BIM BASED RISK MANAGEMENT

FINAL YEAR PROJECT UG 2012

By

Adnan Sadiq	NUST201200035
Hammad Sadiq	NUST201201023
Iqbal Ahmad	NUST201200741
Yawar Abbas	NUST201200844

NUST Institute of Civil Engineering
School of Civil and Environmental Engineering
National University of Sciences and Technology, Islamabad, Pakistan

2016

This is to certify that the

Final Year Project titled

BIM BASED RISK MANAGEMENT

Submitted by

Adnan Sadiq	NUST201200035
Hammad Sadiq	NUST201201023
Iqbal Ahmad	NUST201200741
Yawar Abbas	NUST201200844

Has been accepted towards the requirements
For the undergraduate degree

in

CIVIL ENGINEERING

____

Dr. Muhammad Jamaluddin Thaheem
NUST Institute of Civil Engineering
School of Civil and Environmental Engineering
National University of Sciences and Technology, Islamabad, Pakistan

ABSTRACT

BIM BASED RISK MANAGEMENT

By

Adnan Sadiq

Main purpose of any project is to complete the project within triple constraints time, cost and scope. However, many construction projects fail to complete within the appropriate time and budget .This all because of the lack of planning and Risks management and lack of control over the information of the project during the project life cycle. The risks can be managed with proactive approach. Building information modeling is new way of doing project. Implementation of BIM in construction industry promises to improve communication and collaboration. This allows decision makers to assess the chance of occurrence of the risk in project and also show its impact on the project in an organized way. This helps to make risks explicit and control them. BIM gives a 3D model of 2D drawings of the entire project and then incorporates scheduling of activities and cost, which makes it a 5D model. Development of the 3D model helps in visualization of the project and all parties get clearer idea about the scope. This helps in defining a path which led to the successful completion of the project. This is a systematic way to know about the risks and the problems in the project. After getting knowledge about the risk in the early stage of the project it helps to plan to deal risks. This helps to reduce conflicts in the project as well. Studying risks management through traditional way and through modern way i.e. using BIM there is clear difference between them. Traditional is reactive approach and BIM is proactive approach to deal risks in the projects. This research was aimed at differentiating between the workability and efficiency of traditional and BIM based risks management. The project analyses the suitability of using such tools to improve the construction process.

DEDICATION

Project dedication is to our parents for their unconditional love and support and also to our teachers who support us while doing this project.

ACKNOWLEDGEMENTS

This project would not have been possible without the guidance and supervision of our project advisor Dr. Muhammad Jamaluddin Thaheem. He encouraged us every step of the way and told us to select this project and not be daunted by the tasks ahead.

We would also like to acknowledge the colleagues who supported the decision to choose construction engineering and management as an elective.

ABBREVIATIONS

3D	Three Dimensional x,y,z
CAD	Computer Aided Drawing
BIM	Building Information Modeling
2D	Two Dimensional x,y
4-D	Fourth dimension-Scheduling
5-D	Fifth dimension –Cost Estimation
IT	Information Technology
PM	Project Manager

TABLE OF CONTENT

Table Contents

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The project will be considered successful if it is completed within time in the allotted budget and according to the defined scope. Management of the risks in Pakistan is relatively new field. But there is lack of the following systematic approach. There is no clearly defined method to identify risk in projects. In order to carry out successful completion of the project one must have knowledge about the risk and problems associated with the project. Most of the time reactive approach is adopted in the field to mitigate the risks on the site. Construction projects are now more complex as compare to the previous projects. This need to have some knowledge of the project risks and problems before the start of the project .Otherwise it would result in the loss of time, cost problems and scope changes. Now it is requires engaging all the stakeholders in the project by providing them knowledge about the ongoing project. This would help to decide the responsibilities of the all the stakeholders. Previously risk and the problems of the projects are explained in a tabular form as a risk list and are further explained in written reports, Gantt charts, and sketches. Now with the complexity of the project this trend cannot be followed .this is time consuming and lot of rework. With the advancement in the technology new tools have been introduced. These tools are helpful in visualization one of them is BIM which is helpful in visualization of the project prior to the start of the project. BIM interlinked multiple files. BIM has ability to generate 4D, 5D model.This help in the finding and mitigation of risks in the project in early stages of the project. Virtual schedule and cost estimation can be done in the BIM which lead to the better understanding of the project and cash inflow remains in hand. BIM has some tool which is used to produce high quality drawings. High quality management can lead to the successful completion of the project. It is faster, efficient and easy way to manage the project as well as risks associated.

1.1. Objectives

The main objectives of this research are:

I. Identification of risks involved in construction of projects.

II. Observing the existing risk management practices on the project.

III. To develop a 3D Model of a facility using Revit Architecture for virtual representation of the real Project.

IV. Study how these risks can be handled with BIM.

V. Comparing the results of risks management through traditional methods and through Formal method of BIM.

1.2. Risks management

Risk Management is the process in which we identify, assess, analyze and respond to risk aspects of a project and in the best interests of its objective and scope. We controls possible future events in preemptive risk management rather than reactive.

1.3. Why using BIM in Risk management

1.3.1. Need of the hour

Building Information Modeling is a tool which can be very advantageous to the construction industry. It has many tools that can be used to get information prior and during the project. Helpful software gaining adoption in construction industry. Very much effect on time, cost and scope of the project.

1.3.2. Reliability

BIM reduces time required for design phase and also it assure accuracy of the design and calculations. Many works can be done very fast with BIM like work of estimator, scheduler etc. with great accuracy. This makes the BIM process much faster and more reliable than the conventional methods

1.3.3. Area of application

Building Information Modeling is used for construction analysis and planning, visualization, digital fabrication, code reviews, forensic analysis, energy analysis, cost estimating, quantity takeoff calculations, project scheduling, construction sequencing, conflict and collision detection, project progress simulations and facilities management (Azhar, Nadeem et al. 2008).

1.4. Modern usage

Many experienced users are perceiving the benefits of BIM modeling such as better communication, better productivity, and chances of winning over the client. Furthermore, BIM helps in improved coordination between different departments in the project team due to increased interlinking and integration. This helps in further betterment of productivity, improving quality control and better communication systems. A survey has shown that out of a 100 BIM experts, 82 experts have responded that BIM usage has been very advantageous in improving the productivity of their firm (Young, Jones et al. 2008).

CHAPTER 2

LITERATURE REVIEW

BACKGROUND

There is a very large investment in the construction Industry of Pakistan, but Pakistani companies are not capable of handling projects of a big scope.

The concept of a systematic and proactive risk management process is new in Pakistan.

The problems related to the construction industry in developing countries are more acute, complex, much more pressing than those contrasting theirequivalentselsewhere.

Schedule and cost problem, quality problems and inadequatesafety practices are normal end products of local construction projects. Risks are just observed in industry and they want to mitigate risks with experience. This is reactive approach. PM are not familiar with risk management and not accuratelyadopting risk management methods.

Information obtained help all the key participants to take some management techniques in order to carry out project. This is helpful as we have knowledge very early in the start of the project.

The basic hurdle in the application of any type risk management system is the lack of any systematic approach. This is also followed by lack of coordination among parties .Then it comes lack of information among parties which is main barrier to the risk analysis. Lack of information cause a lot of problems. People try to solve with experience and they sometimes fail.

BIM has better visualization prior to the project start.This is very helpful in understanding of the project before the start of the project. In this method all files are interlinked so any changes to the project can ultimately transferred to the whole project. Minimum chances of the clash detections.

2.1. Risks

Risk is outcome of event predicted through probability.A probability of uncertainty that may be avoided through preventative action .Uncertainty is any negative occurrence for example loss damage, injury susceptibilities etc.

2.1.1. Risks in Construction Industry

Construction industry has high rate of risk due to complexity. The construction industry can be related to practical, organization, logistical, or political features. Identification of risks is very important issue and their possible risks accompanying with a project. Impact of risks to the project is different with different risks. They must be calculated and their influence to the project must be cleared.

2.1.2. Determination of Risk

The qualitative method is based on likelihood and impact of the risk.

What is likelihood of the risk occur?

What is its impact and consequences on the project?

Likelihood and impact is scale from one (1) to five (5). One being lowest and five being highest. By using these factors we develop risk matrix,if that risks occur what will be impact on the project then risk severity analysis is done through combined risk matrix. In this matrix likelihood and impact of risk is seen simultaneously and severity of risk is determined

The quantitative analysis is further analysis of risk which use probability and find cost of risk if it occur. Common way for quantitative analysis is to use decision tree analysis (DTA), which includes the submission of likelihoods more than two results. Other techniques are PERT, experience etc.

2.1.2.1. Resource Availability:

Managing resources is very complex process for contractor. Allocation of resources according to schedule is important to meet the project deadline. We should know how much resources are available and how much are required for the project. More resources secure human, material and equipment resources. However these resources can’t guarantee project success and avoiding risks. Less resources may increase the risk of project.

2.1.2.2. Time Compression:

Time is money. When less time is available for more activities, risk of that project increase. So time schedule is highly crushed in the project. When more time is available, we can schedule project conveniently, and we face less threats.

2.1.3. Risks types:

2.1.3.1. Technical

A technical risk can be related to the inabilityto build or unable to meet the require demands of the purchasers. Technical risks arise due to improper use or no use of knowledge for example

Inadequate or incomplete design.

2.1.3.2. Operational

Chances for the occurrence of the operational risks are when the team members are not working with each other this results in the lack of coordination. This is lack of communication with the stakeholder.

2.1.4. Response to risks:

There are five responses to the Risks.

2.1.4.1. Accepting

When we can't avoid the risk we accept that risk in order to minimize its effect and consequences. We establish contingency plan ahead of that risk in order to minimize its impact.

2.1.4.2. Avoiding

Avoiding risk means to remove the root cause of the risk or remove the reason. Elimination of all risk is impossible. We avoid risk so that we can't suffer the consequences that occur due to that risk

2.1.4.3. Share.

Risk is assign to party which can handle it in a best way. So we share the risk to a party which can take responsibility and consequences of that risk. That party can get benefits and threat, threats are transferred to them and benefits are sheared.

2.1.4.4. Transferring

It is risk management strategy in which risk is pass from one party to another. The other party will be responsible for that risk. As risk is given to a party best able to control and deal with it. For example in insurance a specific risk is passed to insurer

2.1.4.5. Mitigating the risk.

In risk mitigation we reduce likelihood and impact of risk. It is done in steps. In mitigation we reduce, eliminate or lessen the risk. Mitigation decrease impact and likelihood of risk. It is effective technique

2.1.5. Entering Risk Responses into the Risk Register

First of all risk which can't be mitigated is managed. We have risk assessment plan according to their likelihood and impact on the project. From that we can easily find high and low risk. Each risk has its level occurrence as well as impact on the project. These two factors help to form risk register as well as risk assessment. These two criterion are set for the assessment. Then we make risk register by making 'response action'column. Then the responses are made and the duty is assigned to one person who is responsible for the execution and monitoring of the tasks. Risk responses should be correct, realistic cost and time effective, owned by single stakeholder and agreed by all parties in the meeting. There should be no conflicts in the responses.

2.2. Risk management

Managing of risks is vital part of the managerialprocedure in execution. It is accepted as very important part in the project's organizations. Actually a procedure of classifying, studying, answeringand dealing to the risk factors that are consideredas harmful to the successful application of the plan to execute the strategic plan and other related plan.In strategic plan all risks are records. In which after organizing risk, each risk is owned by different stakeholders. Risk is assigned to those party which is best able to control that particular risk.

.

Figure 2.1: Risk Management

2.2.1. Risk Management Systems

Risk management system not only recognizes the risks but this system is made to doing more. Risk management system not only measures the risks but also forecast its impact on the project. So we can find the severity of risk which usually depend upon PM acceptance level for risk. Risk management is finding and documentation of problems, their responses and actions. If risk management is done properly, time and cost of the project is controlled. Risk management is ongoing process it should not stop with the time. It must be taken to till the end of the project. Because risks are very high at the start of the project and they are going down with the time. No one can predict the risks are now zero. New risks arises with time. Need to cater for all these with care .there should be some specific measures to mitigate the risks. Risk management is actually documentation process. Need to document risks and measures of the risks must be made.

2.2.2. Risk Management as a process.

Risk management process is giving priority to the risks. This need the reorganization of the risksand then classify the risks which are most likely to occur. They decide this on the basis of experience which is related to the likelihood of occurrence naturaltouch, lessons eruditeetc.

The risk management become ongoing process because risk changes with time.

The threat and opportunity remain at high level during the process of the planning.but because of the relatively low level of asset to this point, the amount at stake remains low. During the execution of the project risks progressively falls to lower levels those risks which were unknown become knowns. Due to invested resources the amount at the stake increases.

2.2.3. Why should we do Risk Management?

The main purpose of the risk management is to recognize the all risks that might have chance to occur which are very harmful to the success of the project. Then identify those activities which will reduce the probability of the risks, and provide a better basis to take very good decision in planning suitable actions against the possible risk.

The best thing is against the risks is always handling and managing these risks. Monitoring of these risks is also a part of this. Making plan for the assessment of the risks and developing the strategies to minimize the risk is your best answer.

There are also some other process.

- Ensure that greatsignificance threats are belligerentlyaccomplished and that all risks are cost-efficientlyaccomplishedin life cycle of the project.
- Deliver management at all stages with the dataobligatory to make knowledgeableconclusions on mattersserious to project success.

2.2.4. By what method to do Risk Management

We see different available sources; stakeholder and checklist are main sources for that

2.2.4.1. Project Management

- ✓ Risk identifying and analyzing is not considered as Project Management.
- ✓ More than one projects running at a time
- ✓ Incredible schedule promises
- ✓ No functional effort into the planning stage
- ✓ No work till planning stage
- ✓ No party responsible for the total project
- ✓ Lack of control in design changes
- ✓ Lack of control of customer changes
- ✓ Weak understanding of the project manager's job
- ✓ Wrong person allocated as project manager
- ✓ No inter linked planning and control
- ✓ Impractical planning and scheduling

Contradictory project priorities

- **External**
  - ➢ Unpredictable
    - ✓ Unexpectedcontrolling requirements
    - ✓ Natural catastrophes
    - ✓ Destruction, disruption or unexpected side effects
  - ➢ **Predictable**
    - ✓ Working risk
    - ✓ Community
    - ✓ Environmental
    - ✓ Price rises
    - ✓ Fluctuations
  - ➢ **Technical**
    - ✓ Technical changes
    - ✓ Risks curtailing from design process
  - ➢ **Legal**
    - ✓ Violating trademarks and licenses

- ✓ Litigated for break of contract
- ✓ Working place problem
- ✓ Litigation due to offense law
- ✓ Legislature

Appropriate risk management suggests control of possible future events, and is preemptive rather thanresponsive. It will reduce not only the probability of an event happening, but also the degree of its impact.

2.2.5. The Risk Analysis Process

The risk analysis is actually quality problem solving process. Quality and valuationutensils are used to determine and arrange risks for evaluation and tenacity. Following is steps for Risk analysis.

2.2.5.1 Identify the Risk

Identification of risks is thinking step. All possible risks are identified while studying the all possible risks sources that can cause risks and the practices that project team is practicing to deal the risks.in this process risks are then characterized and ranked. Number of risks identified mostly large in number. This is helpful in managing risks who has greater priorities.

2.2.5.2. Assessment of the Risk

Conventional method of problem solving mostly moves from identification of complications/problems to solution of the complications/problems. All need before this, is the identification the main reasons of the problems.The project team must have questions including .what would be the reason for this risk occurrence? What would be the impact of this risk on the project?

2.2.5.3.Development of Responses to the Risk

After risk assessment process team is ready to develop the responses to deal with the situations. Developing responses helps to stop the risk from occurring. They are dealing with two questions.

What are the factors that can help to reduce these risks? What are the steps that can be done to manage this risk, if risks occur?

2.2.5.4.Development of a Contingency Plan for the Risk

After development of the responses to the risk the project team will assign the jobs based on the concept that were recognized to reduce the risks chances. Jobs are recognized to manage the risks that this risks would occur and making contingency plans for this.

2.3. Qualitative Risk Analysis

The occurrence and the impact of any risk that has chance to occur is evaluated by PM. This is done by while taking input from project team and the following method is used

2.3.1. Probability

- High – Greater than 65% to *70 %* probability of happening
- Medium – Between 30% and 70% probability of occurrence
- Low – Below 30% to 35 % probability of happening

2.3.1. Impact

- High –Risks that have very high impact on the project.
- Medium – Risks that have impact on the project but low as compare to high
- Low – little impact on the project.

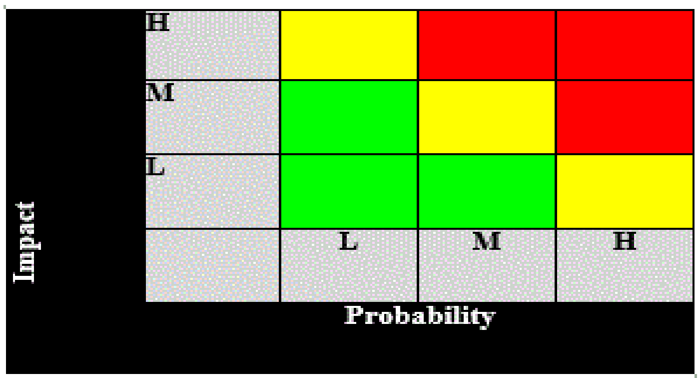

Figure 2.2: Risk Activity

Red and Yellowportion will have risk response planning which may include both a risk justification and a risk possibility plan.

2.4. Quantitative Risk Analysis

Analysis of risk proceedings that have been ordered using the qualitative risk analysis method and their impact on project events will be assessed, a arithmeticalscore applied to each risk based on this analysis, and then registered in this section of the risk management plan.

2.5 BUILDING INFORMATION MODELING (BIM)

2.5.1 Definition

The information of national construction standards committee Modeling (NBIMS) US gives definition of BIM as:

"BIM is a 3Dpicture of physical and functional features of a facility. BIM is Information-sharing source for data about a facility forming a consistent basis for actions to take place during its execution process period. The basic principle of BIM is the communication and teamwork of all shareholders involved in different stages of the life cycle of a facility to supplement, retrieve, bring up-to-date or alter the data/knowledge in the BIM to support and reflect the roles of shareholders (NBIMS, 2010)."

BIM also givesreliable and interconnectedvisualization of the model including valuable data for each view. This is a time saving feature for the designer as coordination of views is done through programmed aptitude of the model.

2.5.2 Types of BIM

2.5.2.1 Hollywood BIM

BIM being used only for developing 3D models and other features of BIM, not utilizing the advanced features of BIM. Contractors may use it to win contracts without utilizing full potential of BIM.

2.5.2.2 Lonely BIM

In type BIM is used internally in the organization and all information and the data remain confidential and it is not being shared with any other persons/stakeholders.

2.5.2.3 Social BIM

Name depicts that in this type data will be shared between different parties involved in the project. It is a more inclusive approach which allows for data sharing related to project plans. This is is better way of communication.

2.5.2.4 Intimate BIM

When the designer, owner and contractors share the risk and reward through integrated project delivery using BIM.

Intimate as well as social BIM encourages the production of better drawings, reduce time and cost, collaboratively (Hergunsel 2011).

2.6 BIM APPLICATION AREAS

There are many application where BIM can be used. Here we are

A building information model can be utilized in the following areas:

2.6.1 Visualizationof the project

It is possible to see model of the project in 3D. This is the feature of the BIM. It helps to view the scope of the project prior to the project start. This application is extremely helpful in viewing the result of the project and end product.

2.6.2 Drawingsof Shop

Generation of shop drawings is very easy for various building systems like MEP etc. It is very helpful tool in gaining information about the facility.

2.6.3 Reviews ofCode

Departments of fire and other officials can practice these models to evaluationof construction projects.

2.6.4 Analysisof Forensic

A BIM can be easily altered to realisticallyshowany clashes, leakages, emptying plans, etc.

2.6.5 Facility Management

This can be used for the management of the facility, which lead to the renovation, any planning that related to space and repairs.

2.6.6 Estimating of Cost

There are many features in this software. One of the best feature is built-in cost estimating features used to extract cost data and adjust the required requests in the model.

2.6.7. Sequencingin Construction

In sequencing it is very helpful. Sequence of activities can be created and work can be done according to it. This would be helpful in managing all activities related sequencing and smooth work can be done with the help of BIM. This is very effective way of doing work and it is helpful indeed.

2.6.8 Conflict, Interfering and Collision Detection

Modeling BIM is done according to scale set, this all could be seen in 3D space .in this way all major systems can be visually checked. Interlink of all files make BIM superior to all other techniques.

(Azhar, Nadeem et al. 2008)

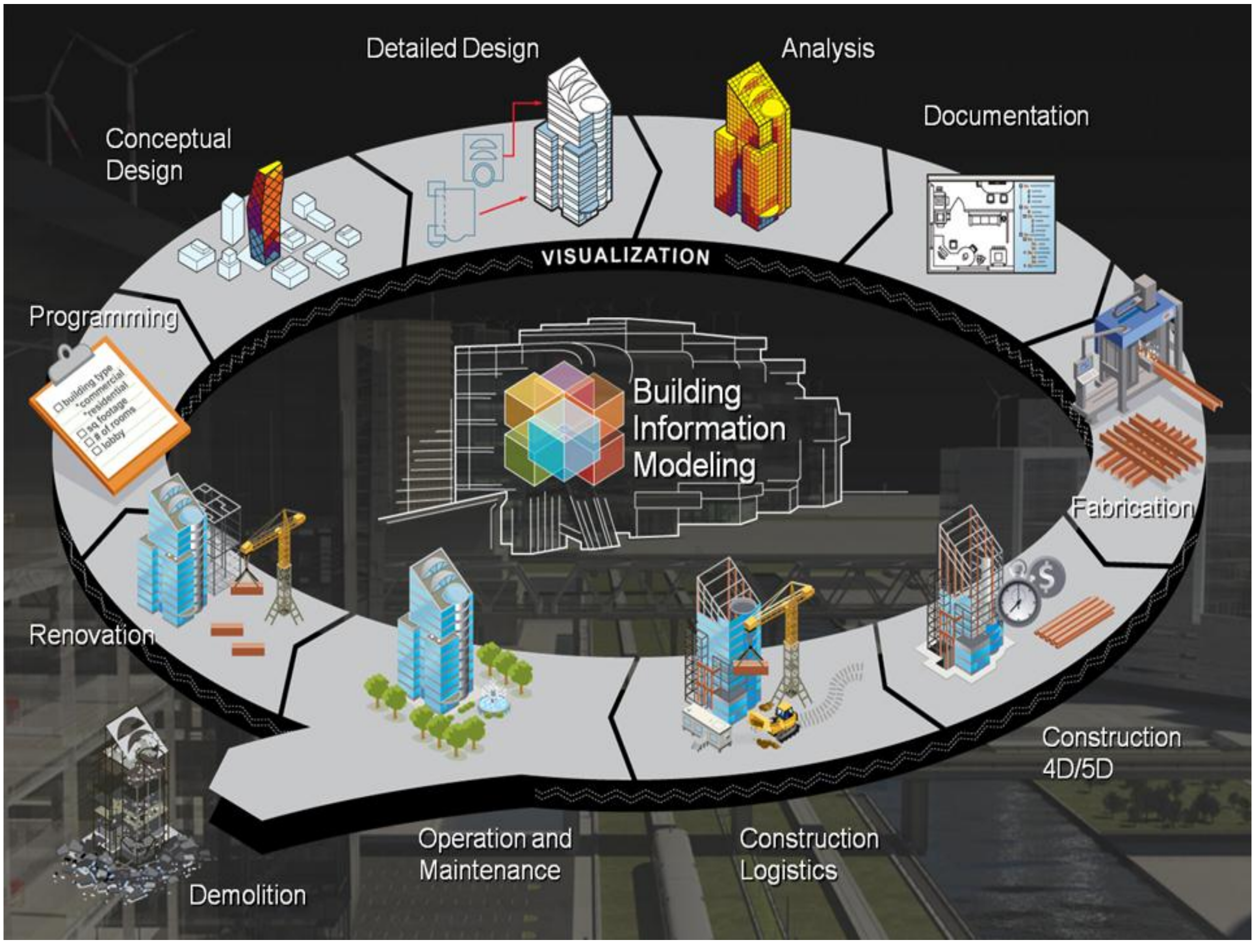

Figure 2.3: Application of BIM

2.7 ADVANTAGES OF BIM

The efficient and accurate 3D representation of the building parts of a project is the main advantage of BIM (Innovation.2007). Other benefits of implementing BIM are explained in the following table:

Table 2.1: Benefits of Application of BIM

Life Cycle Phase	Benefits
For Planning purpose	Easy and Fast way of substitute analysis Enhance energy examination Easy quantity calculations and budget estimation
Phase of Design	Improvement in coordination Easy way information exchange Code checking Easy tracking of change of design
Related to Construction	Lessenclarification problems Improvementin coordination invarious areas Lessen(RFI) Lessens material value Minimizes Constructability issues Enablesappropriate equipment selection Safe work environment
Operation and Maintenance	Down time reduction Providing easy access to maintenance records, warranties, and operation manuals Minimizes rework and waste Resolution of space management issues

(Meadati, Irizarry et al. 2010)

Survey showed following statistics concerning BIM benefits (CIFE. 2007)

- Unbudgeted changes are terminated up to 39%.
- Cost estimates with accuracy within 4% range of actual cost.
- 80% time saved to generate Quantity Takeoffs.
- Clash detection saves 11% cost of contractual value.
- Project Time period reduced by an amount as much as 7%.

2.8 Trend of BIM in Construction industry.

BIM is developing fast between building and construction industry. In 2016 it was reported all the UK government projects will be donewith the help of BIM. The report NBS National BIM 2013, 95 percent of the construction industry in the UK are now aware of BIM -to say almost a common word , 53 % are well aware and is now using BIM while a very small amount of 6% do not know about it or they use(NBS 2013).

According to report of the McGraw-Hill Construction Smart Market Report 2012,there is rapid increase in the utilization of the BIM in construction industry of the North America in the past few years. It is increased to 70% in 2012 from 48% in 2009 and 29% in 2007 respectively.

This rapid increase in adoption is happening because of the following reasons mentioned in Figure below.

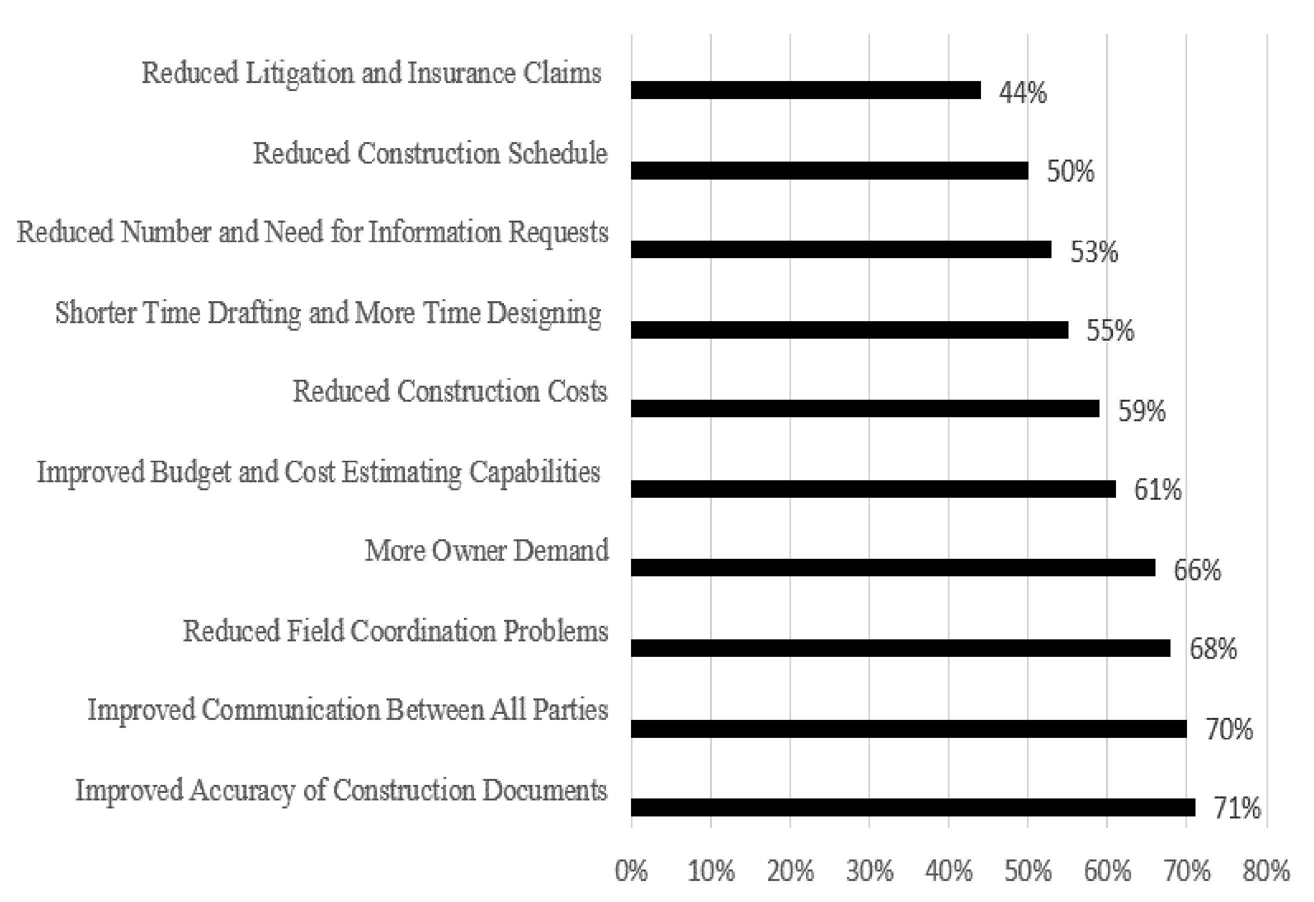

Figure 2.4 (McGraw-Hill Construction 2012)

Various software's are used across the construction industry as Building Information Modeling tools, they are summarized in Table 2.2.

Table 2.2BIM Tools

Company	Software	Primary Usage
Autodesk	Revit	BIM Model generation
	Navisworks	Clash Detection,4D Scheduling, Quantity Takeoff
	Robot Structural Analysis	Structural Analysis
	Green Building Studio	Energy Analysis
Graphisoft	ArchiCAD	BIM Model generation
	Estimator	Estimation
	EcoDesigner	Energy Analysis
Bentley	AECOsim	BIM Model Generation
	Project Wise Navigator	Review and Analysis
Tekla	Tekla Structures	Structural Model generation and Detailing
	Tekla BIMsight	Review and Analysis
Vico	Vico Control	4D Scheduling
	Takeoff Manager	Quantity Takeoff
Synchro	Synchro Professional	4D Scheduling
Innovaya	Visual 4D Simulation	4D Scheduling
	Visual Estimating	Estimation
	Visual Quantity Takeoff	Quantity Takeoff
U.S. Cost	Success Estimator	Estimation
On Center	On Center	Quantity Takeoff
Exactal	Exactal	Quantity Takeoff

(Jiang 2011)

2.10. BIM Method

BIM is not just a software package but a procedure which applies over to whole building lifecycle.

2.10.1. Interoperability

When moving from design phase to construction phase and then from construction phase to operation phase there is chance of the missing data. This is obvious that it results in the loss of the data. This impact increases at each delivery.

2.10.2. Coordination and Teamwork

This promotes coordination and team work of the project. Before this owner, architect, engineer andcontractors usually work separately. Now information is being shared between parties it promotes the team work and coordination of the members improves.

2.10.3. Visualization of the project and Communication improvement

Before this owner have to rely on the information provided on the basis of 2D. It depends on the owner himself to read constructions print. Now owner can view the project before the start of the project. It helps in the scope clarity as well as the conflicts found in the project. Better understanding of the project. This results in the satisfaction of the owner.

2.10.4. Change in the project.

As the model is developed very early in the design of the project. This helps owner to see the project and make any changes prior to the start of the project. This removes many conflicts as well as many responsibilities are assign to different parties. This is all because many people are working together and all files are interlinked. This is very helpful way of mitigation of risks.

2.10.5. Pre planning for the construction tasks.

When BIM are used in the project, then it has access to the all information of the project. Virtual schedule can be built with the help of this information. This schedule helps in construction tasks to achieve on time. This also helps to check out the conflicts and issues related to the project very early of the project. Construction planning can be done according to this schedule. Information in this case is very critical as it is use to develop the project which is the main task.

2.10.6. Prefabrication

High level of information available prior to the project helps in large assemblages can be manufactured prior to the project start. For exampleassemblages of ductwork, pipe and pipe racks, HVAC equipment assemblies.

2.11. BIM APPLICATIONS

2.11.1. 3D Mode: Visualization Model

Three dimensional modeling gives a visual prototype of paper drawings. BIM models may comprise of existing condition models including laser scanning and ground penetration radars (GPR) conversions, safety & logistics models, animations, renderings, walk-throughs. BIM driven prefabrication, clash detection, Laser accurate BIM driven site layout etc. 3D model development is useful to provide visualization to the idea that is still in raw form to execute it into a best desirable output. It is better understandable as compared to two dimensional system of presenting drawings.

2.11.2. 4D: Time Model

4D modeling is based on scheduling of project activities from initiation till termination phase of construction and other work activities during the entire project lifecycle. Project Phasing Simulations involves the stepwise scheduling by dividing the work operations into phase, each phase incorporates the detailed time-based data set of construction activities on BIM interface. Visual validation for payment approval becomes very handy as the comparison of planned and actual work progress can be reported very easily. Planning procedures become very efficient and on-time project delivery can be achieved.

BIM also enables schedule updating and analysis to make improvements in working methodology. Pre-scheduling on BIM serves as a supportive tool to forecast amendments revise decisions and design most effective and productive work plan by making ratifications.

2.11.3. 5D Model: Cost Model

BIM facilitates in real time conceptual modeling and cost planning without any manual quantity surveying calculation procedures. Quantity extraction is performed by software interface without any rigorous efforts to support detailed cost estimates. Trade verifications are performed from models so cost control is enabled without any manual embezzlements avoiding misconceptions in dealings.

2.11.4. 6D Model: Energy Model

In this degree of modeling, major focus lies upon sustainability and from conceptual to detailed energy analysis. Life cycle energy performance of a building is studied in order to improve energy requirements of a building following LEED criterion and making environment friendly impacts. Lighting and day lighting analysis are performed for setting the orientation of respective building for its maximum exposure to light minimizing the electricity consumption. Sun and shadow studies are performed in order make the building temperature internally moderate so that the temperature maintaining appliances are least utilized. Airflow analysis is performed for the purpose of proper ventilation. Climate analysis provides a suitable insight for selection of sustainable building materials that are most affordable and favorable. Solar radiation analysis is carried out for controlling building temperature from exceeding the unsuitable.

2.11.5. 7D Model: Facility Management

Computerized building database for record, renovation and maintenance is developed which can be utilized at the time of carrying out operations for the purpose of better idea of details and framing a working strategy for effective performance avoiding errors, omissions and accidents. Operational and managerial manuals embedded in BIM makes it easy for user to get a better understanding of already performed works and opt a proper pattern of working without disturbing the unnecessary items

2.12. TECHNOLOGIES IMPLEMENTED IN BIM

2.12.1. CAD Technology

This technology supports the drafting of efficient automation.But modern construction requires high level of competence.

2.12.2. Object CAD Technology:

Its main focus is to copy the facility components in CAD drawing, concentrating on the 3 -dimensions and features of the facility, the development of documents from that3 -dimensions CAD drawing and by extracting item data from the facility components in order to be able to generate information about object parameters and quantities (autodesk 2003).

2.12.3. Parametric Building Modeling

This feature is related to the decision support system in the financial community. This would help in blending a Data model with a Behavioral model.

2.13. BIM based Risk Management

Managing risk with the help of BIM is usually term as BIM based risk management. Construction is all over the world.it need to be well organized and should be executed in very proper and organized way. This need innovation with times. Innovation means advancements in the field of the construction. New tools are being introduced to carry out the project in the industry. These are all helpful in project execution. The advancement in Technology also help to clear about the project before the start of the project. This is the very beneficial for the project as we know about the feature of the project prior to the project.

2.13.1 Evolution of concept of Visualization.

Evolution of the concept of visualization develop with time. It has many phase during its evolution. 3D visualization helps to understand the need and demands of the project.

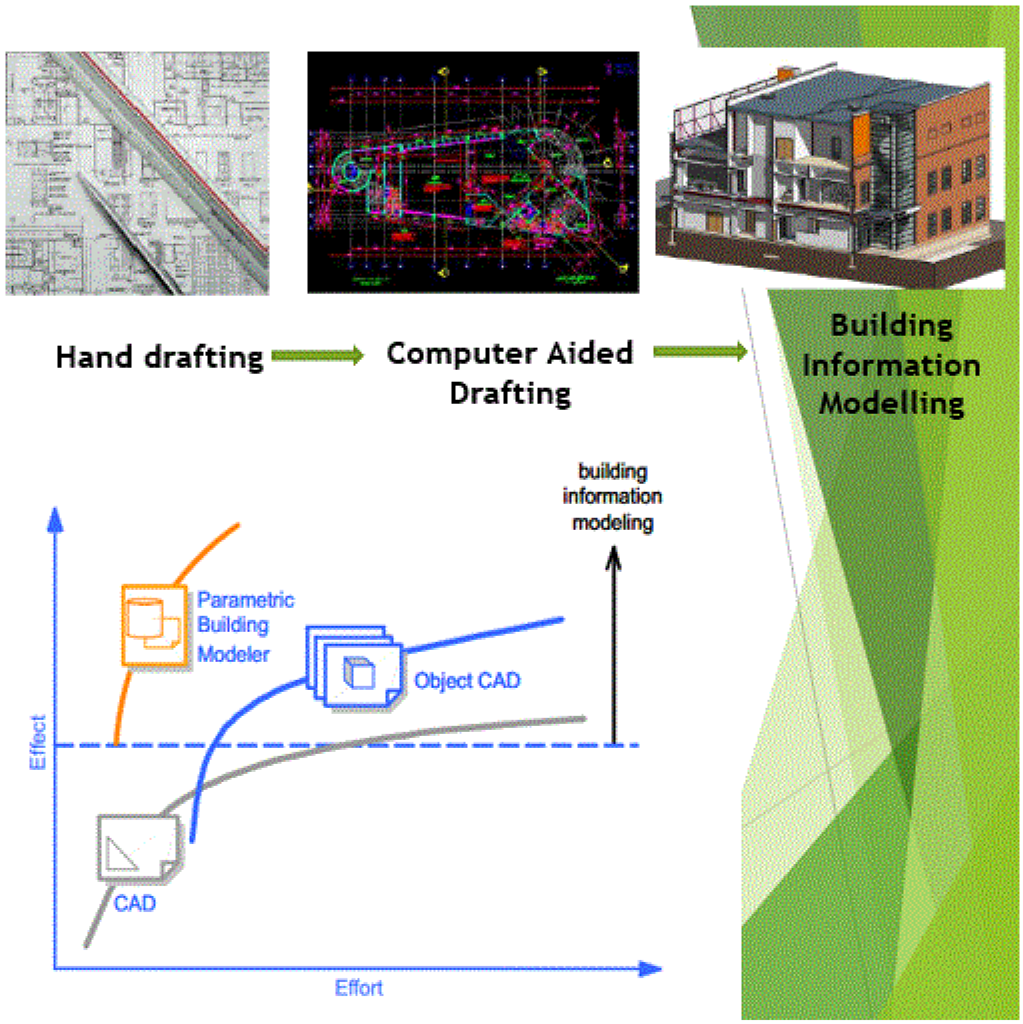

Figure 2.5 Evaluation of drawing

Construction projects are now days more complicated than before. Need to cope up with the demand and to deal risk and problems one has clearer view about the project.

In the start handmade drawings were used for the project. This were error prone. Need to deal problems at the site with the experience. With the development of the technology auto CAD were introduced. AutoCAD have better ability to draw but 3D visualization was a still problem. Later with the time, 3Dvisualization concept wasintroduced which were helpful in complex projects. Complexity of the project and risks associated with the project can be clearly identified with the help of BIM.

People want less effort to get maximum results in this regard graph shown can be seen in the fig.2.5.

BIM has ability reduce time taking for the design as well as for other purposes in the project. Many time design need to be re design. It requires a lot of time. But in case of BIM it helps in modification of design. It saves time, effort and cost as well. Better visualization helps to get information about the future problems associated with the project. In this way BIM is better tool to deal the risks associated with the project. Main task of the manager while doing the project are Increase Output,competence, organization value, brilliance and its skill to continueand Reduce duration of the expenses, time required for execution and coordination and relation of stakeholders of a project.

2.13.2 Requirements

Should have better understanding of the projects .Should have understanding of 3D visualization to get information about the need and requirements of the project just viewing. Better be able to use the tool that are used for the development of the facility.

CHAPTER 3

RESEARCH METHODOLOGY

Figure 3.1 Research Methodology

Introduction:

This chapter covers the work flow which is carried while doing project. Every project is completed under some specific steps. This project has some steps which were adopted while carrying the project. The steps are listed below. Few are explained earlier and few of them will be explained in this section to give about the overview of the project**.**

3.1. Selection of the topic:

"BIM based risk management " was selected as our project. Implementation of BIM to evaluate the risks in construction industry was main purpose of project.

At the end to point out the difference between traditional method and BIM based Method to evaluate the risks in the project.

3.2. Literature Review:

Risk identification is an iterative process. Risk identification is very important part in risk management process. Identification of the risks involved deep study and knowledge of the risks in the industry. Basically risks may be of different kinds in nature and their threats to project are also different. As the risk management progresses, more information will be earned about the process and the risk statement will be regulated to reflect the current understanding. New risks will be recognized as the project progresses through the life cycle. We did following to reach this stage of the Risk management.

To collect information about the risks identification research papers, books, and the internet study was carried out. Literature review yielded many risks that are listed.

3.3. Site Selection:

An under construction building “Center for advanced studies in Energy” was selected as a site for project in NUST H-12.As it is shown in Fig 3.1.

Figure3.2Site of the project

3.4. Data Collection

After learning of the software and development of the 3D Model facility of the project. Next step was to collect data of the project. Few surveys were made before collection of the data about the project in order to understand the nature of the project. Main purpose of the surveys were to familiar with the relevant persons on the project and to get information about risks on the projects that are found in the project.

3.4.1. Choice of the data collection tool.

Main task of the project was to get information about risks involved in the project start from the beginning. For the sake of risks analysis, the observation, in respect to severity and probability of identified risks, of industry experts and construction practitioners were required. Research work is kept as “unbiased” as possible. Today, various methods of data collections are being used throughout the world. Some of various techniques adopted are Individual interviews, Focus groups, Observations, Brainstorming, Action Research. However, keeping in view the nature of work and constraints of time and resources, structured interviews technique was adopted.

3.4.3. Interviews*:*

After the selection of method of structured interviews it was necessary to have some questions. After development of the questions. The next step was to conduct interviews of the required persons.

Firstly we contacted the required persons for interviews to inform them about the final year project and discussed them about the conducting interviews.

Availability of time was discussed with the persons and interviews were conducted according to the set of questions with the required persons.

Various interviews were conducted from different from the required persons.

During interviews list of risks were checked and list of risks after interviews list of risks were made. These were very constructive meeting with the field practitioners.

3.5. Analysis

After collection of the data from the site, analysis of the data was the next step in the research methodology.Data gathered through interviews was summarized and arranged in a proper manner. This helped us in the development of the risks register.

Following steps were performed during analysis.

3.5.1. Clash Detection.

Clash detection was performed on data, gathered through interviews of the required field's practitioners.

Clash detection was actually performed while developing of 3D model of the facility, results were prepared. There were many clashes which were detected while preparing the facility. It was done in order to find out the differences between proactive and reactive approach. Clash detection was helpful in preparing our results, analysis and conclusion.

3.6. Findings:

After analysis of the data through clash detection and discussions with supervisor we come to the findings or results of the project.All risks were listed and summarized all interviews under this section of the research methodology.This was main part of the projects. BIM was used in the project, its finding and results were very important.

Results will be discussed in under chapter of results.

3.7. Conclusions:

After analyzing the project it was clear about the BIM approach in the risk assessment in construction projects. Comparing of traditional method to asses risks versus BIM method of assessing risks were made.

Conclusion will be discussed under the chapter of conclusion.

3.8. Preparation of the final report.

The final phase of the projectinclude following:

3.8.1. 3D Model Submission

3D Model of the building submitted in form of softcopy.

3.8.2. Preparation of Presentation

Presentation for the final defense was made and the project was presented and demonstrated.

CHAPTER 4

ANALYASIS AND RESULTS

Back ground:

This chapter highlights the data analysis. It shows the different risks identified during the project execution. During research methodology chapter, it was explained that the method selected for the data collection is structured interviews. Results obtained through interviews were gathered and analyzed in this chapter.In this chapter interviews are summarized and list of risks is prepared.Then clash detection process is performed through BIM.Data was collected on the basis of interviews.

Interviews were divided into two parts.

1. Background information.
2. General information about risks in field.

4.1. Background information

In this part of interview personal information was asked from the respondent. His/her name, experience, position in company, working experience of same kind of project in other areas.

4.2. General information about risks.

In this part of interview, questions related to the general perception of risks management were asked and its application in the project.Question asked about the risks, their impact on the project and procedure how to address that risks.

There are many respondent who were keen to have risks assessing technique to cater far risks in the project. They said there is no risks assessing technique involved in this project.There should be proactive approach.They said that risks are mitigated through personal experience and there is no risks register in this project. There is reactive approach to deal with risks. This is time consuming. Need of some proactive approach to mitigate risks.Few respondent were satisfied with current situation. They were happy to deal risks with experience. They thought that it would be costly and time consuming.Rest of the respondent were not clear about proactive approach to mitigate risks.They were happy with current situation but also they want some new method to deal with risks mitigation.

4.3. Summary of structured Interviews

Under this section summary of structures interviews are presented. Summary is prepared according to structured interviews conducted during data collection phase. Summary is presented in sequence as questions were asked to respondent during interviews.

Summary is as follows:

4.3.1. Procurements:

Material used in project have to be imported. Materials of selection depends on designer's decision and approval. Imported material causes time delays, schedule problems, dates cannot be given before the start of the project. Cost is also affected due to this delays. Time is money. These things need to be addressed before the project. This would save valuable time of the project and cost of the project.

4.3.2. Planning:

Planning was not at good. There were delays in start of project, scope changing with time. Accelerated contract schedule was a major problem. Need to change scheduling with time. We have to stick with given schedule that was a major problem. Drawing problems changes scope with time. Survey problems, Geotechnical problems and many other similar problems were there.Approval delays by CDA; the client required the site should be approved by the regulatory authorities. Since other buildings on the campus had not obtained approval from CDA, it became a problem for a single building to get approved as CDA ordered to get approval for other buildings on the campus as well. This clash resulted in a delay of one month.

4.3.3. Weather Problem:

As the project was one month late from its start date, the weather conditions kept fluctuating between rain and dry. Dewatering was an additional activity which kept on repeating along with rain in order to remove water, thus causing delay in working and inducing extra costs. There were 30 t0 35 days noted which were affected due to rain.

4.3.4. Building problems:

Geotechnical problems i.e. soil investigation problems was not properly done or was incomplete. This result into the change of scope. Working Hours were the major problem in this case. This thing change the scope of project in a sense we have to change footings. We found 35-40 % fill material. We have to make equal level. There also find a rocky strata. We needed boring to go to the required level of footings.This changed footings of the project from initially designed.

4.3.5. Safety Management:

Proper safety practices were employed on the project. Safety Engineers and Safety Supervisors were on site to ensure hazardless proper working conditions. Health and Safety reports are published on daily basis and view by concerned parties i.e. consultant and contractor.No major just minor safety issues have occurred till now.

4.3.6. Geo-technical Issues

Extra excavation was needed to remove loose material; the cutter rock from other sites was previously dumped on the particular site that needed to be cleared. Rock Cutters (extra equipment) was used; the whole process resulted in delays and extra costs as backfilling was also required. This was an extra work that could have been mitigated if proper geotechnical survey was conducted and information was clarified.

4.3.7. Technical problems

Design changed with time due to the demand of the stake holders, this certainly changed the scope of the project. Drawings changes consumed time. This changes the scope of the project with time.

4.3.8. Site & Office coordination

There was a clear coordination gap between site and office teams. This is because of drawings problems as well as due to inexperience staff. Also different people works in different drawings in project there was a clear communication gap between them. We found difficulty in execution due to different people worked in different files. This would have been very good if one person works on the all drawings.

4.3.9. Execution problems:

There were many problems in execution. If we have 3D model this problem would have been minimum. We have faced problems in execution in beam, slab, and ceilings. These are all due to lack of coordination between different group members. We have been facing problems in alignment of all the Wi-Fi connections, boards, wire connections, HVAC, MEP etc. This would have been very little if we had 3D model.

4.3.10. Alignment problems:

Some alignments problems in Wi-Fi connections, Electric boards, Electric wires, Ventilation duct, ceiling problems in the building etc.

4.3.11. Architectural & Structural drawings

Difficulty in overlapping of architectural &structural drawings. 2D drawings were difficult to comprehend. 3D model in this case would help us in execution of project. Easy to understand.

4.3.12. Finishing problems

Finishing is also facing problems. We need to be careful in this case. We need some experience staff to do finishing.

4.3.13. Security Issues:

Worked was banned for 15 days due to security threats to university. Even working hours were shortened which affected daily activities and proceedings.

4.3.14. Risk Management

Previous experiences and expertise are used to tackle risks.Meetings are held to discuss the problems on board.Contractor was aware of the nature of site due to previous working experience.Inputs from all stakeholders are implemented.Typical risks that occur on common projects are mainly considered. No new technique used to deal risks.

Table 4.1 List risks found in project (From Check list).

Organizational and Project Management Risks	✓ Project scope description is poor ✓ Project schedule in question ✓ Operational and Technical labor units not sufficient or Extra ✓ insufficient staff assigned or lack of experience ✓ Communication failure with project team ✓ Inadequate time to plan ✓ Timely reply to crucial decisions by management ✓ Consultant or contractor delays ✓ Burden to deliver project on an faster schedule ✓ Unintended work that must be housed ✓ Regulator issues
Acquisition Risks of Contract	✓ Unknown acquisition strategy ✓ Acquisition plan results in higher scope risk
	✓ Self-assurance in scope, research, design, ✓ Geotechnical ✓ Civil ✓ Structural ✓ Mechanical ✓ Electrical ✓ Architectural

Technical Risks	✓ Environmental ✓ Controls ✓ Other Specialized Disciplines ✓ Incomplete studies (geotechnical, hydrology and hydraulic, structural, HTRW, etc.) ✓ Surveys late and/or surveys in question ✓ Borrow/fill sources identified / secure ✓ Hazardous waste concerns ✓ Need for design exceptions ✓ Adaptive Management features (construction cost, excluding monitoring)
Lands and Damages	✓ Status of real estate acquisition
Regulatory and Environmental Risks	✓ Status of critical environmental and regulatory studies ✓ Lack of specialized staff ✓ Permits or agency actions delayed or take longer than expected
	✓ Accelerated contract schedule ✓ Inefficient contractor ✓ Subcontractor capabilities ✓ Permits, licenses, submittal approvals ✓ Site access / restrictions (highways, bridges, dams, water, overhead / underground utilities) ✓ Inadequate skilled trades available for

Construction Risks	labor force ✓ Material availability and delivery ✓ Productivity of critical work items ✓ Unknown utilities ✓ Survey information ✓ Transportation / haul routes constricted or unusable during periods of time ✓ Unusual transportation haul distances ✓ Control and diversion of water ✓ Differing site conditionsof construction schedule depicting durations, sequencing, phasing, production rates
Schedule Risks	✓ Prime and subcontractor structure matches likely acquisition strategy ✓ Adequate schedule depicting all project features ✓ Schedule portrays critical construction features, matching estimate productivity
External Risks	✓ Stakeholders request late changes ✓ New stakeholders emerge and demand new work ✓ Stakeholders choose time and / or cost over quality ✓ Market conditions and bidding competition ✓ Unexpected escalation on key materials

	✓ Acts of God (earthquakes, severe weather: freezing, flooding or hurricane

4.4. Clash detection

Under this section 3D model of building was developed. While developing 3D model of the building many clashes found in the building.

3D model was developed with the help of auto cad drawings. This was very easy way to detect the clashes of the project.

One of the important features of BIM technique is that it allows to detect the clashes among the different objects of model. This allows to plan right at the planning phase of the project how to construct all the different components without any clash detection. This thought process in the start of the project makes to reduce the RFI"s on the project and the rework to design the components at the later stage and in in-situ conditions.

Clashes found were related to design, alignment, finishing, fixtures, etc.

4.4.1. Clash found through BIM

Report generated about clashes presented in Appendices B, C,D.

List of clashes found presented in tabular form as shown in table 4.2**.**

Table 4.2. Clashes

Elements	**No of clashes**
Column Door	08
Ducts + walls	105
Light fixture+ Door	03
Ducts + Structural column	03
Pipes + Foundation	20
Column + Light	05
Column + window	04

Ducts pipes	56
total	204

Few images of clash detection are shown below which were found during the project.

4.4.1. Column and door clash found.

This is found due to different files working. This is actually clash between architectural and structural drawings. This happened due to working of different files. That can be identified if BIM used prior to the project design.

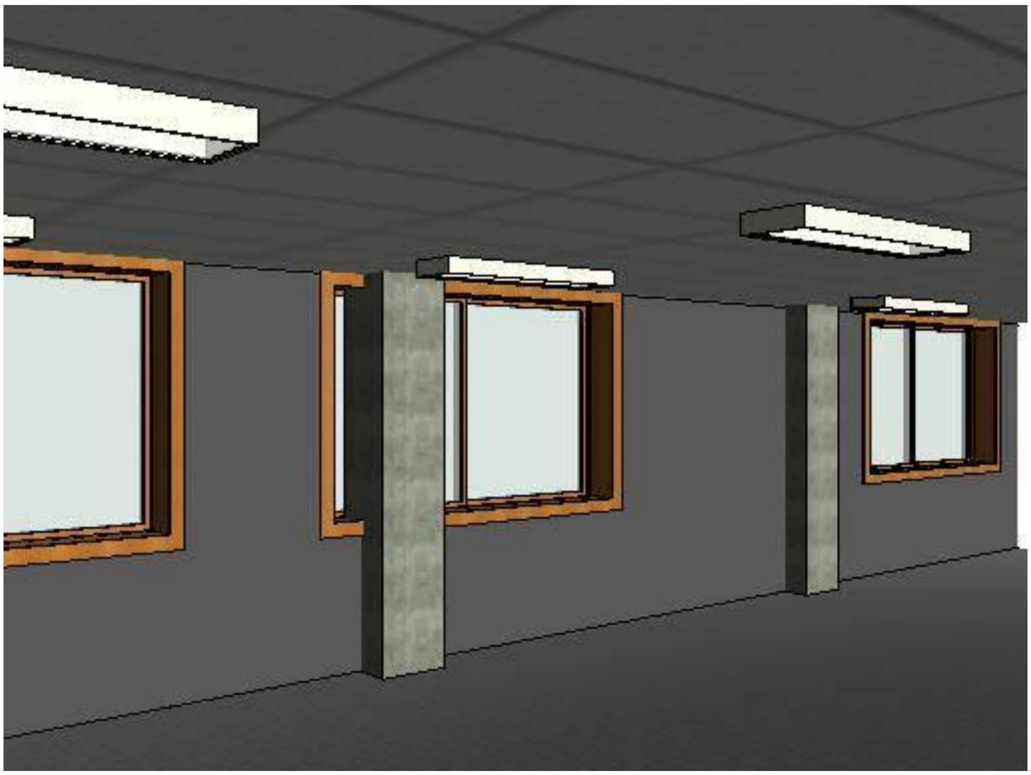

Figure 4.1 Column and door clash

4.4.2. Ceiling light and column clash.

This is also clash found in model. This is related to finishing problem as well. This is an alignment problem in project.

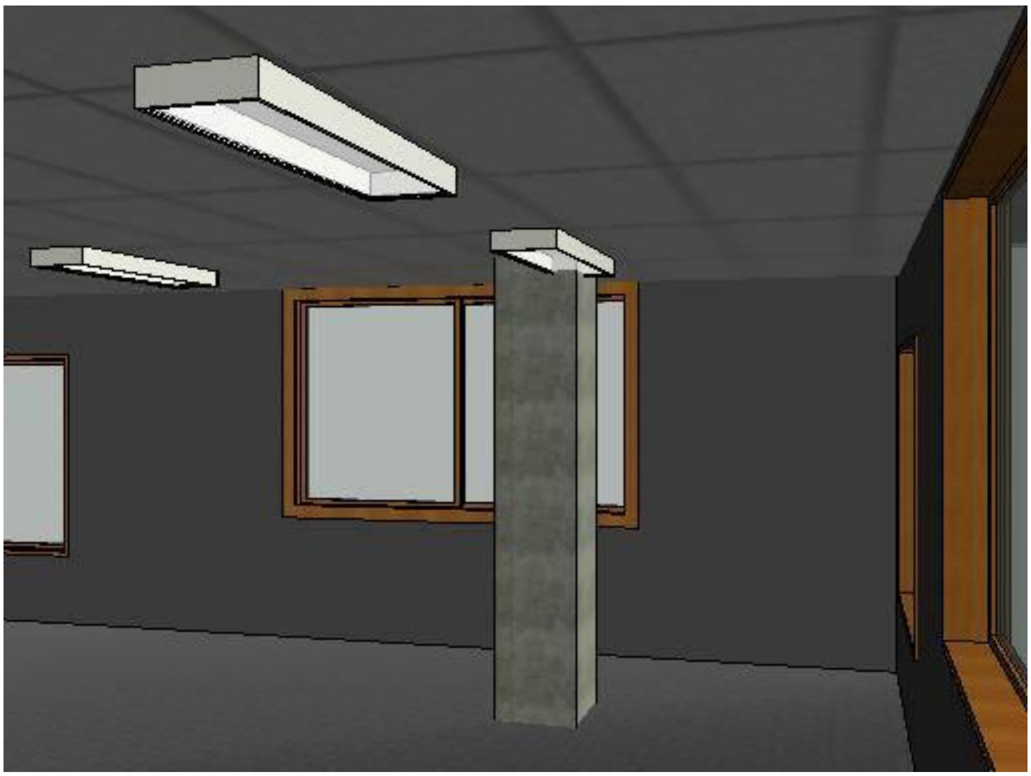

Figure 4.2 Ceiling light and column clash

4.4.3. Column and window clash:

Column clashes in window way. This is also related to architectural and structural drawings. Lack of communication between people causes this clash.

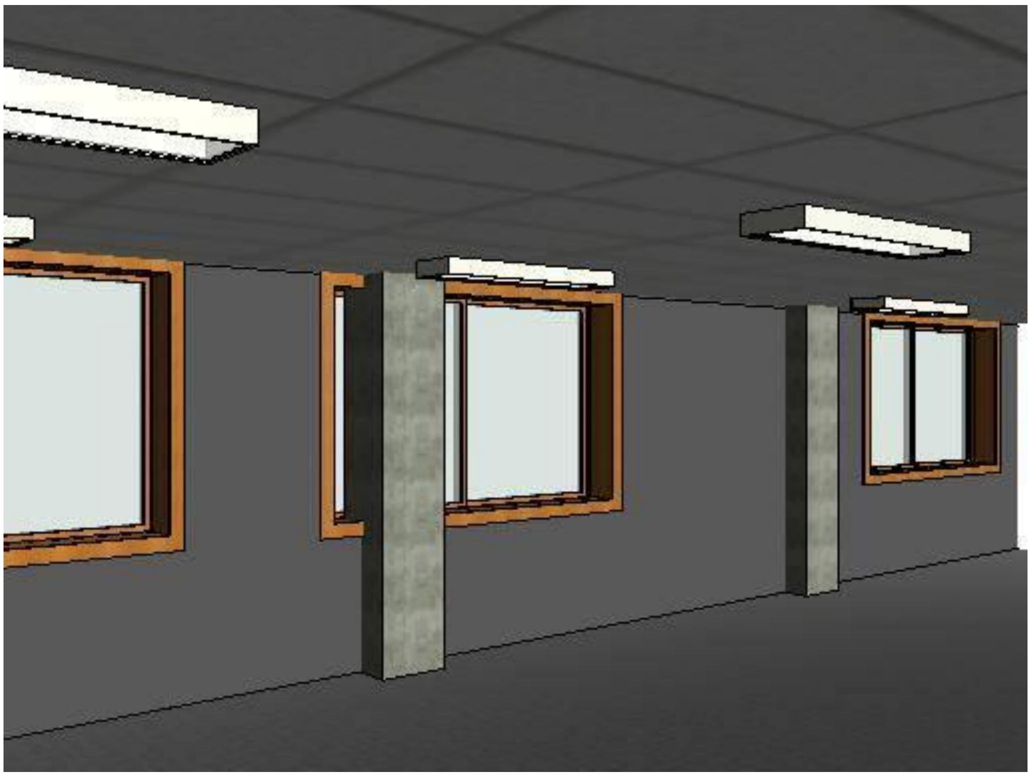

Figure 4.3 Column and window clash

4.4.4. Plumbing clash:

Some plumbing clashes found in project while developing 3D model of the building.

This is shown in fig

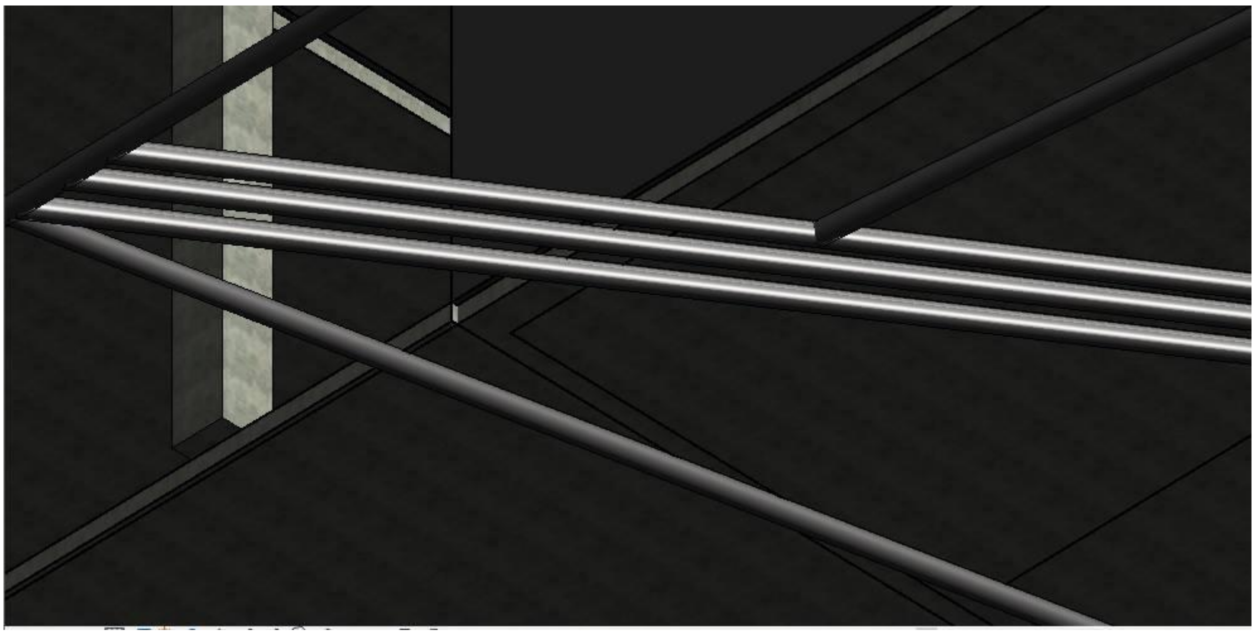

Figure 4.4 Plumbing clash

4.4.5. Ceiling problem.

Height of ceiling is too low. It was found in walk through a Model in BIM. This a major problem.

This is shown in walk through of the building as well as while creating the 3D model of the building. It was noticed during development of the 3D model.

This clash is seen in fig as ceiling height is very much close to door height.

Figure 4.5. Ceiling problem

4.4.6. Beam and door clash.

Door come in beam in auditorium drawings. This was detected while developing 3D model. This the flaw in design .this could have been solved before the project start if drawings were made on BIM.

4.4.7. Slab problem.

Actually slab was designed for 6 inch but at some parts it was placed up to 4 inch. This later would result in leakage or some others issues.

This is practical problem.

4.4.8. **Wi-Fi Alignment.**

There is problem in the alignment of the Wi-Fi connections in the buildings. This problem is discussed in interviews .As there is no alignment in project in design it was faced in later stages of the project. In 3D modeling of the project it can aligned before the start. I can be helpful. No wastage of time in this way.

4.4.9. Electric board Alignment.

There is problem of the electric board placement in the building. Same problem as discussed above. Same solution to the problem.

4.4.10. Plumbing run into beam.

Pipes run into beam at many places. This is found as clash detection while developing the 3D.This is also alignment issue in the building. This problem was due the alignment as well. Pipes running into each other and into beams.

4.4.11. HVAC Clashes

Beams and HVAC clashes found in the 3D model of Building. This was find while developing 3D model of the project. Figure shown is clash of HVAC and beam. This s shown over the

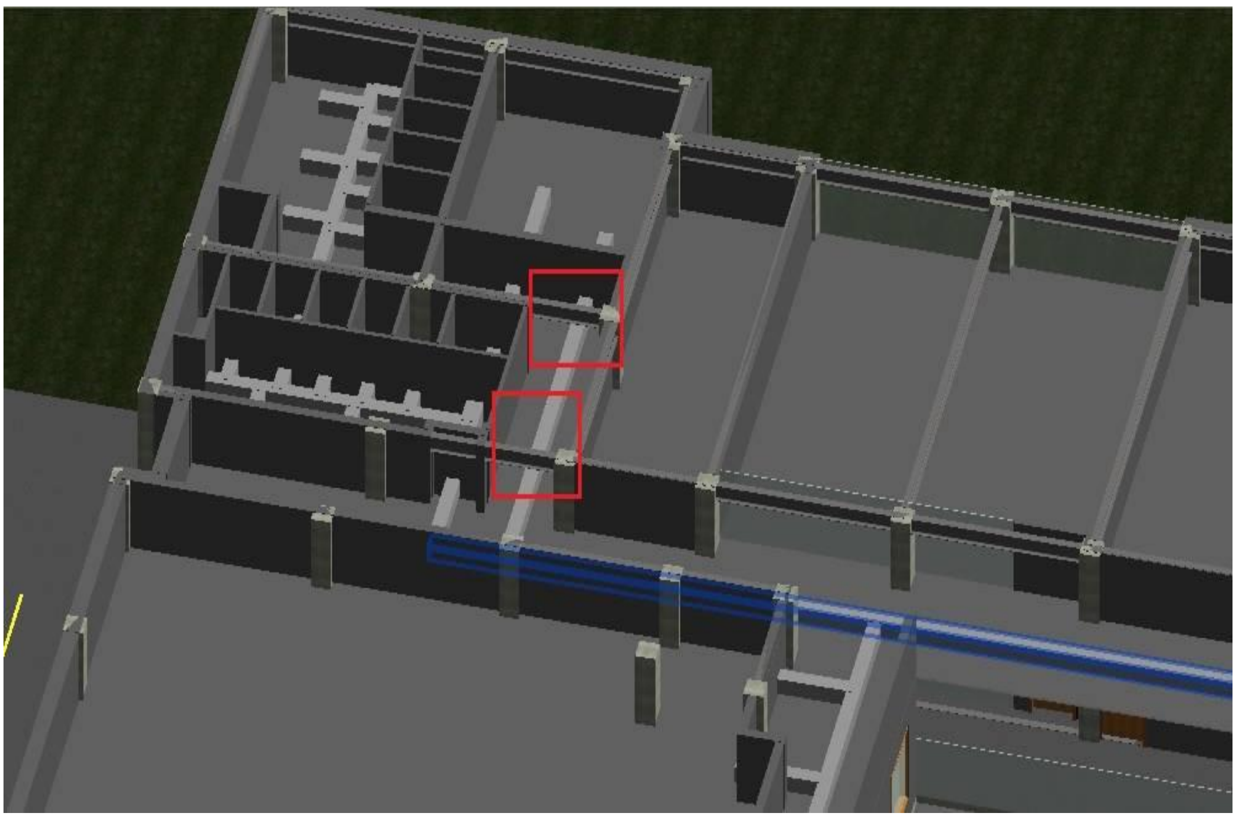

Figure 4.6 HVAC clash

4.4.12. Other fixtures problems.

Fixtures problem is found in BIM model of the project as well. There is no sinks in washrooms. Alignment is major problem. Shortage of fixtures was found during developing and missing of some of the important items were identified during the process of 3D modeling.

4.4.13. Paint color

Paint color of different choicethat can be seen in BIM. Paint color is not chosen till now. This can be viewed well in 3D model of the project.

4.4.14. **Aesthetic issue**

This is the esthetic problem in the project due to overhanging of the ceiling .The ceiling in this section is overhanging this need to be addressed in design phase.There should be covering or need to be well balance ceiling.

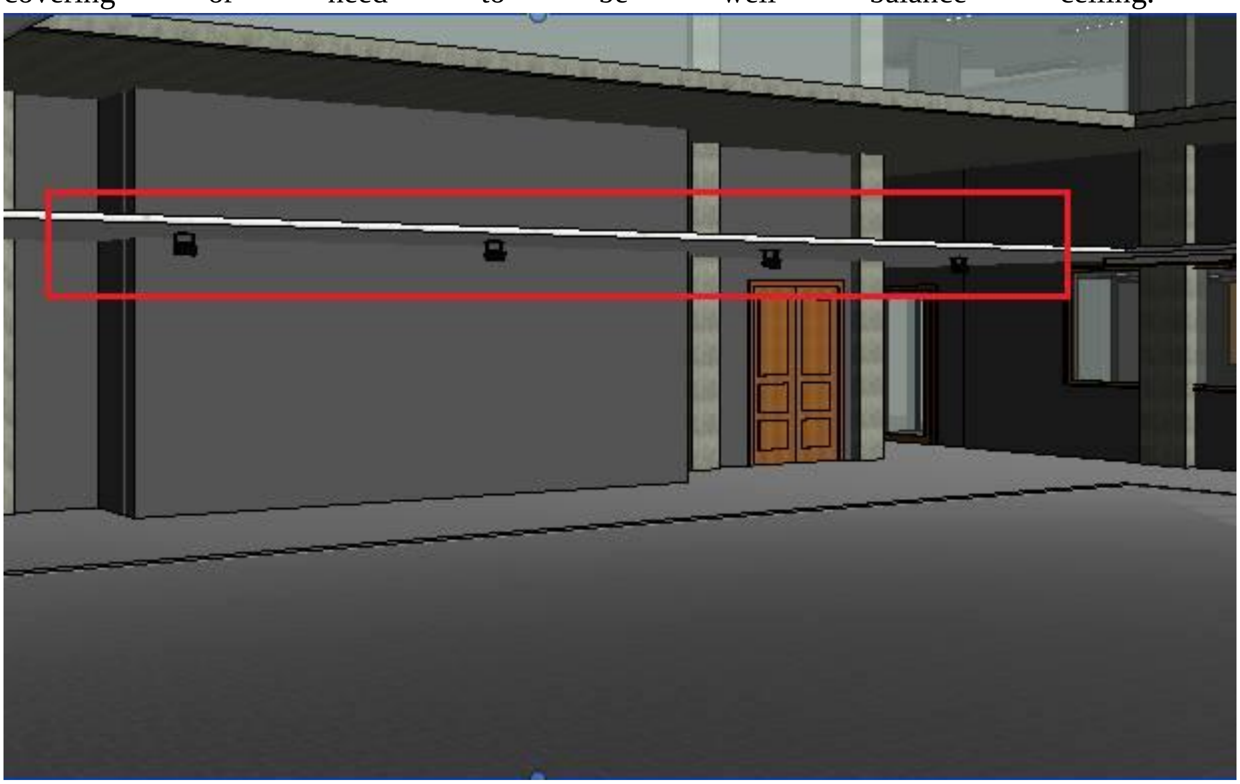

Figure 4.7 Aesthetic issues

4.5. Risk assessment

Risks found during the project are assesses according to their occurrence and their likelihood impact on the project. Total marks are set 5 in both cases. It start from minimum number 1 to maximum number 5.1 represent least number and least occurrence and minimum impact on the project. List of risks is as follows.

Table 4.3 Risk assessment

	Categories	**Likelihood 1(Rare) 5(Frequent)**	**Impact 1(very low)- 5|(very high)**
	Design risks		
D1	Design errors and omissions	4	5
D2	Design process takes longer than anticipated	4	4
D3	Stakeholders request late changes	4	3
D4	Failure to carry out the works in accordance with contract	4	3
	Organizational and Project Management Risks		
O1	Project scope definition is poor or incomplete	2	5
O2	Functional and Technical labor units not available or overloaded	2	4
O3	Inexperienced or inadequate staff assigned	2	4
O4	Communication breakdown with project team	2	3
O5	Insufficient time to plan	1	4
O6	Timely response to critical decisions by management	2	4

O7	Consultant or contractor delays	3	4
O8	Pressure to deliver project on an accelerated schedule	3	4
O9	Unplanned work that must be accommodated	3	3
O10	Local agency/regulator issues	2	3
	Contract Acquisition Risks		
CA1	Undefined acquisition strategy	3	4
CA2	Acquisition strategy results in higher scope risk (Design Build)	3	4
	Technical Risk		
T1	Confidence in scope, investigations, design, critical quantities	4	2
T2	Incomplete studies (geotechnical, hydrology, hydraulic, etc.)	1	4
T3	Surveys late and/or surveys in question	3	4
T4	Hazardous waste concerns	2	3
T5	Adaptive Management features	2	3
	Schedule Risks		
S1	Prime and subcontractor structure matches likely acquisition strategy	4	2
S3	Schedule portrays critical construction features, matching estimate productivity	3	3
	Construction Risks		
C1	Accelerated contract schedule	3	3
C2	Inefficient contractor	2	4
C3	Material availability and delivery	1	4
C4	Inadequate skilled trades available for labor force	1	5

C5	Site access / restrictions (highways, bridges, dams,etc.)	3	3
C6	Productivity of critical work items	3	4
C7	Survey information	4	5
C8	Differing site conditions	3	4
	Regulatory and Environmental Risks		
R1	Status of critical environmental and regulatory studies	3	4
R2	Lack of specialized staff	3	4
R3	Status of real estate acquisition	2	4
R4	Permits or agency actions delayed or take longer than expected	3	4
	External Risks		
Ex1	Stakeholders request late changes	2	3
Ex2	New stakeholders emerge and demand new work	2	4
Ex3	Stakeholders choose time and / or cost over quality	3	3
Ex4	Market conditions and bidding competition	3	3
Ex5	Unexpected escalation on key materials	1	3
Ex6	Acts of God (earthquakes, severe weather: freezing, flooding or hurricane	3	4

4.6. Risk Activity

After risk assessment risk were quantify for its impact on the project related to time, cost, Scope. All risks are arrange in tabular form then they are quantity as shown in table.4.1.Percentage of the risk then calculated with the help of this table. After calculating Percentages of the risks they are presented in pie chart as shown in fig.4.8

Table4.4RiskProfile

Very high	C4	O1,		D1,C7,	
High	O5,T2,C3	O2,O4,O6,C2,R3 Ex2	O7,O8,CA1,CA2 T3, C6, C8 ,R1,R2, R4, Ex6	D2	
Moderate	Ex5	O4,O4,O10,T4,T5 Ex1	O9,S2,C1,C5, Ex3, Ex 4,	D3,D4,	
Very Low				T1,S1	
Low					
LIKELIHOOD/ CONSEQUENCE	Rare	Occasional	Somewhat Frequent	Frequent	Very Frequent

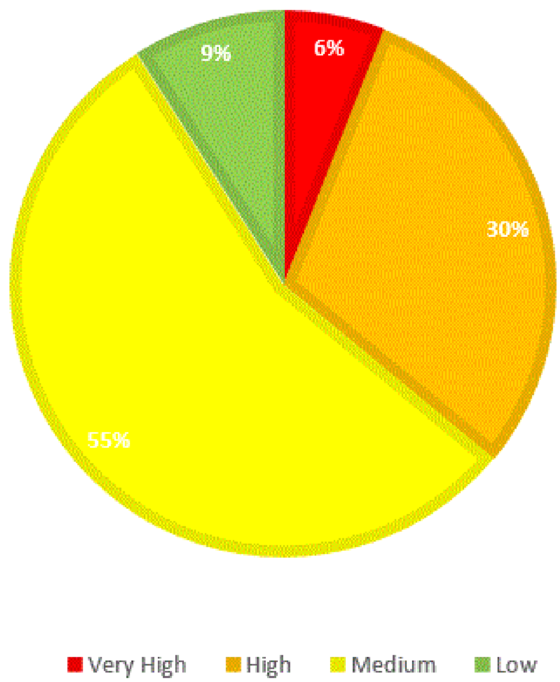

Figure.4.8Percentages of the risks

4.7. Risk allocations

Risk allocation means percentage of risks division to client, contractor, and consultant .This percentage was calculated with the help of experience persons. All risks identified and those risks are found with help of BIM are listed. All risks are assigned to the parties on the basis of lump sum contract. .Risks allocation is shown in fig 4.9.

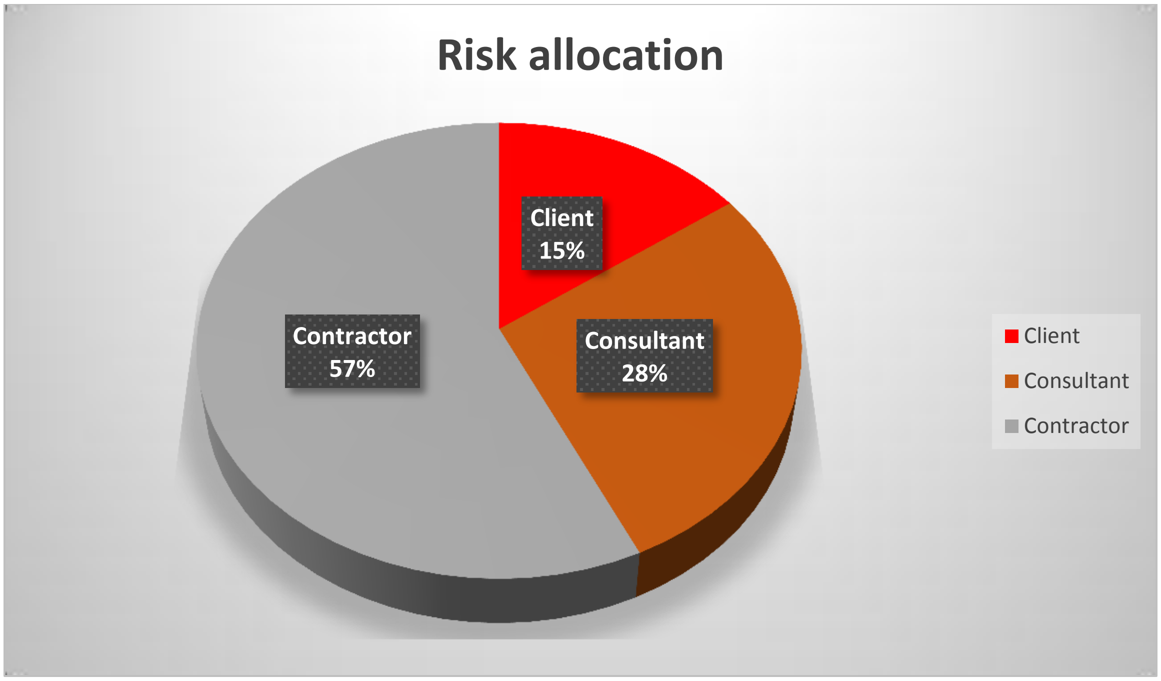

Figure 4.9. Risk Allocation

4.8. COMPARISON OF BIM VERSUS TRADITIONAL METHODS

After examining the results of the project, the project team concluded that BIM has several advantages over the traditional approach. These results can be summarized in the form of the following table.

Table 4.5: Comparison of BIM and Traditional Methods

Traditional Method	BIM
Visualization In conventional method we see 2D model so visualization is impossible. We can't see the 3D so we can't detect clashes and any problem with design so owner gives change order which means change of scope and more work.	We can visualize 3D model in BIM before construction. It shows its each and every aspect clearly. A person can see and change any aspect easily and effectively. We have clear idea how our project look likes.

Quantity Estimation Quantity estimation is done manually or through excel. It is more prone to humane error. It is lengthy and time consuming process. any change cause changes in whole estimation	Quantity estimation through BIM is very easy. It is done through software. It is a faster technique and require less time and work. The chances of errors in calculations are less. Changes if any can be made easily without any difficulty.
Coordination In traditional method all files (structural, MEP, HAVC drawings etc.) Are dependent so there coordination is weak. There is difficulty in finding conflicts as files are not interrelated. This is major problem in project and this need to be address. Coordination of the project became difficult. It is important to have better coordination as if any conflicts arise they can solve it in time.	In BIM all files are interrelated so it is easy to link different files at a time. We can easily detect any clashes b/w different drawings. This is now very helping tool to check out any clashes between different files. Coordination b/w different department is easily done so enhance time work. Clashes and conflicts identified and solved easily
Clashes In traditional method, we can't find clashes before project so if any clash arise they try to solve it through experience. It not only effect astatic but also require time and cost. So clashes found on site and design have to be changed means extra work and cost.	BIM has tool to identify clashes and conflicts in the project. This conflicts can be addressed before the start of the project. Clashes are identified and solved before the project. We saved cost and time which is used to solve the clashes of project.
Time Most work in Traditional method is manually. This is time consuming. Even in design phase if there is to be a change the designer will have to change each drawing manually. Similarly quantity estimation and conflicts during construction waste a lot of time. Files are	BIM is fast and well-organized as compare to traditional method. Everything can be seen before the start of project. One of BIM's key selling points is speed. It is able to perform all of its tasks efficiently and in a timely manner. All files are linked so any changes can be made easily in all files. This would save a lot of manual work and time.

not interlinked so all changes have to be made manually one by one. This is time taking process	
Cost There are numerous costs related with traditional methods which are well-thought-out to be part of the job but are easily preventable. For example, revision of work means material and man power is misused which could have been used for some other part of the project.	BIM decreases all extra costs that are associated with a project. There is no need an estimator, as BIM gives all of the calculations with much more accuracy. Revision of the work is avoided as designs are much more efficient and clashes are determined prior to the project. This means no material is wasted and the project is executed in the most effective manner.
Safety Not much consideration given to safety of the project site in traditional construction Methods. Often accidents occur on site that could be dodged by better design and analysis of the site.	BIM lays a lot of focus on construction health and safety. There are features that analyze a building model to detect safety threats and proposeprecautionary measures to usersfor different cases .BIM automatically detects threats and applies corrections during construction planning and design phase.
Energy Efficiency In Traditional methods tend to not focus on making projects energy efficient. Buildings are designed and built without taking energy features into attention.	BIM focus on making buildings energy efficient. Analyzing the project's location and determinationof the best possible option to make it as proficient as possible. This is not only cost saving it also environment friendly.
Executions Traditional methods mostly work are done in 2D .It is found very difficult to execute sometime in the field. Experience persons are required to carry out the execution. Problems are found on site duringthe execution of the project. No problem was identified prior to the project. Experience is	BIM has many tools to use. One of the finest is clash detection in BIM. This has been explained before it is easy way of finding clashes prior to the start of the project. Proper methodology is adopted to deal these risks and problems. This is the proactive way to mitigate the risks. .This would save time of the project. No need of change of scope at later stages.

use to deal problems. This is time consuming and sometime results in change of the design. This is very time consuming need to be addressed before the conflict arise.	

CHAPTER 5

CONCLUSIONS

Back ground

This chapter summarizes the entire thesis. This chapter informs reader about the limitation of the current study and provides guide lines for the future study of the same subject. This chapter includes remarks and general perception about the current industry in Pakistan. The introduction of the thesis has been presented in chapter No: 1, which describes the general preface, need and objectives of the thesis in details. The theoretical knowledge about the main subject Risk, Risk Management, BIM and BIM based Risk Management has been presented in chapter No: 2.The adopted research methodology has been described in chapter No: 3.The analysis of the data has been done in chapter No: 4. It was required to transformed the theoretical knowledge, which was gained through literature review, into proper research. The main purpose of the study was to accomplish the objectives of the research. In this chapter achieved objectives will be discussed and the issues with them and their significance will be discussed.

This chapter highlights the limitation of the study and future work of the study. Suggestions and guidelines provided for the future work may result in development of an effective BIM based risk Management.

5.1. Future limitation of the project.

Due to limitation of the time and resources, the research study was limited to one ongoing project in Islamabad with a limited number of respondents. Availability of the respondent was the major issue during data collection phase of the research. The major issue during research was availability of the data from authorized parties. This limitation reduced project research from 5D modeling to 3D modeling. Cost and scheduling of the project was not done .Due to all these limitation, structured interviews were decided to take during our data collection phase. It was only suitable method to collect data complying with situation at hand.

Other than Revit software no other computer analysis were performed due to limitation of time.

Autodesk Revit is relatively new software that hasn’t used much in Pakistan and the features used are quite complex so it was a challenge to learn and understand the working environment in a short duration of time. This was major aspect of the project that has to be completed because project’s major work was on clash detection. Clash detection was done on 3D model of the project.

5.2. Research Findings:

It was decided firstly to take this project to 5D modeling. But due to some restrictions and privacy of the project, this project was limited to 3D modeling. This project studied 3D modeling, visualization, 3D coordination, clash detection.

The visualization is the simplest use of a Building Information Model such as Renderings, Analysis, clarifications.During Building Information Model, the quantity takeoffs can be generated to provide cost estimations on a construction project. It is helpful then. The 3D coordination of model was utilized to detect and eliminate trade clashes, flaws in drawings and any conflicts involved. In addition to that, detailed prefabrication drawings can be generated to review and Coordinate work between trades. Once the drawings are designed to build, the Prefabrication of the components of the construction facility can be built to design. This is not limited to prefabricated products arrive at the job site, the planning techniques and 3D model can be combined with other BIM enabled tools to provide construction monitoring services. Based on the construction monitoring, the construction planning can be strategized. This helps to update the schedule and the 3D model. Finally, the record model can be generated as the final progress of the construction as the as-built are completely updated in the Building Information Model.

“Design to Build” activitieswhich include visualization, 3D coordination, and

Cost estimation, can immediately utilize the information generated in BIM. Visualization consisted of rendering of exterior, structural as well as MEP components of the construction.

Overall, visualization helped the project team to collaboratively better understand the expectancy and needs of the project before construction.

This can potentially help the owner with maintenance and renovation of the facility.

The Revit house model demonstrated benefits of parametric modeling in comparison to two dimensional computer aided drafting. Clash detection is the major aspect of the BIM. This helped the engineer to point out the conflicts in the project’s drawings or design. This helped to visually analyze the change of scope and other amendments before the start of the project. Risks are mitigated through this approach of BIM utilization. Major part of the project was to identify the risks before the start of the project. It was helpful in many parts of the projects to clarify the faults and identify the future risks.

5.3. Major conclusions of the projects are as follows.

1. Identification risks in field is very small, it must done in order to get better understanding of the project. This helps remove consequences in the project in the later stage of the project.
2. It is need to improve the practices that are being currently using in the field to deal risks. Some systematic approach is needed.
3. BIM is very promising tool in this field, which offers benefits to all parties involved.
4. BIM analysis saves time as well as it helps many involved persons like Architecture Structural MEP HVAC. Because in BIM modeling any change can be made at any time in the project. All views are interlinked, so any change in any of the view would automatically change the properties of the objects in the simultaneous views.Communication Improved. 3D model helps to understand more effectively compare to 2D model.

5. BIM has some advantages over Traditional method in visualization, coordination, Time, cost, Communication, execution

APPENDIX

APPENDIX A

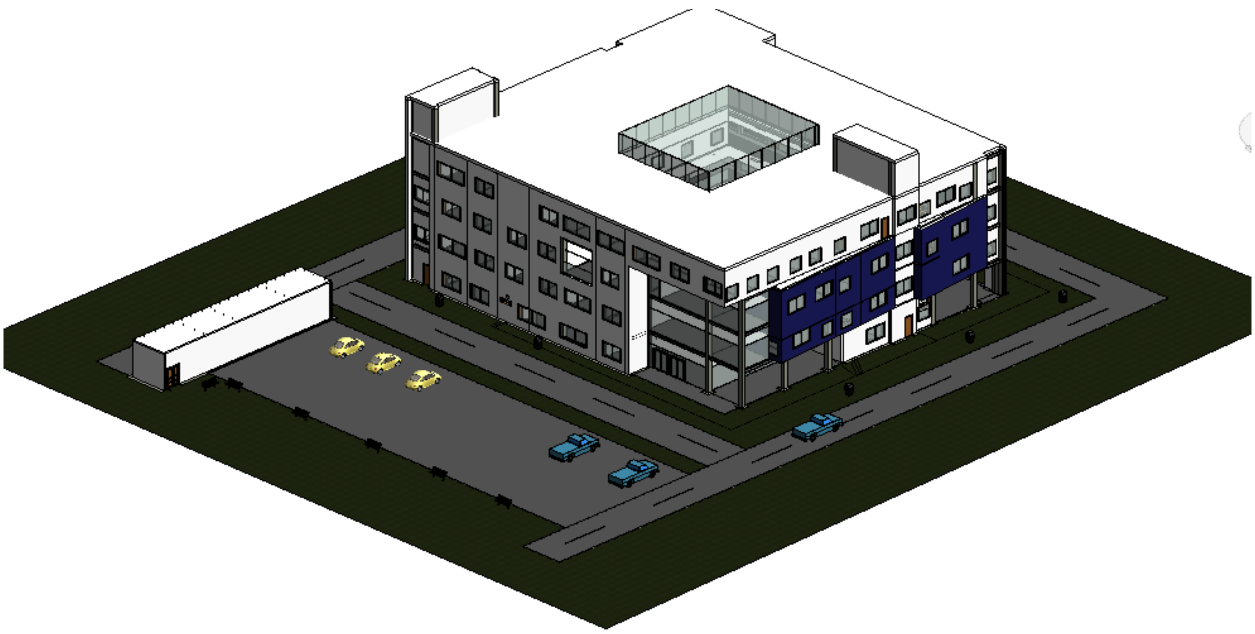

Figure A.1 BIM Model view

APPENDIX B

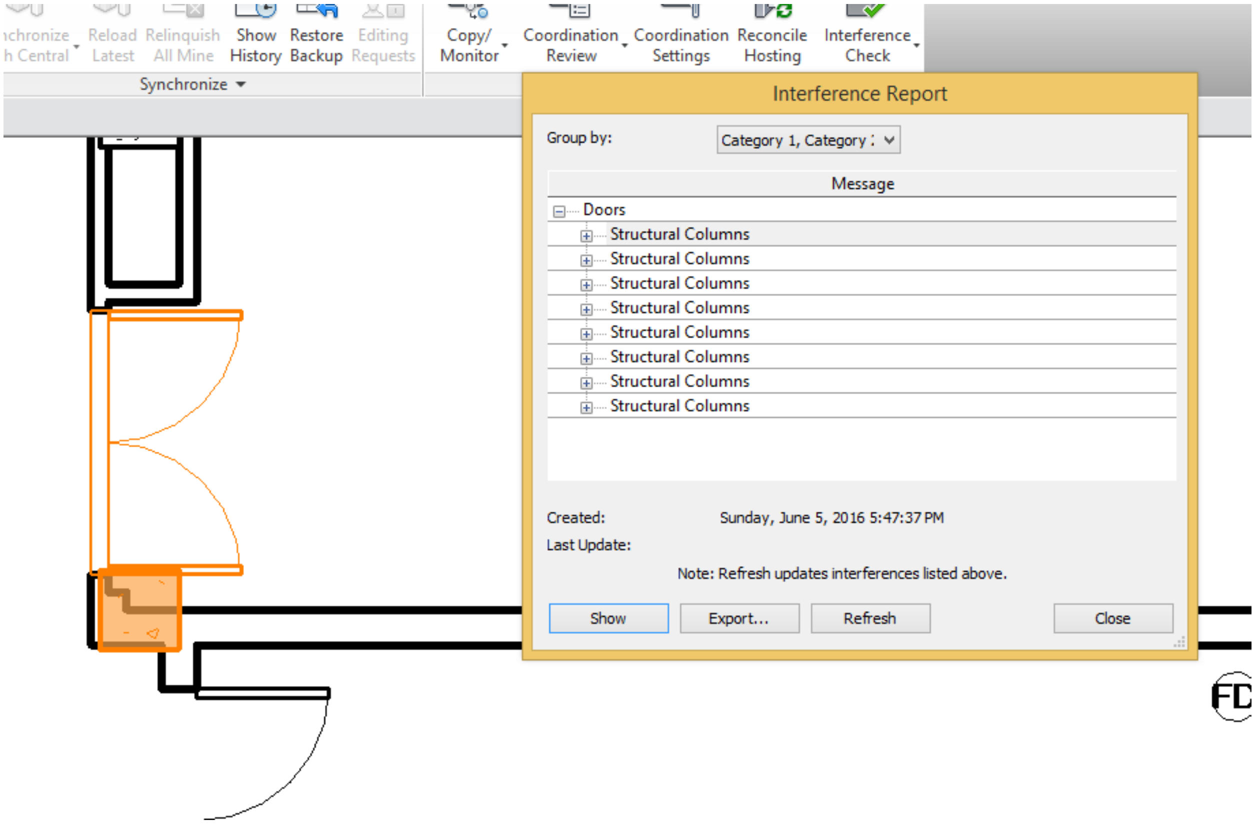

Figure B.1 Clashes found on BIM

APPENDIX C

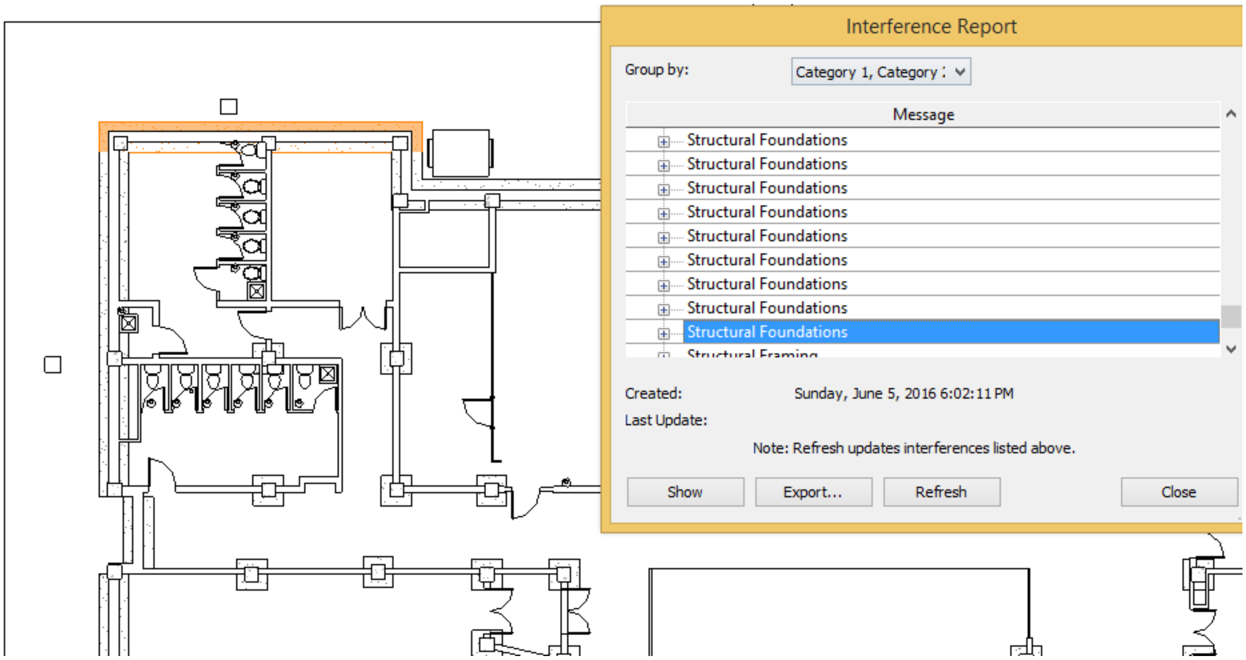

Figure C.1 Pipes and Foundation

APPENDIXD

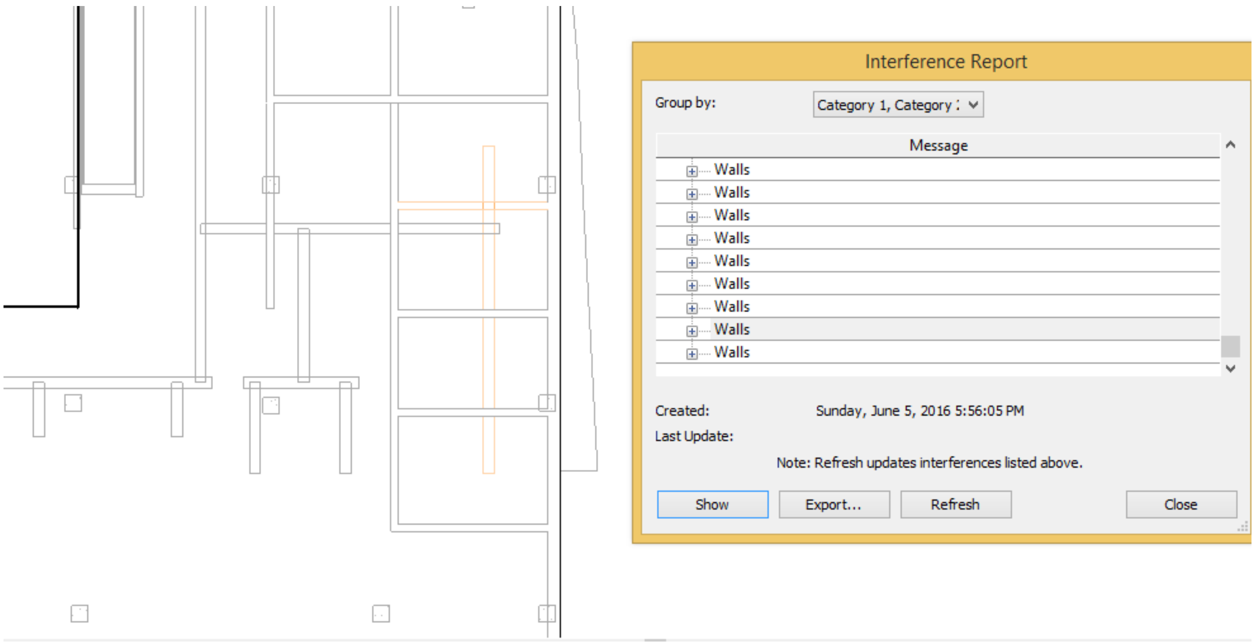

Figure D.1 Ducts clashes

BIBLOGRAPHY

Car-Pušić, D. (2014). PPP Model Opportunities, Limitations and Risks in Croatian Public Project Financing. Procedia-Social and Behavioral Sciences,119, 663-671.

Y. Arayici, P. Coates, L. Koskela, M. Kagioglou, C. Usher, K. O'Reilly, Technology adoption in the BIM implementation for lean architectural practice, Automation in Construction 20 (2) (2011) 189–195.

Arayici, Y. (2008). Towards building information modelling for existing structures. Structural Survey, 26(3), 210-222.

Chien, K. F., Wu, Z. H., & Huang, S. C. (2014). Identifying and assessing critical risk factors for BIM projects: Empirical study. Automation in Construction, 45, 1-15.

Fazli, A., Fathi, S., Enferadi, M. H., Fazli, M., & Fathi, B. APPRAISING EFFECTIVENESS OF BUILDING INFORMATION MODELLING (BIM) IN PROJECT MANAGEMENT.

Robert Eadie , Mike Browne , Henry Odeyinka , Clare McKeown , Sean McNiff'BIM implementation throughout the UK construction project lifecycle: An analysis' 36 (2013) 145–151

Choudhry, R. M., & Iqbal, K. (2012). Identification of risk management system in construction industry in Pakistan. Journal of Management in Engineering, 29(1), 42-49.

Gorbacheva, N. V., & Sovacool, B. K. (2015). Pain without gain? Reviewing the risks and rewards of investing in Russian coal-fired electricity. Applied Energy, 154, 970-986.

Zou, P. X., & Sunindijo, R. Y. (2013). Skills for managing safety risk, implementing safety task, and developing positive safety climate in construction project. Automation in Construction, 34, 92-100.

Righi, M. B., & Ceretta, P. S. (2015). Forecasting Value at Risk and Expected Shortfall based on serial pair-copula constructions. Expert Systems with Applications, 42(17), 6380-6390.

Eldosouky, I. A., Ibrahim, A. H., & Mohammed, H. E. D. (2014). Management of construction cost contingency covering upside and downside risks. Alexandria Engineering Journal, 53(4), 863-881.

Rafindadi, A. D. U., Mikić, M., Kovačić, I., & Cekić, Z. (2014). Global Perception of Sustainable Construction Project Risks. Procedia-Social and Behavioral Sciences, 119, 456-465.

Rafindadi, A. D. U., Mikić, M., Kovačić, I., & Cekić, Z. (2014). Global Perception of Sustainable Construction Project Risks. Procedia-Social and Behavioral Sciences, 119, 456-465.

Lee, P., Lam, P. T. I., & Lee, W. L. (2015). Risks in Energy Performance Contracting (EPC) Projects. Energy and Buildings, 92, 116-127.

Akintoye, A. S., & MacLeod, M. J. (1997). Risk analysis and management in construction. International journal of project management, 15(1), 31-38.

Uher, T. E., & Toakley, A. R. (1999). Risk management in the conceptual phase of a project. International Journal of Project Management, 17(3), 161-169.

Ehsan, N., Mirza, E., Alam, M., & Ishaque, A. (2010, July). Notice of Retraction Risk management in construction industry. In Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference on (Vol. 9, pp. 16-21). IEEE.

Kangari, R. (1995). Risk management perceptions and trends of US construction. Journal of Construction Engineering and Management, 121(4), 422-429.

Platzer, M. F., Jones, K. D., Young, J., & S. Lai, J. C. (2008). Flapping wing aerodynamics: progress and challenges. AIAA journal, 46(9), 2136-2149.

Magyari, E., & Keller, B. (1999). Heat and mass transfer in the boundary layers on an exponentially stretching continuous surface. Journal of Physics D: Applied Physics, 32(5), 577.

Meadati, P., & Irizarry, J. (2010, April). BIM–a knowledge repository. InProceedings of the 46th Annual International Conference of the Associated Schools of Construction, Retrieved November (Vol. 12, p. 2010).

Panushev, I., Eastman, C. M., Sacks, R., Venugopal, M., & Aram, S. (2010). Development of the National BIM Standard (NBIMS) for precast/prestressed concrete. In Proceedings of the CIB W78 2010: 27th International Conference–Cairo, Egypt (Vol. 18).

Eastman, C. (2009). Automated assessment of early concept designs.Architectural Design, 79(2), 52-57.

Teicholz, P., & Fischer, M. (1994). Strategy for computer integrated construction technology. Journal of Construction Engineering and Management, 120(1), 117-131.

Construction, M. H. (2012). The business value of BIM in North America: multi-year trend analysis and user ratings (2007-2012). Bedford, MA: McGraw-Hill Construction.

Jiang, X. (2011). Developments in cost estimating and scheduling in bim technology (Doctoral dissertation, Northeastern University).