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A STUDY ON CRITICAL RISK ASSESSMENT AND SAFETY MANAGEMENT FOR A HIGH RISE BUILDING

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Abstract - *High-rise structures are also called "vertical cities", having the potential to decongest urban sprawl. Indian cities are witnessing immense demographic expansion due to migration from surrounding villages, leading to urban sprawl, housing demand, rise in cost of land. Housing has developed into an economy generating industry. The construction projects are one of the most important one which plays a vital role in development of the country. It is estimated that the High-rise (or) multi storey buildings are the most important part of the construction for the greater development. Given this demand, while high-rise residential structures have become a solution in the metropolitan cities, they remain eluded in tier II cities in India. Low-rise or mid-rise high-density dwelling types have developed in these cities. . Construction risks can be minimized only when their cause are identified. The objective of this study was to study the risk assessment in the construction of high rise buildings. This study was carried out based on literature review . Most of the high-rise projects remain as proposals. An investigation in this case study reveal that high rise structures are not preferred due to user perception of insecurity in case of fire and high cost of the building. The paper aims at studying the availability and use of fly ash in various proportions, which can be used in Indian high-rise residential.*

1. INTRODUCTION

Risk management is a technique which is used in many other industries from, IT related to business, automobile, pharmaceutical industry, to the construction sector. Risks and uncertainties inherent in the construction industry are more than any other industries. Many industries have become more proactive about using risk management techniques in project. However, with respect to the construction industry, the same is not used commonly. Risk is an integral component of any project. If risks are not properly analyzed and strategies are not trained to deal with them, the project is likely to lead to failures. In practice, these new rates would often be valued after the work was executed based on the actual costs. There are number of reason for the introduction of changes on construction works including:

- ✓ Inadequate briefing from the client
- ✓ Inconsistent and late instructions from the client
- ✓ Incomplete design
- ✓ Lack of meticulous planning at the design stage
- ✓ Lack of co-ordination of specialist design work
- ✓ Late clarification of complex details

Additionally on civil engineering works there are many cases where changes and new rates are necessary because of the nature of the ground. Further more changes may occur due to the client's desire to incorporate the latest technology into the project which will led to deviations of time.

1.1 Aim

The aim of this study is

- To analyze the risk assessment and safety management in the construction of high rise buildings
- Comparing the various techniques of risk assessment and identifying better solution.
- Reducing both the Cost of Project and safety measures.

1.2 Objectives

The main objectives of this study are**:**

- To identify the different types of Constructions risks occurring during the Construction of high rise buildings.
- To provide a better provision for safety management.

1.3 Need Of This Project

The normal storied buildings and high rise buildings are very different. So, the activities involved starting from the planning stage will impact the completion of the project. It will require planning of urban infrastructure around the structure.A detailed planning will be required for the building services and utilities in all the stages of construction. The safety requirements, the management requirement all increases drastically. Other factors that favour this are:

1. Rapidly growing urban population that increased demand for tall buildings
2. At the expense of quality of life, the human factors being neglected.
3. To establish priorities for new research in this particular field.
4. The professionals must have the new information on high-rise buildings.

Above points justify considering high rise building construction management different than the normal.

2 RISK MANAGEMENT

Risk is defined as an exposure to the consequences of uncertainty. Risk is usually considered as an unwanted event that can be identified and quantified through its impact and probability of occurrence. The classical definition of risk states that

Risk = Probability x Impact

- A probability of occurrence of that event.
- Impact of the event occurring (Magnitude of amount loss/gain).

A project risk uncertain event (or) condition that, if it occurs, has a positive or a negative effect on at least one project objective. A risk may have one or more causes and, if it occurs, one or more impacts which are inevitable in projects and because of this uncertainty influence project performance. In which the chance of something happening that will have an impact upon project objectives. Traditional methods of coping with project risks and uncertainties mainly consist of establishing a contingency budget which is estimated as a percentage of the various project components. This method of calculating contingencies for risk has a low level of confidence and reliability. Probabilistic risk assessment techniques can provide an analytical basis for establishing contingency budgets by modeling the impact of risk factors using data ranges. The goal of risk assessment and risk management is to minimize cost overruns and scheduling problems. It has been shown that cost overruns are positively related to project size, engineering uncertainty, inflation, project scope increase, the length of time between planning and completion of a project, delays, and the inexperience of administrative personnel. Many systems exist for categorizing risks into different categories but the one presented here is fairly simple.

2.1 Risk Management Cycle

Risk management (RM) is a concept which is used in all industries, from IT related business, automobile or pharmaceutical industry, to the construction sector. Each industry has developed their own RM standards, but the general ideas of the concept usually remain the same regardless of the sector. According to the Project Management Institute (PMI) (2004), project risk management is one of the nine most critical parts of project commissioning. This indicates a strong relationship between managing risks and a project success. While RM is described as the most difficult area within construction management (Winch, 2002; Potts 2008) its application is promoted in all projects in order to avoid negative consequences (Potts, 2008).

One concept which is widely used within the field of RM is called the risk management process (RMP) and consists of four main steps: identification, assessment, taking action and monitoring the risks (Cooper et al., 2005). In each of these steps, there are a number of methods and techniques which facilitate handling the risks.

Each activity or process, regardless of the area of business domain, has a beginning and an end. Similar concepts are used in the engineering world to systemize projects over time. The term project life cycle is used as a management tool to improve a project‟s performance. The scope of life cycles differs among industries and diverse terminology with a various number of phases is used depending on the sectors. However, several terms are often used within one particular sector even though a number of phases can vary (Smith et al., 2006). Therefore, it is difficult to systemize and provide one common scope and definition of a project life cycle.

Smith et al. (2006) concluded that various forms of PLC frameworks described in the literature are a result of variety of project types. For construction projects, for instance, the PLC model can consist of eight succeeding phases including pre-feasibility, feasibility, design, contract/procurement, implementation, commissioning, handover and operation (Smith et al., 2006). In contrast, Pinto and Prescott (1988) present a four stage PLC developed by Adams and Brandt, and King and Cleland as the most widely used framework, where conceptualization, planning, execution and termination are the main phases.

A similar model is used by Westland (2006) who identifies initiation, planning, execution and closure as principal project steps.

3 LITERATURE REVIEW

- **Hanish Verma, Neha Verma, “A Study on Risk Assessment and Safety Management in the Construction of High-Rise Buildings(2017)”** in **International Journal of Engineering Development and Research** States that

Brain storming:

This is one of the most popular techniques. Generally, it is used for idea generation; it is also very useful for risk identification. All relevant persons associated with project gather at one place. There is one facilitator who is briefing about various aspects with the participants and then after note down the factors. Before closing it the facilitator review the factors eliminate the unnecessary ones.

Delphi technique:

This technique is similar to brainstorming but the participants in this do not know each other and they are not at the same place. They will identify the factors without consulting other participants. The facilitator like in brain storming sums up the identified factors.

Interview /expert opinion:

Experts or personnel with sufficient experience in a project can be a great help in avoiding/solving similar problems over and over again. All the participants or the relevant persons in the project can be interviewed for the identification of factors affecting risk.

Past experience:

Past experience from the same kind of project, the analogy can be formed for identification of the factors. When comparing the characteristics of projects will provide insight about the common factors.

Check lists:

These are simple but very useful predetermined lists of factors that are possible for the project. The check list which contains a list of the risks identified in projects undertaken in the past and the responses to those risks provides a head start in risk identification.

Influence diagram:

It is a graphical representation containing nodes representing the decision variables of a problem. A traditional influence diagram is formed by three types of nodes: utility, decision and informational. The causal relationship occurs between utility

- **Seyed Hossein Abedian Kalkhoran,Gholamali Liravi, Fereshte Rezagholi Risk Management in Construction Projects(2014**) in **International Journal of Engineering Trends and Technology** states Risk is involved in every business and construction industry is no exception. Risk in terms of safety, economy and timely completion are more crucial for a project to be a successful one. Indian construction industry is worth about $100 billion and this could grow considerably driven by major projects across the country. The demand for infrastructure is going to be in great volume in the coming future. Use of modern construction equipments and techniques has accelerated the growth. As the industry grows the associated risk also grows. Risk management in construction is one important area that needs attention for successful completion of the project. A risk free project is one that results in a zero dispute situation so that there is a reasonable profit for the parties involved in a project. A well-drafted, balanced contract with a proper administration can mitigate exposure to risk and keep the project on track. Construction Managers need to know how to balance the contingencies of risk with their specific contractual, financial and organizational requirements. In order to achieve this balance, proper Risk identification and Risk analysis is required.

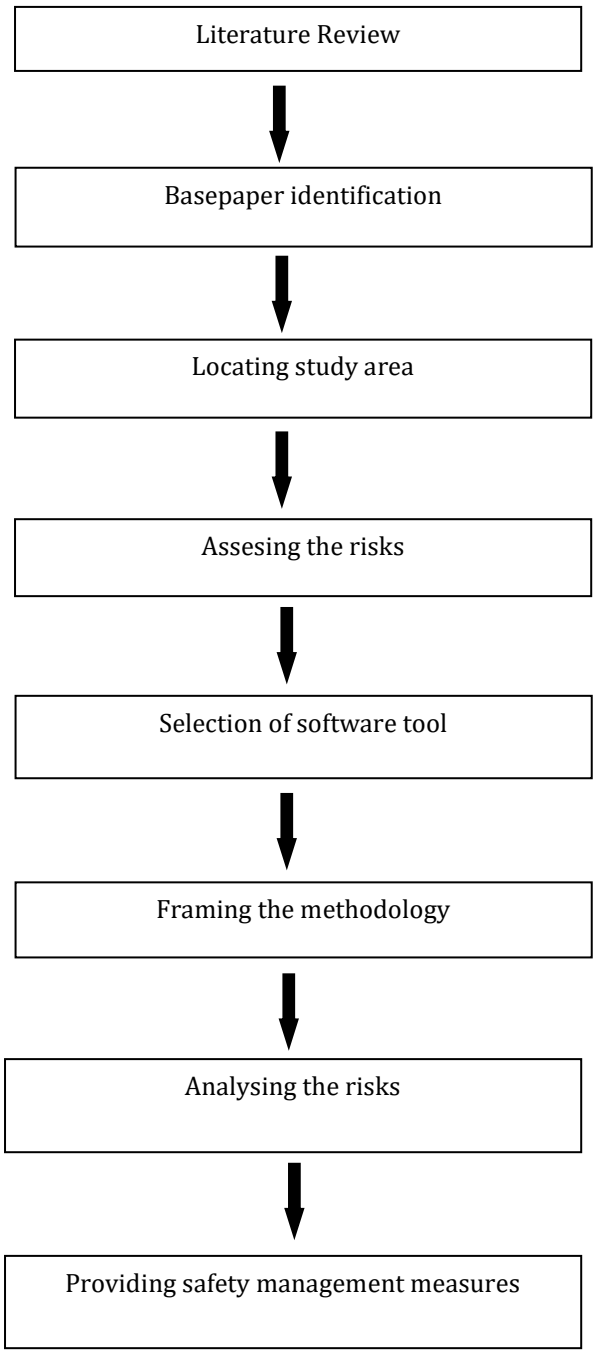
  The objective of the paper is to study the aspects that are more vital for the success of the project and highlight those pitfalls that increase the risk of the project. It is also attempted to arrive at some suggestions by referring to various cases and their judgments delivered in the past.
- In **Anandhababu S., Vinoth M., Visagavel.K Understanding the A Study On Risk Assessment In Construction Project Of An Educational Institution (2014) International Journal of Research in Engineering and Technology** states The risk involved in the construction works is relatively higher than the other works. The biggest challenge is to reduce the risks involved. Risk assessments include identifying risks, analyzing risk and controlling risk qualitatively by various methods. In this study, the Questionnaire checklist method is used to identifying the risk in the construction work, at an educational institution. Based on this, risk assessment is made to control the risks. Checklist analysis is the methodology used for this study. Detailed checklist has been prepared as per the construction work at the educational institution. Checklist analysis has been found to be simple and cost effective analysis, which can provide reasonable results. The checklist is prepared by dividing the whole work into 10 categories. It helps in detailed examination and analysis of the hazard and there by risk identification and risk assessment. The checklist is divided into Excavations and Trenches, Scaffolding, Electricity and Lighting, Machinery and Equipment, Fire safety, Physical Hazards, Chemical Hazards, Psychosocial stress factors, First Aid and Emergency preparedness and Personal Protective Equipment (PPE). Data is collected by direct survey by using the prepared checklist, which provided a better picture of the hazards and risks.

- **Kinnaresh Patel , A Study On Risk Assessment And Its Management In India(2013)** states All of the most challenging construction projects worldwide involve a variety of complex processes working simultaneously. Managing these processes can be quite a challenge for the management. A big part of meeting these challenges is mitigating the RISKS involved. Risk management includes identifying risks, assessing risks either quantitatively or qualitatively, choosing the appropriate method for handling risks, and then monitoring and documenting risks. This study identifies the procedures for risk identification, management and its perception from the Indian construction industry players. Time and cost management need to be fully integrated with the identification process. Time constraints and project managers with sufficient experience are critical when identifying the level of risk for large and/or complex projects.The aim of this study is to advocate for a method of risk mitigation which includes a well-documented procedure which serves as a one stop-solution to all the risks that would emanate in the future.
- **S. M. Renuka, C. Umarani, S. Kamal A Review on Critical Risk Factors in the Life Cycle of Construction Projects(2014)** In any country, infrastructure development will increase the growth of countries economy and generates the large amount of job opportunities. Hence those projects involve a large amount of investment to carry out. In view of that, if any sort of wastage (either time, resources etc) occurs that would lead to the huge monetary losses. These losses occur due to various risks associated with such mega projects. Consequently, these risks play a crucial role for the completion of project within the time schedule and planned budget. In this connection, this study mainly discusses the critical risk factors and its assessment techniques through comparative study of various international construction projects. About 50 relevant articles published over the last 25 years have been reviewed. The review resulted that a simple analytical tool will be developed for each project task to assess the risk easily and quickly, which will encourage the practitioners to do the risk analysis in their project. This review concluded that the earlier risk identification in the project and assessment during the bidding stage of the construction project will lead to the better estimation of the escalation on cost and time overrun. Such risk assessments help to include in the budget and scheduling for the successful completion of the project.
- In **Mr. Satish K. Kamane , Mr. Sandip A. Mahadik Risk Management in Construction Industry** states Construction projects are characterized as very complex projects, where uncertainty comes from various sources. Construction projects gather together hundreds of stakeholders, which makes it difficult to study a network as a whole. But at the same time, these projects offer an ideal environment for network and risk management research. Additionally, construction projects are frequently used in management research, and several different tools and techniques have already been developed and especially for this type of project. However, there is a gap between risk management techniques and their practical application by construction contractor. This paper deals with the identification of risk by different methods, types of risks associated with construction project and different risk mitigation techniques.
- In **K. Jayasudha Dr. B.Vidivelli E.R. Gokul Surjith Risk Assessment and Management in Construction Projects** states that Construction of bridge projects are initiated in complex and dynamic problems resulting in circumstances of high uncertainty and risk, which are compounded by demanding time and cost constrains. The general methodology is to study relies largely on the survey questionnaire which will be collect from the various bridge project construction contractors and project manager of different sizes by mail or personnel meeting. The questionnaire prepared for the survey was formulated by seeing the relevant literatures in the area of construction management. This research seeks to identify the risk factors that affect the performance of bridge projects as a whole and analyze by using appropriate tools and technique and to develop a risk management framework. The responses were analyzed like bar charts were subjected to using the software of SPSS. This questionnaire has been divided in to two factors namely time and finance management. The 25 number of companies related to bridge projects industries. For these factors analysis of t-test and ANOVA were calculated, tabulated and the result are given according to the suitable suggestions.
- **Akintola S Akintoye, Malcolm J MacLeod Risk analysis and management in construction** states that The paper describes, on the basis of a questionnaire survey of general contractors and project management practices, the construction industry's perception of risk associated with its activities and the extent to which the industry uses risk analysis and management techniques. It concludes that risk management is essential to construction activities in minimizing losses and enhancing profitability. Construction risk is generally perceived as events that influence project objectives of cost, time and quality. Risk analysis and management in construction depend mainly on intuition, judgement and experience. Formal risk analysis and management techniques are rarely used due to a lack of knowledge and to doubts on the

suitability of these techniques for construction industry activities.

4. METHODOLOGY

4.1 Flow Chart



5. IDENTIFICATION OF RISKS

The risks that are assessed from the detailed literature review are

- Financial risks
- Political risk
- Legal risks
- Environment risk
- Force majeure risks
- Operating risks

6. SCHEDULING PROCESS

Microsoft project is project management software used in construction for preparation of construction schedule. In this project management software, we can assign duration and resources to each activity in construction so that the final output will be total duration required to complete the project and total budget for the project.

6.1 Scheduling Using MSP Software

The first level of creating a project schedule in Microsoft project is to open a new project and create a project calendar depending on necessity of the project. Project calendar helps in creating new calendar for specified project with specified hours of work on each day & setting work days to specific number of days in a week. In this project, calendar was set to 8 hours of work on each day and 6 days of work in week and also included holidays wherever necessary. Project start date was set in project information. Entire project was divided into number of levels and under each level necessary tasks were included under each work package.

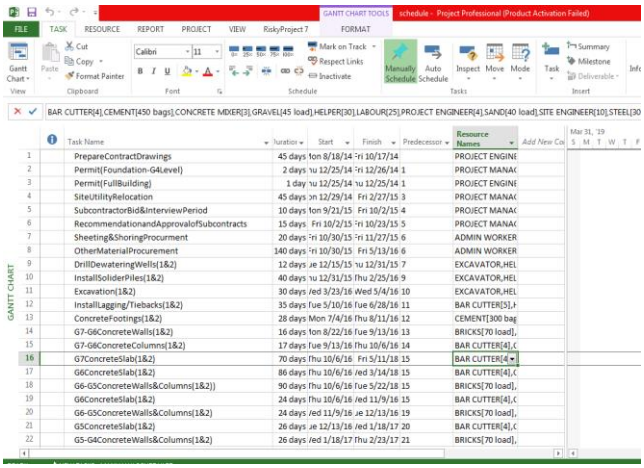


Fig 6.1 Scheduling by using MSP

Various resources included in the project are entered in resource sheet. In resource sheet, resource names and its initials are entered. Resources types is assigned for each resource depending on usage nature which involves rate per day or per hour. Material type is assigned to all material resources such as cement, sand etc that are measured in specific units such as bags, load etc. Cost

type is assigned to resources that involve cost per use as concrete mixer lift.

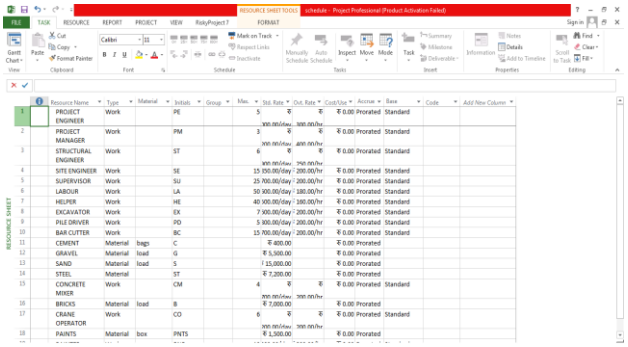


Fig 6.2 Resource Sheet of Schedule

7. MSP AND RPP

7.1 MSP

Microsoft Project is a project management software designed for enterprises of all sizes. Microsoft Project also works as a resource for project budgeting, which can help management estimate costs for a complex project to determine resource allocation. Microsoft Project can be deployed on-premise with a user license or on the cloud with a monthly subscription. The software provides tables, views, filters, fields, calendars, and a database for doing things like:

- Developing project plan
- Assigning resources
- Tracking time & progress
- Creating Gantt charts
- Creating & managing budgets
- Balancing workloads
- Scheduling tasks & resources
- Creating graphical reports
- Storing project data in a shared database

Here are some of the main benefits that MS Project can provide:

Deploy resources as efficiently and effectively as possible, reducing downtime and increasing utilization.

Provide a big picture view of organizational capacity to prevent overbooking and support hiring decisions.

Forecast revenue by providing reports on upcoming projects and planned resource deployment.

7.2 RPP

Risky Project Professional is comprehensive project risk analysis and management software. Risky Project Professional allows users to perform Monte Carlo simulations of project cost and schedule using discrete risk events and uncertainties defined by three point's estimates. Cost and schedule risk analysis allows users to create realistic "risk adjusted" cost and schedule estimates to complete their projects. Risky Project Professional also provides a comprehensive project risk management capability that is compatible with all major project risk methodologies and processes, such as those supported by PMI, Prince II, and ISO 31000.

Risky Project Professional allows project planners and managers to perform integrated **schedule and cost risk analysis.** With resource loaded schedules, users can link risks from their risk register to project activities and resources, and define uncertainties related to schedule and cost of each task. Risky Project Professional will provide results in the form of cumulative project cost curves and probabilistic cash flow plots, and joint confidence scatter plots for cost and schedule. In addition, Risky Project Professional calculates the amount of work for each time frame for each resource, which provides probabilistic work and resource allocation reports.

Risky Project Professional provides comprehensive **sensitivity analysis** on project risks, cost, duration, finish time etc. The results of the sensitivity analysis can be viewed as Tornado charts and are available in a variety of reports. In addition, using the Monte Carlo simulations and sensitivity analysis, Risky Project Professional will automatically rank risks in the risk register.

8. ANALYSIS AND RESULTS

The project schedule has been analysed by the RISKY PROJECT PROFESSIONAL to attain the risk management in the actual project schedule.

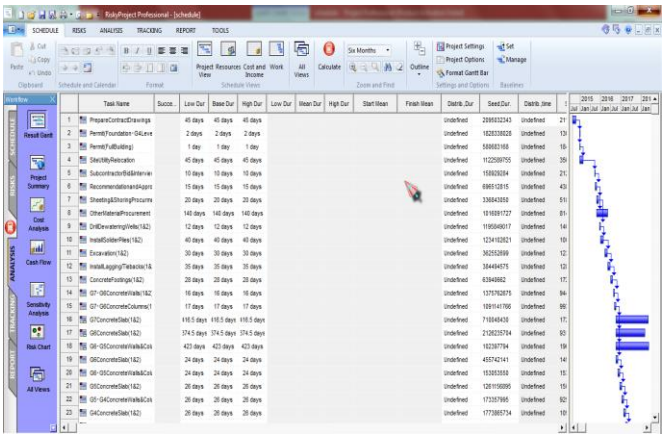


Fig 8.1 Exporting Schedule to RPP

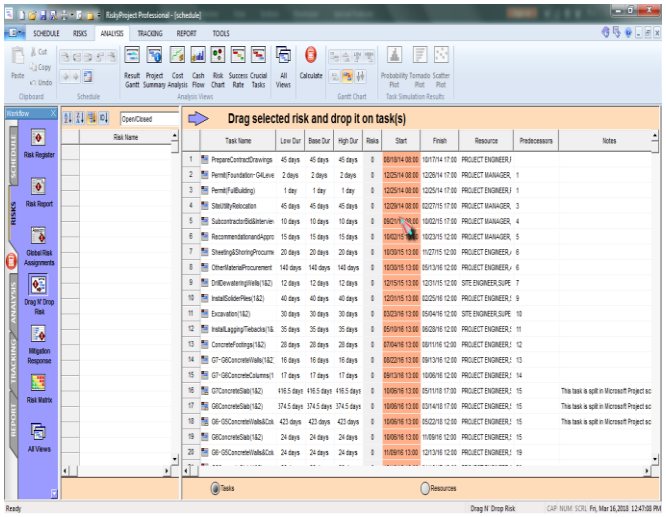


Fig 8.2 Risk implemented in Actual Schedule

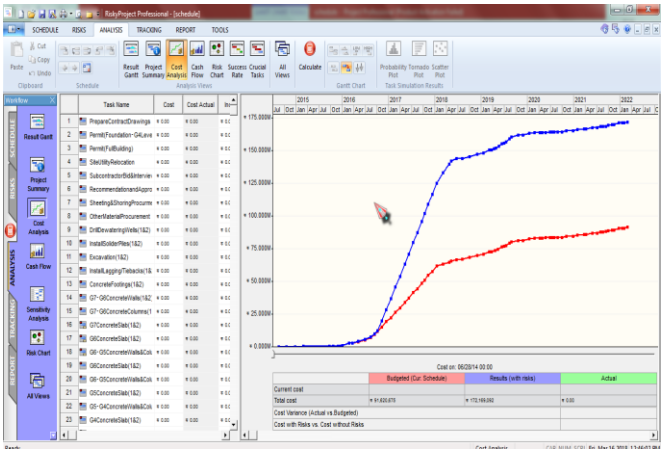


Fig 8.3 Cost analysis of Risk implemented Project

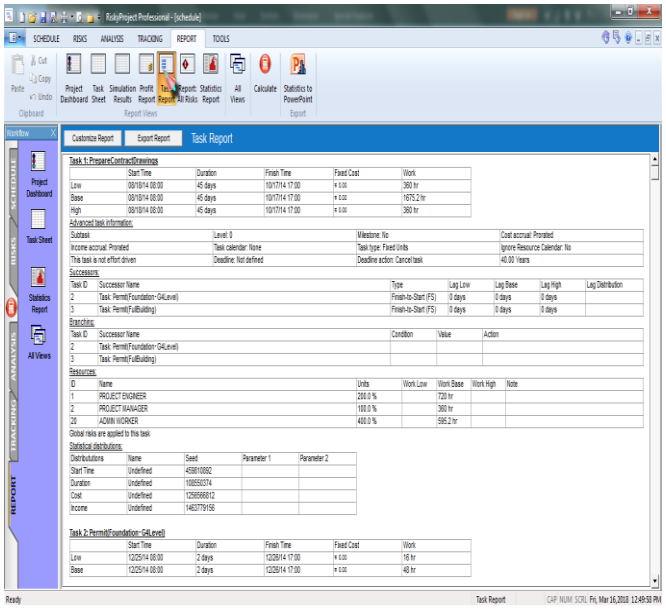


Fig 8.4 Report of Actual Schedule

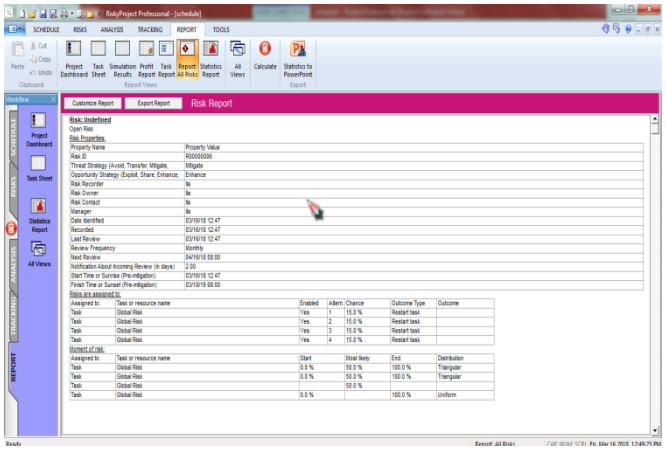


Fig 8.5 Report of Risk implemented Project

9. CONCLUSION

In this project, the study denotes the risks occurred in the construction industry thus the risks causes the different impacts on completion of the project. The study is based among the tool named "Risky Project Pro". The schedule has been done in the MS-Project, then the tool has been used for the further process. According to the methodology, The risks factors are identification based on the literature collected and by consulting the experts, based on this the questionnaires were prepared. Totally for ten companies the questionnaires were given, out of which three had an effective reply. Thus the response rate is 60% which is considered a good response in this type of survey. According to them the major part of risks in high-rise buildings are caused due to technical, financial, physical and constructional problems. This paper has presented a general review of structural systems for tall buildings. Unlike the height-based classifications in the past, a system-based broad classification (i.e., exterior versus interior structures) has been proposed. Various structural systems within each category of the new classification have been described with emphasis on innovations. As far as the engineers concerned Lack of knowledge of arbitration has the maximum risk rating and other risks are material shortage, shortage in supply of electricity, poor quality of procured materials, loss due to fluctuation of interest rate, accident in site sub-contractor related problems, error in drawings, improper verification of contract documents, and competition from other companies. The least risk rating given by project engineer is environmental risk, relation with government departments, local protectionism and industrial disputes.

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