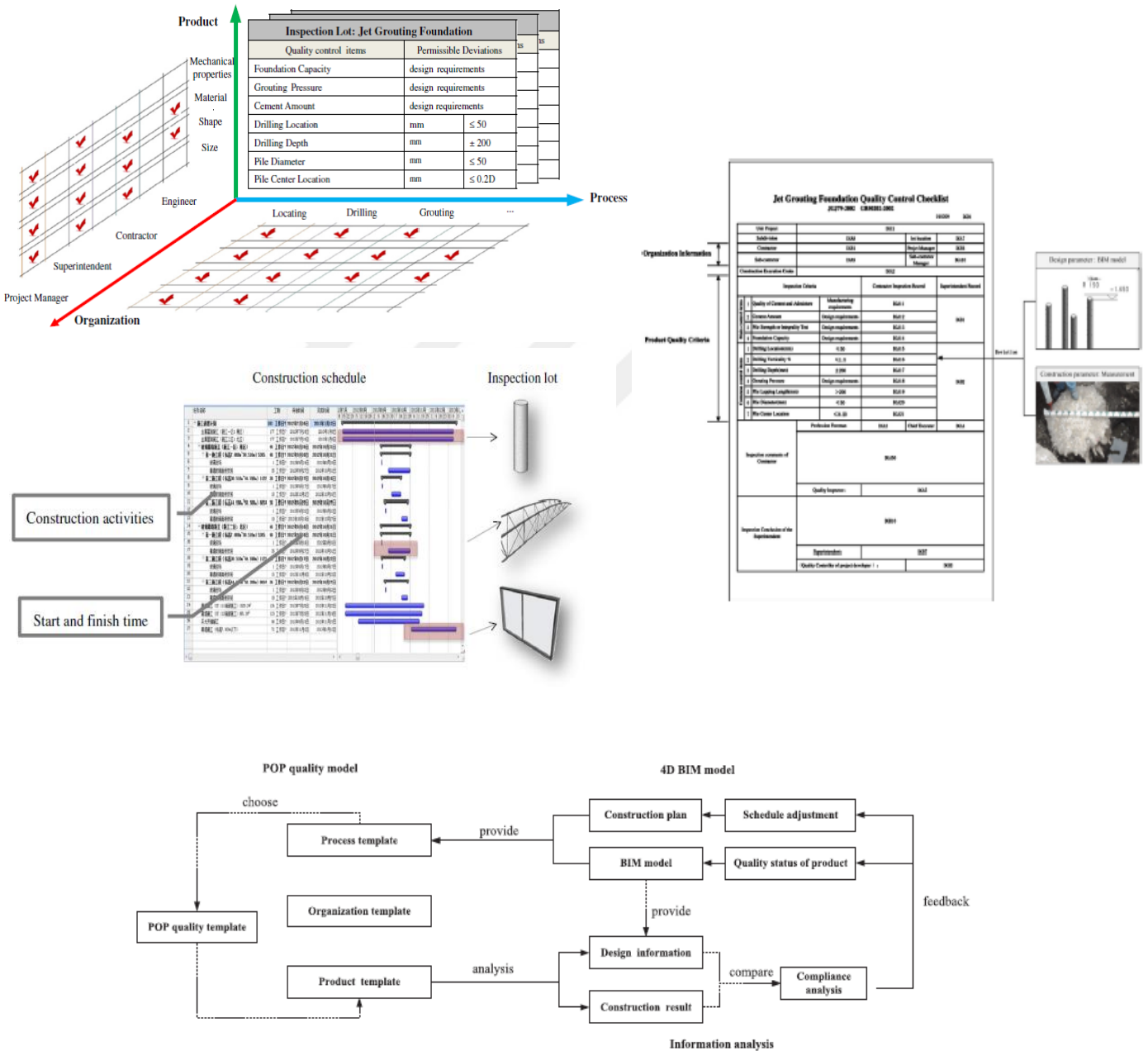


Figure 4.9. Product template, Organization template, Process template, BIM-based construction quality model (LiJuan Chen & Hanbin Luo; 2014)

In a standard BIM, every component is just characterized with geometry characteristics; this does exclude the point by point data essential for quality administration, for example, development process, strategy, material, and members. It should be kept in mind that the end goal is to contain all accessible data components, assessment criteria and connections, the quality model comprising a standard BIM, planning and the standard POP model, see Fig 4.9 which demonstrate the product format, organization layout, process layout, BIM-based development quality model [51]

After the development of a BIM-based development quality model, the work process request is produced, as appeared in the flowchart in Fig.4.8. The quality control process begins with the solicitation for an acknowledgment after finishing of an investigation part for the last errand done before the following one starts. At that point, the information gathered from the development site is input into the layout for constant and ongoing information honesty examination, deviation investigation and consistency investigation. At long last, if the examination part passes the acknowledgment investigation, the undertaking continues to the following errand; if the assessment parcel comes up short, a NCR report with restorative activities will be issued. After the remedial activities are finished, the entire procedure will cycle once more. The outcome is outwardly shown in the BIM for improved and usability for quality administrators. Since information is from the BIM-based quality model and shared among development members all through the development procedure, the need to rehash the contribution of information in various structures for information examination, information sharing and correspondence is significantly diminished, see Figure 4.10.

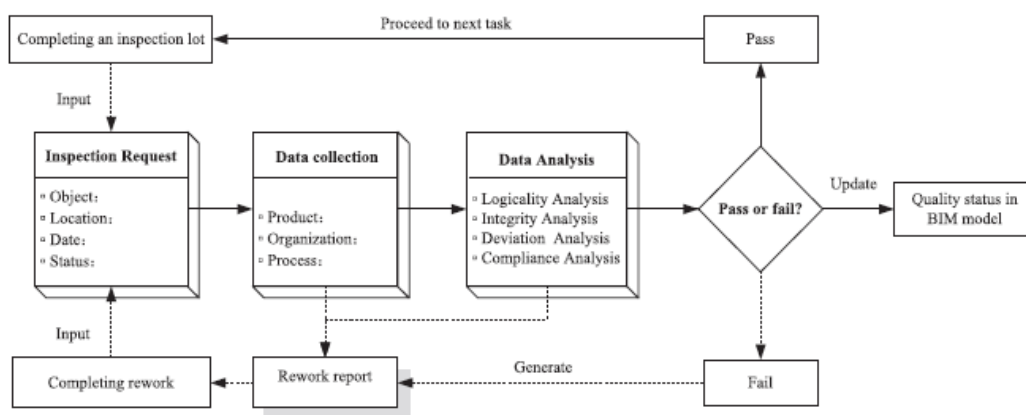


Figure 4.10. Workflow of BIM-based construction quality model (Source: LiJuan Chen & Hanbin Luo; 2014)

#### **4.9 Conclusions based on previous studies**

The exhibited discoveries add to the comprehension of the potential utilization of BIM in development quality administration and fill a current crevice in the learning of the utilization of BIM for development quality administration. This paper investigated the execution of BIM in quality administration and proposed coordinated answers for enhancing current quality administration forms with the help of a BIM working environment. A BIM-based quality model has been proposed to consolidate BIM and the current quality POP model. Likewise, this paper talks about how these two models will cooperate to encourage development quality administration. It assists the task members to better comprehend the quality advancement and to team up all the more successfully on account of an envisioned information design [6].

The advantages of the quality development model proposed in this paper lie in the accompanying perspectives: First, the usage of outline data guarantees data consistency and encourages quality administration process. Second, the completely institutionalized and organized development codes are incorporated into the model to give clear development errand necessities to direction and confirmation. Running through the mill mistakes brought about by a misconception of cross-reference codes can be evaded. Third, the 4D application guarantees the convenient assessment and virtualization of the entire procedure, which assists the venture members to better comprehend the quality prerequisites acknowledgment and to team up in an envisioned way. It can be inferred that the BIM-based development quality application is reasonable and supportive in a quality consistent administration. To start with, because of information consistency, it is conceivable and doable to apply BIM for quality administration and completely use plan data through virtualization of the development procedure. Second, BIM can be fit into the present business standard practices in quality administration and accepted through a contextual analysis. Albeit, quantitative results are not offered because of the restriction of this exploration venture, examinations are made between BIM-based and non-BIM-based undertakings. The conventional quality administration is neglected to associate progressively with scattered outline drawings and the quality administration processes. For this reason, when studying, with the utilization of BIM-based development quality model, the data is aggregated and disconnected from the same information source to organize completely and convey between the configuration and the development stage. As complete development necessities are illuminated in a 3D

group for better understanding, the task was conveyed on time, identified with establishment works. In any case, the BIM-based quality model has the accompanying constraints.

A BIM model created for outline purposes does not contain impermanent structures, for example, outside formwork, and platform. In this manner, transitory structures must be added to the first BIM outline arranged model. The utilization of personal computers on location is not helpful as of now with the proposed strategy and cell phones ought to be utilized as a part without bounds for development in recording field information and direct information exchange to BIM [6].

#### **4.10 Summary**

Supplanting a 2D or 3D CAD environment with a BIM framework includes much more than securing programming, preparing, and redesigning equipment. Powerful utilization of BIM requires that progressions are made to practically every part of a company's business (not simply doing likewise things recently). It requires an intensive comprehension and an arrangement for execution before the transformation can start. While the particular changes for every firm will rely upon their sector(s) of AEC movement, the general strides that should be considered are comparative and incorporate the accompanying:

- Dole out top level administration duty regarding building up a BIM reception arrangement that covers all parts of the firm's business and how the proposed changes will affect both inward divisions and outside accomplices and customers.
- Make an inward group of key chiefs in charge of executing the arrangement, with cost, time, and execution spending plans to control their execution.

### **Proposal 5D Framework For Quality Management**

4D BIM can be defined as the timetable of the foreseen development advancement incorporated into a building data model. It includes the booking and sequencing of the parts and assignments to arrange and screen the development progress. As it were, this technique graphically imagines the venture plan and empowers the clients to mimic the site and development any time. This kind of recreation gives significant knowledge to the task and encourages early identification of mistakes rather than acknowledging them later in the development stage and resolving them. Missteps can be dispensed within the configuration stage. Also, time estimation can be used to improve the logistical viewpoints. Different option arrangements for executing the development can be mimicked and weighted against each other to locate the most valuable arrangement.

Two basic techniques can be utilized to make 4D Building Information Models, to be specific (1) CPM and (2) line of balance. In CPM, the time required for the achievement of every project, every assignment is connected to another errand as successors. In light of the reliance and term of the errands, the longest way is characterized as the most critical path. In this technique, if characterized assignments are not proficient inside foreseen terms, the aggregate length of the venture will be further extended. CPM is a utilized a system that keeps tasks inside the timetable.

While the second techniques "line of balance" uses the area as the premise for time scheduling. It fits iterative undertakings to enhance the worker's efficiency. In this strategy, undertaking terms depend on some individuals accessible on location and the grouping of the area. The strategy concentrates on the areas being finished by the group before the other team moves in. Therefore, some mobilizations and assets can be minimized. Besides, the efficiency of the exchange can be overhauled to come to the

pre-characterized plan. A line of parity is a legitimate booking strategy to arrange and screen iterative exercises amid development progress.

Arranging by a method for BIM amid the design and hand over stages enhances space coordination and site utilization. Some BIM programming apparatuses, for example, smart boards can join site segments to the model with the specific end goal of encouraging space administration and usage. For instance, all movement access courses, site work advancement and area of hardware can portray in the model as a component of the logistic arrangement.

4D can also be utilized as a proactive technique to enhance the observation and arrangement of the site's well-being. At the end of the day, security arranges, for example, transitory structures (rails, walls, and so on.) and related exercises which can outwardly be demonstrated. Hence, this adds to better observing the complete safety measures on the occupation site.

### **5.1 Cost valuation provides for (5D) and its effect on quality**

Cost predominantly refers to 5D, the elements in (3D) can be connected to the value records for various materials plan. Price lists are based mainly on the size of the cost of materials but can also include the cost of workers and equipment needing more detailed cost estimates. This allows BIM users to generate accurate and reliable estimates of the cost regarding automatic quantity taking off from the construction model; getting responses at a faster cost reaction to changes in the design phase and understand the financial implications of design decisions. Thus, materials and construction solutions are evaluated from an economic perspective [12]. The ability of the cost value of both the contractor and the customer appreciation can be used as a basis in the early stages of the project in order for the contractor to control costs and improve quality requirements based on the budget.

Value records are constructed fundamentally in light of the span of the expense of materials yet can likewise incorporate the expense of specialists and hardware requiring more point-by-point cost gauges. This permits BIM clients to produce precise and dependable assessments of the expense as far as amount programmed for taking off from the development model is concerned; getting quicker reactions makes a response to change in the outline stage and helps comprehend the monetary ramifications of configuration choices. Consequently, materials and development arrangements are

assessed from a financial point of view [12]. The capacity of the cost estimation of both the contractual worker and the client appreciation. It can be utilized as a premise right on time as a part of the task to the contractual worker to control costs and enhance quality prerequisites taking into account the financial plan.

Two primary components of cost evaluation are amount take-off and valuing. Amounts from a Building Information Model can be separated to a cost database or an exceed expectations record. Taking a toll estimation requires an ability to break down the parts of a material and the way in which they can be introduced. Taking a Toll estimator, in the long run, can help discover the unit value comprising of the unit material cost, worker unit cost, overhead cost, and benefit. The worker unit expense is driven by the activation and establishment terms and the employee wage. Likewise, the unit material expense is the aggregate of the material costs utilized for a movement of every unit. Once the unit cost is recognized, the expense of the whole action can be accomplished by an increase of the aggregate amount extricated from BIM and unit cost. For the most part, amount extraction by a method of BIM innovation is significantly encouraged especially if the outline group cooperatively gives the required information to the estimator. The key elements for estimating the cost are some executive quantities pricing. The quantities of building information model can be taken from the cost checklist of a database or an Excel file, which is installed by expertise. Cost estimator equal to the unit cost of materials, the unit, cost factor, labor charge wages and profits. The amount extracted by BIM technology, which makes it much easier especially if the design team provides a required cooperative data.

## **5.2 Construction Quality Management Life Cycle Inspection Plan with 5D BIM**

Construction is an expensive and time powerful technique by which development quality can incredibly progress. One of the real requirements for this strategy is an exact outline and erection data. Construction can profit by getting data with abnormal state of exactness using BIM through a combination of 3D visual to every segment with details. In any case, the related test to adjust BIM in pre-assembled structures may be the interoperability of BIM with programming utilized by fabricators [60].

A good example of the noticeable usage of BIM in construction is curtain wall systems; the frameworks are separated into two classifications, to be specific, punished or stick framework. In stick framework, segments are collected nearby while punished

framework comes pre-assembled with every one of the components including protection, coating, and confining. Dividers, rooms, and houses with all roughed mechanical, electrical, plumbing segments can be planned and raised using BIM.

Reconciliation of BIM and construction strategy improves the data trade of the items between undertaking individuals and fundamentally, it is utilized to essentially facilitate the area and steering of the items.

### 5.3 Proposal Concept Framework

Figure 5.1 explains what BIM means and its producers. BIM comprises mostly of 3D displaying ideas notwithstanding data, database innovation and programming in a desktop, personal computer environment that planners, specialists, and contractual workers can use to outline ideas and mimic development. This innovation permits individuals from the task group to produce a virtual model of the structure and the greater part of its frameworks in 3D and to have the capacity to impart that data to each other. Similarly, the drawings, determinations and development points of interest are essential to the model.

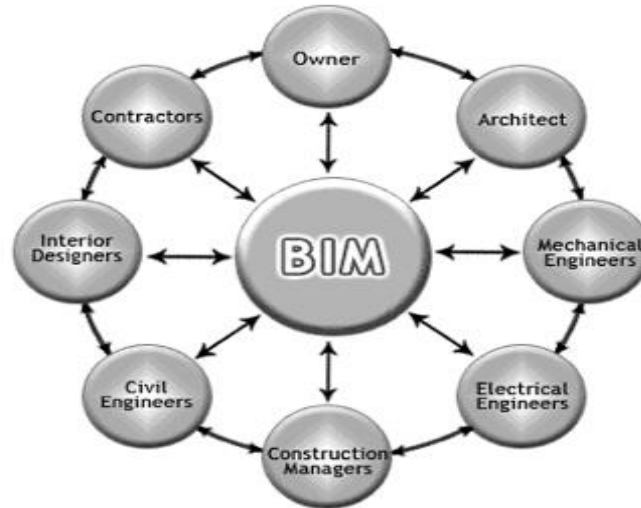


Fig 5.1 BIM Relationship of any Project (Source: Sam Kubba, 2012)

BIM is accordingly a procedure by which you produce and oversee building information amid an undertaking life cycle. It normally utilizes three-dimensional, dynamic building-displaying programming to oversee and increment efficiency in building configuration and development. The procedure creates the building data model,

which envelops every single significant data identified with building geometry, spatial connections, and amounts and properties of building segments.

5D simulation describing construction activities which belong to 3D objects in a building model is in order to mimic the construction process over time. The 5D framework shown in Figure 5.2 can be produced at various phases of a development task to break down the outline and its constructability and for development arrangement and observation. The 5D model configuration was presented before the appearance of the building data demonstrating BIM yet picked up from the improvement of BIMs three-dimensional models. BIM is a slow way to deal with arranged activities' display and reconciliation of multi-dimensional development information. During the most recent years, it has been additionally identified with effectiveness and nature of computerized data trades encouraging coordinated effort between development specialists.

The reception rate of a 5D model by development experts stays low. Despite the fact that it is progressively utilized as a part of wide-scale or certain building/engineering ventures, there are many inputs from investigations on standard tasks. One must say that it is a new innovation that must still be adjusted to fit the genuine business needs. Specifically, one crucial issue is identified with the level of the point of interest of the data involved in building data models, which ought to be fit for the normal 5D uses performed by professionals.

It is an especially complex issue because 5D reproductions join both 3D models items together with development exercises schedules here and are delivered by different partners in no concurrence. In the BIM approach, the term level of improvement is used to demonstrate that detailing is about geometry as well as manageing non-graphical data. In 5D models, the standard of advancement determination should be in this way managed both at the graphical level of subtle elements and at the fleeting level of data. In the expansion, levels of points of interest must match to business needs relating to the proper utilization of the model at various phases of the development venture. The framework shown in Figure 5.2 demonstrate a 5D model expressing a certain case study carried out on a construction project.



Fig. 5.2 shows the general technique of a significant worthy evaluation of course of action utilizing a BIM quality model. In any case, the quality control course of action is created given the work organization, the examination plan and wander properties. Secondly, quality worksheet observing is recuperated from the 5D BIM-based advancement quality model, as demonstrated by employment groupings and the methodology of improvement activities, when requested by an authoritative laborer. Thirdly, the audit is driven by recording the field estimations and test results are required in the worksheet. Fourthly, an objective relationship between design necessities and improvement results is thus created. Fifth, decisions are made on whether to recognize and keep on the next strategy or to reject this part and issue a nonconformance report with specific essentials from the BIM-based quality model. Finally, the audit work brings about feedback and it is reflected in the model. Thus, the model and the examination game plan are updated. The quality organization is a precise and complex method which requires data and work experience.

There a few inquiries that BIM model must overview like the data administration where the BIM model incorporates the projection of qualities, cost reserve funds, and/or efficiencies, yet, what happens when the building is finished, these projections neglect to appear? Does the proprietor have the sole responsibility of the model after development? To make a BIM model requires coordination, which gathering is in charge of this, and who has admittance to the models and to what degree? To answer all these questions the figure below 5.3 can give use the relationship between project parts that will build the BIM model.

BIM programs today are outlined applications in which the documentation streamed from is a subordinate of the procedure, from schematic configuration to development, to office administration. Moreover, with BIM innovation, an exact virtual model of a building can be built digitally and when finished, the PC created model will contain all the important information and precise the geometry expected to bolster the development, manufacture, and acquisition.

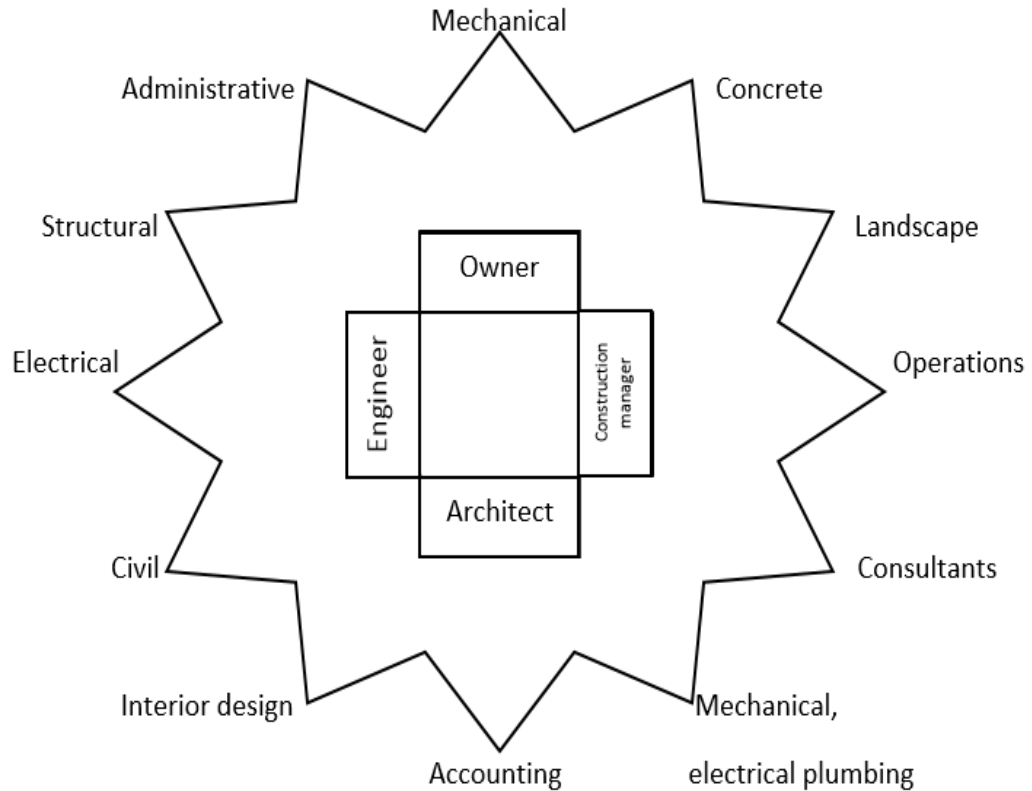


Fig 5.3 Relationship between project parts

#### 5.4 Role on Research: Framework Analysis, Simulation, and Work Processes (the Framework)

The portrait itemized in this segment was a 5D model in the zones of procedure and innovation. The requirement for exploration identifies with both plans, development forms with both blueprints and improvement structures to the dependent advancements on which BIM depends on. Development prompts process changes, and change process offers climbing to new gadgets [61].

BIM and the connection have the even chances on access to building information at both the endeavor and industry - wide levels. Information framework gets the chances to be close snappy and participation all stressed inside an endeavor can get the opportunity to be synchronous, which is a perspective change from customary to simultaneous work forms. Standard work forms with the dynamic time, submittal, and reviews of drawings - which can be iterative and wasteful because changes are no more appropriate

The master and real forms that have progressed in association with these work procedures are comparably forbidden for helpful arrangement and advancement frames, with curtailed process spans and immovably planned information framework.

While educational examination has a section to play in portraying new thoughts and measures of information of development worth, it is likely that "trial - and - blunder" tries by industry pioneers - driven by realistic destinations - will be crucial with new BIM workflows. New definitive structures, sets of obligations, and procurement business plans, ought to be arranged, attempted, and refined. Such attempts will reinforce and animate the change of new gadgets in both the informed group and industry. Parts of the heading for the latter are laid out underneath.

Keeping up respectability across over different framework models (e.g., building versus essential versus improvement) will be fundamental, as changes are made to the diverse models by their different requests. Deplorably, in the short term, interoperability instruments won't reinforce coordination past visual examination and the conspicuous proof of physical clashes in geometry. Regulating changes across different systems - including loads (fundamental or warm) or other execution relations - will be a crucial and compelling issue. One approach to managing this relies upon misleadingly sharp pros prepared for performing examinations between different models, including across requests.

These master framework operators would need to track changes inside models and after that recognize important changes made to one model that should be spread to different models, with or without a transaction between architects. The examination should decide the way of the connections between building objects that are executed in an alternate control - particular frameworks.

The need to create a new generation of construction law checkers and different sorts of adaptable outline audit devices that will prompt hard – coding.

## **5.5 Benefits of The Framework**

The graphs appearing in Figures 5.2, 5.3 clarify that every individual from the task group would have an alternate idea of what is BIM's most helpful perspective. To help us, BIM proposed model would break these advantages into particular gatherings and then that really expound, for every gathering, as follows:

Benefits in arranging: The advantages incorporate architect, cost engineer organizer and proprietor.

Benefits in outline: The advantages incorporate building designer, electrical originator, mechanical planner, plumbing, scene creator, auxiliary architect, structural designing architect, cost engineer, quality monitor, and proprietor.

Benefits in development: The advantages incorporate development administrator, development contractual worker, and proprietor.

Benefits of operations: The advantages incorporate the tenant and proprietor.

The proposal gives flat building proprietors, designers, architects, contractual workers, and fabricators moderate access to a full scope of intelligent apparatuses for the refitting of structures for improved vitality preservation, and greening these structures along the line.

BIM model empowers vitality investment funds appraisals for each possible part of an undertaking from floor arrangement outlines to high, innovative and superstructures.

## **5.6 Summary**

The development of models on the necessities definition level forms the establishment for the frameworks outline and advancement. Besides, the utilization of models is stretched out to the motivation behind business process reengineering, altering the bundled programming, movement based costing, and the choice of programming. Along these lines, the interest for a high-quality model is obvious.

This chapter demonstrated a requirement for a better incorporation of task groups and a joint effort between all gatherings. It is additionally required to have another method for managing data and moving from the report worldview to the Project Integrated Database worldview. The data breakdown pointed in the course where BIM could be the instrument that permits better reconciliation of groups and data. As it need to be, the outline is made, and different types of shared conveyance strategies empower better open doors for the customer to profit by BIM reception especially on the grounds that every single prime player is included from the soonest functional minute. The configuration, for the most part, is performed in-house and whole venture groups similarly (or likewise) incentivized to accomplish the same arrangement of objectives [62]. Nevertheless, it is still expected to discover elective BIM-based ways to deal with

conveying an office that creates a win-win circumstance for all partners and addresses every single discovered test in existing strategies.

Conventional advancement processes in building tasks are wasteful and confront numerous difficulties. The eventual fate of building tasks lies in the utilization of innovation and BIM is relied upon to construct this future. The presentation of BIM into the life cycle of building ventures requires essential changes in conventional undertaking improvement forms.

In particular, BIM means to center the effort in early outline stage when the expense of any change is lower and utilize the CE (cost estimation) idea to alter successive 4 & 5D model into an incorporated configuration model. When all is said and done, BIM can alter conventional advancement processes with specific end goals to have additional time and financially perceptive forms amid building life cycle.

As a computerized representation, BIM gives a virtual perspective of the items in the work with physical geometry (2D, 3D 4D&5D) and other practical parameters, for example, materials and spatial relationship. This model consolidates both natural and utilitarian data put away in the BIM objects. This capacity builds the configuration quality, encourages central leadership on the field and the usefulness of space, it also empowers arranging and sequencing of the development segments and enhances correspondence and coordinated effort.

5D coordination before construction plans have fewer mistakes and gives the better comprehension to members, expands the worker profitability and minimizes wasteful procedures on location. Besides, plan, creation and erection of parts in pre-assembled structures can be completed in a controlled domain since BIM can organize the area and steering of the items.

BIM likewise can consolidate venture plan (4D) and segment value (5D) to the building model. 4D BIM recreates the development procedure, imagines the arrangement of development and uncovers potential issues on the site and open doors for enhancements. 5D BIM creates precise and dependable cost gauges with a specific end goal of controlling costs and enhancing the quality necessities in regards to the customer's financial plan.

Record BIM goes about as a real database and contains data identified with building and establishment segments. It assists the office chiefs with finding data less demanding,

investigating the framework productivity and preventing any loss of information. Additionally, record model is utilized to oversee security and well-being of data. After the consummation of the building design, all the data can be created by clients for manufacturing, breaking down, venture booking (4D BIM), cost evaluation (5D BIM), and in the long run, for office administration amid operation stage.



### **Building Information Modeling Case Study**

This chapter demonstrates contextual analyses of specific ventures in which BIM constitutes a basic part. It speaks to the encounters of proprietors, specialists, temporary worker's legally binding laborers, even development groups and all pioneers in the utilization of BIM. The contextual investigations recorded in this part speaks to a wide extent of structures for different limits including manufacturing, government workplaces, value, helpful, sports, private, working environments, halting, retail and exchange.

The building is 950 square meters consisting of three floors. The contextual investigations cover the utilization of BIM over all periods of the office conveyance process. Every investigation demonstrates a varying game plan of favorable circumstances to various affiliations, coming to fruition in view of the utilization of BIM mechanical assemblies and strategies. The data coordination with the Revit model was accomplished by contractor utilizing Autodesk Revit application programming interface \_API.

No single venture has yet understood all or even a larger part of BIM's potential advantages and it is farfetched that the majority of the points of interest that the innovation empowers has been found or even recognized. Every contextual investigation exhibits the striking parts of the BIM procedure and spotlights on the ways every group utilized the accessible instruments to their greatest advantage. We additionally highlight the numerous lessons that these groups learned as they had trouble in actualizing the new advances and procedures [52].

Usually, research was constrained to the accessibility of different members and their eagerness to uncover data. Design, building, development, creation and land

improvement are competitive fields, and associations that are frequently hesitant to unveil their undertaking aptitude. Overall, most organizations and people were amazingly useful and endeavored critical efforts to share their stories and give pictures, data and successful experiences.

## **6.1 Background on related work**

Case studies utilizing 4D simulation have been discussed. It utilized two official life case studies keeping in mind the end goal to present another methodology of extensible 4D recreations improvement. Their point was to survey the man-hours info important to run the model [63]. The two case studies are a school of health venture (a complex venture) and a primary school venture considered as a more straightforward task [63]. They inferred that "man-hours increase according to the availability of design information"[64]. They reported an ethnographic-activity probe safe arranging of hospital redesigns taking into account 4D models and proposed a technique to create hospital development process in light of 4D reproduction [65]. They exhibited the second experimentation in 2014 utilizing the same ethnographic-activity research approach [65]. The analysts investigated the impact of booking reason changes on the 4D-model setup. Therefore, they concentrated on how specialists iteratively actualized and utilized a genuine 4D model. As a result, they monitor that distinguishing errands, allotting assets and imparting among partners are the fundamental purposes of arranging stage. Arranging logistics, concentrating on conditions amongst errands and relieving deferral are the basic centers of job site booking. Other late trials have been accounted for including those identified with the utilization of 4D reproduction to bolster workspace struggle investigation, method examination, quality development assessment and fall risk recognizable proofs.

The examinations are obviously exceptionally educational and give exploratory learning about the improvement of this innovation. In any case, it ought to be said that independent few examinations are concentrated so far on the specific issues identified with describing the substance of 4D models. The topic of the level of advancement was just immediately implied in the 4D research works. In 2000, Koo and Fischer noticed that 4D models pass on an extraordinary view point of the undertaking, i.e. identified with planning. As per them, it does not empower the different specialists required in the undertaking to utilize the 4D model for various needs.

Koo and Fischer concentrated on the plausibility of 4D recreation in business structures and presumed that clients ought to have the capacity to produce models, so as to quickly investigate distinctive choices. Even more as of late, they characterized a system appropriate for the outline of 4D representations, in which they mapped the portrayal of a "shared circumstance" to the "instructive requirements" of a given specialist [66]. The methodology expressly details the substance expected in a "4D perception" for a given connection of utilization and is relevant when planning representation systems.

## **6.2 Methodology**

The research methodology followed in this research is quite similar to the action research approach defined and used in previous research works. In this project, researchers have been trained to use the 5D software and involved in a real AEC project development, in parallel with the contractual projects team. The aim was not to design new technological development but rather to analyze the usefulness of market-available 5D technology and to highlight their limits to fit construction management routines in the construction project. "Autodesk Revit application programming interface API was used to generate the 5D as-built model since it's necessary to match the 3D model with the time scheduling and funds expense, the plan delineating progress as recorded on the day by day site progress reports were made in Microsoft Project. The 3D layout model, real working calendar and daily expenditure were connected to create the 5D as-constructed model. This 5D model is an active model that controls the advancement of the 3D model with respect to the calendar and cost change with a specific end goal to utilize the Revit BIM as a 5D model. It was important to program some extra components into the product. The extra elements were expected to show a static graphical model demonstrating the segments introduced amid a predefined time [33].

## **6.3 Building Information Modeling (5D) for existing buildings (case study)**

The building of administration department in the Midland Oil Company in Iraq/Baghdad will be considered as a contextual investigation analysis methodology. It was embraced to clarify the efficient specialty control demonstration that was created from a thorough site examination. For the case study considered, the assessment information was gained from the undertaking general temporary worker, CAD drawings, and the schedule and expenses were gotten from the venture proprietor and

contractual workers. The examination comprises of four noteworthy areas: First, investigation of value control techniques in huge framework development through site review; second, matching project implemented with the 3D BIM model via Autodesk Revit®; third, definition of the strategy to coordinate the quality information built with BIM in view of hypothetical exploration; fourth, advancement of a 5D BIM application work process for quality administration. Approval of the suggestion layout is acquired through a contextual investigation of the established development at the administration department building of the Midland Oil Company in Iraq/Baghdad. The establishment work was finished with no postponement because of real quality deformities. Shortened clarification and use of the four-stage methodology of this case study is displayed in the following parts.

#### **6.4 5D model -based building quality control**

Quality control covers evaluation and testing, unlike verification reporting and this stage was made in the midst of the improvement stage. The quality control procedure sets with making quality organization course of action considering the drawings and particulars, which set up the way of the material and devices, the affirmation norm for the work set up and the examination and testing to be performed. By then, through coordination between material creators and assignment fabricates, all the specific and quality data in the procurement request for material and instruments have been transmitted for acquisition. In the midst of improvement work, the general chief and the field engineer watch the subcontracted work for conformance. The additional screen of all professional and character insufficiencies passed decent breaking points. An endless supply of the work, acknowledgment assessment, and acceptance testing are directed to confirm conformance with the prerequisites of the endorsed development records. When all is said and done, the control of value on a development venture comprises field reviews, which ensure that workmanship, physical properties, hardware, and materials supplied by the temporary worker adjust to the outline arrangements and determinations.

In the present contextual analysis, worksheet organizations are used for quality examinations. Each analysis contains quality control criteria requested given national, and industry based quality control codebooks for Iraqi details. Every examination part can be considered as a record. The obligations of every association that take part in

developing the last item are distinguished and recorded alongside the checklist. Advancement quality affirmation is isolated into the unit (sub-units) expand, the segment (sub-section) amplify, the sub-wander and the survey part. An audit worksheet is made out of a particular number of tests that are duplicated in the same conditions and pooled in a supported approach to the test. The course of action of affirmation is the other route from routine affirmation systems - from the base agenda to the whole assignment. The examination part is the smallest unit and can be considered as an improvement identical to a section in a BIM model.

For better form of full information interrelationships for quality organization purposes in BIM, the data from BIM should be carefully dealt with and progressed. The item, affiliation, and method showing the system to supplement 3D item models with procedures and association models to reinforce diagram and advancement were proposed. 5D showing is an instance of product–process showing and organization–process illustrating. The latter is used to assemble and imitate the correspondence among gatherings and/or affiliations, and their related obligations, in different times of an endeavor. The prior work of building a motivation database is capable of structuring codes and will be used as the foundation for this examination.

## **6.5 Description of Project**

In the case, it was important to change 3D outlines to 5D models. The venture was a learning knowledge for all and included paying little attention to an earlier foundation. The timetable was created to show when every part of the task would be developed and when step-by-step configuration would be required for every sort of work inside that division, for example, sections, segments, sprinklers, plumbing, electrical, and so forth. The 3D CAD model indicated precisely how every item connected with others and took into account close joint effort among the different exchanges.

A building contractor has a position within a construction company to help clients in giving a shape to their housing and commercial projects. The construction company is performing construction work, and under adverse weather conditions. has the experience of welding, bricklaying, carpentry, plumbing, painting, roofing, flooring, tiling and scaffold erecting. The contractor has worked on highway construction projects, tunnel excavation, residential construction, and house building and demolition projects.

The skills of a contractor include excellent communication and knowledge of building construction practices together with great organizational, coordination and monitoring skills. What's more, he\ she should have strong management and leadership skills together with understanding of construction laws and contracting business. Being skilled in obtaining construction permits, creating floor design, and negotiating with suppliers is also needed in a contractor. Having an excellent ability to interpret and work according to the blueprints, being computer literate and hard-working professional, and being skilled in collaborating with other cross-functional team are the skills needed in a contractor. Arranging and managing subcontractors to work for every stage of construction, supervising a subcontractor's work to ensure buildings are of an acceptable standard quality and having a progress according to the schedule, organizing the delivery times of materials to match with various stages of building process, communicating with financial institutions and lawyers on the issues relating to contracts loans for building projects are among the many tasks a contractor is required to do.

If the company that has implemented this project has enough capital to cover all the costs of the project and finish it without the need to get extra money from another resource, it is thought to have succeeded.

The company has completed four housing projects in Baghdad, construct power plant in the Najaf, concrete tank to save water in the khanqeen and highway roads.

Figure 6.1 demonstrates some picture during and after implementation the three-story building.



Figure 6.1A: Pictures for the Project (Case Study)



Figure 6.1(cont.) B: Pictures for the Project (Case Study)

## 6.6 Case study Form with BIM

Building information modeling rises above conventional drawings to incorporate the extra measurements of stature, time and cost. Furthermore, in light of the fact that BIM permits materials contribution to the model (counting information required), any proposed changes could rapidly be dissected to affirm that they do not negatively affect the objects' undertakings.

BIM permits designers, architects and contractual workers to measure the expenses and advantages of the dominant part of building segments and their interrelationships. Each drawing, perspective, upgrade and change is saved inside one single advanced document that can be messaged for precise follow-up, booking and correspondence. For this contextual analysis, BIM gave booking that is more precise, enhanced cost take-off, and fitted the undertaking cost model.

The main actors involved in the simulation were the architect, the structural and energy engineers, the project manager (an actor with technical skills in this project). The process starting by the 3D model was created using SketchUp at LOD 200 on the basis of architectural design drawings imported from ArchiCAD. The volume and the orientation of the building were precisely modelled but many other 3D elements were only approximated. The sequencing of activities was realized directly within the 4D&5D Virtual Builder plugin for SketchUp to execute the project and make the necessary updates during implementation. Before getting the results, a comparison has been made in specification, contract, standard, and project plan. if matching print report either No make determine and reviewing the consistency of the 5D model.

There are five levels start from first level (LOD 100) which is limited to a generic representation of the building while (LOD 500) model corresponds to the project "as-built" model and incorporates useful elements for operation and facility management.

The construction project manager holds a breadth of skills, as this job requires both technical construction knowledge as well as general management ability. As construction projects increase in complexity, the project manager's duties continue to broaden. This places extra pressure on the project manager to ensure that everything runs smoothly, as any tiny mistake can have devastating results on a project's success. This framework helped the project manager eliminate costly mistakes.

The presented findings contribute to the understanding of the potential use of BIM in construction quality management and fill an existing gap in the knowledge on the use of BIM for construction quality management. This case study explored the implementation of BIM in quality management and proposed integrated solutions to improve current quality management processes with assistance of a BIM working environment.

A BIM-based quality framework has proposed to combine BIM and the existing quality framework. Also discussed how these two models will work together to facilitate construction quality management. It helps the project participants to better understand the quality progress and to collaborate more effectively thanks to a visualized data format.

Lastly, such plan varieties may normally have brought about change request, while now they have been checked rapidly and with a negligible push to decide their effects on the undertaking.

### **6.7 Benefits applied the Framework on this project**

This BIM application enabled the company to identify potential collisions or clashes between various structural and mechanical systems. During the design development phase, 45 clashes were identified, which resulted in additional cost avoidance. The model was updated and resolved collisions were tracked. Each critical clash was shared with the design team via the model viewer and a numbered collision log with a record of individual images of each collision per the architectural or structural discipline has been kept. The collision cost savings values were based on estimates for making design changes or field modifications had the collision not been detected earlier. More than 570 clashes were detected before actual construction began. For calculating net cost savings, a conservative approach was adopted by assuming that 75% of the identified collisions can be detected through conventional practices (e.g., sequential composite overlay process using light tables) before actual construction begins.

When process chart of 5D framework (Fig 5.2) is applied it suggested in the project that we implement by using Building Information Modeling principle, positive notes related with project components appeared, as shown: -

- Materials

The magnitude of wastage of construction materials on construction projects sites should be decreased. A survey was conducted that included clients, contractors, and consultants. This research aims to study the causes of waste and achieve the aim by identifying the most important causes of wastage of materials in construction site which are as follow:

Frequent design and client's changes; rework due to workers mistakes; poor contract items; lack and misuse of storage of materials; poor strategy for waste minimization; poor site conditions; shortage and lack of experience of skilled workers; damage during transportation; theft and vandalism; and mistakes in quantity surveying and over allowance. Also, the percentage of waste materials was accounted for by values between 15% and 21% on the construction site, after comparing with quantity material in the previous project.

- Labor

Productivity in construction is defined as output per labor hour. Construction cost labor constitutes a large part of it and while performing a task in construction the amount of labor hours is more susceptible to the influence of management than is capital or materials, this productivity measure is often referred to as labor productivity.

In the course of working, it has been noticed that labor productivity is not a measure of the capabilities of labor alone but it is a measure of the overall effectiveness of an operating system in utilizing labor, capital and equipment to convert labor efforts into some useful output. For example, increasing labor productivity in a piece of new equipment to perform certain tasks in construction by increasing output for the same number of labor hours. Construction output may be expressed in terms of functional units or constant dinar (1 dollar=1200 dinar).

In the first case, labor productivity is associated with units of product per labor hour, such as cubic meter of concrete placed per hour.

In the second case, labor productivity is identified with the value of construction (in constant Dinar) per labor hour. The value of construction is measured by the benefit of constructed cost. When labor productivity measured in this way, it requires considerable care while interpreting the results. In construction, costs, wages are an important component. As a result, the value of construction put in place per hour of work will decline, suggesting lower productivity.

In this project, we applied the first case.

As we know, the project manager is the work leader who has to keep this implementation running smoothly while ensuring that the project is on track. He is responsible for solving problems during actions and completing the project from requirements gathering through planning, implementation and installation into production, which requires a mixture of problem-solving, communication, presentation, and management skills. The project was completed smoothly and on schedule, by implementing some points to project management success:

The first step begins with developing positive relationships additionally to open communication among everyone who is contributing to the project, for implementation management success. Project managers work with many talented and highly skilled professionals, and these individuals expect to be recognized for their expertise—both by the fellow team members and the project leader.

Second comes process definition and follow-up. To avoid conflicts and define work boundaries, by implementation processes and then follow the defined process ensuring that the whole staff follows the same guidelines.

Implementation manager is also responsible for making life easy for every stakeholder by defining the acceptance Criteria during the initiation phase to ensure smooth project delivery and to secure a happy client at the end.

Third comes continuing education to enhance the expertise. The best way to ensure knowledge and skills are as comprehensive and current as possible through professional education, by undertaking training for labors that is relevant to the work.

- Machine

Construction equipment has a great importance in the modern construction industry. It was used for accomplishing construction task rapidly. It is found that in building a project, the equipment cost has the important place of the direct cost, additionally to gain the time. The arrangement of user equipment (motorized wheelbarrows and mortar mixers, sophisticated scaffolding systems, and forklift trucks etc.) and innovative methods has made the best possible changes to construct buildings.

During implementation, the previous building had problems of more complex management, divergence of results because it was obtained through conventional

procedures. To realize the success of the project within cost and time, would require planning and implementation of earthworks, its activities and all other activities step by step. Concurrently, miscalculation of proper size and number of required equipment for the project may result in suffering from overhead costs and wastage of time. Therefore, considering the proper selection of equipment is a vital factor for any construction project, it also helps to the arrangement of use of the equipment on the working site, attention to the cycle time (as the amount of time taken by the machine to implement a repetitive part of an operation). It is measured as the time required for the machine to return to the same position. It is the time required to complete one entire process for equipment which includes many repeated operations.

One of the important factors for improving performance is regular maintenance. Good maintenance will minimize defects and repair costs, maximize production and profits, with the increase in profit. It helps to control costs and service intervals, lengthens equipment life and minimizes downtime.

In this project, equipment played an important role in completing construction activities. It is essential to understand its fundamentals towards the success of the project. Thus, it is the important role of the building information modeling for planning, selection, and performance.

Some of the factors that can affect the performance of equipment can be concluded as following:

1) Productivity of the particular work is directly affected by selection of incorrect equipment. 2) Using the equipment in the right place and correct time. 3) If the operator has poor skills, time saved per cycle is nothing 4) Regular repairs and maintenance of equipment may increase its life providing better performance.

#### - Time

In implementing any project, the time is a major function. The success of supervision or monitoring of this project implementation depends on the time taken to implement project activities. The supervisor pays particular attention to time scheduling, time control measures and its supervision, time postponement and extension, damages for non-completion and defect or warranty period.

There isn't any additional operational expenditure, which means it doesn't have any loss of revenue, the project had been implemented as planned without delay of service delivery. It was controlled in the project implementation through control on events and activities that must start, take a certain specific duration and end on certain dates. In the previous project, many operations outside this critical path would have led to possibilities of poor quality, delays and losses, and extra costs. The problems were successfully solved by control in: planning, setting targets, choosing a program or the right working plan, controlling and evaluating progress in a timely manner and taking immediate corrective action.

Most often, the supervisor instructs the contractor to prepare and develop the time schedule. For effective time management, another effective technique would be effective time management. Although this technique does apply to various management areas, it is very important with regard to project cost control.

- Cost

For efficient project cost control, some valuable and essential techniques are utilized:

Planning the Project Budget: The making of this budget depends on a lot of research and critical thinking. Making a budget at the beginning of the project, for all payments and costs that you will need during the project life cycle. Cost estimation accuracy to within 3%, additionally up to 80% reduction in time taken to generate a cost estimate. The key to the profit from the project is adhering to the project budget at all times. Always leave room for adjustments as the costs may not remain the same right through the period of the project.

Keeping a Track of Costs: It includes keeping track of all actual costs. It is better to prepare a budget that depends on time. This will help to know the budget of a project during implementation. The actual costs will have to be tracked with the targets that have been set out in the budget. These targets could be on a weekly or monthly or even yearly basis.

This is much easier than having one complete budget for the full period of the project. If any new work happens, there exist the need to make a reasonable guess out of this and see if it can be enough with the final amount in the budget. Project cost was controlled through a constant review of the budget and other financial information. Additionally,

providing reports on project financials at regular intervals helps to keep track of the project. This would ensure that overspending do not take place.

Above all, we conclude that coming up with a project budget is not adequate for the success of a project but through assistance from the team to keep the costs close to the figures in the initial budget. Additionally, to keep in mind the risks that came with cost escalation. The main reason for the failure of the project must be unable to meet the project deadlines. On the reverse, the cost of your project could keep rising which effectively means that the budget will be exceeded if the project is not completed within the definite time. Modern change control systems are utilized in this project to take into account anything utilized in this project which considered any changes that could occur during the course of the project. Any change in project track will have an impact on the deadlines of the deliverables. We can conclude that any changes may increase project cost by increasing the effort needed for the project.

## **6.8 The main significant advantages of Proposed Model**

The most significant advantages of BIM Framework in Figure 5.2 and our case study are:

- 1- Reducing expenses for proprietors, planner's engineers.
- 2- Providing a schematic model proceeding to the generation of a detailed building model, permitting the planner to make a more exact appraisal of the proposed scheme and assessing whether it meets the utilitarian and feasible necessities set out by the proprietor; this expands venture execution and general quality.
- 3- Enhancing profitability because of simple recovery of data and enhancing records.
- 4- Decreasing development time, disposing of progress requests and reducing extra cost.
- 5- Reliable 2D drawings created at any phase of the configuration, which lessens the measure of time expected to deliver layouts for the diverse outline disciplines.
- 6- Control time of project implementation.
- 7- Implanting and connecting of imperative data, for example, collecting a particular material, areas of points of interest, and amounts required for estimation and offering.
- 8- Visualization by the venture group and proprietor of the outline at any phase of

the procedure with the understanding that it will be dimensionally steady in each perspective, along these lines enhancing observing effectiveness and decreasing working expenses.

- 9- Shortening the configuration period while lessening potential outline mistakes and exclusions; additionally more noteworthy understanding and early discovery of conceivable configuration issues, taking into account better execution expectation.

## **6.9 Summary**

The displayed discoveries add to the comprehension of the potential utilization of BIM in development quality administration and fill a current hole in the learning on the utilization of BIM for development quality administration. This paper investigated the execution of BIM in quality administration and proposed coordinated answers for enhancing current quality administration forms with the help of a BIM working environment. A BIM-based quality model has been proposed to join BIM and the current quality POP model. Additionally, this paper mentions how these two models will cooperate to encourage development quality administration. It assists the undertaking members with understanding the quality advancement and teaming up the more adequately because of an imagined information group. The fundamentally favorable circumstances of the quality development model proposed in this paper lie in the accompanying angles: First, the use of configuration data guarantees information consistency and encourages quality administration process. Second, the completely institutionalized and organized development codes are incorporated into the model to give clear development undertaking prerequisites to direction and confirmation. Running the mill blunders brought on by a misconception of cross-reference codes can be prevented. Third, the 4D application guarantees the auspicious assessment and simulation of the entire procedure that assists the task members with understanding the quality prerequisites acknowledgment better, and to work together in an imagined way.

Likely, it is derived that the BIM-based advancement quality implementation is proper and pleasing in a quality consistent organization. In any case, because of data fittings, it is likely and feasible to apply BIM for a quality organization and to use arrangement datum totally through simulation of the advancement techniques. Secondly, BIM can reconcile the present business regularity practices in a quality organization and

acknowledge them through a logical examination. Though quantitative results are not offered as a result of the limitation of this examination wander, connections are made between BIM-based or non-errands.



### DISCUSSION AND CONCLUSION

#### 7.1 Discussion

Building information modeling requires improved coordination of undertaking groups and joint effort between all the gatherings of BIM-based ventures. The close coordinated effort of the prime players in the most particular stage is exceptionally good with BIM capacities. Furthermore, shared techniques can determine the issues, for example, a division of motivating forces picked up by BIM amongst partners and absence of contractual worker's information in the outline stage by their initial association. Nonetheless, there are still a few difficulties significant to the administration of task groups, having focused offers and addressing customer's needs that infer a requirement for advancement of new strategies and clear rules to create a win-win circumstance for all partners.

BIM is an impermanent pattern, it can also alter the present procedure of building advancement. The examination discoveries demonstrate a requirement for more important comprehension of BIM's effect on the business procedure of all controls inside the firm amid the venture life cycle. Right now, the creator has attempted another examination utilizing master feeling overview to gather important subjective data on how BIM has changed the business procedure and authoritative structure of development firms.

The study portrayed thus concurs that BIM can be useful to enhance venture quality and that more tasks are prone to utilize BIM later on to pass data. The particular goal of this study is to be proficient for the most part through the BIM, and relating examinations are as follows:

- (1) Verifying that BIM gives more advantage in concept, feasibility, and design
- (2) Enhancement in building performance and quality
- (3) Fast and more careful visualizations of a design
- (4) Reducing time for corrections when changes are needed to design
- (5) Easy to generate accurate and consistent 2D drawings at any part of design extract cost estimates
- (6) Investigating the characteristics of coincidence design and construction planning
- (7) High-quality management by responding to design or site problems
- (8) Studying the effect of the best implementation of lean construction techniques and great management methods and operation facilities.
- (9) Using the model data of previous research to validate a 4D model procedure.

To discuss the result of this study, while comparing the current reality of quality management in the Iraqi construction industry with the reality of management quality of the construction industry in developed countries and with global systems, we can conclude that there are clear shortcomings as below:

- 1-There is no assessment method of the practicality of a proposed plan for projects; also, there are no effects for an economic feasibility study in the financial planning in many projects.
- 2-There is no literal in describing the projects or work to make an attractive announcement irrelevant.
- 3-The study process often begins with details without discussion.
- 4-The absence of scrutiny by other side related with projects and confined to only one hand in most of the projects.
- 5-The viewfinder of the project's reliance on the financial evaluation is more important than the technical evaluation when making a decision.
- 6-Choosing unexperienced contractor because of erroneous analysis of tenders which cause lack of focus in the selection of contractors who have previous experience in similar acts.
- 7-A lack of guidelines and procedures for the correct usage of control procedures of maintenance, and a lack of expertise in the study carried out and supervising.
- 8-Noncompliance with the requirements and specifications by the contractor seeks to make a larger profit.
- 9- Lack of securing the necessary materials and equipment for construction in a timely manner.

- 10- Failure by the resident engineer department in the project (supervisor) perform a good observation in the application of making the necessary tests for all executed parts in the project and not relying on some tests at the end of the implementation of receipt.
  - 11- Lack of usage of scientific methods in engineering management during the implementation of the operations at the site, such as schedule work progresses; to help in controlling the implementation project.
  - 12- The absence of cooperation between parties of the project (the owner - designer - executor - supervisor) and the contractor in order to do the right job.
  - 13- The appearance of defects during receipt of the project, which cannot be fully corrected, or its cost of repairing being very high.
  - 14- The emergence of future defects, especially after the end of the maintenance period because of lack of inspection conducted by the owner or as a result of lack of experience, or due to the delay in their appearance.
- Attention and application of some notes must be considered:
- 1- Emphasis on the implementation of the key stages of the construction project should be put properly.
  - 2- Attention to the preparation of the study for the project, whether preliminary or detailed scrutiny should be paid and regular checks from more than one part should be performed.
  - 3- The conventional principle of contract in Iraq that gives financial assessment more importance than the technical should be changed.
  - 4- There is a need to apply sufficient control by the authorities supervising during implementation and conduction of all possible tests to ensure a good level of implementation.
  - 5- Engineering and scientific management methods in the course of implementation, such as programming time, scheduling resources and costing methods to optimal investment mechanisms should be relied on
  - 6- The receipt process should be focused on so that the procedures and preset are enough to ensure a lesser extent of defects and errors
  - 7- Need for facilities and maintenance reinvested permanently during control.

Conventional quality administration neglected to associate progressively with dispersed outline depiction and the quality administration process. For this situation, in a study, with the utilization of BIM-based development quality model, the data is aggregated

and disconnected from the same information source to be organized completely and imparted through the configuration and the development stage. As a whole development necessity is cleared up in a 3D design for best realization, the undertaking was conveyed on time identified with establishment works. Be that as it may, the BIM-based quality model has the accompanying constraints: (1) A BIM layout produced for configuration objective does not have brief structures, for example, outer formwork and framework. In this manner, the impermanent building must be input to the initial BIM outline arranged layout. (2) Utilization of PCs on location is not advantageous as of now with the proposed technique while cell phones ought to be used later on for development in recording field information and direct information exchange to BIM.

## **7.2 Conclusion**

Beginning to utilize the BIM framework produce customary reports from the building model. This will uncover where there are shortages in the building objects, in yield capacities, in connections to investigation programs, and so forth. It will likewise give instructive chances to administrative staff. The results in the beginning should be used to instruct and direct, continued with the selection of BIM programming and extra staff preparation. Furthermore, senior administration should be kept informed of advancement, issues, bits of knowledge and so forth. Stretching the utilization of BIM to new ventures and starting working with outside individuals from the undertaking groups in new synergistic methodologies permit early coordination and sharing of information utilizing the building layout. Integrating BIM capacities into all parts of the association's capacities should be kept on and these new business forms should be mirrored in authoritative reports with customers and business accomplices. Intermittently, the BIM usage procedure should be planned again to mirror the advantages and issues observed up to this point, and new objectives for execution, time, and cost should be set. BIM should be extended and changes to new areas and capacities inside the firm should be encouraged. In Chapters 4 to 6, where particular uses of BIM over the lifecycle of a building were discussed, extra appropriation rules particular to every gathering required in the building procedure were checked.

BIM is an encouraging advancement in the design, building, and development fields. It changes the way contractual workers, specialists work together, however, its application is still moderately new, and there is much to know. One approach to take in is from

exploring how business fields utilize BIM and their hardships en-route. BIM was presented over 10 years back mostly to recognize the data-rich 3D displaying design from the customary 2D drawing. It is being acclaimed by its promoters as a lifeline for confused ventures due to its capacity to right blunders ahead of schedule in the configuration stage and precisely plan development

BIM is not a thing or a kind of programming yet rather a human development that finally incorporates broad method changes being developed. Starting now, a wide combination of proprietors asks for BIM and changes contract terms to enable it. New capacities and parts are being made such as compelling pilot use development, provoking corporate - wide uptake due to initiation.

Brief specialists and legally binding improvement laborers are executing present day structures. A study conducted in mid-2007 found that 74% of US compositional firms are currently using 3D showing and BIM gadgets, but only 34% of them use it for shrewd showing. BIM - standard attempts; for instance, the National BIM Standards in the US - get-together steam and generally, society is dynamically asking for greener structures. BIM and 4,5D CAD instruments are getting the chance to be essentially developed in site workplaces. The nonattendance of legitimately arranged talented staff, rather than the development itself, is the present bottleneck to endless utilization.

The development designs fuse the change of motorized checking for code conformance with constructability using building information models. A couple of merchants have broadened the degree of their BIM gadgets, while others offer more prepared- particular c value, for instance, organization advancement limits. It ends up being more typical for building item producers to give 3D lists, and BIM is making globalization of assembling for dynamically complex building sub - social events monetarily practical.

BIM is inception to change the way structures look, the direction they work, and the courses in which they are prepared. All through this research, we have intentionally and dependably used the term BIM to depict a development (building data demonstrating), rather than an article (as in the development of information model). This mirrors our conviction that BIM is not a thing or a kind of programming, yet, rather an individual development that finally incorporates full procedure changes being developed. In this part, we plan to give two perspectives on the possible destiny of building using BIM.

This dissertation discussed together with a short presentation depicting the start and improvement of BIM until today. It gives our perspectives on what is coming soon. The evaluation is isolated into two-time distributions: a sensibly arranged guess of the not totally inaccessible future that looks ahead to the upcoming five years. The nearby - term guess reflects stream market designs having been discussed in sections before this exposition and a while later reviews energy research. The long - term gage relies on upon examinations of possible drivers and an extensive measure of sense.

Improvement industry specialists will reflect, with the learning of the past, on the methodology changes that will happen in the future. They will have presumably discovered varying group to perceive between such impacts as BIM, grade advancement, and execution driven arrangement. Without each other, these techniques could theoretically prosper on themselves. Their belongings, regardless, are compared in crucial ways, and they are being acquired in the meantime.

### **7.3 Main Results and Contributions**

Some key advantages acknowledged from the utilization of 5D models include :

- 1) Improved task conveyance by quickening development progress, making development more precise and financially savvy and expanding security at the work site .
- 2) Improved correspondence between the main partner groups (e.g., Proprietor, advisors, temporary worker, service organizations, prefabrication, and material suppliers).
- 3) Enhanced conflict recognition and recognizable proof of conceivable blunders and irregularities in outline before development .
- 4) Improved representation of subgrade components and potential utility clashes.
- 5) Random evaluation checks rather than at determined cross segment separations.
- 6) Material cost investment funds.
- 7) Labor cost investment funds, expanded profitability, expanded effectiveness.
- 8) Fewer clashes and changes amid development.
- 9) Early distinguishing proof of constructability issues, enhanced configuration precision, and simplicity of visual check for quality control. Once manufactured, the

model can be used all through the full lifecycle of an office and by different organizations, for instance amid base support, operations, and resource administration work.

#### **7.4 Recommendations for Further Studies**

Begin masterminding with the 3D model at half arrangement change; start indicating essentially after 95% framework headway (to avoid patching up). Guarantee all trades use a 3D model for blueprint so that the consolidated model is as exact as could be normally considering the present situation; arranging in 2D and after that building, a 3D model is a poor substitute for plotting particularly in 5D. Get prepared and make a week-by-week setup, coordination, and advancement arrangement for that association's practices together in light of presenting dates for the week ahead; guarantee "reliable individuals" from each trade go to every week, and having them make obligations regarding their specific clusters. Do whatever it takes to stick to coordination sequencing over the range of work, i.e., do obligations and stick to them.

## REFERENCES

---

- [1] Dobyns, L. and Crawford-Mason, C., *Quality or Else: The Revolution in World Business*, Houghton Mifflin, New York, NY, 1991.
- [2] Smith, Deke (2007). "An Introduction to Building Information Modeling (BIM)". *Journal of Building Information Modeling*, Fall 2007, 12–14.
- [3] Lee, N., Dossick, C. S., & Foley, S. P. (2013) "A Guideline for Building Information Modeling in Construction Engineering and Management Education.". *Journal of Professional Issues in Engineering Education and Practice*, 139(4): 266–274.
- [4] Bani Ismail, Loiy.(2012): *An Evaluation of The Implementation of Total Quality Management (TQM) within The Construction Sector in The United Kingdom and Jordan*. Doctoral thesis, University of Huddersfield.
- [5] Succar, B. *Building Information Modelling Framework: A Research and Delivery Foundation for Industry Stakeholders*. *Autom. Constr*, 18(3):357-375, 2009. ISSN 0926-5805.
- [6] Chen, L.J. and Luo, H.B.(2014): *A BIM-Based Construction Quality Management Model and its Applications*[J]. *Journal of Automation in Construction* 64–73.
- [7] Peter Ray Allison. *New Observations and Methods for Modeling Nonlinear Site Response (CD-ROM)*. *Proceedings of the 4th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics and Symposium in Honor of Professor W.D. Liam Finn*, March 26-31, San Diego, CA, 3-13.
- [8] Youde, R.K., "Cost of Quality Reporting", *Management Accounting*, 37 (34): 34-8.
- [9] Volk, R.; Stengel, J.; Schultmann, F. (2014): *Building Information Models (BIM) for Existing Buildings – Literature Review and Future Needs - Automation in Construction* 38: 109-127.
- [10] McGraw Hill Construction (2012). "The Business Value of BIM for Infrastructure: Addressing America's Infrastructure Challenge with Collaboration and Technology," McGraw-Hill Construction SmartMarket Report, New York.

- [11] Seulki Lee, Jungho Yu and David Jeong.(2015): BIM Acceptance Model in Construction Organizations[J]. *J. Manage. Eng.*, 2015, 31(3): 04014048
- [12] Chuck Eastman, Paul Teicholz, Rafael Sacks, Kathleen Liston. (2008): *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors*. Copyright © 2008 John Wiley & Sons, Inc.
- [13] J. W. Cao, H. K. Zheng, "Study on Cost Decision Model Based on BIM and AHP", *Applied Mechanics and Materials*, Vols. 584-586, pp. 2205-2208, 2014
- [14] Gregory P. Luth, M.ASCE, Alyssa Schorer and Yelda Turkan, Aff.M.ASCE. *Lessons From Using BIM to Increase Design-Construction Integration*. *Pract. Period. Struct. Des. Constr.*, 2014, 19(1): 103-110.
- [15] Timothy Leighton Hamilton.(2012) : *BIM Deployment: A Process to Adopt and Implement a Disruptive Technology Approved*. Thesis Presented to the Faculty of the Graduate School of The University of Texas at Austin in Partial Fulfillment of the Requirements for The Degree of Master of Science in Engineering.
- [16] Gilmore, H.L., "Continuous Incremental Improvement: an Operations Strategy for Higher Quality, Lower Costs, and Global Competitiveness", *Sam Advanced Management Journal*, 55(1): 21-5.
- [17] Woo, J., Wilsmann, J., & Kang, D. (2010, May). Use of As-Built Building Information Modeling. In *Construction Research Congress* 1:538-547.
- [18] Andre, G. R. (2011). *Building Information Modeling (BIM): Special Contract Issues: K&L GATES*.
- [19] Lowe, R. H., & Muncey, J. M. (2008a). *BIM Contracting Made Easy: The ConsensusDOCS 301 BIM Addendum*. *Constructor* (Sep/Oct 2008), 87-90.
- [20] Zeidler Partnership Architects. (2011). *Building Information Modeling (BIM) Agreement*. Canada.
- [21] Guo, W.J. (2007). "The Newest Development of Intelligent Building." *Construction Technology*, 36(4): 17-19.
- [22] Huang, K.W. (2014). "Application of BIM in Project Management." *Applied Mechanics and Materials*, 496(500): 2836-2839.
- [23] Li, H., Guo, H.L., Huang, T., Cheng J.Y. and Cheng J.J. (2010). "Research on The Application Architecture of BIM in Building Projects." *Journal of Engineering Management*, 24(5): 525-529.
- [24] Li, Y. and Guan, C.S. (2012). "Construction Project Information Management Based on BIM." *Journal of Engineering Management*, 26(4): 17-21.
- [25] Man, Q.P. and Li, X.D. (2012). "Collaborative Construction Based on Ubiquitous Computing and BIM." *Journal of China Civil Engineering*, 45(2): 311-315.
- [26] Su, H. (2013). "Research on Construction Contract Under BIM Conditions."

- Journal of Applied Sciences, 13: 3926-3930.
- [27] Wang, C.Y. (2012). "Detailed Design Management Based on BIM." *Journal of Engineering Management*, 26(4): 12-16.
- [28] Cerovsek, T. (2011). "A Review and Outlook for a 'Building Information Model (BIM): A Multi-Standpoint Framework for Technological Development.'" *Advanced Engineering Informatics*, 25: 224-244.
- [29] Bryde, D., Broquetas, M. and Volm, J.M. (2013). "The Project Benefits of Building Information Modeling (BIM)." *International Journal of Project Management*, 31: 971-980.
- [30] Young N W, Jones S A, Bernstein H M, *Building Information Modeling (BIM)-Transforming Design and Construction to Achieve Greater Industry Productivity*, SmartMarket Report, (2008), 48.
- [31] Lieyun Ding and Xun Xu. Application of Cloud Storage on BIM Life-cycle Management. *Int Adv Robot Syst*, 2014, 11:129.
- [32] Qusay Saleh, Khairuddin Nasr and Dr. Mohammad Jalali "Administration to The Quality of Construction Projects in Syria," *Damascus University Journal of Science and Engineering*: 22.
- [33] Hosny Abdel-Hady H, (1994) :Managements Quality for Construction Projects. First International Conference for Building and Construction. June 23-26-Cairo-Egypt.
- [34] Griffith Alan, Stephenson paul , Watson paul ( 2000 ) "Management System for Construction Pearson Education".
- [35] Haupt, T. C., & Whiteman, D. E. (2004). Inhibiting Factors of Implementing Total Quality Management on Construction Sites. *The TQM Magazine*, 16(3), 166-173.
- [36] Bani Ismail, Loiy.(2012): An Evaluation of The Implementation of Total Quality Management (TQM) Within The Construction Sector in The United Kingdom and Jordan. Doctoral thesis, University of Hudders Field.
- [37] Kumaraswamy, M. M., & Dissanayaka, S. M. (2000). ISO 9000 and Beyond: From a Hong Kong Construction Perspective. *Construction Management and Economics*, 18: 783-796.
- [38] Lai, K. H., Weerakoon, T. S., & Cheng, T. C. E. (2002). The State of Quality Management Implementation: A Cross-Sectional Study of Quality-Oriented Companies in Hong Kong. *Total Quality Management*, 13(1): 29-38.
- [39] Landin, A. (2000). ISO 9001 Within the Swedish Construction Sector. *Construction Management and Economics*, 18, 509-518.
- [40] Jaim. Prof. K. C and Chitale. Prof. A. K. (1998) "Quality Assurance and Total Quality Managements", KHANNA Publishers.
- [41] Harted Institute of Building ( 1989 ) "Quality Assurance in The Building

Process".

- [42] Love, P. E. D., Li, H., Irani, Z., & Faniran, O. (2000). Total Quality Management And The Learning Organization: A Dialogue for Change in Construction. *Construction Management and Economics*, 18, 321-331.
- [43] Project Management Institute. (2000). *A Guide to The Project Management Body of Knowledge (PMBOK)*. Project Management Institute, Pennsylvania, 95-105.
- [44] Rodgers, R., Hunter J. E., & Rogers, D. L. (1993). Influence of Top Management on Management Program Success. *Journal of Applied Psychology*, 78(1): 151-155.
- [45] WL-Bastawisy, Madge, (1997): Improving Building Quality in Egypt Through Developing The Quality Management System. In *Proceeding of The Conference, Inter Build 97, Cairo, Egypt*, 641-656.
- [46] Serpell A, Thenoux G, Ochoa G (2000): A Mythology for Evaluating The Management of Quality in Chilean Construction Companies. *Proceeding of Second International Conference on Construction in Developing Country*.
- [47] Solminihač, Aserpell and Figarić (2000) "A General Diagnosis of Construction Quality in Chile" *Proceeding of Second International Conference on Construction in Developing Country*.
- [48] Grilo, A.; Jardim-Goncalves, R. B. Value Proposition on Interoperability of BIM and Collaborative Working Environments. *Automation in Construction*, 19(5): 522-530.
- [49] Kim, S.-A., S. Chin, et al. (2009). "Automated Building Information Modeling System for Building Interior to Improve Productivity of BIM-based Quantity Take-Off." *Information and Computational Technology*.
- [50] Eastman, 2008: *BIM for Construction Industry, BIM Hand book*
- [51] Eastman, 2008: *BIM Case Studies, BIM Hand Book, 02/02/2008*
- [52] Eastman, 2008: *The Future: Building with BIM, BIM Hand Book, 02/02/2008*
- [53] Vladimir Popov, Saulius Mikalauskas, Darius Migilinskas, Povilas Vainiūnas, Complex Usage of 4D Information Modeling Concept for Building Design, Estimation, Scheduling and Determination of Effective Variant, *Technol. Econ. Dev. Econ.* 12 (2): 91–98.
- [54] N. Han, Z.F. Yue, Y.F. Lu, Collision Detection of Building Facility Pipes and Ducts Based on BIM technology, *Adv. Mater. Res.* 346, 312–317.
- [55] Bin Cheng, YuWang, BIM's Content and Its Application in Contemporary Architectural Design, 2010 International Conference on Management and Service Science, 2010, 1–4.
- [56] Qiu Xin, Building Information Modelling (BIM) Adoption of Construction Project Management Based on Hubei Jingzhou bus Terminal Case, 2011

- International Conference on Business Computing and Global Informatization, 282–284.
- [57] Inhan Kim, Jieun Kim, Jongcheol Seo, Development of an IFC-based IDF Converter for Supporting Energy Performance Assessment in The Early Design Phase, *J. Asian Archit. Build. Eng.* 11 (2): 313–320.
- [58] Sattineni, A. and R. H. Bradford II (2011). "Estimating With BIM: A Survey of US Construction Companies.
- [59] A.J. Fox, H.A. Cornell, et al., *Quality in the Constructed Project: Proceedings of the Workshop Sponsored by The American Society of Civil Engineers: Chicago, Illinois November 13–15, 1984*, American Society of Civil Engineers, New York, N.Y., 1985.
- [60] Conrad Botton, Sylvain Kubicki and Gilles Halin. The Challenge of Level of Development in 4D/BIM Simulation Across AEC Project Lifecycle. A Case Study[J]. *Journal of ScienceDirect*, 2015, 123: 59-67.
- [61] Dr. Peter Smith. BIM & the 5D Project Cost Manager[J]. *Journal of ScienceDirect*, 2014, 119: 475-484.
- [62] Kubicki, S., Botton, C., "It Barometer Survey in Luxembourg : First Results to Understand It Innovation in Construction Sector" *Computing in Civil And Building Engineering* .179-186. American Society of Civil Engineering, Orlando, USA (2014).
- [63] Dawood, N., Sriprasert, E., Mallasi,Z, Hobbs, B.: 4D Visualisation Development : Real Life Case Studies. *Distributing knowledge in Building – CIB w78 Conference* 12-14.
- [64] Botton.C, Kubicki.S, Halin.G. The Challenge of Level of Development in 4D/BIM Simulation Across AEC Project Lifecyle. A Case Study. *Journal of ScinceDirect*, 2015, 123:59-67.
- [65] Hartmann, T.: 4D Model to Support Safe Planning of Hospital Renovations *Proceedings of CIB W78 2011*. Sophia Antipolis (2011).
- [66] Koo, B., Fischer, M.: Feasibility study of 4D CAD in Commercial Construction. *J. Constr. Eng. Manag.* 126, 251-260.

## CURRICULUM VITAE

---

### PERSONAL INFORMATION

**Name Surname** : Sarmad Faraj Ismael Al-HUMAIRI  
**Date of birth and place** : 14.05.1986  
**Foreign Languages** : English, Turkish  
**E-mail** : sarmadfismael@gmail.com

### EDUCATION

<b>Degree</b>	<b>Department</b>	<b>University</b>	<b>Date of Graduation</b>
Graduate	Civil Engineering	Yildiz Technical University	2017
Undergraduate	Building and Construction Engineering	University of Technology- Baghdad	2008
High School	Baccalaureate	Al-adhmiya Secondary School	2004

### WORK EXPERIENCE

<b>Year</b>	<b>Corporation/Institute</b>	<b>Enrollment</b>
2013- .....	Iraqi Midland Oil Company	Engineer
2011-2013	Iraqi Midland Oil Company	Engineer. Asst
2009-2011	Baiji Oil Refinery	Engineer. Asst

