IDENTIFYING PROJECT RISK FACTORS AFFECTING PROJECT COST PERFORMANCE IN STEEL INDUSTRY: AN INDIAN PERSPECTIVE

By

GANESH VISHWAKARMA

COLLEGE OF MANAGEMENT AND ECONOMIC STUDIES

(DEPARTMENT OF LOGISTICS & SUPPLY CHAIN MANAGEMENT)

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Under the

Guide	Registered Guide:
Dr. Neeraj Anand	**Dr. Krishan Kumar Pandey**
Professor & HOD	**Professor & Vice Dean,**
LSCM & Operations	**Jindal Global Business**
School CoMES, UPES,	**Sonipat**

CONTENTS

PERSONAL RESUME:

Ganesh Vishwakarma

Director (Projects & Business Planning)

Steel Authority of India Ltd.

N. Delhi

Email: ganesh_vishwakarma@yahoo.com

Educational Qualifications

2008 **Master of Engineering** (Environment Science & Engineering)
Bhilai Institute of Technology, under Pt. Ravishankar University, Raipur (C.G.),

1989 **Graduate in Industrial Engineering,** Indian Institute of Industrial Engineering, Mumbai

1981 **Bachelor of Engineering** (Mechanical Engineering), Government Engineering College under APS University, Rewa (M.P.), India

1986 **Post Graduate Diploma in Business Management,** Durga College Pt. Ravishankar University, Raipur.

Membership of Professional bodies

- **Life Fellow Member** of "Institution of Engineers (India)"
- **Life Fellow Member** of "Indian Institution of Industrial Engineers"
- **Life Fellow Member** of **"**Indian Institute of Metals"

UNIVERSITY OF PETROLEUM
AND ENERGY STUDIES
www.upes.ac.in
UPES
THE NATION BUILDERS UNIVERSITY

Date:

Thesis Completion Certificate

This is to certify that the thesis on "Identifying Project Risk Factors Affecting Project Cost Performance in Steel Industry: An Indian Perspective" by Ganesh Vishwakarma in Partial completion of the requirements for the award of the degree of Doctor of Philosophy (Management) is an original work carried out by him under our joint supervision and guidance.

It is certified that the work has not been submitted anywhere else for the award of any other diploma or degree of this or any other University.

Guidance of

Dr. Neeraj Anand

Co Guidance of

Dr. Krishan Kumar Pandey

BIDHOLI CAMPUS Energy Acres, PO Bidholi Via Prem Nagar, Dehradun 248007 (UK), INDIA, T +91-135-2102690/1, 2694201/3/8 F +91-135-2694204
KANDOLI CAMPUS Knowledge Acres, Vill. Kandoli, PO Bidholi Via Premnagar, Dehradun 248007 (UK), INDIA, T +91-135-2102647/2102760
CORPORATE OFFICE 2nd Floor, 210, Okhla Industrial Estate, Phase III, New Delhi-110020, INDIA, T +91-11-41730151-53 F +91-11-41730154

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February, 2016. **GANESH VISHWAKARMA**

DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

February, 2016. (Ganesh Vishwakarma)

CERTIFICATE

This is to certify that the thesis entitled "**IDENTIFYING PROJECT RISK FACTORS AFFECTING PROJECT COST PERFORMANCE IN STEEL INDUSTRY: AN INDIAN PERSPECTIVE"** submitted by **GANESH VISHWAKARMA** to University of Petroleum and Energy Studies (UPES) for the award of the degree of Doctor of Philosophy is a bona fide record of the research work carried out by him under my (our) supervision and guidance. The content of the thesis, in full or parts have not been submitted to any other Institute or University for the award of any other degree or diploma.

Guided by

Dr. Neeraj Anand
Professor & HOD
LSCM & Operations, CoMES
UPES, Dehradun.
Date: February, 2016

Co Guided by

Dr. Krishan Kumar Pandey
Professor & Vice Dean
Jindal Global Business School,
Sonipat
Date: February, 2016

EXECUTIVE SUMMARY

Chapter 1 begins with the development of Steel sector in India along with the sector reforms. It further discusses significance of Steel sector in India's economic growth with Industry structure in India. It discusses context and motivation of Steel sector in India and its significance in India's economic growth. The later part of the chapter draws attention towards the delay in projects in India majorly construction projects, challenges they face and overview of reasons for projects schedule delay during the execution discussed. At the end it discusses the problem during the infrastructure development and the business problem for the proposed research is summarized.

Chapter 2 is concerned with the literature review which was done under six verticals as Risk Management, Risk Mitigation, Risk Variables of Overseas Projects, Project Risk Management and Risk reporting. Themes listed are summarized. Projects have been studied in order to understand various risks associated with various types of projects worldwide and cost overrun of factors considered are listed. Further, discussed in detail reasons for schedule overruns in majority of infrastructure projects in India with the help of statistics.

Chapter 3 is concerned with the research methodology adopted. It includes the rationale / need of the research, followed by research gap which focuses on the variables responsible for cost overrun during execution of large integrated steel plant in India and problem statement with objectives. Exploratory research was conducted for identification of variables in research methodology. Explained how the sample size was considered and framed the hypothesis with list of identified risks.

Chapter 4 deals with the data analysis to identify various risk variables associated with the project cost performance in establishing steel plant in India by Factor Analysis using IBM SPSS (Statistical Package for the Social Sciences) software. Explained step wise procedure involved while using the software. Then, Identified the factors from Rotated Factor Matrix table. Data analysis for another objective i.e to establish the interrelationship between identified factors and cost overrun responsible for the project cost overrun of steel plant projects in India. Further by using Regression Method the top risk variables responsible for the project cost overrun for construction of steel plant in India are identified and at the end findings from the data analysis are mentioned.

Chapter 5 presented Conclusion and Recommendations. Further, discussed directions for future research.

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LIST OF ABBREVIATIONS

TISCO	Tata Iron and Steel Company
MT	Million Tons
SAIL	Steel Authority of India
RINL	Rashtriya Ispat Nigam Limited
MSPs	Mini Steel Plants
DPR	Detail Project Report
SMS	Steel Melting Shop
BOF	Basic Oxygen Furnace
HR	Heat Resistant
MoSPI	Ministry of Statistics and Programme Implementation
PMI	Project Management Institute
PSU	Public Sector Unit
ICRAM	International Construction Risk Assessment Model
CRMS	Construction Risk Management System
PRM	Project Risk Management
PUMA	Project Uncertainty Management Assessment
FICCI	Federation of Indian Chambers of Commerce and Industry
BHEL	Bharat heavy Electricals Ltd
NREGA	National Rural Employment Guarantee Act
JNNURM	Jawaharlal Nehru National urban Renewal Mission
EPC	Engineering Procurement and Construction
NHAI	National Highway Authority of India
PCA	Principal Component Analysis
EFA	Exploratory Factor Analysis
SPSS	Statistical Package for the Social Sciences

CHAPTER – 1

INTRODUCTION

ABSTRACT

This Chapter begins with the development of Steel sector in India along with the sector reforms. It further discusses significance of Steel sector in India's economic growth with Industry structure in India. It discusses context and motivation of Steel sector in India and its significance in India's economic growth. The later part of the chapter draws attention towards the delay in projects in India majorly construction projects, challenges they face and overview of reasons for projects schedule delay during the execution discussed. At the end it discusses the problem during the infrastructure development and the business problem for the proposed research is summarized.

CHAPTER – 1

INTRODUCTION

1.1 BACKGROUND

The establishment of Tata Iron and Steel Company (TISCO) in 1907 was the starting point of modern Indian steel industry. Afterwards a few more steel companies were established namely Mysore Iron and Steel Company, (later renamed Visvesvaraya Iron & Steel Ltd) in 1923; Steel Corporation of Bengal (later renamed Martin Burn Ltd and Indian Iron & Steel Ltd) in 1923; and Steel Corporation of Bengal (later renamed Martin Burn Ltd and Indian Iron and Steel Co) in 1939.[1] All these companies were in the private sector.

Key Events

1907*: Tata Iron and Steel Company set up.

1913: Production of steel begins in India.

1918: The Indian Iron & Steel Co. set up by Burn & Co. to compete with Tata Iron and Steel Co.

1923*: Mysore Iron and Steel Company set up

1939*: Steel Corporation of Bengal set up

1948: A new Industrial Policy Statement states that new ventures in the iron and steel industry are to be undertaken only by the central government.

[1] *Government of India, Joint Plant Committee Report 2007.*

1954: Hindustan Steel is created to oversee the Rourkela plant.

1959: Hindustan Steel is responsible for two more plants in Bhilai and Durgapur.

1964: Bokaro Steel Ltd. is created.

1973: The Steel Authority of India Ltd. (SAIL) is created as a holding company to oversee most of India's iron and steel production.

1989: SAIL acquired Visvesvaraya Iron and Steel Ltd.

1993: India sets plans in motion to partially privatize SAIL.

Source: * Government of India, Joint Plant Committee Report 2007 and rest of the dates from:

http://www.fundinguniverse.com/company-histories/Steel-Authority-of-India-Ltd-Company-History.html

At the time of independence, India had a small Iron and Steel industry with production of about a million tonnes (mt). In due course, the government was mainly focusing on developing basic steel industry, where crude steel constituted a major part of the total steel production. Many public sector units were established and thus public sector had a dominant share in the steel production till early 1990s. Mostly private players were in downstream production, which was mainly producing finished steel using crude steel products. Capacity ceiling measures were introduced. Basically, the steel industry was developing under controlled regime, which established more public sector steel companies in various segments.

Undoubtedly there has been significant government bias towards public sector undertakings. But not all government action has been beneficial for the public sector companies. Freight equalization policies of the past were one example. The current governmental ‘moral-suasion’ to limit steel price increases is another.

However, after liberalization—when a large number of controls were abolished, some immediately and others gradually—the steel industry has been experiencing new era of development. Major developments that occurred at the time of liberalization and thenceforth[2] were:

1. Large plant capacities that were reserved for public sector were removed;
2. Export restrictions were eliminated;
3. Import tariffs were reduced from 100 percent to 5 percent;
4. Decontrol of domestic steel prices;
5. Foreign investment was encouraged, and the steel industry was part of the high priority industries for foreign investments and implying automatic approval for foreign equity participation up to 100 percent; and
6. System of freight ceiling was introduced in place of freight equalization scheme.

As a result, the domestic steel industry has since then, become market oriented and integrated with the global steel industry. This has helped private players to expand their operations and bring in new cost effective technologies to improve competitiveness not only in the domestic but also in the global market. Private sector contribution in the total output has since been increasing in India. Development of private sector has caused high growth in all aspects of steel industry that is capacity, production, export and imports. During the last decade more than 12 mt of capacity has been added in the steel industry, this is mostly in the private sector. Recently, the steel industry is receiving significant foreign investments such as POSCO—South Korean steel producer—and Arcelor-Mittal Group—UK/Europe based steel producer—announcing plans for establishing about 12 mt production units each in India.

[2] *Government of India, Ministry of steel, Annul Report 2007-08.*

The Indian steel industry, with a production of about 1 mt at the time of independence, has come long way to reach the production of about 57 mt in 2006-07. Moreover, the steel industry is showing promising future growth as major players in the industry have announced their plans for significant investments in expanding their capacities.

Impressive development of the steel industry with active participation of private sector and integration of India steel industry with the global steel industry has also induced the government to come up with a National Steel Policy in 2005. The National Steel Policy 2005 was drafted with the aim of establishing roadmap and framework for the development of the steel industry. The policy envisages steel production to reach at 110 mt by 2019-20 with annual growth rate of 7.3 percent. As later sections will show these expectations are not excessively high.

With increasing need for large investments in the industry private sector's role would be crucial in the development of the steel industry. TISCO, public sector entities, POSCO, Jindals, Essar, and Arcelor-Mittal will be among the major players accounting for the bulk of the 100 plus million tons of production in the future.

There is a key factor behind the predominance of large units and oligopolistic industry structure, and that is the production process. The following section discusses the process and underlying technology.

The Indian iron and steel industry is nearly a century old, with Tata Iron & Steel Co (Tata Steel) as the first integrated steel plant to be set up in 1907. It was the first core sector to be completely freed from the licensing regime (in 1990-91) and the pricing and distribution controls. The steel industry is expanding worldwide. For a number of years it has been benefiting from the exceptionally buoyant Asian economies (mainly India and China). The economic modernization processes in these countries are driving the sharp rise in demand for steel.

The demand for steel in India is expected to rise 7 percent in the next financial year beginning April 1 as compared to the sluggish 5.5 percent projected growth in 2012-13. The overall outlook for the steel sector is positive and the demand was likely to pick up in the next financial year on the back of revival in economic growth and the government's measures to ease infrastructure investment rules.

In fiscal 2012-13, growth in domestic steel demand is expected to be around 5.5 percent. Total demand is expected to be around 75 million tonnes, up from 71 million tonnes in 2011-12. In 2013-14, demand is expected to be higher at around seven percent.

India is currently the world's fourth largest producer of crude steel after China, Japan and the US. Major public as well as private sector firms including Tata Steel, SAIL and JSW Steel are expanding production capacity. The steel production is expected to reach 200 million tonnes by 2020 as compared to 71 million tonnes recorded last year. In steel production, India is expected to leave behind USA and Japan in a couple of years. However, it will substantially lag behind China that produces almost 700 million tonnes of steel per year.

Steel being a basic commodity for all industrial activities, quantum of its consumption by a particular country is considered as an index of industrial prosperity of that country. Since independence, there has been a substantial growth in the steel production in India from 1.5 Mt/yr in 1950-51 to about 72.0 Mt/yr in 2013-14. Apparent consumption of finished steel in India was 14.84 Mt in 1991-92 which increased to 48.7 MT by 2006-07 and 57 MT in 2012.

Despite the above mentioned growth in the steel sector, the per capita steel consumption continues to remain at a level of about 57 kg only, compared to about 215kg as international average. Further, with nearly 20% of the world population, India’s contribution is only of the order of 4% of the world steel production. Hence, long term and short term strategies are necessary in planning the steel industry in the country to improve the level of per capita steel consumption.

While modernization of the existing steel plants in India may increase steel output marginally, setting up of new steel plant facilities will be essential to meet the increasing steel demand. The country now has a vision to achieve annual production of 180-200 Mt by the year 2019-20

According to a recent press report of Ministry of Steel, Government of India, the rank of our country among the top steel producers of the world has moved up from 4th position in 2013 to 5th position. , there is a considerable gap between the consumption and production of steel products in India, considering the per capita consumption of developing country.

1.1.1 INDUSTRY STRUCTURE

Indian Iron and steel Industry can be divided into two main sectors Public sector and Private sector. Further on the basis of routes of production, the Indian steel industry can be divided into two types of producers.

Integrated producers: Those that convert iron ore into steel. There are three major integrated steel players in India, namely Steel Authority of India Limited (SAIL), Tata Iron and Steel Company Limited (TISCO) and Rashtriya Ispat Nigam Limited (RINL).

Secondary producers: These are the mini steel plants (MSPs), which make steel by melting scrap or sponge iron or a mixture of the two. Essar Steel, Ispat Industries and Lloyds steel are the largest producers of steel through the secondary route.

1.1.2 CONTEXT & MOTIVATION

India is today witnessing growth of large number of integrated large scale projects both green field and brown field. As on date India is a net steel importer, but in the near future with commitments, for such huge capacity coming up will become a net exporter of steel. With the huge iron ore reserves of very high quality, the country will always have an edge in the world market provided that the production lines are made more and more energy efficient. The liberalized industrial policy and other initiatives taken by the government of India have given definite impetus to the private players. This has led to modernization / expansion of existing plants and a large number of new / green field plants coming up. New modern plants incorporating cost effective, state of art technology are coming up in different parts of the country at places close to natural resource supplies.

1.1.3 SIGNIFICANCE

India's economic growth is contingent upon the growth of the Indian steel industry. Consumption of steel is taken to be an indicator of economic development. While steel continues to have a stronghold in traditional sectors such as construction, housing and ground transportation, special steels are increasingly used in engineering industries such as power generation, petrochemicals and fertilizers. India occupies a central position on the global steel map, with the establishment of new state-of-the-art steel mills, acquisition of global scale capacities by players, continuous modernization and upgradation of older plants, improving energy efficiency and backward integration into global raw material sources.

The great challenge now is timely completion and execution of these new projects so that the capitalization of the huge investments starts at the earliest without cost overrun. The last two decades saw the development sector booming worldwide, especially in developing countries that are rich in natural resources which has pressurized the governments to develop large scale projects such as large scales that can accommodate newly emerging developments **(Baydoun M, 2011).** Due to lack of necessary expertise and financing, governments in most developing countries joint ventures with private sector for developing and commissioning of these projects **(Koppenjan and Enserink, 2009).**

In India, the steel industry is subject to more risks due to the unique features of construction activities, such as long period, complicated processes, abominable environment, financial intensity and dynamic organization structures hence, it becomes essential to know all the variables which are affecting project cost and are responsible for project cost overrun. As there has been less (Or no work) work done in Indian perspective to detect variables responsible for cost overrun, This study will help future Indian steel projects and can be used as a basic guide to avoid maximum possible variables responsible for impacting cost overrun.

1.2 DELAY OF PROJECTS IN INDIA

In India, construction projects are becoming bigger with a lot of complications. Though we have a lot of method to make sure that we finish project on schedule so that we improve our profit margins, still delay is inevitable, which ultimately results the reduction in profit margins.

So far lots of studies have been carried out by various researches to identifying the factors that affect the schedule and profitability of the project. Still there are a lot of projects which run behind schedule and suffer a heavy loss. Lot of study has been carried out by various researches to find out the factors that affect the schedule of the project, but the root cause of all these factors are the contract clauses which are the binding between the Employer and Contractor.

This factor made us to identify the clauses that affect the schedule performance and project profitability of the construction project.

It is a known fact that a large number of infrastructure projects in India have been delayed due to regulatory clearances, environmental issues and problems pertaining to land acquisition. Also, there are challenges in the tendering phase that affect viability of projects thus delaying implementation, construction phase is beset with over-runs and disputes and last but not the least; provider skills are weak all across the value chain. This report attempts to identify these pertinent issues and also brings out how professional project management practices can bring about a positive change in the completion of projects on time and within budget.

Nodal agencies in India tend to focus less on design and engineering excellence than their global counterparts. They usually select engineering consultants on a lowest price or L-1 basis, overlooking the quality aspect. This is evident in the fact that the cost of creating a detailed project report (DPR), as a percentage of project cost, is much lower in India compared with global benchmarks. Not surprisingly, this leads to bottlenecks and cost over- runs during the construction phase.

Majority of infrastructure projects in India are affected by time overruns. These overruns vary from a few months to as high as five or more years, placing the project viability at risk. Survey respondents identified the bottlenecks which affect their projects and the challenges they face in conquering them. These bottlenecks, as enlisted below, are divided into two phases –

(i) Pre-execution phase and

(ii) Execution and closing phase.

Reasons for project schedule delay in pre-execution phase:

- Land/ site handover
- Delay in regulatory approvals
- Lack of strong R&R policies
- Relationship with other projects
- Non-flexible country plan
- Delay in decision making
- Ineffective procurement planning.

The factors affecting the project timelines primarily appear to be associated with external factors the underlying reason behind them remains the delayed or non-identification of pre-requisites to overcome these factors. In the absence of adequate identification of these dependencies the projects usually land in trouble at the start itself which in turn manifests into delayed project delivery or higher cost at completion.

Reasons for project schedule delay in execution and closing phase:

- Design/ scope change.
- Inadequate availability of skilled resources
- Contractual disputes.
- Industrial relations and law problems
- Geological surprises
- Pre-commissioning teething troubles.
- Coordination issues with Project Team/vendors.
- Geographical challenges and cultural differences.
- Delay in regulatory approvals(for commissioning)
- Ineffective programme management.
- Ineffective project monitoring
- Lack of awareness of modern technology

- Unavailability of funds.

Cost revisions and cost overruns are common across infrastructure projects. Project organizations have repeatedly failed to address the issues related to contracts administration and timely procurement which if handled effectively can help in reducing the costs substantially.

Over the last decade, the steel industry has experienced many challenges, especially regarding delay in Implementation of projects in steel industry. Construction of Steel plants in India is plagued with complex issues which require immediate attention. As per Annual report of 2010-2011, Government of India out of 19 projects related to steel industry 11 projects are time over run which are at the range of 27-37 months and whose cost overrun is almost 50%. The time overrun in projects is coming down resulting in reduction in the cost overrun of the projects due to close monitoring, timely resolution of problems and systems improvements. An analysis of the last 19 years shows that the cost overrun has come down drastically.

Even in projects that are completed on time and within budget, substantial optimization opportunities are lost. This is mainly because best practices in engineering, procurement and construction are not widely followed. Inefficiencies in infrastructure implementation in steel industry have substantial negative impact on India’s economic growth.

Figure – 1.1: Typical Process-cum-flow sheet of a Steel Plant

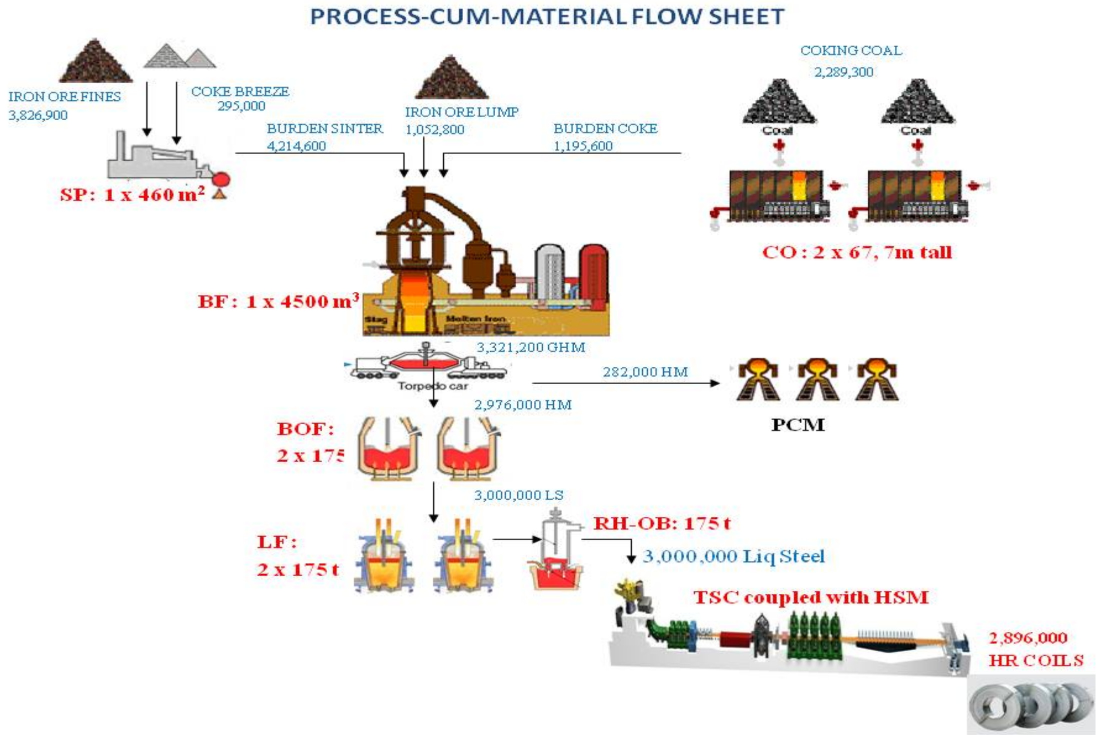


Figure – 1.2

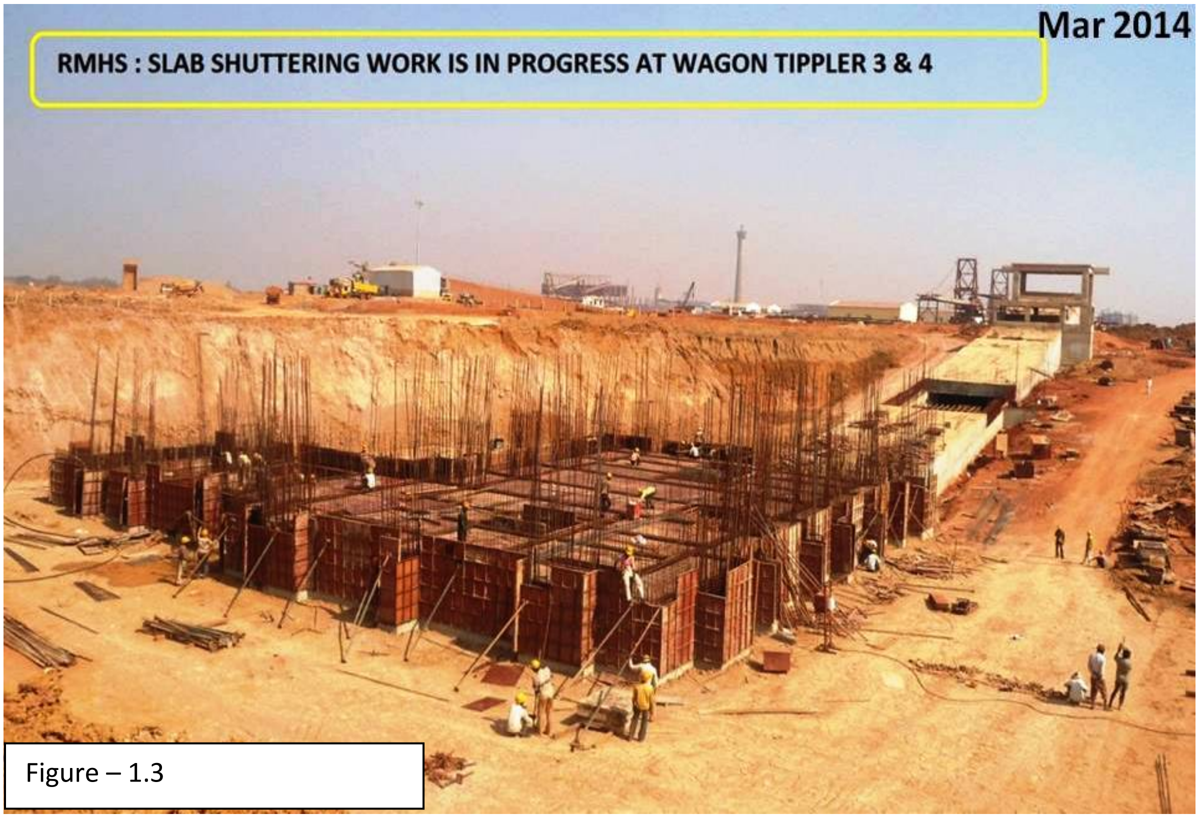


Figure – 1.3

Figure – 1.4

Figure – 1.5

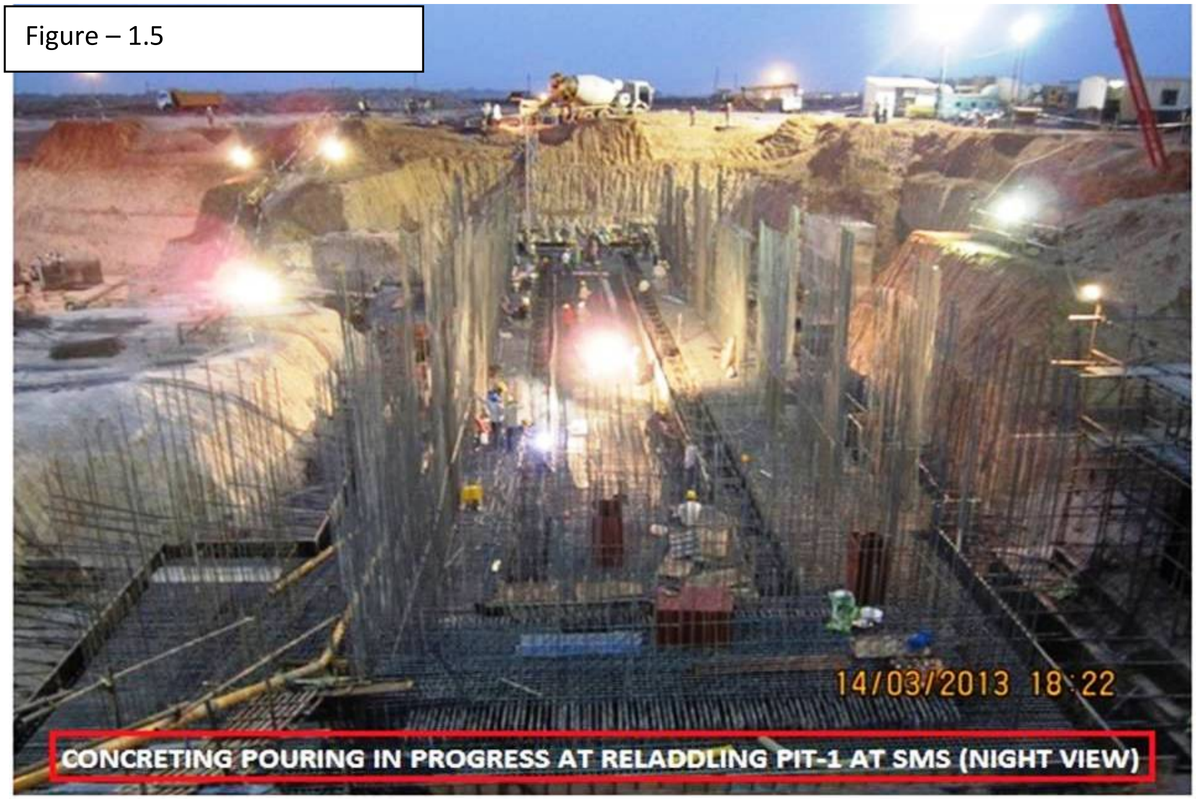


Figure – 1.6

Figure –1.7

Figure – 1.8

1.3 Business Problem:

Risk is never static. It is in a constant state of evolution. Risk management must always be seen against the business objectives that are sought.

The overall aim of this research is to increase the understanding of risk management in the different procurement options, design-bid-build contracts, design-build contracts and collaborative form of partnering. Deeper understanding is expected to contribute to a more effective risk management and, therefore, a better project output and better value for both clients and contractors.

It is a known fact that a large number of infrastructure projects in India have been delayed due to regulatory clearances, environmental issues and problems pertaining to land acquisition. Also, there are challenges in the tendering phase that affect viability of projects thus delaying implementation, construction phase is beset with over-runs and disputes and last but not the least; provider skills are weak all across the value chain. Given the critical role of infrastructure in ensuring a sustained growth trajectory for India, it is imperative that we identify the core issues affecting completion of infrastructure projects in India and chalk out initiatives that need to be acted upon in short term as well as long term. Almost 79% of our respondents felt that the infrastructure sector faces an acute shortage of skilled project managers. This absence of project managers with the requisite skill sets has emerged as the major cause for time and cost overruns. Young graduates today are being lured away be other seemingly lucrative opportunities and project management education and training is not yet getting the priority it requires.

As per Risk management - The commercial imperative, Sir Michael Latham 1994 “No construction project is risk free. Risk can be managed, minimized, shared, transferred, or accepted. It cannot be ignored."

Hence therefore the business problem for the proposed research can be summarized as below;

“Non- identified risk factors for steel plant construction projects, causing delay in steel plant construction project which is resulting in to a significant project cost overrun.”

SUMMARY

This chapter explained the development of Steel sector in India along with the sector reforms and significance of Steel sector in India's economic growth with Industry structure in India. It focused on context and motivation of Steel sector in India and its significance in India's economic growth.

This chapter even covers the delay in projects in India majorly construction projects, challenges they face and overview of reasons for projects schedule delay during the execution. The problems faced during the infrastructure development and the business problems for the proposed research are summarized.

CHAPTER – 2

REVIEW OF LITERATURE

ABSTRACT

This chapter describes the literature review which was done under six verticals as Risk Management, Risk Mitigation, Risk Variables of Overseas Projects, Project Risk Management and Risk reporting. Themes listed are summarized. Projects have been studied in order to understand various risks associated with various types of projects worldwide and cost overrun of factors considered are listed.

CHAPTER – 2

REVIEW OF LITERATURE

Extensive literature review on the following themes has been done by the researcher. Researcher has studied all the aspect of risk in steel projects as well as other construction projects which are directly related with our research goal. Till date there has been many studies showing different types of risk in steel industry, however in Indian scenario we often see factors which are consider unique in nature. We have tried to cover all the major factors in our study.

Literature review has been done under six verticals as Risk Management, Risk Mitigation, Risk Variables of Overseas Projects, Project Risk Management and Risk reporting. Above six covers major construction projects & broader aspect of steel project life cycle.

Table – 2.1:

Sl.No	Title/ Theme	Author & Year	Inferences/ Key highlights	Research Gap
	a) Risk Management			
1	Risk is "the possibility of bringing about misfortune or loss" which also bear the same meaning as "danger, hazard, pitfall, peril and **uncertainty**".	(Collins Concise Dictionary, 2006)		
2	Risk is future uncertainty which needs to be managed in order to avoid variety of	(Triantis, 2000)	Real Options and Corporate Risk	

	consequences ranging from negative surprises to permanent loss		Management	
3	Risk is the function of the probability and outcomes of an uncertain happening. Although the concept of "risk" is defined and approached differently by different points of views, within the context of construction projects, it is generally defined as the probability of occurrence of events that may positively or negatively affect the project's predefined objectives. Even if risk may have both adverse and favorable consequences according to this definition, risk-based approaches are mostly concentrated on its negative outcomes.	(Crandall & Al-Bahar, 1990) **;**(PMBok, 2000)**;**(Baston, 2009)**, and** (Edwards, 2009)	Systematic Risk Management Approach for Construction Projects	
4	Risk management process is generally defined as an iterative process that starts with identification of risk factors, followed by qualitative and/or quantitative assessment of risk impacts on the project, and	(H.Zhi, 1995)**;**(Wang, 2004)**;**(Han, 2008)**, and** (Edwards, 2009)**.**	Risk Management of Overseas Construction Projects, Risk Management Framework for	All the papers cover Risk Management Framework for Construction Projects

	finally, development of risk mitigation strategies to maintain an optimum risk-return structure between the project participants		Construction Projects in Developing Countries, A web Based Integrated System for International Project Risk Management. Automation in Construction , Identifying and Communicating Project Stakeholder's Risk.	related to refinery, bridges, roads, etc but not covering steel Plant.
5	Project Risk Management (PRM) is the systematic process of identifying, analyzing, and responding to project risks	PMI (PMBok, 2000)	A Guide to Project Management Body of Knowledge. USA: Project Management Institute.	
6	Supporting the integration of PRM processes with companies' routines and with	(Sanchez, 2005)	Neural Risk Assessment System for	This paper has identified the most

	project environments, the author claims that the main objectives of risk management are oriented toward these three tasks.		Construction Projects.	common risks in infrastructure projects in Germany and other EU countries only but not in India. The risks are quantified in terms of monetary only.
7	PRM as a systematic and formal process which should be conducted throughout the life of a large scale project which comprises of three phases, namely identifying, analyzing and responding to the project risks.	(Wang, 2004)	Risk Management Framework for Construction Projects in Developing Countries.	This paper covers risk management in other developing countries but not in India.
8	PRM process as a four-step systematic approach including risk classification, risk identification, risk assessment, and risk responses phases	(H.Zhi, 1995) and (Berkley, 1991)	Risk Management of Overseas Construction Projects. Project Risk	

			Action Management. Construction Management and Economics	
9	The most effective approach toward the PRM of large scale projects is the process consisting of the following five steps: 1) Risk Identification, 2) Risk Analysis, 3) Risk Evaluation, 4) Risk Response, and 5) Risk Monitoring. (Edwards, 2009) modify such definitions through emphasizing on the importance of the risk-related knowledge after the accomplishment of each PRM cycle. He introduced six subsequent phases as the necessary steps for PRM, namely 1) Establishment of the Context, 2) Risk Identification, 3) Risk Analysis, 4) Risk Response, 5) Risk Monitoring and Controlling, and 6) Capturing Risk Knowledge. In this way the PRM started from three to	(Han, 2008)	Web Base Integrated System for International Project Risk Management. Automation in Construction	This paper focus on Risk Management in overseas construction projects other than Steel Plant using a web based support system and it reviews basic decision making process only.

	ended as six step process.			
10	The author has found that proposed systems are typically common in the following major phase's viz. risk identification, risk assessment and risk response.	(Eybpoosh 2010)	Identification of Risk paths in International Construction Projects	
11	For the purpose of feasibility assessment and strategic decision making, is important to identify the most probable risks at pre-construction stage of the candidate project. Also, exhaustive identification of potential risks that may significantly affect project and corporate objectives will lead to proactive management decisions rather than corrective responses to raised problems. On the other hand, subsequent phases of risk management process (assessment, analysis and responding) are carried out based on the identified risk factors	(Al – Bahar and Crandall, 1990; Wang et al., 2004)	Systematic Risk Management Approach for Construction Projects, Risk Management Framework for Construction Projects in Developing Countries.	Paper covers identification of most probable risks at pre-construction stage, but not all probable risk variable responsible for cost overrun
12	Risk management practices will be beneficial for the	(Bajaj et al., 1997;	An Analysis of contractors	No focus on running

	companies only if the products of its initial stages (identification and assessment) are reliable and inclusive	Chapman, 1998).	approaches to risk identification in New South Wales, Australia	project risk variables
13	Risk identification and assessment phases are considered as most important phases of systematic risk management process	(Crandall & Al-Bahar, 1990)(Ward, 1999)**; (Bajaj et al., 1997);**(Russell A.D., 2003)**;**(Wang, 2004)**;**(Maytorena, 2007)**;**(Baston, 2009)**;**(Edwards, 2009)	Systematic Risk Management Approach for Construction Projects, Knowledge Based Risk Identification in Infrastructure Projects, Risk Management Framework for Construction Projects in Developing Countries, The influence of Experience and Information Search Styles on Project Risk Identification Performance. Transactions on	No Focus on Cost Over run

			Engineering Management, Project Risk Identification Methods for Construction Planning and Execution.	
14	The author suggested a structured risk management process for international construction projects. He classified individual risk factors according to their initial sources, namely external and internal risks, and assessed considering their likelihood and impact degrees.	**(H.Zhi, 1995)**	Risk Management of Overseas Construction Projects.	
15	The author has designed a risk model named “Construction Risk Management System” (CRMS) comprising of four main phases of risk management process. For the purpose of identification, they classified risks in accordance with their natures and potential outcomes. They also offered	(Crandall & Al-Bahar, 1990)	Systematic Risk Management Approach for Construction Projects.	

	utilization of influence diagrams and Monte Carlo simulation methods as approaches for analysis and evaluation phases			
16	The author supported the development of project and organization-specific risk management process. They proposed a project uncertainty management (PUMA) including a generic PRM process from the view point of project owner and consultant. Supporting the application of a systematic risk management process	(Cano & Cruz, 2002)	Integrated Methodology for Project Risk Management.	This paper focused on a generic project risk management process from the owner and consultant point of view only.
17	The author identified different project stakeholders' risk factors throughout the life cycle of the project using questionnaire survey. They claim that risk factors of construction projects are not one-time happening events and should be studied through whole phases	(Zou et. al., 2007)	Understanding the Key Risks in Construction Projects in China.	

18	He identified critical risk factors affecting construction projects in developing countries, classified them under three main levels, rankedthem, and proposed some response strategies to cope with these identified risks.	Wang et al. (2004)	Risk Management Framework for Construction Projects in Developing Countries.	
19	He has developed taxonomy of possible risk factors for infrastructure projects with the aim of facilitating risk identification at the planning phase. Batson introduced 15 risk headings which may cause 96 potential problems in terms of quality, quantity, schedule and cost.	Batson (2009)	Project Risk Identification Methods for Construction Planning and Execution.	
20	He has identified a list of most critical risk factors affecting cost performance of infrastructure projects in Germany, and developed a Neural-Risk Assessment System to quantify the money value of the identified risks impacts.	Sanchez (2005)	Neural Risk Assessment System for Construction Projects.	

21	He proposed for risk assessment of underground construction projects. Their presented assessment process starts with identification of most critical risk events based on collected risk-related data and information. A probabilistic fuzzy-based approach is recommended for evaluation and assessment of these identified events.	Choi et al. (2004)	Construction Project Risk Assessment using Existing Database and Project Risk Information.	
22	The work of have identified the most important risk factors leading to cost and time overruns in Indonesian construction industry through expert interviews. They propose the identified list of risk groups comprising of most important individual risks to be considered during risk management process in construction projects conducted in Indonesia.	(Kaming et. al., 1997)	Factors Influencing Construction Time and Cost Overruns on High Rise Projects in Indonesia.	
23	ICRAM-1 model (International Construction Risk Assessment Model), is another systematic approach toward the	(Hastak & Shaked, 2000)	ICRAM-I: Model For International Construction	

	assessment of potential risk factors in international projects. They categorized 73 tangible and intangible risk indicators under three interrelated levels, namely "macro environment", "construction market" and "project" levels.		Risk Assessment.	
24	He has proposed a hierarchical risk breakdown structure in order to classify diverse risks (categorized as external and internal) that may affect construction projects. Three attributes of each risk, called "risk factors", "risks" and "consequences" are assumed to be causally dependent, and is assessed using a structured fuzzy risk rating approach. In their research,	Tah and Carr (2000)	Knowledge Based Approach to Construction Risk Management.	
25	He utilized a fuzzy risk rating approach to qualitatively assess the risk of cost overrun in the bidding stage of international projects by taking into account of interrelations between various risk factors and impact	**Dikmen et al. (2007)**	Using fuzzy risk assessment to rate cost overrun risk in international construction	

	of project-related factors as well as contract conditions on the risk level of projects. In order for development of a fuzzy decision making framework.		projects.	
26	He has identified several global risk factors affecting cost performance of construction projects through detailed literature review. Assessment and management issues of such identified risks were examined for further modeling purposes. Claiming global risk factors to be the most critical ones in international projects, they classified potential risks under the headings of "organization-specific" (internal environment), "global", and "acts of God" (external environments).	(Baloi & Price, 2003)	Global Risk Factors affecting Construction Cost Performance.	
27	He has developed a knowledge-based approach for identification of possible risks associated with a new large infrastructure project by means of two types of knowledge	**Zoysa and Russell (2003)**	Knowledge based risk identification in infrastructure projects.	

	structures, namely a reusable document comprising of stored past experiences, and rule sets defined for reasoning and similarities used in determination of project attributes and characteristics of the environment. As an outcome, a project-specific updatable risk register is developed comprising of a list of probable risks under diverse categories. They have mentioned “process”, “physical”, “socio-economic” and “organizational” factors to be the most dominant risk areas in infrastructure projects			
28	He has formulated a risk identification model explaining the causality amongeach risk factor and its possible consequences. A knowledge-based risk identification system is then established employing some If-Then rules acquired from expert knowledge.	(Leung et. al., 1998)	A Knowledge Based System for Identifying Potential Project Risks.	

29	He has proposed an updating approach for identification of a limited number of most critical project-specific risks which are obtained referring to large amount of data available. These project-specific identified risks will be used as the inputs for their developed risk assessment methodology.	Choi and Mahadevan (2008)	Construction Project Risk Assessment using Existing Database and Project Risk Information.	
30	This workis another attempt in development of software tools facilitating the learning-based risk management of construction projects. In their formulated system, risks, classified in a hierarchical risk breakdown structure which comprises project and work package risks, and the corresponding actions are stored in a catalog which is customizable for every project and forms the risk database of the developed system. A risk management framework supporting all stages of risk management process in an updatable and flexible manner	(Tah & Carr, 2001)	Knowledge Based Approach to Construction Risk Management.	

	is developed and tested through a software prototype.			
31	He developed an ontology-based process-oriented risk management framework. It is claimed that reuse of risk-related knowledge and past experiences of the experts through this validated knowledge extraction model can enhance the performance of various risk management processes.	(Tserng et. al., 2009)	A Study of Ontology Based Risk Management Framework of Construction Projects Through Project Life Cycle. Automation in Construction	
32	The authors have discussed the importance of studying combination of diverse risks in the form of possible cause-effect scenarios, and have demonstrated the possible causalities and associations among different attributes of large project establishment risks. Identification of individual risks, without examining their origins, and the effects they may have on the subsequent risks cannot draw a realistic picture. At the same time, the project	Ashley and Bonner (1987), Tah and Carr (2000), Zou et al. (2007), Dikmen et al. (2007), Han et al. (2007), and Han et al. (2008),	Political risks in international construction Knowledge Based Approach to Construction Risk Management, Understanding the Key Risks in Construction Projects in China, Using fuzzy risk assessment to rate cost	Political issue in international construction

	outcomes are affected by the combination of various interdependent risk factors and making decisions based on the sole impacts of individually independent risks may lead to unrealistic rather biased conclusions. Therefore, risk identification systems and subsequent assessment models, should be based on interdependent risks		overrun risk in international construction projects, Approaches for making risk-based decision for international projects.	
33	The large scale projects, the efforts of identification and assessment of risks normally done at the pre-construction or pre-contract stages of the large scale projects, in which very limited data and information are available about the upcoming project condition. Therefore, it is highly uncertain to make predictions which may make the decision process quite subjective.	(Choi & Mahadevan, 2008)	Construction Project Risk Assessment using Existing Database and Project Risk Information.	This paper develops a risk assessment methodology for construction projects but not covering steel plant on upcoming risks.
	c) Risk Mitigation			
34	The study shows relationship between time overrun and	Oko John Ameh&Emek	Study of Relationship	

	labour productivity. The study concludes by recommending that early appointment of project managers could ensure proper management of both the human and material resources that could guarantee improved productivity and ultimately save projects from time overrun	a Emmanuel Osegbo (2011)	between Time Overrun and Productivity on construction sites	
35	Time overrun is the time during which some part of construction project is completed beyond the project completion date or not performed as planned due to unanticipated circumstances.	Bramble and Callahan (1987)	Construction delay.	
	e) Risk Variables of Overseas Projects			
36	1.Investigating the causes of project failures 2. Identifying the ten critical factors such as project scope, managerial goals, time planning and management, communication with owner etc.	Pinto and Mantel(1990)	The causes of Project failure - scope, planning and communication.	This paper focused on 97 failure projects by Project managers & parent organization but not on

				steel industry in India
37	1.Classifying risks in line with country environment, construction industry, characteristics of company and project conditions 2. Deriving total 60 risks with the structures of three levels	Zhi (1995)	Risk management for overseas construction projects	
38	1.Focusing on Political risks and deriving critical factors based on the survey results 2. Classifying risks into six groups such as regulation and law changes, corruption, delays of permit, force majeure, etc.	Wang et al. (2000)	Evaluation and management of risk in China's BOT Projects. This paper focused on political risk only	
39	Providing critical success factors on the performance of design build projects	Chan et al (2001)	Design and build project success factors :multivariate analysis	
40	Identifying international risk in more detail , by grouping them into design, competitiveness, customs and cultures , construction, economy	Baloi & Price (2003)	Modeling global risk factors affecting construction cot performances	

	conditions			
41	The article presents a decision support system dedicated for risk assessment in pipeline projects. It also analyses the impact of changing input attributes on the estimated overruns by conducting a sensitivity analysis.	Dr Ahmed S Edieb (2007)	DSS –PL : Decision support System for Risk Assessment of Pipeline Projects	This article focused on risk assessments in pipeline projects only.
42	The existing approaches to risk management have many shortcomings, namely failure to capture uncertainty effectively , they are prominently quantitative and neglect the qualitative side of risk; they build on statistical decision theory which is largely prescriptive and does not take experience and judgement into account; most decision making problems in construction incorporate judgement and experience	Daniel Baloi and Andrew D. F. Price (2001)	Evaluation of global risk factors affecting Cost performance in Mozambique	
43	There are some risk factors which have relatively strong and stable relationships to cost overrun.	MasateruTsu noda, AkitoMonde n,Kenichi	Analyzing Risk factors Affecting Project Cost	

		Matsumoto,	Overrun	
	g) Risk reporting			
44	Reports how risk related knowledge can be codified, stored and retrieved to facilitate learning from previous projects and constructing the risk map for a forthcoming project. Risk event histories of real construction projects will be presented and how risk scenarios as well as risk maps can be generated using this information will be demonstrated on a real case study.	A E Yildiz & I Dikmen, & M.T.Birgonul , KErcoskun S Alten	A Risk mapping tool for construction projects	
45	Successful and effective risk management requires a clear understanding of the risks faced by the project and business The RBS is a powerful aid to risk identification, assessment and reporting and the ability to roll up or drill down to the appropriate level provides new insights into overall risk	David Hillson (2003)	Using a Risk Breakdown Structure in Project management	

	exposures.			
46	Identification of key points in RATTs application so as to enhance their application to BOT projects.	Prasanta K Dey and Stephen O Ogunlana	Selection and applications of risk management tools and techniques for build –operate – transfer projects	
47	There are three types of risks: predictable risks that organizations know they face; the risks which an organization knows it might run but which are caused by chance and the risks which organizations do not know they are running	Barrie Dale, Mark Smith, Rolf Visser , Ton van der Wiele and Jos van Iwaarden	Quality and risk management: what are the key issues?	

Summary of above themes:

1. (Collins Concise Dictionary, 2006), Risk Management

Risk is "the possibility of bringing about misfortune or loss" which also bear the same meaning as "danger, hazard, pitfall, peril and **uncertainty**".Taking this definition into economic perspective, risk is future uncertainty which needs to be managed in order to avoid variety of consequences ranging from negative surprises to permanent loss (Triantis, 2000). It is important to emphasize risk assessment in managerial activities. Firms manage risks for various reasons.

2. (Triantis, 2000), Real Options and Corporate Risk Management

Risk is future uncertainty which needs to be managed in order to avoid variety of consequences ranging from negative surprises to permanent loss. For example, in current conditions where input suppliers hold their reserves to enjoy profits on surging market and higher prices, there is a need to enter into a contract with better terms thus agreed upon a specific price (Triantis, 2000); or face the risk of incurring higher input cost for production in the future. Firms should plan to maintain a steady cash flow so that the risk of falling short of earnings is avoidable (Triantis, 2000). Maintaining a ―proper flow of revenue is also part of tax strategy to avoid the risk of paying higher tax (Chapman, 2006). Reducing variability and volatility of cash flow lead to higher after tax profits. In undertaking new investments, proper risk management will reduce the incidents of decreasing value of investment decisions and reduce the probability of costly external financing on firm's value.

3. (Crandall & Al-Bahar, 1990) ; (PMBok, 2000); (Baston, 2009), and (Edwards, 2009), Systematic Risk Management Approach for Construction

Risk is the function of the probability and outcomes of an uncertain happening. Although the concept of "risk" is defined and approached differently by different points of views, within the context of construction projects, it is generally defined as the probability of occurrence of events that may positively or negatively affect the project's predefined objectives. Even if risk may have both adverse and favorable consequences according to this definition, risk-based approaches are mostly concentrated on its negative outcomes.

According to authors such as Al-Bahar and Crandall (1990), and Wang et al. (2004), the aim of the risk management is to optimize the level of the risk mitigation, risk elimination, and risk control through a whole-life practice.They have emphasized the importance of identification phase of risk management process, as subsequent phases (assessment, analysis and responding) are carried out based on the pre-identified risk factors. Unrealistic, inaccurate, and incomprehensive list of risks will lead to reactive responses to the occurred problems rather than proactive strategies for mitigation of their impacts and controlling their occurrence patterns. In other words, the accuracy of the risk identification phase will directly affect the rationale of applying PRM which is proactive dealing with probable risks and threats before they become surprising problems. Effectiveness and advantages of further stages of the risk management process depend on accuracy and reliability of the identified risks, since these phases are conducted based on the initially identified risk factors. Adequate risk identification at initial stages of a candidate project will lead to a more realistic simulation of the unknown future, better understanding of the project environment.

4. (H.Zhi, 1995); (Wang, 2004); (Han, 2008), and (Edwards, 2009). Risk Management of Overseas Construction Projects, Risk Management Framework for Construction Projects in Developing Countries, A web Base Integrated System for International Project Risk Management. Automation in Construction Identifying and Communicating Project Stakeholder's Risk.

Risk management process is generally defined as an iterative process that starts with identification of risk factors, followed by qualitative and/or quantitative assessment of risk impacts on the project, and finally, development of risk mitigation strategies to maintain an optimum risk-return structure between the project participants

Complexities derived from dynamic interactions between various global, country and project specific factors necessitate a systematic, comprehensive and proactive risk management process for international construction projects

PRM, as a systematic and formal process, which should be conducted throughout the life of the construction project and comprises of three phases, namely identifying, analyzing and responding to the project risks.

The aim of the risk management is to optimize the level of the risk mitigation, risk elimination, and risk control through a whole-life practice.

Wang et al. (2004) identified critical risk factors affecting construction projects in developing countries, classified them under three main levels, ranked them, and proposed some response strategies to cope with these identified risks.

5. PMI (PMBok, 2000), A Guide to Project Management Body of Knowledge. USA: Project Management Institute.

Project Risk Management (PRM) is the systematic process of identifying, analyzing, and responding to project risks. In spite of different definitions and processes adopted for risk management of construction projects, most of the introduced approaches cover these aforementioned three phases.

6. (Sanchez, 2005), Neural Risk Assessment System for Construction Projects.

Supporting the integration of PRM processes with companies' routines and with project environments, the author claims that the main objectives of risk management are oriented toward these three tasks.
According to Sanchez, the main issue of the PRM in construction industry is evaluation of risk impacts on various objectives and estimation of the costs of potential risks.

Sanchez has identified a list 11 of most critical risk factors affecting cost performance of infrastructure projects in Germany, and developed a Neural-Risk Assessment System to quantify the money value of the identified risks' impacts.

7. (Wang, 2004), Risk Management Framework for Construction Projects in Developing Countries

PRM, as a systematic and formal process, which should be conducted throughout the life of a large scale project, comprises of three phases, namely identifying, analyzing and responding to the project risks. Wang et al. identified critical risk factors affecting construction projects in developing countries, classified them under three main levels, ranked them, and proposed some response strategies to cope with these identified risks levels, ranked them, and proposed some response strategies to cope with these identified risks.

8. (H.Zhi, 1995)and(Berkley, 1991), Risk Management of Overseas Construction Projects. Project Risk Action Management. Construction Management and Economics

PRM process as a four-step systematic approach including risk classification, risk identification, risk assessment, and risk responses phases

Reviewing the formal PRM processes developed by researchers, it is found that proposed systems are typically common in the following major phases; 1) Risk Identification 2) Risk Assessment 3) Risk Response.

9. Han(2008),Web Base Integrated System for International Project Risk Management. Automation in Construction

The most effective approach toward the PRM of large scale projects is the process consisting of the following five steps: 1) Risk Identification, 2) Risk Analysis, 3) Risk Evaluation, 4) Risk Response, and 5) Risk Monitoring. (Edwards, 2009) modify such definitions through emphasizing on the importance of the risk-related knowledge after the accomplishment of each PRM cycle. He introduced six subsequent phases as the necessary steps for PRM, namely 1) Establishment of the Context, 2) Risk Identification, 3) Risk Analysis, 4) Risk Response, 5) Risk Monitoring and Controlling, and 6) Capturing Risk Knowledge. In this way the PRM started from three to ended as six step process.

Numerous other PRM approaches similar to, or differing in some details from, these mentioned approaches are also offered within the construction management literature

However, as Han et al. (2008) state, traditional risk management methods are not adequate for modelling and management of diverse risks and complex and dynamic interactions among them in international construction projects.

Han et al. (2008) developed an integrated risk management system for international construction projects comprising of a model for risk-based bidding decision, profitability estimations at preconstruction stage, and risk management of construction phase. In their scenario-based checklist, they proposed identification of risk-paths showing the cause-effect relations among diverse risks

10. (Eybpoosh 2010),Identification of Risk paths in International Construction Projects

The author has found that proposed systems are typically common in the following major phase's viz. risk identification, risk assessment and risk response.

International construction projects have more complex risk emergence patterns as they are affected from multiple global and foreign country conditions as well as project-related factors. Huge and complicated interrelationships and dynamic interactions among these influencing factors necessitate more systematic, comprehensive, and multi-attribute risk management process for overseas projects. In order to satisfy the requirements of such a risk management system, a realistic, inclusive, and accurate picture of the real case, reflecting all the aforementioned aspects of the international projects, is necessary.

11. (Al – Bahar and Crandall, 1990; Wang et al., 2004), Systematic Risk Management Approach for Construction Projects, Risk Management Framework for Construction Projects in Developing Countries.

For the purpose of feasibility assessment and strategic decision making, is important to identify the most probable risks at pre-construction stage of the candidate project. Also, exhaustive identification of potential risks that may significantly affect project and corporate objectives will lead to proactive management decisions rather than corrective responses to raised problems. On the other hand, subsequent phases of risk management process (assessment, analysis and responding) are carried out based on the identified risk factors.

They have emphasized the importance of identification phase of risk management process, as subsequent phases (assessment, analysis and responding) are carried out based on the pre-identified risk factors.

The aim of the risk management is to optimize the level of the risk mitigation, risk elimination, and risk control through a whole-life practice.

Generally, construction risks are dealt based on personal experiences, rules of thumbs and subjective judgments of the practitioners (Al-Bahar and Crandall, 1990)

Al-Bahar and Crandall (1990) define risk identification as "the process of systematically and continuously identifying, categorizing, and assessing the initial significance of risks associated with a construction projects". Risk identification is one of the initial steps of the most of the offered PRM systems through which potential risk factors that may have adverse impacts on project objectives, and their sources and possible consequences are recognized in a systematic manner.

12. Zoysa and Russell (2003)

He has developed a knowledge-based approach for identification of possible risks associated with a new large infrastructure project by means of two types of knowledge structures, namely a reusable document comprising of stored past experiences, and rule sets defined for reasoning and similarities used in determination of project attributes and characteristics of the environment. As an outcome, a project-specific updatable risk register is developed comprising of a list of probable risks under diverse categories. They have mentioned “process”, “physical”, “socio-economic” and “organizational” factors to be the most dominant risk areas in infrastructure projects.

13. Leung et. al., 1998

He has formulated a risk identification model explaining the causality among each risk factor and its possible consequences. A knowledge-based risk identification system is then established employing some If-Then rules acquired from expert knowledge.

The key activity with respect to risk is to manage it. argued that this starts with a risk assessment where the organization attempts to estimate the probable consequences of threats and opportunities (risk identification, measurement and prioritization), followed by Risk Management, where decisions need to be made about how to manage the perceived consequences of that risk. Business risk assessment is the first stage which is designed to give a top-down, business-risk orientation

14. Choi and Mahadevan (2008)

He has proposed an updating approach for identification of a limited number of most critical project-specific risks which are obtained referring to large amount of data available. These project-specific identified risks will be used as the inputs for their developed risk assessment methodology.

Risk management has become an increasingly challenging activity. According to a global study, this study emphasizes the need for the function of risk to be more than simply compliance with a bureaucratic exercise. This situation is also apparent in the construction industry. The launch of a new project is considered a bet on a future often regarded as uncertain. The conception of a new venture project is considered the riskiest step because at this step, the ideal aspects of the project are defined, including its architectural and construction features, its target audience, and the marketing strategies used to reach this target audience. At this step, all necessary planning for the proposed aims is carried out and achieved. The decisions made at this stage have a significant impact on the achievement of the project goals.

15. Tah & Carr, 2001

This work is another attempt in development of software tools facilitating the learning-based risk management of construction projects. In their formulated system, risks, classified in a hierarchical risk breakdown structure which comprises project and work package risks, and the corresponding actions are stored in a catalog which is customizable for every project and forms the risk database of the developed system. A risk management framework supporting all stages of risk management process in an updatable and flexible manner is developed and tested through a software prototype.

The construction industry is greatly plagued by risk; too often, this risk is not dealt with adequately, resulting in poor project performance. Communication of construction project risks in practice is poor, incomplete and inconsistent, both throughout the supply chain and through the project lifecycle. Part of the problem is the lack of a formalized approach to the project risk management process. Recently, attempts have been made to overcome this and this paper uses these attempts as a foundation for building a better approach to construction risk management. Underlying this approach is the development of a common language for describing risks and remedial actions. This is grounded in a taxonomy of risk based on a hierarchical risk breakdown structure. In addition, to facilitate the production of a working risk management system, a number of models have been developed using unified modelling language.

16. Tserng et. al., 2009

He developed an ontology-based process-oriented risk management framework. It is claimed that reuse of risk-related knowledge and past experiences of the experts through this validated knowledge extraction model can enhance the performance of various risk management processes.

Some of these factors are inherent to organizations that are solely responsible for managing them, whereas others are closely related to the political, cultural, economic, and operational environments of the project's location. In practice, project participants tend to be indifferent to risks outside of their control or believe that measures such as forms of contracts and insurance adequately allocate risks between the various parties. Furthermore, many owners and contractors are unaware of the full range of these risks, and few have demonstrated the expertise and knowledge to manage them effectively.

17. Ashley and Bonner (1987), Tah and Carr (2000), Zou et al. (2007), Dikmen et al. (2007), Han et al. (2007), and Han et al. (2008)

The authors have discussed the importance of studying combination of diverse risks in the form of possible cause-effect scenarios, and have demonstrated the possible causalities and associations among different attributes of large project establishment risks. Identification of individual risks, without examining their origins, and the effects they may have on the subsequent risks cannot draw a realistic picture. At the same time, the project outcomes are affected by the combination of various interdependent risk factors and making decisions based on the sole impacts of individually independent risks may lead to unrealistic rather biased conclusions. Therefore, risk identification systems and subsequent assessment models, should be based on interdependent risks. Simplistic risk analysis techniques: None of the risk analysis techniques alone is fully capable of quantification of risk impacts on project success. For example, the most widely used risk rating technique based on multiplication of probability with impact is an over-simplistic approach as it is based on the assumption that "risk factors are independent". There are usually correlations between risks as they may be affected from similar underlying sources such as political risk and economic risk affected from the general forces in the macro economic environment. Thus, a hierarchical structure is necessary to ensure evaluation of risks at each level; where how a risk factor in the upper level affects another one in the lower level becomes a critical issue which can not easily be solved with the classical rating technique. Moreover, in the assignment of ratings (usually using Likert scale), there may be significant differences between the values attached by different decision-makers due to a usually forgotten subject, which is "controllability". Some people may consider that the probability of occurrence of risk factors is low if they are controllable, by assuming that necessary precautions will be taken to eliminate them, while others may consider probability of occurrence regardless of response.

18. Choi & Mahadevan, 2008

The large scale projects, the efforts of identification and assessment of risks normally done at the pre-construction or pre-contract stages of the large scale projects, in which very limited data and information are available about the upcoming project condition. Therefore, it is highly uncertain to make predictions which may make the decision process quite subjective.

19. Oko John Ameh&Emeka Emmanuel Osegbue (2011)

The study shows relationship between time overrun and labour productivity. The study concludes by recommending that early appointment of project managers could ensure proper management of both the human and material resources that could guarantee improved productivity and ultimately save projects from time overrun.

In most construction sites, best possible performance is unachievable with poor productivity resulting in time overrun and consequently cost escalation of the projects.

The contractor on the other hand bears the risk associated with time overrun on matters related to low labour productivity, inadequate scheduling or mismanagement, construction mistakes, weather, equipment breakdowns, staffing problems, etc. There are however, time overrun caused by events beyond the control of either the owner or the contractor. Such delays may rise as a result of force majeure, exceptionally inclement weather, civil commotion, industrial unrest, just to mention but a few.

Time overrun results in the growth of adversarial relationships, litigation, arbitration, cash flow problems and a general feeling of apprehension between project participants.

Risk management is nothing new. But the global financial crisis and corporate failures in recent years have put risk management in the spotlight. Who is ultimately responsible for it? Responsibility for risk management should start in the boardroom, as the board is ultimately responsible for the organization's decision making, business performance, and value creation, all of which are associated with risk. The chief executive officer, who is accountable to the board, has the responsibility to ensure proper execution of the risk-management strategy and policies laid down by the board. The board governs while management manages. The board's risk management role should therefore be the governance of risk overseeing, directing, and setting policies and monitoring performance.

20. Bramble and Callahan (1987)

Time overrun is the time during which some part of construction project is completed beyond the project completion date or not performed as planned due to unanticipated circumstances.

(1) Problem of shortages or inadequacies in industry infrastructure, mainly supply of resources.

(2) Problems caused by clients and consultants.

(3) Problems caused by incompetence of contractors.

21. Pinto and Mantel (1990)

1. Investigating the causes of project failures.

2. Identifying the ten critical factors such as project scope, managerial goals, time planning and management, communication with owner etc.

3 An effective and efficient risk management approach requires a proper and systematic methodology and, more importantly, knowledge and experience

4 Today, risk management is an integral part of project management where one of the most difficult activities is determining what are the project's risks and how should they be prioritized. This is a key process and most of project managers know that risk management is essential for good project management

22. Zhi (1995)

1. Classifying risks in line with country environment, construction industry, characteristics of company and project conditions

2. Deriving total 60 risks with the structures of three levels

3 Contracting overseas construction projects is usually considered a 'high risk business', mostly because of a lack of adequate overseas environmental information and overseas construction experience. Similar construction projects may have totally different risk characteristics in different region Risk.

4 A useful risk assessment technique is introduced which combines risk probability analysis with risk impact assessment. Vital risk response techniques for overseas projects.

23. Wang et al. (2000)

1. Focusing on Political risks and deriving critical factors based on the survey results

2. Classifying risks into six groups such as regulation and law changes, corruption, delays of permit, force majeure, etc.

3. Identifying risk allocation preferences is important for any project's risk management process, and should be performed as early as possible

4. To make an effective and efficient risk management it is necessary to have a proper and systematic methodology and, more importantly, knowledge and experience of various types. For example, it requires knowledge of the unforeseen events that may occur during the execution of a project.

24. Chan et al (2001)

Providing critical success factors on the performance of design build projects.. Risk identification, analysis, and allocation are critical in projects, where the liability of the private investor in design and construction is limited and the public sector primarily faces the financial and operational risks.project risks, may relate to uncertainties in construction, completion, operation and financing; political risks, which relate to wars, civil disturbances, and breach of contract; regulatory risks, which arise from a lack of suitably developed regulatory system

; and systemic risks, which arise owing to fluctuations in exchange rates and changes in interest rates.

25. Baloi& Price (2003)

Identifying international risk in more detail , by grouping them into design, competitiveness, customs and cultures , construction, economy conditions .Outcomes of this research will allow a client or contractor first, to develop or improve its project risk management capability based on international and local best practices and second, to continuously improve the performance of this function along the realization of new projects.The novelty of this approach is that it addresses the risk management function from a knowledge-based perspective and that it will be based in a web application that will be available to every organization.

26. Dr Ahmed S Edieb (2007)

The article presents a decision support system dedicated for risk assessment in pipeline projects. It also analyses the impact of changing input attributes on the estimated overruns by conducting a sensitivity analysis.Determined when and how the possible qualitative and quantitative risk management, what the methods of management and gauges risk modeling capabilities perspective of risk situations are.Adequate description of efficient procedures for integrated risk management systems in the rapidly developing sector that would make a pronounced impact to the overall economy growth rate.

27. Daniel Baloi and Andrew D. F. Price (2001)

The existing approaches to risk management have many shortcomings, namely failure to capture uncertainty effectively , they are prominently quantitative and neglect the qualitative side of risk; they build on statistical decision theory which is largely prescriptive and does not take experience and judgment into account; most decision making problems in construction incorporate judgment and experience. Poor cost performance of construction projects has been a major concern for both contractors and clients. The effective management of risk is thus critical to the success of any construction project and the importance of risk management has grown as projects have become more complex and competition has increased. Contractors have traditionally used financial mark-ups to cover the risk associated with construction projects but as competition increases and margins have become tighter they can no longer rely on this strategy and must improve their ability to manage risk.

28. MasateruTsunoda, AkitoMonden,Kenichi Matsumoto

There are some risk factors which have relatively strong and stable relationships to cost overrun. Discriminant methods such as linear discriminant analysis and logistic regression have been used to predict cost overrun projects. However, accuracy of discriminant methods often becomes low when a dataset used for predict is imbalanced, i.e. there exists a large difference between the number of cost overrun projects and non cost overrun projects.

29. A E Yildiz& I Dikmen, &M.T.Birgonul, K. Ercoskun S. Alten

Reports how risk related knowledge can be codified, stored and retrieved to facilitate learning from previous projects and constructing the risk map for a forthcoming project. Risk event histories of real construction projects will be presented and how risk scenarios as well as risk maps can be generated using this information will be demonstrated on a real case study.When the literature on RM in construction is investigated, four categories can be identified according to the scope of work which is;

(1) Development of conceptual frameworks and process models.

(2) Investigation of risks, risk management trends Constraints (resources etc.) Objectives (short/ long term) given/ selected conditions (contract clauses etc) Strategies/choices (risk allocation scheme etc.) Initial risk sources Final risk

sources Risk responses Secondary risks Residual risks Consequence variables Project performance scenarios A critical review of risk management support tools 1153 and perceptions.

(3) Application of risk identification and analysis techniques and (4) development of integrated risk management support tools.

30. David Hillson (2003)

Successful and effective risk management requires a clear understanding of the risks faced by the project and business The RBS is a powerful aid to risk identification, assessment and reporting and the ability to roll up or drill down to the appropriate level provides new insights into overall risk exposures.

Projects are complex undertakings involving a unique set of tasks and activities con-ducted within a set of constraints to meet defined objectives. Risk in projects is also complex, arising from a wide range of sources and having a broad scope of possible effects on the project. Given these two dimensions of project complexity, the manage-ment of the relationship between project work and project risk is a key success factor for every project. This paper develops a method for understanding and managing risk on a project, using a combination of the Work Breakdown Structure (WBS) and Risk Break- down Structure (RBS), resulting in the Risk Breakdown Matrix (RBM). An example is used to demonstrate how to measure risk concentration within the RBM using a " risk score " based on the scale or size of individual risks. It is also possible to combine different lev-els of the WBS and RBS into a pyramidal structure where each of the layers is an RBM

31. Prasanta K Dey and Stephen O Ogunlana

Identification of key points in RATTs application, so as to enhance their application to BOT projects. Risk and uncertainty are inherent in all construction work no matter what the size of the project. Although size can be one of the major causes of risk, other factors carrying risk with them include complexity, speed of construction, location of the project, technology being used and familiarity with the work. The involvement of multi-entity necessitates risk analysis in a systematic and understandable manner. Risk analysis implemented in an unclear and unsystematic.

32. Barrie Dale, Mark Smith, Rolf Visser , Ton van der Wiele and Jos van Iwaarden

There are three types of risks: predictable risks that organizations know they face; the risks which an organization knows it might run but which are caused by chance and the risks which organizations do not know they are running.

It is pointed out that in the past the challenge for quality management professionals was to support process and design improvements, but the challenge of the future is to improve relationships in order to reduce and manage the most important risks.he examination is built on more than 20 years' experience in the area of quality management and extensive involvement in recent developments around risk management (e.g. the Australian/New Zealand standard for risk management – AS/NZ4360, the development of a risk management model by the European Foundation for Quality Management, and the launch of risk-based instruments by a number of private companies).

The following Projects have also been studied in order to understand various risks associated with various types of projects worldwide:

Table - 2.2:

Year	Author(s)	Country	Type of Project	Cost Overrun Factors Considered
1988	Okpala and Aniekwu	Nigeria	Construction Projects	Price fluctuations, additional works, delays, inaccurate estimates,

				fraudulent practices and kickbacks, shortening of contract period and insurance
1997	Kaming et al.,	Indonesia	High Rise Construction Project	Tender price increase due to inflation, change orders, financial constraints, owner's lack of experience, Non availability of materials like Stone aggregates, Sand, cement, reinforcement and labour, contractor and combination, unpredictable weather conditions, cost increased by inflation, inaccurate quantity take-off, labour cost increased due to environmental restrictions, lack of experience of project location, lack of experience of project type and lack of experience of local regulation
2002	Jackson	UK	Building Construction	Poor project management, unexpected ground

			Projects	condition, design development, information availability, design brief, estimating method, design team performance, time limit, claims, commercial pressure, procurement route, external factor and people
2003	Frimpong et al.,	Ghana	Groundwater	Planning and scheduling deficiencies, deficiencies the prepared cost estimates, inadequate control procedures, delays in work approval, waiting for information, mistakes during construction, delays in inspection and testing of work and cash flow during construction, frequent breakdowns of construction plant and equipment, shortages of technical personnel, labour shortage, monthly payment difficulties, poor contract management, shortage of materials, plant/equipment parts,

				contractor's financial difficulties, low bid, material procurement, imported materials, late delivery of materials and equipment, escalation of material prices, slow decision-making, inflation, difficulties in obtaining construction materials at official current price, ground problem, bad weather and unexpected geological conditions
2005	Creedy	Australia	Highway Project	Design/project scope change, contract tender price higher than original estimate, design scope change – drainage, quantity increased measure, design scope change - pavement materials/depth, latent condition - remove and replace unsuitable material, design scope change - environmental issues, constructability -

				under traffic, services relocation costs, material cost increase – pavement materials, constructability difficulty costs, resumption/accommodation works, project administration cost increase, wet weather effects/rework, latent condition - rock encountered, remote location costs, specification change, extras unspecified, project acceleration requirement, design scope change - safety audit requirement, cultural heritage issues, latent condition - requires design change, material cost increase - principal supplied components or materials, government initiative – contribution by developer, latent condition - additional stabilizing, material cost increase – earthworks, design scope change -

				design error, material/process quality issue, design – reduced scope change saving money, design preload requirement, design change to sub-grade, government initiative - employment continuity, government initiative - contribution by local
2005	Koushki et al.,	Kuwait	Private Residential Projects	Government, government initiative - contribution by rail, material cost increase – asphalt, material cost increase - bitumen price, contract failure - new contract establishment costs and contract
2006	Omoregie and Radford	Nigeria	Infrastructure Projects	Price fluctuation, financing and payment for completed work, poor contract management, delay, change in site condition, inaccurate estimate, shortage of materials, imported materials and plant items, additional works and

				design change
2008	Azhar et al.,	Pakistan	Construction Projects	Fluctuation in prices of raw materials, unstable cost of manufactured materials, fraudulent practices and corruption, mode of financing and payment for completed work, improper planning, high interest rates charged by bankers on loans received by contractors, frequent design changes, long period between design and time of bidding/tendering, lack of coordination between design team and general contractor, lack of coordination between general contractor and subcontractors, high machineries costs, high cost of skilled labour, high transport costs, domination of construction industry by foreign firms and aids, contract management,

				inadequate duration of contract period, inappropriate government policies, inadequate production of raw materials in the country, poor financial control on site, absence of construction cost data, inappropriate contractual procedure, additional works, wrong method of cost estimation, poor relationship between management and labour, stealing and waste on site, labour/skill availability, dispute on site, adverse effect of weather, bureaucracy in bidding/tendering method, lowest bidding procurement method, litigation, numerous construction activities going on at the same time, scope changes arising from redesign and extensive variation occasioned by change in

				brief, inadequate site investigation, inadequate preconstruction study, work suspensions owing to conflicts. Finally, inadequate quality/Ambiguity of contract documents, inappropriate contractual policies and poor project (site) management/poor cost control
2009	Kaliba et al.,	Zambia	Road Construction Projects	Bad weather, inflation, schedule delay, scope changes, local government pressures, strikes, technical challenges and environmental protection and mitigation
2009	Enshassi et al.,	Gaza Strip	Construction Projects	Increment of materials prices due to boarder closures, delay in construction, supply of raw materials and equipment, fluctuation in the cost of building materials, project materials monopoly by

				some suppliers, unsettlement of local currency in relation to dollar value, design changes, contractual claims (such as, extension of time with cost claims), inaccurate quantity take-off; lack of cost planning/monitoring during pre- and post-contract stages and resources constraints - funds and associated auxiliaries not ready.
2012	Kasimu, M.A	Nigeria	Construction Projects	Incomplete Design at the time of tender, Additional work at owner's request, changes in owner brief, lack of cost planning/monitoring during pre-and-post contract stage, site/poor soil conditions, adjustment of prime cost and provisional sums, re measurement of provisional works, logistics due to site

				location, lack of cost reports during construction stage, delays in issuing information to the contractor during construction delays, technical omissions at design stage, contractual claims, such as, extension of time with cost claims, improvements to standard drawings during construction stage, wrong decision by the supervising team in dealing with the contractor's queries in delays, delays in costing variations and additional works, omissions and errors in the bills of quantities, ignoring items with abnormal rates during tender evaluation, especially items with provisional quantities, some tendering maneuvers by contractors, such as front-loading of

				rates.
2007	Alagbhari et al.,	Malaysia	Construction Projects	Financing and payment for completed works, schedule delay, inaccurate estimate, long period between design and time of bidding/tendering, lack of coordination between design team and general contractor.
2008	Sweis et al.,	Jordon	Infrastructure Projects	Financing and payment for completed works, frequent breakdowns of construction plant and equipment, shortages of technical personnel, labour shortage, monthly payment difficulties, poor contract management.
2010	Fugar and Agykwah-Baah	Ghana	Construction Projects	Owner's lack of experience, materials, weather, labour, contractor and combination, logistics due to site location, lack of cost reports during construction stage.

1996	Ogunlana et al.,	Thailand	Building Construction Projects	Shortage of materials, poor contract management, information availability, design brief, estimating method, design team performance.
1994	Mansfield et al.,	Nigeria	Infrastructure Projects	Changes in site condition, delays in issuing information to the contractor during construction delays, technical omissions at design stage, contractual claims.
2000	Al-Momani	Nigeria	Infrastructure Projects	Variations and changes in the site conditions, delays in costing variations and additional works, omissions and errors in the bills of quantities, ignoring items with abnormal rates during tender evaluation.
2002	Xiao and Proverbs	Japan, US, UK	Construction Projects	Weather conditions, design changes, changes in site conditions, shortage of materials.

1984	Chalabi and Camp	India	Construction Projects	Act or failure to act by the owner, breaches in owner's obligations stated in contract, failure of owner or its representative to furnish the contractor with relevant information.
1988	Rowlinson	Hong Kong	Construction Projects	Project owners delay in issuing approvals, signing contracts and allowing site access.
2008	Long Le-Hoai et al.,	Vietnam	Construction Projects	Poor site management and supervision, Poor project management, assistance, Financial difficulties of owner, Financial difficulties of contractor, Design changes
2007	Sambasi-Van	Malaysia	Infrastructure Projects	Improper planning, Site management, Inadequate contractor experience, Finance and payments of completed work, Subcontractors
2006	Acharya et al.,	South Korea	Construction Projects	Public interruptions, Changed site conditions, Failure to provide site, Unrealistic time

				estimation, Design errors
2006	Lo et al.,	Hong Kong	Construction Projects	Inadequate resources due to contractor/lack of capital, Unforeseen ground, conditions, Exceptionally low bids, Inexperienced contractor, Works in conflict with existing utilities
2006	Faridi	U.A.E	Infrastructure Projects	Preparation and approval of drawings, Inadequate early planning of the project, Slowness of the owner's decision-making process Shortage of manpower, Poor supervision and poor site management
2006	Aibinu	Nigeria	Infrastructure Projects	Contractors' financial difficulties, Clients' cash flow problem Architects' incomplete drawing, Subcontractor's slow mobilization, Equipment breakdown and maintenance problem
2007	Joshua and	Nigeria	Construction	changes in work, delayed payment on contract,

	Jagboro		Project	financial failure of owner, labour disputes, labour, equipment and material availability, productivity of labour, defective materials, productivity of equipment, safety.
2007	Laryea and Dontwi	Kuwait	Construction Projects	poor quality of work, unforeseen site conditions, financial failure of contractor, political uncertainty, changes in government regulation, permits and ordinances, delays in resolving litigation/arbitration disputes , inflation, cost of legal process and force majeure
1985	Perry and Hayes	Nigeria	Building Construction Projects	Physical risk, environmental risk, logistics risk, financial risk, legal risk and political risk.
1998	Hegazy and Ayed	Kuwait	Highway Projects	season, location, type of project, contract duration, and contract size had a

				significant impact on individual contract costs
1986	Herbsman	Washington, D.C.	Highway Projects	In addition to input costs of materials, labor, equipment, and the total volume of contracts bid each year the so-called bid volume all influence project costs
1998	Minato and Ashley	Jordan	Highway Projects	External risk due to modifications in the scope of a project and changes in the legal, economic, and technologic environments; technical complexity of the project; inadequate project management due to the control of internal resources, poor labor relations, and low productivity; and unrealistic estimates because of The uncertainties involved
1998	Akinciand Fischer	Nigeria	Highway Projects	Considered design and project-specific factors to be the key factors

				affecting the cost estimate of a project, including vagueness in scope, design complexity, and project size.
1992	Barrie and Paulson	UK	Highway Projects	Engineering designs have a high level of influence on project costs and sometimes a non-satisfactory design performance can lead to cost overrun
1994	Anderson and Tucker	Jordan	Highway Projects	Reported that their survey found about one-third of architectural/ Engineering projects miss cost and schedule targets
2002	Chang	Japan	Construction Projects	There have been few instances where an engineering design is so complete that a project could be built to the exact specifications contained in the original design documents
1998	Bramble and	UK	Highway Projects	Many construction problems are due to

	Cipollini			design defects and can be traced back to the design process
1998	Keil et al.,	USA	Building Construction Projects	Lack of top management commitment to project, failure to gain user commitment, misunderstanding the requirements, lack of adequate user involvement and failure to manage end user expectations.
2010	Montek S Ahluwalia	India	BOT Construction Projects	Technical, quality or performance risk such as employment of inexperienced designers, changes in the technology used, or in the industry standards during the project. Organizational risks such as cost, time and scope objectives that are internally inconsistent, lack of prioritization of projects, inadequacy or interruption in funding,

				and resource conflicts with other projects in the organization. External risks such as shifting legal or regulatory environment (including institutional changes), poor geological conditions, and weather-related force majeure risks such as earthquakes and floods. Project management risks such as poor allocation of time and resources, inadequate quality of the project plan, and poor use of project management disciplines.
2000	Nevitt and Fabozzi	UK	Construction Projects	Country risk, political risk, sovereign risk, foreign exchange risk, inflation risk, interest rate.

The theory of constraints (TOC) is an overall management philosophy introduced by Eliyahu M. Goldratt in his 1984 book titled The Goal, that is geared to help organizations continually achieve their goals. Goldratt adapted the concept to project management with his book Critical Chain, published 1997.

An earlier propagator of the concept was Wolfgang Mewes in Germany with publications on power-oriented management theory (MachtorientierteFührungstheorie, 1963) and following with his Energo-Kybernetic System (EKS, 1971), later renamed EngpasskonzentrierteStrategie as a more advanced theory of bottlenecks. The publications of Wolfgang Mewes are marketed through the FAZ Verlag, publishing house of the German newspaper Frankfurter AllgemeineZeitung. However, the paradigm Theory of constraints was first used by Goldratt.

The underlying premise of the theory of constraints is that organizations can be measured and controlled by variations on three measures: throughput, operational expense, and inventory. Inventory is all the money that the system has invested in purchasing things which it intends to sell. Operational expense is all the money the system spends in order to turn inventory into throughput. Throughput is the rate at which the system generates money through sales.

Before the goal itself can be reached, necessary conditions must first be met. These typically include safety, quality, legal obligations, etc. For most businesses, the goal itself is to make money. However, for many organizations and non-profit businesses, making money is a necessary condition for pursuing the goal. Whether it is the goal or a necessary condition, understanding how to make sound financial decisions based on throughput, inventory, and operating expense is a critical requirement.

Theory of constraints is based on the premise that the rate of goal achievement by a goal-oriented system (i.e., the system's throughput) is limited by at least one constraint.

The argument by Reductio ad Absurdum is as follows: If there was nothing preventing a system from achieving higher throughput (i.e., more goal units in a unit of time), its throughput would be infinite — which is impossible in a real-life system.Only by increasing flow through the constraint can overall throughput be increased.

Graham K. Rand published a paper (Critical Chain: Theory of constraints applied to project management) in International Journal of Project Management which explores the relationship between the ideas developed in the critical chain and the CPM/PERT approach. In critical chain, other aspects of project management are dealt with, such as the issue of subcontracting work on price and not on lead time or reliability. In contrast to PERT/CPM, which may be characterized as dealing solely with certain technical aspects of project management, the application of the Theory of Constraints focuses very much on how senior management deal with human behavior, both in terms of constructing the project network, and in managing it afterwards. As far as the technical aspects are concerned, the key messages are to avoid milestones, to focus on the critical areas, by identifying the critical chain, and to insert buffers at the appropriate points in the project network. Milestones have become so ingrained in project management culture, that it is startling to discover someone recommending that they should be avoided because they can lead to delays in project completion. For many this will be counter-intuitive. Whether the point is accepted will depend on your understanding of the psychology of your workforce, as argued earlier in the section on why a new approach is needed.

Khalid Almarri and Paul Gardiner presented a paper (Application of resource-based view to project management research: supporters and opponents) in 27th IPMA World Congress.The Resource-based View (RBV) of the firm is a strategic management theory that is widely used by managers in project management. The RBV has to date been a promising theory that examines how resources can drive competitive advantage, especially project management (PM) capabilities that have been customized to a specific organizational environment and developed over time. However, Despite the advantages offered by the RBV to practitioners and scholars alike, the theory has been under attack by opponents claiming that there is an over enthusiasm for what the theory can deliver, especially concerning a lack of criteria for generalizability and definitional ailments. This position paper will give an overview of the supporters and opponents of the application of the RBV in PM practice and research. The main areas of criticism on theory: definitional flaws, generalizability, and construct validity were analyzed to show the significance of the criticism, and to build solid grounds for the refutation of the allegations of their dysfunction. The criticism reveals areas for theoretical consideration as it challenges theorists to revise their methodologies and improve their work. Therefore, this paper ends with “future research” suggestions highlighting all three areas of criticism. To reduce such criticism, in-depth longitudinal studies on refining the definitions used to measure intangible resources in PM are recommended for future researchers.

Svetlana Cicmil and Damian Hodgson, published a paper “New Possibilities For Project Management Theory: A Critical Engagement”, where this paper provides avenues for a broader engagement with the conceptual considerations of projects and project management with the aim of creating new possibilities for thinking about, researching, and developing our understanding of the field as practiced. Attention is drawn to the legacy of conventional but deeply rooted mainstream approaches to studying projects and project management, and implications of the specific underpinning intellectual tradition for recommendations proposed to organizational members as best practice project management. The identified concerns and limitations are discussed in the context of project management evolution where taken-for-granted advantages of project management as a disciplined effective methodology and its popularity are reexamined. The paper sheds light on a variety of voices from both scholarly and practitioner communities that have attempted to respond to this paradox and move the field forward. Taking issue with conventional labels of project success or failure, and drawing attention to alternative theoretical and methodological propositions, the argument turns toward critical management studies, outlining the implications of this intellectual tradition for studies of projects, project management, project performance, and individual skills and competencies to cope with social arrangements labeled "projects."

JA Willett, submitted an engineering report to Washington State University. This paper discusses the application of Visual Project Management (VPM) as a method to track and manage projects. Visual Project Management is a simple, as opposed to simplistic, way to manage individual and multiple projects by incorporating the proven practices of Critical Chain Project Management without the negative aspects of CCPM. VPM offers managers a tool to get all their projects moving and keep them moving efficiently towards completion. The VPM philosophy drastically minimizes bad multitasking. Through frequent reporting, VPM provides an indicator to identify when inefficiencies, including multitasking, appear in the projects. It allows for frequent status reporting without the subjectivity of other management methods. VPM has a bright future in the project management methodologies and should be considered as an effective and efficient way to manage small to mid-sized projects.

In PMI (PMBok, 2000) it is given Project Risk Management (PRM) is the systematic process of identifying, analyzing, and responding to project risks. According to (Sanchez, 2005) supporting the integration of PRM processes with companies' routines and with project environments; the author claims that the main objectives of risk management are oriented toward these three tasks.

As per (Wang, 2004) PRM as a systematic and formal process which should be conducted throughout the life of a large scale project which comprises of three phases, namely identifying, analyzing and responding to the project risks. In (H.Zhi, 1995) and (Berkley, 1991) PRM process as a four-step systematic approach including risk classification, risk identification, risk assessment, and risk responses phases. In (Han, 2008), The most effective approach toward the PRM of large scale projects is the process consisting of the following five steps: 1) Risk Identification, 2) Risk Analysis, 3) Risk Evaluation, 4) Risk Response, and 5) Risk Monitoring. (Edwards, 2009) modify such definitions through emphasizing on the importance of the risk-related knowledge after the accomplishment of each

PRM cycle. He introduced six subsequent phases as the necessary steps for PRM, namely 1) Establishment of the Context, 2) Risk Identification, 3) Risk Analysis, 4) Risk Response, 5) Risk Monitoring and Controlling, and 6) Capturing Risk Knowledge. In this way the PRM started from three to ended as six step process.

As per (Eybpoosh 2010) The author has found that proposed systems are typically common in the following major phases viz. risk identification, risk assessment and risk response. (Al – Bahar and Crandall, 1990; Wang et al., 2004) For the purpose of feasibility assessment and strategic decision making, is important to identify the most probable risks at pre-construction stage of the candidate project. Also, exhaustive identification of potential risks that may significantly affect project and corporate objectives will lead to proactive management decisions rather than corrective responses to raised problems. On the other hand, subsequent phases of risk management process (assessment, analysis and responding) are carried out based on the identified risk factors. In (Bajaj et al., 1997; Chapman, 1998) Risk management practices will be beneficial for the companies only if the products of its initial stages (identification and assessment) are reliable and inclusive. As per (Crandall & Al-Bahar, 1990) (Ward, 1999); (Bajaj et al., 1997); (Russell A.D., 2003); (Wang, 2004); (Maytorena, 2007); (Baston, 2009); (Edwards, 2009) Risk identification and assessment phases are considered as most important phases of systematic risk management process.

In (H.Zhi, 1995) The author suggested a structured risk management process for international construction projects. He classified individual risk factors according to their initial sources, namely external and internal risks, and assessed considering their likelihood and impact degrees. In (Crandall & Al-Bahar, 1990) the author has designed a risk model named "Construction Risk Management System" (CRMS) comprising of four main phases of risk management process. For the purpose of identification, they classified risks in accordance with their natures and potential outcomes. They also offered utilization of influence diagrams and Monte Carlo simulation methods as approaches for analysis and evaluation phases.

According to the (Cano & Cruz, 2002)The author supported the development of project and organization-specific risk management process. They proposed a “project uncertainty management” (PUMA) including a generic PRM process from the view point of project owner and consultant. Supporting the application of a systematic risk management process. In (Zou et. al., 2007) the author identified different project stakeholders’ risk factors throughout the life cycle of the project using questionnaire survey. They claim that risk factors of construction projects are not one-time happening events and should be studied through whole phases. As per Wang et al. (2004) He identified critical risk factors affecting construction projects in developing countries, classified them under three main levels, ranked them, and proposed some response strategies to cope with these identified risks.

(Eypoosh, 2010) He has developed taxonomy of possible risk factors for infrastructure projects with the aim of facilitating risk identification at the planning phase. Batson introduced 15 risk headings which may cause 96 potential problems in terms of quality, quantity, schedule and cost. Sanchez (2005) He has identified a list of most critical risk factors affecting cost performance of infrastructure projects in Germany, and developed a Neural-Risk Assessment System to quantify the money value of the identified risks’ impacts. (Ozcan, 2008)He proposed for risk assessment of underground construction projects. Their presented assessment process starts with identification of most critical risk events based on collected risk-related data and information. A probabilistic fuzzy-based approach is recommended for evaluation and assessment of these identified events. (Kaming et. al., 1997) . The work of have identified the most important risk factors leading to cost and time overruns in Indonesian construction industry through expert interviews. They propose the identified list of risk groups comprising of most important individual risks to be considered during risk management process in construction projects conducted in Indonesia. (Hastak & Shaked, 2000) ICRAM-1 model (International Construction Risk Assessment Model), is another systematic approach toward the assessment of potential risk factors in international projects. They categorized 73 tangible and intangible risk indicators under three interrelated levels, namely “macro environment”, “construction market” and “project” levels.

Tah and Carr (2000) He has proposed a hierarchical risk breakdown structure in order to classify diverse risks (categorized as external and internal) that may affect construction projects. Three attributes of each risk, called “risk factors”, “risks” and “consequences” are assumed to be causally dependent, and is assessed using a structured fuzzy risk rating approach. In their research, Dikmen et al. (2007) He utilized a fuzzy risk rating approach to qualitatively assess the risk of cost overrun in the bidding stage of international projects by taking into account of interrelations between various risk factors and impact of project-related factors as well as contract conditions on the risk level of projects. In order for development of a fuzzy decision making framework, (Baloi & Price, 2003) He has identified several global risk factors affecting cost performance of construction projects through detailed literature review. Assessment and management issues of such identified risks were examined for further modeling purposes. Claiming global risk factors to be the most critical ones in international projects, they classified potential risks under the headings of “organization-specific” (internal environment), “global”, and “acts of God” (external environments).

Zoysa and Russell (2003) He has developed a knowledge-based approach for identification of possible risks associated with a new large infrastructure project by means of two types of knowledge structures, namely a reusable document comprising of stored past experiences, and rule sets defined for reasoning and similarities used in determination of project attributes and characteristics of the environment. As an outcome, a project-specific updatable risk register is developed comprising of a list of probable risks under diverse categories. They have mentioned “process”, “physical”, “socio-economic” and “organizational” factors to be the most dominant risk areas in infrastructure projects. In (Leung et. al., 1998) He has formulated a risk identification model explaining the causality among each risk factor and its possible consequences. A knowledge-based risk identification system is then established employing some If-Then rules acquired from expert knowledge.

(Choi & Mahadevan, 2008) The large scale projects, the efforts of identification and assessment of risks normally done at the pre-construction or pre-contract stages of the large scale projects, in which very limited data and information are available about the upcoming project condition. Therefore, it is highly uncertain to make predictions which may make the decision process quite subjective.

In construction projects, risks play a significant part in decision making and may affect the performance of a project. If they are not dealt with sensibly, they may cause cost overruns, delays on schedule and even poor quality. Each project has a different level and combination of risks and sites will adopt different strategies to minimize them because the characteristics of projects are unique and dynamic.

To identify factors causing project delays and cost overruns, a considerable number of studies have been conducted. Akinci and Fischer (1998) conducted a study to identify factors affecting cost overrun and surveys to collect factors causing project delays were conducted by Assaf et al. (1995), Nkado (1995), Ogunlana et al. (1996), Chan and Kumaraswamy (1997), Mezher and Tawil (1998), Kumaraswamy and Chan (1998), Al-Khalil and Al-Ghafly (1999), Al-Momani (2000), Elinwa and Joshua (2001) and Odeh and Battaineh (2002). The factors influencing cost overruns and delays were also identified by the surveys conducted by Mansfield et al. (1994) and Frimpong et al. (2003).

Compared with many other industries, the construction industry is subject to more risks due to the unique features of construction activities, such as long period, complicated processes, abominable environment, financial intensity and dynamic organization structures (Flanagan and Norman, 1993; Akintoye and MacLeod, 1997; Smith, 2003).

SUMMARY

The important six verticals of Project Management are Risk Management, Risk Mitigation, Risk Variables of Overseas Projects, Project Risk Management and Risk reporting.

CHAPTER 3

RESEARCH METHODOLOGY

ABSTRACT

This chapter comprises of research methodology adopted for the purpose of study. It includes the rationale / need of the research, followed by research gap which focuses on the variables responsible for cost overrun during execution of large integrated steel plant in India and problem statement with objectives. Exploratory research was conducted for identification of variables in research methodology. Explained how the sample size was considered and framed the hypothesis with list of variables. It also covers the data collection method and mentions the tools used for data analysis.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 RATIONALE / NEED OF THE RESEARCH

Every project passes through a number of phases and each phase has a unique purpose, duration and scope. It is important to break down the entire project into various phases and it is a part of the process of project management. The project must start from some kind of definition of need, after which follows design, contracting, construction and project completion **(Hughes, 2000).** The large integrated Steel Plants are faced with the choice between upgrading existing facilities or increasing their efficiencies by other means and going in for green field investments. If the Indian industry has to strengthen its global presence, it will obviously have to overcome some of the major constrains and challenges lying in the project management **(Gupta P. et al 2007).**

Risk and uncertainty are inherent in all the phases through which the construction project passes, from demonstrating the need to do operation and maintenance. **Latham (1994)** said that no construction project is risk free. Risk can be managed, minimized, shared, transferred or accepted. It cannot be ignored. Risks do not appear only in major projects. Although size may be a cause of risk, complexity, construction speed, site and many other factors that affect time, cost and quality to a greater or lesser degree cannot be overlooked. All the participants in the deciding process should observe risks and their effects on all key points of decision-making before and during project realization. **Gupta P.et. al (2007)**while discussing the past experience in Project Management of Indian Steel Industry have commented that a project plan has included in it some risks, simply listed, but no further review happened and no plans towards responding to the risk occurrence took place.

3.2 RESEARCH GAP

During study of published literature, it was observed that no structured study has so far been carried out for Identifying Project cost overruns in Indian Steel Industry.

Most of the studies, as observed after reviewing literature have been done on the pre- execution phase of large construction projects i.e. not during project implementation of infrastructure projects.

Also, these studies have been done on projects outside India. No study has been carried out for identifying factors responsible for project cost overruns in other large Indian Industrial projects e.g. steel, cement, aluminum, copper, etc.to the best of knowledge of the researcher.

No specific research has been done on the risk factors responsible for project cost overrun during execution of large integrated steel plants in India.

This research focuses on the variables responsible for cost overrun during execution of large integrated steel plant in India. The focus point of this research is to take into account the very practical aspects during execution of large integrated steel plants in India which are important and more relevant to the executing project manager.

Through review of literature, the researcher has tried to identify the gap for theoretical premise of the study. “Theories of Constraints” has been found suitable for the study for the proposed research.

3.3 PROBLEM STATEMENT

"Cost overrun in Indian steel industry resulting into increase in project/ capital cost and erosion of profit."

3.4 RESEARCH QUESTION - 1

What are the various risks factors responsible for cost overrun of Steel Plant Projects in India?

3.4.1 RESEARCH OBJECTIVE - 1

To identify various risks factors responsible for cost overrun of Steel Plant Projects in India.

3.4.2 PHASE 1: IDENTIFICATION PHASE

3.4.3 RESEARCH METHODOLOGY- PHASE I

Exploratory research was conducted for identification of variables (Phase-1).

1. Various risk variables were identified by literature survey, brain storming and expert interviews. For this, the experts and consultants from Steel Industry who were associated with the construction of steel plants were targeted as respondents for identification of risk variables. During the risk identification phase, the list of 73 risk variables associated with construction of steel plant projects was prepared. This list of the 73 identified risk variables is as under:

Table – 3.1: List of identified risks

List of identified risks	
Sl. No	**Observed variables**
1	Instability of Economic Condition
2	Instability of Government
3	Instability of International Relations
4	Social unrest
5	High Level of Bureaucracy
6	Immaturity of Legal System
7	Restrictions for Foreign Companies
8	Unavailability of Local Material
9	Unavailability of Equipment
10	Unavailability of Local Skilled Labor
11	Unavailability of Local Skilled Subcontractors
12	Unavailability of Infrastructure
13	Poor/Incomplete Design
14	Design Errors
15	Complexity of Design
16	Low Constructability
17	Complexity of Construction Method
18	Uncertainty of Geotechnical Condition
19	Strict Quality Requirements
20	Strict Environmental Regulations
21	Strict Health & Safety Regulations
22	Strict Project Management Requirements
23	Vagueness of Contract Clauses
24	Contractual Errors
25	Technical Incompetency of Engineer
26	Managerial Incompetency of Engineer

27	Engineer’s Lack of Financial Resources
28	Poor Site Supervision
29	Lack of Site Facilities
30	Contractor’s Lack of Experience in Similar Projects
31	Contractor’s Lack of Experience in the Country
32	Contractor’s Lack of Experience about the project delivery System
33	Contractor’s Lack of Experience with Client
34	Contractor’s Lack of Financial Resources
35	Contractor’s Lack of Technical Resources
36	Contractor’s Lack of Staff
37	Poor Project Scope Management
38	Poor Project Time Management
39	Poor Project Cost Management
40	Poor Project Quality Management
41	Poor Human Resources Management
42	Poor Communication Management
43	Poor Project Risk Management
44	Poor Procurement Management
45	Changes in Currency Rate
46	Change in Economic Indicators
47	Change in Taxation Policies
48	Change in Laws & Regulations
49	Conflicts with Government
50	Conflicts with Engineer
51	Conflicts with Client
52	Poor Public Relations
53	Change in Performance of Client Representative
54	Change in Client’s Staff/Organization
55	Change in Financial Situation of Client

56	Scope Changes
57	Design Changes
58	Change in Site/Project Organization
59	Change in Functional Performance of Contractor
60	Change in Availability of Material
61	Change in Availability of Equipment
62	Change in Availability of Subcontractors
63	Change in Geological Conditions
64	Change in Site Conditions
65	War/ Hostilities
66	Rebellion/ Terrorism/ Naxelism
67	Natural Catastrophes
68	Delays/Interruptions
69	Decrease in Productivity
70	Increase in Amount of Work
71	Decrease in Quality of Work
72	Increase in Unit Cost of Work
73	Lags in Cash Flow

2. The 73 identified risk variables were studied in detail and reviewed by experts to shortlist them (Table 3.2). This reduced the list to 30 variables. (Appended file: Question Interdependency of Observed Variables)

3. Thereafter, a structured questionnaire was developed, including the weightage of various risks associated in terms of their effects on cost overrun for previously realized projects in India. A 5-Point **Likert's Scale** was used for rating the weight importance.

Table – 3.2

S. no.	Scale	Range of Cost Overrun Percentage
1.	Very Low (1)	Actual Overrun ≤ 20%
2.	Low (2)	20% < Actual Overrun ≤ 40%
3.	Medium (3)	40% < Actual Overrun ≤ 60%
4.	High (4)	60% < Actual Overrun ≤ 80%
5.	Very High (5)	80% < Actual Overrun

The above scale has been used by **Daniel Baloi and Andrew D.F. Price (2001)** for evaluating the impact of global risk factors on cost performance of construction projects, and also by **EybpooshMatineh (2010)** for identifying the risk paths in international construction projects at Turkey.

A pilot testing of the questionnaire was done for the reliability of the instrument using **chronbach alpha.** The questionnaire was then administered to various project management experts and consultants who have managed steel plant projects in India.

3.4.4 SAMPLE SIZE

A large sample size for applying factor analysis was taken. As described by (Bentler & Chou, 1987), the required sample size for Factor Analysis 8:1 which means for every one variable, there has to be at least 8 respondents. The sample size was accordingly determined to be more than 250. In our case the respondents were 300.

Before answering the questions, the respondents were given a few minutes presentation about the vulnerability and risk concepts and about the ultimate purpose of the research so that all of them have the same perception about the concepts and have no confusions and misunderstandings.

3.4.5 TOOLS OF DATA ANALYSIS

The data so generated was collected, and tabulated then subsequently run through Factor Analysis.

The critical risk factors were identified using factor analysis. **Daniel Baloi and Andrew D.F. Price (2001)** and **Kasimu M.A.(2012)** have also used factor analysis for large scale construction projects and **TsunodaMasateru et al (2010)** has also applied factor analysis for analyzing risk factors affecting project cost overrun of information technology projects.

3.5 RESEARCH QUESTION - 2:

What is the interrelationship between Identified risk factors and cost overrun for steel plant projects in India?

3.5.1 RESEARCH OBJECTIVE – 2

To establish the interrelationship between identified factors and cost overrun responsible for the project cost overrun of steel plants in India.

3.5.2 RESEARCH METHODOLOGY - PHASE II

3.5.3 PHASE 2: INTERRELATIONSHIP BETWEEN RISK FACTORS AND COST OVERRUN

In order to establish interrelationship between various identified risk factors and cost overrun, the factors so identified were ranked only by the top level executives, experts and consultants having experience of more than 20 years in execution of large scale projects.

Another set of questionnaire was administered **only to** the experts who have been associated with the construction of steel plants who have suffered cost overrun. They were asked to rank the risk factors on the basis of their effects on the cost overrun. Logistical regression has been applied for accomplishing the second objective.

3.5.4. SAMPLING TECHNIQUE

- Sampling Method: Judgmental
- Sampling Unit: Experts with at least 20 years experience
- Sample Size: 15

3.5.5 TOOLS OF DATA ANALYSIS

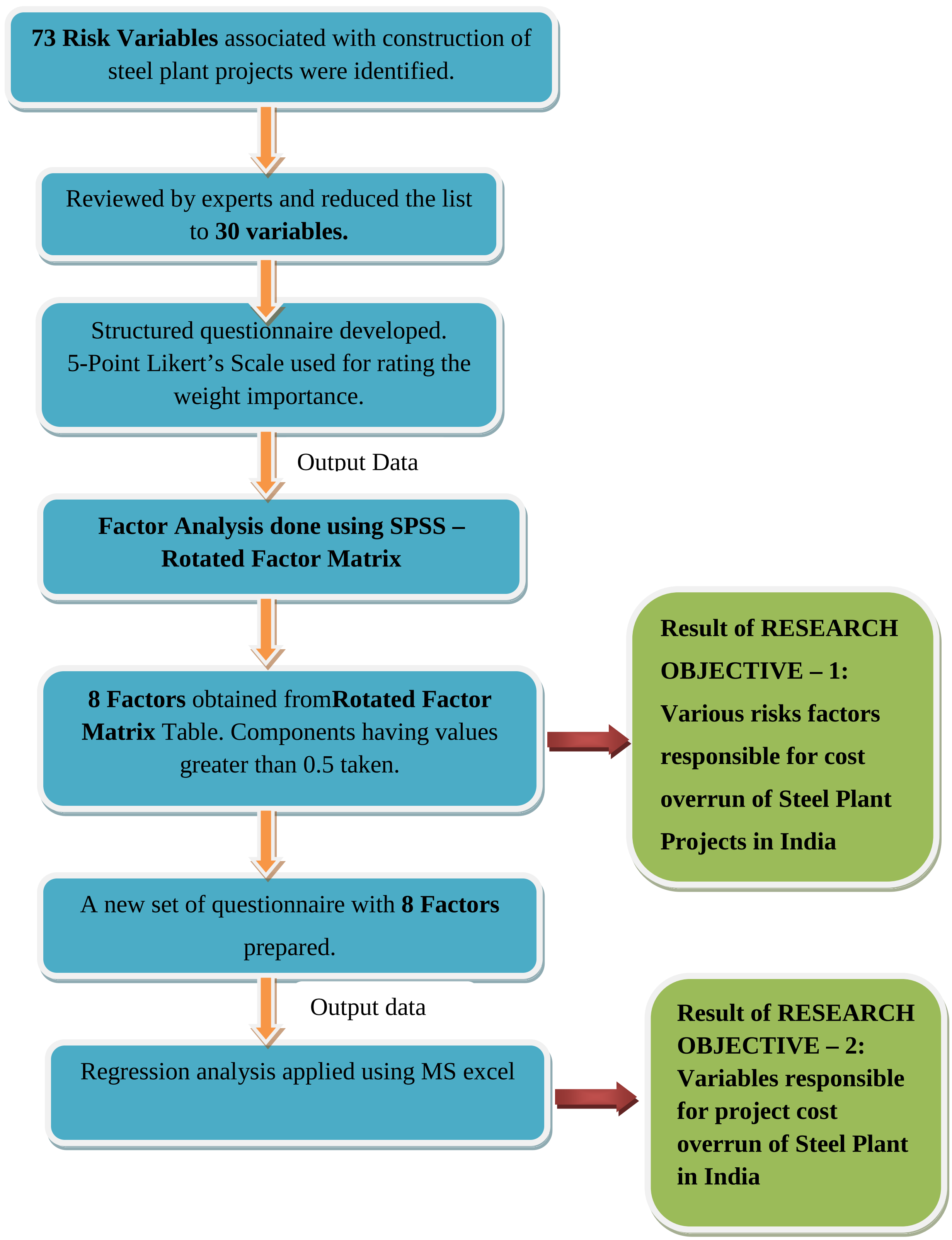
1. Ordinal Logistical regression
2. Hypothesis Testing

3.6 HYPOTHESIS

Null Hypothesis: Cost overrun of Steel plant projects **is significantly independent** of the identified risk factors.

Alternate Hypothesis: Cost overrun of Steel plant projects **is significantly dependent** on the identified risk factors.

Fig. 3.1 Flow Chart of Total Project



SUMMARY:

During study of published literature, it was observed that no structured study has so far been carried out for Identifying Project cost overruns in Indian Steel Industry.

Most of the studies, as observed after reviewing literature have been done on the pre- execution phase of large construction projects i.e. not during project implementation of infrastructure projects.

No specific research has been done on the risk factors responsible for project cost overrun during execution of large integrated steel plants in India.

Through review of literature, the researcher has tried to identify the gap for theoretical premise of the study. "Theories of Constraints" has been found suitable for the study for the proposed research.

Exploratory research was conducted for identification of variables (Phase-1).

Various risk variables were identified by literature survey, brain storming and expert interviews. For this, the experts and consultants from Steel Industry who were associated with the construction of steel plants were targeted as respondents for identification of risk variables. During the risk identification phase, the list of 73 risk variables associated with construction of steel plant projects was prepared.

In order to establish interrelationship between various identified risk factors and cost overrun, the factors so identified were ranked only by the top level executives, experts and consultants having experience of more than 20 years in execution of large scale projects.

Another set of questionnaire was administered **only to** the experts who have been associated with the construction of steel plants who have suffered cost overrun. They were asked to rank the risk factors on the basis of their effects on the cost overrun. Logistical regression has been applied for accomplishing the second objective.

Tools for data analysis used are Ordinal Logistical regression and Hypothesis Testing

CHAPTER – 4

DATA ANALYSIS

ABSTRACT

This chapter deals with the data analysis to identify various risk variables associated with the project cost performance in establishing steel plant in India by Factor Analysis using IBM SPSS (Statistical Package for the Social Sciences) software. Explained step wise procedure involved while using the software. Researcher has Identified the factors from Rotated Factor Matrix table. Data analysis for another objective i.eto establish the interrelationship between identified factors and cost overrun responsible for the project cost overrun of steel plant projects in India. Further by using Regression Method the top risk variables responsible for the project cost overrun for construction of steel plant in India are identified and at the end findings from the data analysis are mentioned.

CHAPTER – 4

DATA ANALYSIS

4.1 OBJECTIVE 1

To identify various risks factors responsible for cost overrun of Steel Plant Projects in India.

4.1.1 DATA ANALYSIS FOR OBJECTIVE - 1

To identify various risks factors responsible for cost overrun of Steel Plant Projects in India (cost overrun in steel plant projects in India), have used **“factor analysis”** and found out seven factors that have a significant contribution in the project cost performance.

4.1.2 RESEARCH METHODOLOGY- PHASE I

Exploratory research was conducted for identification of variables (Phase-1).

4. Various risk variables were identified by literature survey, brain storming and expert interviews. For this, the experts and consultants from Steel Industry who were associated with the construction of steel plants were targeted as respondents for identification of risk variables. During the risk identification phase, the list of 73 risk variables associated with construction of steel plant projects was prepared. This list of the 73 identified risk variables are as under.

5. The 73 identified risk variables were studied in detail and reviewed by experts to shortlist them (Table 3.2). This reduced the list to 30 variables.

6. Thereafter, a structured questionnaire was developed, including the importance weights of various risks associated in terms of their effects on cost overrun for previously realized projects in India. A 5 Point **Likert’s**

Scale was used for rating the weight importance.

7. The data so generated was collected and then subsequently run through Factor Analysis to find out the seven factors that have significant contribution in the Project Cost Performance.

Table – 4.1

S. no.	Scale	Range of Cost Overrun Percentage
1.	Very Low (1)	Actual Overrun ≤ 20%
2.	Low (2)	20% < Actual Overrun ≤ 40%
3.	Medium (3)	40% < Actual Overrun ≤ 60%
4.	High (4)	60% < Actual Overrun ≤ 80%
5.	Very High (5)	80% < Actual Overrun

The above scale has been used by **Daniel Baloi and Andrew D.F. Price (2001)** for evaluating the impact of global risk factors on cost performance of construction projects, and also by **EybpooshMatineh (2010)** for identifying the risk paths in international construction projects at Turkey.

A pilot testing of the questionnaire was done for further reduction of the risk variables and then the reliability of the instrument was checked. The questionnaire was then administered to various project management experts and consultants who have managed steel plant projects in India.

Subsequently, a project-specific risk checklist was constructed.

The critical risk factors were identified using factor analysis. **Daniel Baloi and Andrew D.F. Price (2001)** and **Kasimu M.A.(2012)** have also used factor analysis for large scale construction projects and **aTsunodaMasateru et al (2010)** has also applied factor analysis for analyzing risk factors affecting project cost overrun of information technology projects.

4.1.3 FACTOR ANALYSIS:

Interrelationships among a large number of variables and to explain these variables in terms of a smaller number of common underlying dimensions. This involves finding a way of condensing the information contained in some of the original variables into a smaller set of implicit variables (called factors) with a minimum loss of information.

For example, suppose one would like to test the observation that customer satisfaction is based on product knowledge, communications skills and people skills. We develop a new questionnaire about customer satisfaction with 30 questions: 10 concerning product knowledge, 10 concerning communication skills and 10 concerning people skills. Before using the questionnaire on the sample, we pre-test it on a group of people similar to those who will be completing the survey.

We perform a factor analysis to check, whether these three factors are really there or not. If they are, then we will be able to create three separate scales by summing the items on each dimension.

Factor analysis is based on a correlation table. If there are k items in the study (e.g. k questions in the above example) then the correlation table has $k \times k$ entries of form r_{ij} where each r_{ij} is the correlation coefficient between item i and item j. The main diagonal consists of entries with value 1.

Closely related to factor analysis is the **"principal component analysis"**, which creates a picture of the relationships between the variables useful in identifying common factors.

Factor analysis is based on various concepts from Linear Algebra, in particular Eigenvalues, Eigenvectors, orthogonal matrices and the spectral theorem. We review these concepts first before explaining how principal component analysis and factor analysis work.

Factor analysis can be seen as a family of techniques, of which both PCA and EFA are members. Factor analysis is a statistical approach that can be used to analyze interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions (factors). It involves finding a way of condensing the information contained in a number of original variables into a smaller set of dimensions (factors) with a minimum loss of information

Four basic steps of Factor Analysis:

- Data collection and generation of the correlation matrix
- Extraction of initial factor solution
- Rotation and interpretation (also validation)
- Construction of scales or factor scores to use in further analyses.

A good factor should:

- Makes sense
- Will be easy to interpret
- Possesses simple structure
- Items have low cross-loadings

Researcher conducted Factor Analysis Using SPSS (**Statistical Package for the Social Sciences).**

SPSS Statistics is a software package used for statistical analysis. Long produced by SPSS Inc., it was acquired by IBM in 2009. The current versions (2014) are officially named IBM SPSS Statistics. Companion products in the same family are used for survey authoring and deployment (IBM SPSS Data

Collection), data mining (IBM SPSS Modeler), text analytics, and collaboration and deployment (batch and automated scoring services).

Questionnaires are made up of multiple items each of which elicits a response from the same person. As such, it is a repeated measures design. Given we know that repeated measures go in different columns; different questions on a questionnaire should each have their own column in SPSS.

4.1.4 INITIAL CONSIDERATION:

Sample Size:

Correlation coefficients fluctuate from sample to sample, much more so in small samples than in large. Therefore, the reliability of factor analysis is also dependent on sample size.

Data Screening:

SPSS will nearly always find a factor solution to a set of variables. However the solution is unlikely to have any real meaning if the variables analyzed are not sensible. The first thing to do when conducting a factor analysis is to look at the inter-correlation between variables. If our test questions measure the same underlying dimension (or dimensions) then we would expect them to correlate with each other (because they are measuring the same thing). If we find any variables that do not correlate with any other variables (or very few) then you should consider excluding these variables before the factor analysis is run.

4.1.5 CORRELATION MATRIX

The table was included in the output because we included the keyword **correlation** on the **/print** subcommand. This table gives the correlations between the original variables (which are specified on the **/variables** subcommand). Before conducting a principal components analysis, you want to check the correlations between the variables. If any of the correlations are too high (say above 0.9), you may need to remove one of the variables from the analysis, as the two variables seem to be measuring the same thing. Another alternative would be to combine the variables in some way (perhaps by taking the average). If the correlations are too low, say below .1, then one or more of the variables might load only onto one principal component (in other words, make its own principal component). This is not helpful, as the whole point of the analysis is to reduce the number of items (variables).

Table-4.1

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.828
Bartlett's Test of Sphericity	Approx. Chi-Square	4952.321
	Df	1128
	Sig.	0.000

1. **Kaiser-Meyer-Olkin Measure of Sampling Adequacy** - This measure varies between 0 to 1 and values closer to 1 are better. A value of 0.6 is a suggested minimum.

2. **Bartlett's Test of Sphericity** - This tests the null hypothesis that the correlation matrix is an identity matrix. An identity matrix is matrix in which all of the diagonal elements are 1 and all off diagonal elements are 0. You want to reject this null hypothesis.

Taken together, these tests provide a minimum standard which should be passed before a principal components analysis (or a factor analysis) should be conducted

Table-4.2:

Communalities

S.no		Initial	Extraction
1	Instability of Economic Condition	0.644	0.577
2	Changes in forex rate	0.567	0.484
3	Fluctuations in cost of fuel/energy prices	0.325	0.109
4	Instability of Government	0.435	0.307
5	Instability of International Import	0.390	0.266
6	Bureaucratic Delay regarding clearance/ decision	0.468	0.345
7	Complexity of Legal System	0.576	0.611
8	Change in Taxation Policy	0.399	0.260
9	Unavailability of Local Skilled Labor	0.376	0.400
10	Unavailability of Local Skilled Subcontractors	0.303	0.223
11	Technical Incompetency of Engineer	0.452	0.372
12	Managerial Incompetency of Engineer	0.609	0.517
13	Lack of skilled Staff with the Contractor’s	0.669	0.620
14	Low Constructability	0.410	0.458
15	Complexity of Construction Method	0.396	0.422
16	Strict Quality Requirements	0.312	0.209
17	Strict Project Management Requirements	0.437	0.314
18	Lack of Financial Resources	0.396	0.315
19	Poor Site Supervision	0.444	0.474

20	Poor/ ill-defined Scope	0.464	0.426
21	Poor Project Time Management	0.538	0.424
22	Poor Project Cost Management of the contractor	0.417	0.295
23	Poor Project Quality Management	0.598	0.660
24	Poor Communication	0.613	0.637
25	Poor Project Risk Management	0.665	0.677
26	Poor Procurement Management	0.563	0.430
27	Poor Conflict resolution	0.483	0.374
28	Contractor's Lack of expertise in Similar Projects	0.436	0.259
29	Contractor's Lack of Experience in the Country	0.336	0.172
30	Contractor's Lack of Experience with Client	0.359	0.266
31	Contractor's Lack of Financial Resources	0.491	0.403
32	Contractor's Lack of Technical Resources	0.547	0.525
33	Unavailability of Local Mineral Material	0.219	0.124
34	Unavailability of earth moving/lifting Equipment locally	0.468	0.413
35	Uncertainty of Geotechnical Condition	0.394	0.290
36	Lack of testing Facilities	0.562	0.486
37	Change in Availability of Subcontractors	0.334	0.098
38	Change in Geological Conditions	0.436	0.310
39	Poor Human Resources Management	0.545	0.496

40	Change in Client's Staff/Organization dealing with local public/ administration	0.532	0.478
41	Change in Financial Situation of Client	0.377	0.291
42	Scope Changes	0.434	0.475
43	Change in Site/ Project Organization	0.466	0.413
44	44. Increase/ decrease in quantity of Work	0.509	0.437
45	45. Social unrest	0.537	0.573
46	46. Rebellion/ Terrorism/ Naxelism	0.572	0.522
47	47. Natural Catastrophes	0.724	0.704
48	48. Fire/ Theft and other possible unwanted events	0.750	0.763

Extraction Method: Maximum Likelihood.

Communalities - This is the proportion of each variable's variance that can be explained by the principal components (e.g., the underlying latent continua). It is also noted as h^2 and can be defined as the sum of squared factor loadings.

Table-4.3 Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.109	18.976	18.976	8.555	17.823	17.823	4.410	9.187	9.187
2	5.252	10.941	29.917	4.630	9.645	27.468	3.745	7.801	16.988
3	2.212	4.609	34.526	1.728	3.600	31.068	3.659	7.622	24.611
4	1.798	3.746	38.272	1.225	2.552	33.620	2.139	4.456	29.067

5	1.570	3.271	41.543	.910	1.895	35.515	1.607	3.348	32.415
6	1.522	3.171	44.714	.960	1.999	37.515	1.555	3.239	35.654
7	1.481	3.086	47.800	.850	1.771	39.286	1.316	2.742	38.395
8	1.359	2.832	50.632	.844	1.759	41.045	1.272	2.649	41.045
9	1.323	2.757	53.389						
10	1.233	2.569	55.958						
11	1.132	2.359	58.317						
12	1.116	2.324	60.642						
13	1.034	2.154	62.796						
14	.992	2.067	64.863						
15	.931	1.941	66.803						
16	.901	1.878	68.681						
17	.865	1.802	70.483						
18	.807	1.681	72.165						
19	.782	1.630	73.795						
20	.778	1.622	75.416						
21	.752	1.568	76.984						
22	.716	1.492	78.476						
23	.710	1.480	79.956						
24	.661	1.377	81.333						
25	.615	1.280	82.613						
26	.584	1.218	83.831						
27	.548	1.142	84.973						
28	.535	1.115	86.088						
29	.512	1.067	87.155						
30	.500	1.042	88.197						
31	.475	.989	89.186						
32	.460	.959	90.145						
33	.440	.917	91.062						
34	.426	.887	91.950						

35	.413	.861	92.811						
36	.395	.824	93.634						
37	.358	.746	94.380						
38	.330	.687	95.067						
39	.328	.684	95.751						
40	.304	.634	96.385						
41	.288	.599	96.984						
42	.255	.532	97.515						
43	.234	.488	98.003						
44	.231	.482	98.485						
45	.218	.455	98.940						
46	.193	.402	99.341						
47	.165	.344	99.686						
48	.151	.314	100.00						

Extraction Method: Maximum Likelihood.

Factor - The initial number of factors is the same as the number of variables used in the factor analysis. However, not all 48 factors will be retained. Only the first 8 factors will be retained.

Initial Eigenvalues – Eigenvalues are the variances of the factors. Because we conducted our factor analysis on the correlation matrix, the variables are standardized, which means that the each variable has a variance of 1, and the total variance is equal to the number of variables used in the analysis, in this case, 48.

Total - This column contains the Eigenvalues. The first factor will always account for the most variance (and hence have the highest Eigenvalue), and the next factor will account for as much of the left over variance as it can, and so on. Hence, each successive factor will account for less and less variance.

% of Variance - This column contains the percent of total variance accounted for by each factor.

Cumulative % - This column contains the cumulative percentage of variance accounted for by the current and all preceding factors.

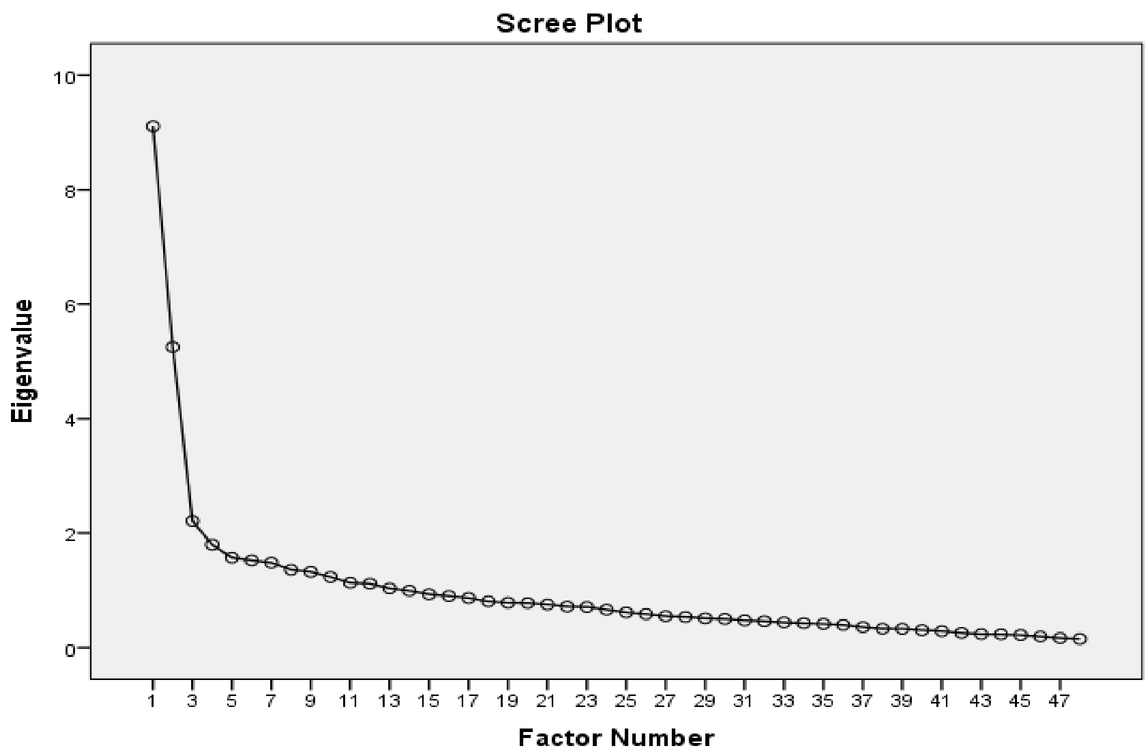
Extraction Sums of Squared Loadings - The number of rows in this panel of the table correspond to the number of factors retained. The values in this panel of the table are calculated in the same way as the values in the left panel, except that here the values are based on the common variance. The values in this panel of the table will always be lower than the values in the left panel of the table, because they are based on the common variance, which is always smaller than the total variance.

Rotation Sums of Squared Loadings - The values in this panel of the table represent the distribution of the variance after the varimax rotation. Varimax rotation tries to maximize the variance of each of the factors, so the total amount of variance accounted for is redistributed over the three extracted factors.

SPSSS Output Total Variance Explained table lists the eigenvalues associated with each linear component (factor) before extraction, after extraction and after rotation. Before extraction, SPSS has identified 48 linear components within the data set. The eigenvalues associated with each factor represent the variance explained by that particular linear component and SPSS also displays the eigenvalue in terms of the percentage of variance explained. It should be clear that the first few factors explain relatively large amounts of variance (especially factor 1) whereas subsequent factors explain only small amounts of variance. SPSS then extracts all factors with eigenvalues greater than 1, which leaves us with 9 factors. The eigenvalues associated with these factors are again displayed (and the percentage of variance explained). The eigenvalues of the factors after rotation are displayed. Rotation has the effect of optimizing the factor structure and one consequence for these data is that the relative importance of the four factors is equalized. Before rotation, factor 1 accounted for considerably more variance than the remaining twelve, however after extraction it accounts for only 41% of variance.

4.1.6 SCREE PLOT

Figure – 4.1



Factor analysis is an exploratory tool and so it should be used to guide the researcher to make various decisions. One important decision is the number of factors to extract. By Kaiser's Criterion we should extract 8 factors and this is what SPSS has done. However, this criterion is accurate when there are less than 30 variables and communalities after extraction are greater than 0.7 or when the sample size exceeds 250 and the average communality is greater than 0.6. Scree Plot can be used in such cases. Scree Plot can be produced using SPSS. The Scree

Plot shown, indicating the point of inflexion on the curve. The scree plot graphs the eigenvalue against the factor number.

4.1.7 ROTATED FACTOR MATRIX

Table-4.4: Rotated Factor Matrix[a]

	Factor							
	1	2	3	4	5	6	7	8
39. Poor Human Resources Management	.660							
12. Managerial Incompetency of Engineer	.635							
40. Change in Client's Staff/Organization dealing with local public/administration	.575							
13. Lack of skilled Staff with the Contractor's	.535							
9. Unavailability of Local Skilled Labor								
11. Technical Incompetency of Engineer								
38. Change in Geological Conditions								
36. Lack of testing Facilities								

5. Instability of International Import								
17. Strict Project Management Requirements								
25. Poor Project Risk Management		.645						
19. Poor Site Supervision		.611						
20. Poor/ill-defined Scope		.608						
27. Poor Conflict resolution		.546						
21. Poor Project Time Management		.544						
26. Poor Procurement Management		.514						
18. Lack of Financial Resources		.509						
41. Change in Financial Situation of Client								
22. Poor Project Cost Management of the contractor								
30. Contractor’s Lack of Experience with Client								
10. Unavailability of Local Skilled								

Subcontractors								
28. Contractor’s Lack of expertise in Similar Projects								
33. Unavailability of Local Mineral Material								
3. Fluctuations in cost of fuel/energy prices								
7. Complexity of Legal System			.749					
1. Instability of Economic Condition			.711					
2. Changes in forex rate			.618					
48. Fire/Theft and other possible unwanted events			.617					
8. Change in Taxation Policy								
4. Instability of Government								
6. Bureaucratic Delay regarding clearance/decision								
35. Uncertainty of Geotechnical Condition								
46. Rebellion/				.610				

Terrorism/ Naxelism								
47. Natural Catastrophes				.592				
45. Social unrest								
29. Contractor’s Lack of Experience in the Country								
37. Change in Availability of Subcontractors								
42. Scope Changes					.671			
43. Change in Site/Project Organization								
44. Increase/decrease in quantity of Work								
34. Unavailability of earth moving/lifting Equipment locally								
23. Poor Project Quality Management						.688		
24. Poor Communication						.565		
32. Contractor’s Lack of Technical Resources							.567	
31. Contractor’s Lack of Financial Resources								

14. Low Constructability								.576
15. Complexity of Construction Method								.528
16. Strict Quality Requirements								

Extraction Method: Maximum Likelihood.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 15 iterations.

Rotated Factor Matrix - This table contains the rotated factor loadings (factor pattern matrix), which represent both how the variables are weighted for each f actor but also the correlation between the variables and the factor. Because these are correlations, possible values range from -1 to +1.

For orthogonal rotations, such as varimax, the factor pattern and factor structure matrices are the same.

Factor - The columns under this heading are the rotated factors that have been extracted.

Table-4.5: Factors Chosen for Study:

From the Rotated Factor Matrix Table components are chosen whose values are greater than 0.5.

Sl.no	Factor	Loadings	
1	Human Resources Development/ Management	39. Poor Human Resources Management	0.660
		12. Managerial Incompetency of Engineer	0.635
		40. Change in Client's Staff/Organization dealing with local	0.575

		public/administration	
		13. Lack of skilled Staff with the Contractor’s	0.535
2	Project Management	25. Poor Project Risk Management	0.645
		19. Poor Site Supervision	0.611
		20. Poor/ill-defined Scope	0.608
		27. Poor Conflict resolution	0.546
		21. Poor Project Time Management	0.544
		26. Poor Procurement Management	0.514
		18. Lack of Financial Resources	0.509
3	Economic – Legal Factor	7. Complexity of Legal System	0.749
		1. Instability of Economic Condition	0.711
		2. Changes in forex rate	0.618
		48. Fire/Theft and other possible unwanted events	0.617
4	Socio-Natural Factors	46. Rebellion/ Terrorism/ Naxalism	0.610
		47. Natural Catastrophes	0.592
5	Scope Management	42. Scope Changes	0.671
6	Quality and Communication Management	23. Poor Project Quality Management	0.688
		24. Poor Communication	0.565
7	Technical Resources Management	32. Contractor’s Lack of Technical Resources	0.567
8	Construction Management	14. Low Constructability	0.576
		15. Complexity of Construction Method	0.528

4.2 DATA ANALYSIS FOR OBJECTIVE - 2

To establish the interrelationship between identified factors and cost overrun responsible for the project cost overrun of steel plant projects in India.

4.2.1 RESEARCH METHODOLOGY - PHASE II

1. A set of questionnaire with 7 Factors was administered only to the experts who have been associated with the construction of steel plants. They were asked to rate the risk factors on the basis of their effects on the cost overruns. The factors so identified were rated only by the top level executives, experts and consultants having experience of more than 20 years in execution of large scale projects.

2. After getting the ratings from experts regression analysis using MS excel was performed.

4.2.2 PHASE 2: INTERRELATIONSHIP BETWEEN RISK FACTORS AND COST OVERRUN

In order to establish interrelationship between various identified risk factors and cost overrun, the factors so identified were ranked only by the top level executives, experts and consultants having experience of more than 20 years in execution of large scale projects.

Another set of questionnaire was administered **only to** the experts who have been associated with the construction of steel plants who have suffered cost overrun. They were asked to rank the risk factors on the basis of their effects on the cost overrun.

In order to identify various risk variables responsible for the project cost overrun for the construction of a steel plant in India, linear regression method was used for 7 factors obtained from objective 1.

Logistic regression is helpful to predict a categorical variable from a set of predictor variables, hence this methodology is used to establish interrelationship between various identified risk factors and cost overrun.

In order to establish interrelationship between various identified risk factors and cost overrun, the factors so identified were ranked only by the top level executives, experts and consultants having experience of more than 20 years in execution of large scale projects.

Another set of questionnaire was administered **only to** the experts who have been associated with the construction of steel plants who have suffered cost overrun. They were asked to rank the risk factors on the basis of their effects on the cost overrun.

A set of questionnaire with 8 Factors was administered only to the experts who have been associated with the construction of steel plants. They were asked to rate the risk factors on the basis of their effects on the cost overruns. The factors so identified were rated only by the top level executives, experts and consultants having experience of more than 20 years in execution of large scale projects.

After getting the ratings from experts regression analysis using MS excel was performed.

Excel produces the following Summary Output (rounded to 3 decimal places).

Researcher performed regression for all the 8 factors

The regression output for all 8 factors are attached as annexure –

4.2.3 INTERPRETATION:

Table 4.6 : Interpretation of Results from Regression

Sl. no	Factors	Coefficients		Predicted Value (y) = mx+c	Sequencing of Factors based on y value	Components
		intercept – C	M			
1	Project Management	5.00438596	-0.003176	5.00-0.003x	1	1. Poor Project Risk Management 2. Poor Site Supervision 3. Poor/ill-defined Scope 4. Poor Conflict resolution 5. Poor Project Time Management 6. Poor Procurement Management 7. Lack of Financial Resources
2	Quality and Communication Management	4.66353383	0.000713	4.66-0.0007x	2	1. Poor Project Quality Management 2. Poor Communication
3	Technical Resources Management	3.71428571	-0.001037	3.71 - 0.001x	3	1. Contractor’s Lack of Technical Resources

4	Scope Management	3.55576441	-0.00162	3.55 - 0.001x	4	2. Scope Changes
5	Human Resources Development/ Management	2.50438596	0.0049909	2.50-0.005x	5	1. Poor Human Resources Management 2. Managerial Incompetency of Engineer 3.Change in Client's Staff/Organization dealing with local public/administration.
6	Construction Management	2.3245614	0.0027223	2.32+0.003x	6	1. Low Constructability 2. Complexity of Construction Method
7	Economic – Legal Factor	1.29260652	0.0056391	1.29-0.006x	7	1. Complexity of Legal System 2. Instability of Economic Condition 3. Changes in forex rate 4. Fire/Theft and other possible unwanted events
8	Socio-Natural Factors	1.19423559	-0.002463	1.19-0.002x	8	1. Rebellion/ Terrorism/ Naxalism 2. Natural Catastrophes

Components present in this are more suitable Project Risk Factors affecting Project Cost Performance in Steel Industry in an Indian perspective as because from Regression analysis of all 8factors, Factor-3 value is more close to 5 (high scale range). Hence its influence is more.

4.2.4 LOGISTIC REGRESSION

Table 4.7 : Logistic Regression		
Output Created		
Input		
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	345
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing
Syntax		LOGISTIC REGRESSION VARIABLES Y /METHOD=ENTER X1 X2 X3 X4 X5 X6 X7 X8 /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
Resources	Processor Time	00:00:00.03
	Elapsed Time	00:00:00.05

Warnings

Due to redundancies, degrees of freedom have been reduced for one or more variables.

Table 4.8 : Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	345	100.0
	Missing Cases	0	.0
	Total	345	100.0
Unselected Cases		0	.0
Total		345	100.0

a. If weight is in effect, see classification table for the total number of cases.

Table 4.9: Dependent Variable Encoding

Original Value	Internal Value
0	0
1	1

Block 0: Beginning Block

Table 4.10: Classification Table[a,b]

Observed	Predicted		
	Y		Percentage Correct
	0	1	

Step 0	Y	0	260	0	100.0
		1	85	0	.0
	Overall Percentage				75.4

a. Constant is included in the model.

b. The cut value is .500

Table 4.11: Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-1.118	.125	80.072	1	.000	.327

Table 4.12: Variables not in the Equation[a]

			Score	df	Sig.
Step 0	Variables	X1	40.574	1	.000
		X2	21.032	1	.000
		X3	.341	1	.559
		X4	8.527	1	.003
		X5	.186	1	.666
		X6	.624	1	.429
		X7	1.002	1	.317
		X8	1.604	1	.205

a. Residual Chi-Squares are not computed because of redundancies.

Variables X1 Human Resources Development/Management,X2Project Management and X4 Socio-Natural Factors will significantly affect the cost overrun of the project

Variables X3 Economic – Legal Factor,X5 Scope Management,X6 Quality and Communication Management, X7 Technical Resources Management and X8 Construction Management will not significantly affect the result or cost overrun of the project

Table 4.13: Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	66.372	7	.000
	Block	66.372	7	.000
	Model	66.372	7	.000

Table 4.14: Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	318.869[a]	.175	.260

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 4.15: Classification Table[a]

Observed			Predicted		
			Y		Percentage Correct
			0	1	
Step 1	Y	0	250	10	96.2
		1	50	35	41.2
	Overall Percentage				82.6

a. The cut value is .500

Table 4.16: Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	X1	.733	.139	27.718	1	.000	2.081
	X2	.582	.154	14.228	1	.000	1.790
	X3	.028	.142	.038	1	.846	1.028
	X4	.330	.136	5.894	1	.015	1.391
	X5	.080	.140	.332	1	.565	1.084
	X6	-.106	.142	.558	1	.455	.899
	X7	-.121	.138	.774	1	.379	.886
	Constant	-1.295	.145	79.189	1	.000	.274

a. Variable(s) entered on step 1: X1, X2, X3, X4, X5, X6, X7.

The top risk variables responsible for the project cost overrun for construction of steel plant in India are found out on the basis of regression analysis:

1. **Poor Project Risk Management**
2. **Poor Site Supervision**
3. **Poor/ill-defined Scope**
4. **Poor Conflict resolution**
5. **Poor Project Time Management**
6. **Poor Procurement Management**
7. **Lack of Financial Resources**

4.3 MAJOR FINDINGS:

4.3.1 RESEARCH OBJECTIVE - 1

What are the various risks factors responsible for cost overrun of Steel Plant Projects in India?

FINDINGS: Eight factors are established in the research using Factor Analysis.

1. **Project Management**
2. **Quality and Communication Management**
3. **Technical Resources Management**
4. **Scope Management**
5. **Human Resources Development/ Management**
6. **Construction Management**
7. **Economic – Legal Factor**
8. **Socio-Natural Factors**

4.3.2 RESEARCH OBJECTIVE - 2

To establish the interrelationship between identified factors and cost overrun responsible for the project cost overrun of steel plants in India.

FINDINGS: On the basis of Regression Analysis of the variables, following are the top variables:

1. **Poor Project Risk Management**
2. **Poor Site Supervision**
3. **Poor/ill-defined Scope**
4. **Poor Conflict resolution**
5. **Poor Project Time Management**
6. **Poor Procurement Management**
7. **Lack of Financial Resources**

The overall model is a successful fit for the purpose of understanding the relationship between the various risk factors and the Cost overrun for the construction of steel plant in India.

SUMMARY

Exploratory research was conducted for identification of variables (Phase-1).

During the risk identification phase, the list of 73 risk variables associated with construction of steel plant projects was prepared. This list of the 73 identified risk variables are as under. The 73 identified risk variables were studied in detail and reviewed by experts to shortlist them to 30 variables.

Thereafter, a structured questionnaire was developed, including the importance weights of various risks associated in terms of their effects on cost overrun for previously realized projects in India. A 5 Point **Likert's Scale** was used for rating the weight importance.

The data so generated was collected and then subsequently run through Factor Analysis to find out the seven factors that have significant contribution in the Project Cost Performance.

Factor analysis is an exploratory tool and so it should be used to guide the researcher to make various decisions. One important decision is the number of factors to extract. By Kaiser's Criterion we should extract 8 factors and this is what SPSS has done. However, this criterion is accurate when there are less than 30 variables and communalities after extraction are greater than 0.7 or when the sample size exceeds 250 and the average communality is greater than 0.6. Scree Plot can be used in such cases. Scree Plot can be produced using SPSS. The Scree Plot shown, indicating the point of inflexion on the curve. The scree plot graphs the eigenvalue against the factor number.

A set of questionnaire with 7 Factors was administered only to the experts who have been associated with the construction of steel plants. They were asked to rate the risk factors on the basis of their effects on the cost overruns. The factors so identified were rated only by the top level executives, experts and consultants having experience of more than 20 years in execution of large scale projects.

After getting the ratings from experts regression analysis using MS excel was performed.

In order to establish interrelationship between various identified risk factors and cost overrun, the factors so identified were ranked only by the top level executives, experts and consultants having experience of more than 20 years in execution of large scale projects.

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In order to identify various risk variables responsible for the project cost overrun for the construction of a steel plant in India, linear regression method was used for 7 factors obtained from objective 1.

Logistic regression is helpful to predict a categorical variable from a set of predictor variables, hence this methodology is used to establish interrelationship between various identified risk factors and cost overrun.

In order to establish interrelationship between various identified risk factors and cost overrun, the factors so identified were ranked only by the top level executives, experts and consultants having experience of more than 20 years in execution of large scale projects.

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After getting the ratings from experts regression analysis using MS excel was performed.

Components present in this are more suitable Project Risk Factors affecting Project Cost Performance in Steel Industry in an Indian perspective as because from Regression analysis of all 8factors, Factor-3 value is more close to 5 (high scale range). Hence its influence is more.

The top risk variables responsible for the project cost overrun for construction of steel plant in India are found out on the basis of regression analysis.

CHAPTER – 5

CONCLUSION & RECOMMENDATION

Abstract:

This chapter deals with the conclusion and recommendation on the research topic. Various risk factors and the results obtained from the research analysis are as mentioned.

The model in this research can refine the condition that evaluates the overall cost performance or the cost overrun in construction of a steel plant in India just by taking care of the top ten risk factors which were obtained through an in-depth research.

CHAPTER - 5

CONCLUSION & RECOMMENDATION

5.1 CONCLUSION:

The various risk factors and the results obtained from the research analysis are as mentioned below:

1. Poor Project Risk Management
2. Poor Site Supervision
3. Poor/ill-defined Scope
4. Poor Conflict resolution
5. Poor Project Time Management
6. Poor Procurement Management
7. Lack of Financial Resources

5.2 RECOMMENDATIONS

The model in this research can refine the condition that evaluates the overall cost performance or the cost overrun in construction of a steel plant in India just by taking care of the top ten risk factorswhich were obtained through an in-depth research.

Lack of Financial Resources is one of the most important factors. The projects which were nearly complete were also put on hold, due to lack of financial resources at this stage. This financial problem cause reducing productivity, increase absenteeism and affecting employer profitability. If the cost of a project exceeds the original budgeted estimated cost, construction work may have to delay until additional finance could be arranged. Claim for escalation/ idle charges may be filed for the same.

Poor Site Supervision can cause project delay and affect productivity. poor site supervision causes problem of cost overrun in construction projects. A contractor should have ability to control the site worker so the project can run smoothly. Some of the contractor did not cooperation with their site staff due to lack of communicated. A lot of problem could be arising due to communication problem between contractor site staff or employer. Contractor and site staff should solve the problems by discussing with each other.

Most infrastructure projects are victims of **change in project scope** which often lead to project delays. Scope changes during project execution create lots of problems and conflicts which results in delay of project.

Poor Project Time Management is the most significant effect of cost overrun. The absence of any define time frame for project has an impact on subsequent project plans resulting in unaccounted delays in project delivery.

Poor Project Risk Management is one of the cause for cost overrun, project risk planning to be done at the conceptualization stage itself. Poor project risk management leads to inefficient project delivery.

Poor Procurement Management is one of the causes of cost overrun in the construction project. Sometimes the demand of construction material may exceed the supply of the local market. The progress of construction may delay if the site workers are ready but without materials. Thus, contractor needs to import these construction materials from oversea. These import construction materials are expensive and delay in delivery. These materials have been not estimate in the original cost and finally lead to cost overrun for the project.

Poor Conflict resolution during execution leads to cost overruns of project. The resolution through judiciary is generally a tedious, lengthy process and sometimes even takes several years to resolve. Conflicts during project construction stage have to be resolved immediately to avoid delays.

5.3 DIRECTIONS FOR FUTURE RESEARCH

This study may be beneficial to steel plant companies planning to put up a new steel plant, either green field of brown field, expansion of existing plant, regulators, policy makers, project management consultants, designers, etc. Further research in similar way can be carried out on other major projects like power plant, cement plant, fertilizer plants and other metallurgical industries like aluminum, copper etc., both in India and abroad.

Using other methodologies on the same topic could also be researched like qualitative research, case study, mixed research etc.

Most of the major variables affecting cost overrun on major projects have been considered, but some project specific and site specific variables, which some other researched feels having an impact small or large can be further researched.

SUMMARY:

Lack of Financial Resources is one of the most important factors. The projects which were nearly complete were also put on hold, due to lack of financial resources at this stage.

Poor Site Supervision can cause project delay and affect productivity. Poor site supervision causes problem of cost overrun in construction projects.

Most infrastructure projects are victims of **change in project scope** which often lead to project delays.

Poor Project Time Management is the most significant effect of cost overrun. The absence of any define time frame for project has an impact on subsequent project plans resulting in unaccounted delays in project delivery.

Poor Project Risk Management is one of the causes for cost overrun, project risk planning to be done at the conceptualization stage itself. Poor project risk management leads to inefficient project delivery.

Poor Procurement Management is one of the causes of cost overrun in the construction project. Sometimes the demand of construction material may exceed the supply of the local market. The progress of construction may delay if the site workers are ready but without materials.

Poor Conflict resolution during execution leads to cost overruns of project. Conflicts during project construction stage have to be resolved immediately to avoid delays.

This study may be beneficial to steel plant companies planning to put up a new steel plant, either green field of brown field, expansion of existing plant, regulators, policy makers, project management consultants, designers, etc.

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Annexure: I QUESTIONNAIRE

Identifying Project Risk Factors Affecting Project Cost Performance in Steel Industry: An Indian Perspective

Dear Sir/ Ma'am,
Warm Greetings,

I am Ganesh Vishwakarma, Doctoral Research Fellow at University of Petroleum & Energy Studies (UPES), currently pursuing PhD in the field of Risk Management in Steel Plant. The purpose of this study is to Identify Project Risk Factors Affecting Project Cost Performance in Steel Industry: An Indian Perspective.
I shall be grateful for your valuable response on the suggested questionnaire. I assure, this response will be used for academic purpose only and will be confidential. Your inputs undoubtedly will help me in validating the variables and will go a long way in carrying out this study effectively.

Kindly provide your personal details

Name: ____
Email ID: ____
Designation: _______________________________________
Phone Number: _____________________________________
Organization: _______________________________________
Location: ____
Please read each question given below & indicate your response by marking against the preferred option.

Point Likert Scale was used for rating the weight importance.

S. No.	Scale	Range of Cost Overrun Percentage
1.	Very Low (1)	Actual Overrun ≤ 20%
2.	Low (2)	20% < Actual Overrun ≤ 40%
3.	Medium (3)	40% < Actual Overrun ≤ 60%
4.	High (4)	60% < Actual Overrun ≤ 80%
5.	Very High (5)	80% < Actual Overrun

SECTION 1

This section covers the Economy related variables that affects Project cost performance in steel industry.

Top of Form

1. Instability of Economic Condition

*Help Text: Economic condition covers change in currency rate, Change in Economic indicators, Change in Taxation Policies

● 1 ● 2 ● 3 ● 4
● 5

2. Changes in forex rate

● 1 ● 2 ● 3 ● 4
● 5

3. Fluctuations in cost of fuel/energy prices

*Help Text: Here fuel prices means diesel/petrol/other prices

● 1 ● 2 ● 3 ● 4
● 5

SECTION 2

This section covers the problems faced by steel project due to Government structuring, policies and relations

4. Instability of Government

*Help Text: Changes of Government, Changes in Ministry and other internal management changes

● 1 ● 2 ● 3 ● 4
● 5

5. Instability of International Import

*Help Text: Fluctuations in import

- 1
- 2
- 3
- 4
- 5

6. Bureaucratic Delay regarding clearance/decision

*Help Text: Acceptance, delay or hold

- 1
- 2
- 3
- 4
- 5

7. Complexity of Legal System

- 1
- 2
- 3
- 4
- 5

8. Change in Taxation Policy

- 1
- 2
- 3
- 4
- 5

SECTION 3

This section covers the problems faced by steel projects due to Manpower issues. *Help text: Manpower issue covers skilled manpower availability including engineers/ supervisors with relevant experience.

9. Unavailability of Local Skilled Labor

- 1
- 2
- 3
- 4
- 5

10. Unavailability of Local Skilled Subcontractors

- 1
- 2
- 3
- 4
- 5

11. Technical Incompetency of Engineer

- 1
- 2
- 3
- 4
- 5

12. Managerial Incompetency of Engineer

- 1
- 2
- 3
- 4
- 5

13. Lack of skilled Staff with the Contractor’s

- 1
- 2
- 3
- 4
- 5

SECTION 4

This section covers the problems faced by steel projects due to Steel Project complex engineering design issues

14. Low Constructability

*Help Text: Detail Engineering/Basic Engineering issues

- 1
- 2
- 3
- 4
- 5

15. Complexity of Construction Method

*Help Text: Complexity of method may result less accurate completion

- 1
- 2
- 3
- 4
- 5

16. Strict Quality Requirements

*Help Text: Quality in terms of engineering and design

- 1
- 2
- 3
- 4
- 5

SECTION 5

This section covers the problems faced by steel projects due to Project Management

17. Strict Project Management Requirements

- 1
- 2
- 3
- 4
- 5

18. Lack of Financial Resources

*Help Text: Unstructured cash flow or non-availability of funds

- 1
- 2
- 3
- 4
- 5

19. Poor Site Supervision

- 1
- 2
- 3
- 4
- 5

20. Poor/ill-defined Scope

- 1
- 2
- 3
- 4
- 5

21. Poor Project Time Management

- 1
- 2
- 3
- 4
- 5

22. Poor Project Cost Management of the contractor

- 1
- 2
- 3
- 4
- 5

23. Poor Project Quality Management

- 1
- 2
- 3
- 4
- 5

24. Poor Communication

- 1
- 2
- 3
- 4
- 5

25. Poor Project Risk Management

- 1
- 2
- 3
- 4
- 5

26. Poor Procurement Management

- 1
- 2
- 3
- 4
- 5

27. Poor Conflict resolution

- 1
- 2
- 3
- 4
- 5

SECTION 6

This section covers the problems faced by steel project due to contract clauses and contractors issues

28. Contractor's Lack of expertise in Similar Projects

*Help Text: Contractor's relevant work experience

- 1
- 2
- 3
- 4
- 5

29. Contractor's Lack of Experience in the Country

- 1
- 2
- 3
- 4
- 5

30. Contractor’s Lack of Experience with Client

*Help Text: Mutual understanding with client

- 1
- 2
- 3
- 4
- 5

31. Contractor’s Lack of Financial Resources

- 1
- 2
- 3
- 4
- 5

32. Contractor’s Lack of Technical Resources

- 1
- 2
- 3
- 4
- 5

SECTION 7

This section covers the problems faced by steel project due to Site constraints

33. Unavailability of Local Mineral Material

- 1
- 2
- 3
- 4
- 5

34. Unavailability of earth moving/lifting Equipment locally

- 1
- 2
- 3
- 4
- 5

35. Uncertainty of Geotechnical Condition

*Help Text: Geotechnical uncertainty during project

- 1
- 2
- 3
- 4
- 5

36. Lack of testing Facilities

*Help Text: Test lab on field, can be strength or other

- 1
- 2
- 3
- 4
- 5

37. Change in Availability of Subcontractors

*Help Text: Subcontractor change

- 1
- 2
- 3
- 4
- 5

38. Change in Geological Conditions

- 1
- 2
- 3
- 4
- 5

SECTION 8

This section covers the problems faced by steel project due to Human Resource
***Help Text: Human Resource Management is for educated executives**

39. Poor Human Resources Management

- 1
- 2
- 3
- 4
- 5

40. Change in Client's Staff/Organization dealing with local public/administration

- 1
- 2
- 3
- 4
- 5

SECTION 9

This section covers the problems faced by steel project due to Client issues

41. Change in Financial Situation of Client

- 1
- 2
- 3
- 4
- 5

42. Scope Changes

*Help Text: Ambiguous contract requirement

- 1
- 2
- 3
- 4
- 5

43. Change in Site/Project Organization

- 1
- 2
- 3
- 4
- 5

44. Increase/decrease in quantity of Work

- 1
- 2
- 3
- 4
- 5

SECTION 10

This section covers the problems faced by steel project due to Force Majure

45. Social unrest

*Help Text: Related to land owners, traders, other related/intermediary persons

- 1
- 2
- 3
- 4
- 5

46. Rebellion/ Terrorism/ Naxelism

- 1
- 2
- 3
- 4
- 5

47. Natural Catastrophes

- 1
- 2
- 3
- 4
- 5

48. Fire/Theft and other possible unwanted events

- 1
- 2
- 3
- 4
- 5

Annexure: II QUESTIONNAIRE

Identifying Project Risk Factors Affecting Project Cost Performance in Steel Industry: An Indian Perspective

Dear Sir/Ma'am,

Warm Greetings,

I am Ganesh Vishwakarma, Doctoral Research Fellow at University of Petroleum & Energy Studies (UPES), currently pursuing PhD in the field of Risk Management in Steel Plant. The purpose of this study is to Identify Project Risk Factors Affecting Project Cost Performance in Steel Industry: An Indian Perspective.
I shall be grateful for your valuable response on the suggested questionnaire. I assure, this response will be used for academic purpose only and will be confidential. Your inputs undoubtedly will help me in validating the variables and will go a long way in carrying out this study effectively.

Kindly provide your personal details

Name

Company Name

Desingnation

Number of Years Experience in industries

Please read each question given below & indicate your response by marking against the preferred option.

Point Likert Scale was used for rating the weight importance.

S. No.	Scale	Range of Cost Overrun Percentage
1.	Very Low (1)	Actual Overrun ≤ 20%

2.	Low (2)	20% < Actual Overrun ≤ 40%
3.	Medium (3)	40% < Actual Overrun ≤ 60%
4.	High (4)	60% < Actual Overrun ≤ 80%
5.	Very High (5)	80% < Actual Overrun

Factor A : Human Resources Development/Management – Corresponds to

1. Poor Human Resources Management
2. Managerial Incompetency of Engineer
3. Change in Client's Staff/Organization dealing with local public/administration
4. Lack of skilled Staff with the Contractor's

- 1
- 2
- 3
- 4
- 5

Factor B : Project Management – Corresponds to

1. Poor Project Risk Management
2. Poor Site Supervision
3. Poor/ill-defined Scope
4. Poor Conflict resolution
5. Poor Project Time Management
6. Poor Procurement Management
7. Lack of Financial Resources

- 1
- 2
- 3
- 4
- 5

Factor C: Economic – Legal Factor - Corresponds to

1. Complexity of Legal System
2. Instability of Economic Condition
3. Changes in forex rate
4. Fire/Theft and other possible unwanted events

- 1
- 2
- 3
- 4
- 5

Factor D: Socio-Natural Factors - Corresponds to

1. Rebellion/ Terrorism/ Naxalism
2. Natural Catastrophes

● 1 ● 2 ● 3 ● 4
● 5

Factor E: Scope Management - Corresponds to

1. Scope Changes

● 1 ● 2 ● 3 ● 4
● 5

Factor F: Quality and Communication Management - Corresponds to

1. Poor Project Quality Management
2. Poor Communication

● 1 ● 2 ● 3 ● 4
● 5

Factor G: Technical Resources Management - Corresponds to

1. Contractor's Lack of Technical Resources

● 1 ● 2 ● 3 ● 4
● 5

Factor H: Construction Management - Corresponds to

1. Low Constructability
2. Complexity of Construction Method

● 1 ● 2 ● 3 ● 4
● 5

ANNEXURE III: SPSS OUTPUT FILE

Factors with Loading

SL.No.	Factor	Loadings	
1	FACTOR 1	39. Poor Human Resources Management	.660
		12. Managerial Incompetency of Engineer	.635
		40. Change in Client's Staff/Organization dealing with local public/administration	.575
		13. Lack of skilled Staff with the Contractor's	.535
2	FACTOR 2	25. Poor Project Risk Management	.645
		19. Poor Site Supervision	.611
		20. Poor/ill-defined Scope	.608
		27. Poor Conflict resolution	.546
		21. Poor Project Time Management	.544
		26. Poor Procurement Management	.514
		18. Lack of Financial Resources	.509
3	FACTOR 3	7. Complexity of Legal System	.749
		1. Instability of Economic Condition	.711
		2. Changes in forex rate	.618
		48. Fire/Theft and other possible unwanted events	.617
4	FACTOR 4	46. Rebellion/ Terrorism/ Naxelism	.610
		47. Natural Catastrophes	.592
5	FACTOR 5	42. Scope Changes	.671
6	FACTOR 6	23. Poor Project Quality Management	.688
		24. Poor Communication	.565
7	FACTOR 7	32. Contractor's Lack of Technical Resources	.567
8	FACTOR 8	14. Low Constructability	.576
		15. Complexity of Construction Method	.528

	Factor							
	1	2	3	4	5	6	7	8
39. Poor Human Resources Management	.660							
12. Managerial Incompetency of Engineer	.635							
40. Change in Client's Staff/Organization dealing with local public/administration	.575							
13. Lack of skilled Staff with the Contractor's	.535							
9. Unavailability of Local Skilled Labor								
11. Technical Incompetency of Engineer								
38. Change in Geological Conditions								
36. Lack of testing Facilities								
5. Instability of International Import								
17. Strict Project Management Requirements								
25. Poor Project Risk Management		.645						
19. Poor Site Supervision		.611						
20. Poor/ill-defined Scope		.608						
27. Poor Conflict resolution		.546						
21. Poor Project Time Management		.544						
26. Poor Procurement Management		.514						
18. Lack of Financial Resources		.509						

41. Change in Financial Situation of Client								
22. Poor Project Cost Management of the contractor								
30. Contractor's Lack of Experience with Client								
10. Unavailability of Local Skilled Subcontractors								
28. Contractor's Lack of expertise in Similar Projects								
33. Unavailability of Local Mineral Material								
3. Fluctuations in cost of fuel/energy prices								
7. Complexity of Legal System			.749					
1. Instability of Economic Condition			.711					
2. Changes in forex rate			.618					
48. Fire/Theft and other possible unwanted events			.617					
8. Change in Taxation Policy								
4. Instability of Government								
6. Bureaucratic Delay regarding clearance/decision								
35. Uncertainty of Geotechnical Condition								
45. Social unrest								
29. Contractor's Lack of Experience in the Country								
37. Change in Availability of Subcontractors								

43. Change in Site/Project Organization								
44. Increase/decrease in quantity of Work								
34. Unavailability of earth moving/lifting Equipment locally								
23. Poor Project Quality Management						.688		
24. Poor Communication						.565		
32. Contractor’s Lack of Technical Resources							.567	
31. Contractor’s Lack of Financial Resources								
14. Low Constructability								.576
15. Complexity of Construction Method								.528
16. Strict Quality Requirements								

Extraction Method: Maximum Likelihood.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 15 iterations.

ANNEXURE IV: ANALYZING FACTORS USING REGRESSION METHOD

Name	Company Name	Designation	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8
N. G. Banerjee	MESCO Ltd.	E.D.	5	3	5	4	3	2	3	2
Bhaskar JV	RINL	DGM	5	3	4	4	4	2	3	2
N K Paul	MECON Ltd	DGM	4	4	5	3	2	1	2	1
T K Raman	SEW Infra Str Ltd	President	4	4	5	3	2	2	2	1
Ganapati Rao IV	RINL	DGM	5	4	5	3	2	2	2	1
Anjan Roy	M N Datur & Co.	Director	5	4	5	3	2	2	2	1
T Bhattacharya	MECON Ltd	GM	5	4	5	4	3	2	3	2
S K Verma	MECON Ltd	DGM	5	4	5	4	3	2	2	2
Swapan Mitra	TPL	DGM	5	4	5	4	3	2	2	2
N Balakrishnan	MECON Ltd	E.D.	5	4	5	4	3	2	2	2
Narasimha Rao	RINL	DGM	4	4	5	3	2	2	2	1
K S N Murthy	NMDC Ltd	Jt. GM.	5	4	5	3	2	2	2	1
A Rajshekharan	MECON Ltd	DGM	4	4	5	3	2	1	2	1
A P Singh	MECON Ltd	GM	4	4	5	3	2	1	2	1
B K Samal	MECON Ltd	DGM	5	3	5	4	4	2	3	2
Y K Singh	BEC	GM	5	3	4	4	3	2	3	2
P K Roy Sinha	MECON Ltd	DGM	5	4	5	4	3	2	2	2
R Jha	MECON Ltd	DGM	4	4	5	3	2	1	2	1

Joshi AD	RINL	DGM	4	4	5	3	2	2	2	1
Jain MK	RINL	DGM	5	4	5	3	2	2	2	1
S A Siddhiqui	MECON Ltd	E.D.	5	4	5	4	3	2	3	2
S K Chaurasiya	NMDC Ltd	Jt. GM.	5	3	5	4	3	2	3	2
B N Singh	MECON Ltd	DGM	5	3	5	4	4	2	3	2
S K Singh	MECON Ltd	DGM	5	3	4	4	4	2	3	2
A K Srivastava	SAIL	GM	5	3	4	4	3	2	3	2
K N Murthy	SAVVY Projects pvt ltd	Director	5	3	4	4	4	2	3	2
A Nagarajan	Shriram EPC	Regional Director	5	4	5	4	3	2	2	2
S K Gupta	BEC	GM	4	4	5	3	2	2	2	1
S Thakur	MECON Ltd	DGM	5	4	5	3	2	2	2	1
Kanai Ghosh	BOC I Ltd	Sr. PM	4	4	5	3	2	1	2	1
Rana S Chakraborthy	MECON Ltd	DGM	4	4	5	3	2	2	2	1
Sanjeev Joshi	Techpro System Ltd	GM	5	4	5	3	3	2	2	2
S Sinha	MECON Ltd	DGM	5	4	5	4	3	2	2	2
Abhijit kumar Ghosh	ELECON Engg CO Ltd	GM	5	3	4	4	3	2	3	2
Sourav Sen Gupta	BOC I Ltd	PM	5	3	5	4	4	2	3	2
J P Verma	MECON Ltd	GM	5	3	4	4	4	2	3	2
S K Sinha	MECON Ltd	DGM	5	4	5	4	3	2	3	2
Poyyamozhi V	JSW	VP	4	4	5	3	2	1	2	1
Raghav Rao V	RINL	DGM	4	4	5	3	2	1	2	1

B K Choudhary	NINL	E.D.	5	4	5	3	2	2	2	1
S K Srivastava	Bhushan Steel Pvt Ltd	DGM	5	4	5	4	3	2	2	2
H K Desai	SAIL	DGM	5	4	5	4	3	2	2	2
P B Neogi	MECON Ltd	DGM	4	4	5	3	2	1	2	1
N K Thakur	MECON Ltd	DGM	5	4	5	3	2	2	2	1
Kirpal Singh	KEC Int. Pvt. ltd	PM	5	4	5	4	3	2	2	2
M Saini	MECON Ltd	DGM	5	3	5	4	4	2	3	2
S C Prasad	MECON Ltd	DGM	4	4	5	3	2	1	2	1
Annam Ramesh	JSW	GM	5	3	5	4	4	2	3	2
Rajiv Jain	BEC	E.D.	5	3	5	4	4	2	3	2
S S Shekhawat	Mecon Ltd	GM	5	4	5	4	3	2	3	2
J Vikram	Viswa Infra Pvt Ltd	Director	5	3	4	4	3	2	3	2
U K Vishwakarma	Mecon Ltd	DGM	5	4	5	3	2	2	2	1
Raghavendra Rao G	RINL	DGM	4	4	5	3	2	1	2	1
Rajendra PM	JSW	Sr.VP	4	4	5	3	2	1	2	1
S Pandey	Mecon Ltd	DGM	4	4	5	3	2	2	2	1
H M Bengani	BOC India Ltd	GM	4	4	5	3	2	1	2	1
Rajashekar P	JSW	Sr,.VP	4	4	5	3	2	1	2	1

S.N.	Factors	Coefficients		Predicted Value (y) = mx+c	Sequencing of Factors based on y value	Components
		intercept - C	m			
1	**Factor 3**	4.81278195	0.0015038	4.81+0.002x	1	1. Lack of Financial Resources 2. Poor Site Supervision 3. Poor/ill-defined Scope 4. Poor Project Time Management 5. Poor Project Risk Management 6. Poor Procurement Management 7. Poor Conflict resolution
2	**Factor 1**	4.76657553	-0.003589	4.77-0.004x	2	1. Lack of skilled Staff with the Contractor's 2. Poor Project Quality Management 3. Poor Communication 4. Unavailability of earth moving/lifting Equipment locally 5. Uncertainty of Geotechnical Condition 6. Lack of testing Facilities

3	**Factor 2**	3.7512987	-0.000649	3.75 -0.001x	3	1. Instability of Economic Condition 2. Changes in forex rate 3. Change in Geological Conditions 4. Social unrest 5. Rebellion/ Terrorism/ Naxelism 6. Natural Catastrophes 7. Fire/Theft and other possible unwanted events
4	**Factor 4**	3.55444293	-0.001846	3.55 -0.002x	4	1. Instability of Government 2. Instability of International Import 3. Contractor's Lack of Experience in the Country 4. Poor Human Resources Management 5. Change in Client's Staff/Organization dealing with local public/administration
5	**Factor 5**	2.72768284	-0.001059	2.73-0.001x	5	1. Contractor's Lack of Financial Resources 2. Contractor's Lack of Technical Resources

6	**Factor 7**	2.32617908	0.0004443	2.32+0.0004x	6	1. Scope Changes 2. Change in Site/Project Organization
7	**Factor 6**	1.93219412	-0.005571	1.93-0.006x	7	1. Complexity of Legal System 2. Change in Taxation Policy 3. Unavailability of Local Skilled Labor
8	**Factor 8**	1.56725906	-0.001675	1.57-0.002x	8	1. Bureaucratic Delay regarding clearance/decisi on 2. Low Constructability 3. Complexity of Construction Method 4. Strict Quality Requirements

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Letter of Approval

Date: 18th March, 2013

This is to certify that SAP ID. **500011108**, **Ganesh Vishwakarma**, Scholar Part-time PhD (Management) with the University of Petroleum & Energy Studies had presented his **Abstract** in the FRC meeting held on **2nd March 2013** chaired by **Dr. Anirban Sen Gupta, Chairman FRC and Dean, College of Management Studies**. His **Abstract** on the topic **"Project Risk Analysis for Steel Projects "** has been **Approved** as on date under the guidance of Internal Guide **Dr MS Pahwa.**

Abstract of **Ganesh Vishwakarma** was duly **Approved** by the members present in the FRC meeting.

Convener

Dr Amitabh Bhattacharya

Controller of Examination

C.C to Internal Guide

Corporate Office : Hydrocarbons Education & Research Society
3rd Floor, PHD House, 4/2 Siri Institutional Area, August Kranti Marg,
New Delhi 110 016 India Ph.: +91 11.41730151-53 Fax : +91.11.41730154

Campus : Energy Acres, P.O. Bidholi Via Prem Nagar,
Dehradun 248007 (Uttarakhand) India
Ph.: +91.135.2776201,2776061,2776091,95 Fax : +91.135.2776090

URL : www.upes.ac.in

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CENTRE FOR CONTINUING EDUCATION

RESULT SHEET OF PH.D. COURSE WORK

Date: 17.09.2012

Enrolment No./SAP id: 500011108

Course : Ph.D. Management

Name of the Student: Ganesh Vishwakarma

Year of Registration: Jan 2010

RESULT DETAILS:

SL.NO	COURSE WORK	MAXIMUM MARKS	MARKS OBTAINED	STATUS (QUALIFIED/ NOT QUALIFIED
1	COMPETITIVE INTELLIGENCE	100	56	QUALIFIED
2	FINANCIAL MANAGEMENT	100	80	QUALIFIED
3	LOGISTICS & SUPPLY CHAIN MANAGEMENT	100	54	QUALIFIED
4	MARKETING MANAGEMENT	100	57	QUALIFIED
5	PROJECT MANAGEMENT	100	51	QUALIFIED
6	RESEARCH METHODOLOGY	100	69	QUALIFIED
	Aggregate % of Marks		61.17	

Overall Result: Qualified

Every Research Scholar shall obtain at least 50% marks in each individual course and at least 60% marks in aggregate across all the courses to successfully complete the Ph.D. Course Work Examination.

Prepared By : ____________

Checked By : ____________

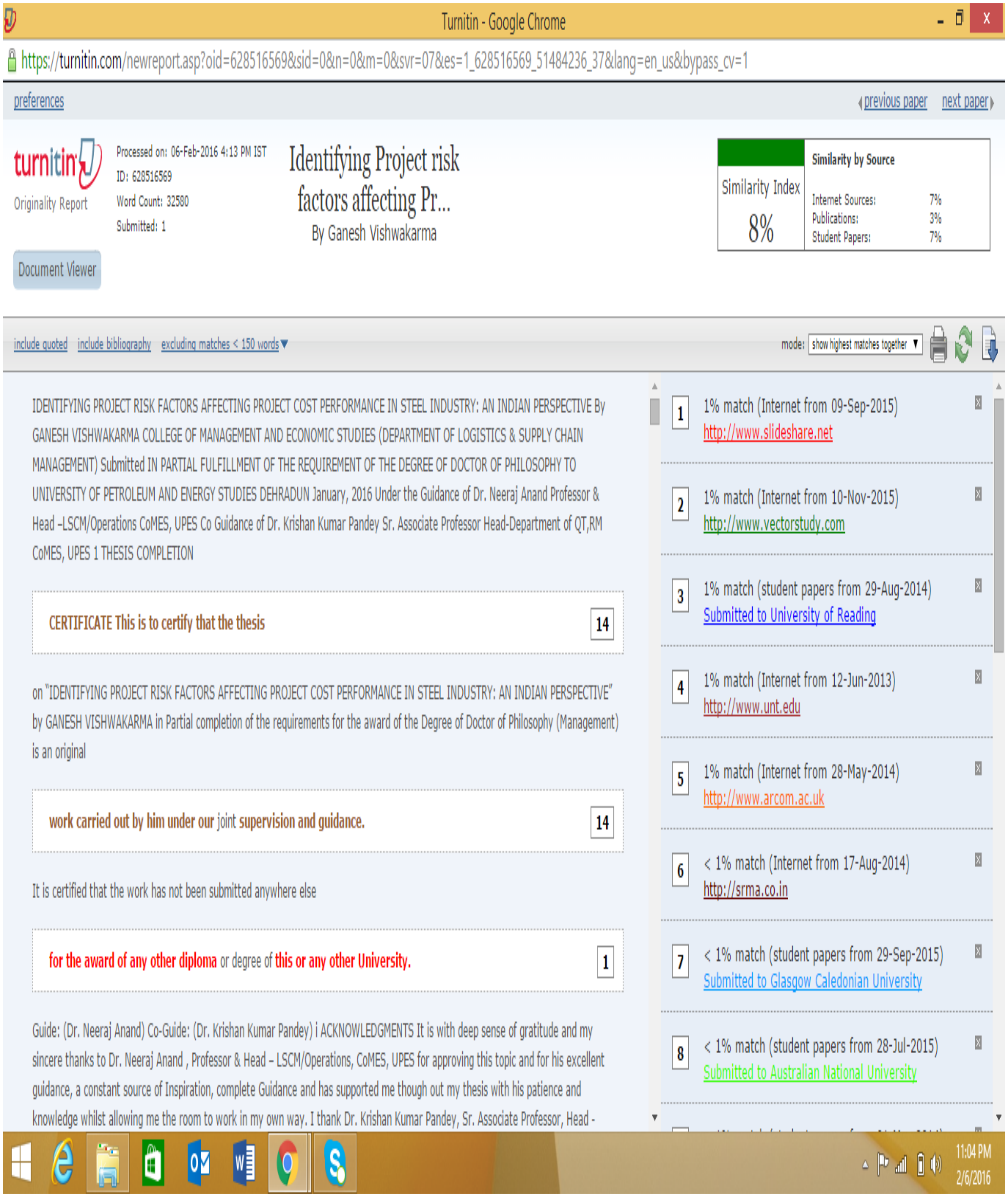
Authorized Signatory

Student Record & Evaluation Department

Corporate Office : Hydrocarbons Education & Research Society
3rd Floor, PHD House, 4/2 Siri Institutional Area,August Kranti Marg,
New Delhi 110 016 India Ph.: +91 11 41730151-53 Fax : +91.11.41730154

Campus : Energy Acres, P.O. Bidholi Via Prem Nagar,
Dehradun 248007 (Uttarakhand) India
Ph.: +91 135 2776201,2776061,2776091,95 Fax : +91 135 2776090

URL : www.upes.ac.in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IDENTIFYING PROJECT RISK FACTORS AFFECTING PROJECT COST PERFORMANCE IN STEEL INDUSTRY: AN INDIAN PERSPECTIVE By GANESH VISHWAKARMA COLLEGE OF MANAGEMENT AND ECONOMIC STUDIES (DEPARTMENT OF LOGISTICS & SUPPLY CHAIN MANAGEMENT) Submitted IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE DEGREE OF DOCTOR OF PHILOSOPHY TO UNIVERSITY OF PETROLEUM AND ENERGY STUDIES DEHRADUN January, 2016 Under the Guidance of Dr. Neeraj Anand Professor & Head -LSCM/Operations CoMES, UPES Co Guidance of Dr. Krishan Kumar Pandey Sr. Associate Professor Head-Department of QT,RM CoMES, UPES 1 THESIS COMPLETION
CERTIFICATE This is to certify that the thesis 14
on "IDENTIFYING PROJECT RISK FACTORS AFFECTING PROJECT COST PERFORMANCE IN STEEL INDUSTRY: AN INDIAN PERSPECTIVE" by GANESH VISHWAKARMA in Partial completion of the requirements for the award of the Degree of Doctor of Philosophy (Management) is an original
work carried out by him under our joint supervision and guidance. 14
It is certified that the work has not been submitted anywhere else
for the award of any other diploma or degree of this or any other University. 1
Guide: (Dr. Neeraj Anand) Co-Guide: (Dr. Krishan Kumar Pandey) i ACKNOWLEDGMENTS It is with deep sense of gratitude and my sincere thanks to Dr. Neeraj Anand , Professor & Head - LSCM/Operations, CoMES, UPES for approving this topic and for his excellent guidance, a constant source of Inspiration, complete Guidance and has supported me though out my thesis with his patience and knowledge whilst allowing me the room to work in my own way. I thank Dr. Krishan Kumar Pandey, Sr. Associate Professor, Head -
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