FACTORS RESPONSIBLE FOR TIME AND COST OVERRUN IN HIGHWAY CONSTRUCTION PROJECTS: INDIA

A DISSERTATION

Submitted in partial fulfillment of the requirements
for the award of the degree
of
MASTER OF TECHNOLOGY
In
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By

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CANDIDATE'S DECLARATION

I hereby declare that the work carried out in the dissertation report entitled **" Factors responsible for time and cost overrun in highway construction Projects: India"** is presented in partial fulfillment of the requirements for the award of degree of **"Master of Technology"** In Infrastructure Systems ,submitted to the Centre of Excellence in Transportation Systems, Indian Institute of Technology, Roorkee , under the guidance of Dr. A Ramesh at Centre of Excellence in Transportation Systems(CTRANS).

Date: 22.05.2016 **(Rajat Kumar Kanaujia)**
Place: Roorkee

This is to certify that above statement made by the candidate is correct to the best of my knowledge and belief.

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My thanks and appreciation also goes to almighty, my parents and those who have willingly helped me out with their abilities.

ABSTRACT

As infrastructure is the backbone of a country and plays an important role in the growth of the economy of the country. But the problem of the delays and cost overrun is the main problem in India which is hindering the performance of the projects and affecting the economy in the negative way.

This study was carried out with aim to find out the most critical factors which are responsible for the time and cost overrun in highway construction projects which would help to sort out the problem of the time and cost overruns and ensure the timely completion of projects. The research was done by carried out the questionnaire survey and personal interviews of the professionals who are experienced in this field. The prioritization of factors was done after checking the difference in the perceptions of the different stakeholder organization. The factors were prioritizing from most critical to the desirable factors. A binary logistic model was also developed to check the probability that whether the project was within time and cost or not by comparing the dividing the respondents into two categories namely, one who have handled projects which were completed on time and within cost and other who have handled projects with time and cost overrun.

Table of contents

LIST OF FIGURES

LIST OF TABLES

Chapter 1

INTRODUCTION

1.1. Highway infrastructure in India

Introduction

The road network of India is second largest in the world with total length of 5.4million km. This highway network contributes to transport more than 60 percent of goods and 85 percent of total passenger's traffic. The highway transportation sector has increased gradually over the years with improved connectivity between cities, villages and towns in the country.

The highways in India carry almost 91 percent of the Indian passenger traffic and around 65 percent of freight. India shows a rapid growth in sales of automobiles and movement of freight by highways.

Table1.1.classification of roads

Source: Economic Survey 2017-18

Market Size

The growth in transport infrastructure sector in India is expected to grow at 6.1 % in real terms in 2017 and compounded annual growth of 5.9 % through the year 2021, thereby highway sector becoming the fastest expanding component of the infrastructure sector in India.

The highways construction reached 8142 km during FY 2016-2017, with an all time high average pace of 22.3 km per day. In the starting two months of FY 2016-17, a total of 1,627 km was constructed at an average rate of 26.3 km per day.

Total length of highways constructed under Prime minister's Gram sadak Yojna was 47,448 km in 2017-18.

1.2. Current status of NHDP:

NHDP phase/Year of approval	Project description	Total length	Cost	Development model
Phase I/December 2000	Development of Golden Quardilteral, North South and East West (NS-EW) corridor, port connectivity and other national highways	13,390	US$5.6 Billion	EPC
Phase II/December 2003	Development of North South and east west (NS-EW) corridor and other National Highways	7,142	US$6.3 Billion	EPC
Phase III/April 2007	Development of 4-lane National Highways	12,109	US$18.5 Billion	PPP(BOT)
Phase IV/ February 2012	Upgradation of single lane to 2-lane	20,000	US$12 Billion	PPP
Phase V / October 2006	Upgradation of 4-lane highways to 6-lane and port connectivity	6,500	US$9.3 Billion	PPP
Phase VI/November 2006	Development of expressway. The project is targeted to be completed by December 2015	1,000	US$3.8 Billion	PPP(DBFO)
Phase VII/December 2007	Development of ring highways, bypass and flyovers	700	US$ 4.2 Billion	PPP(BOT)

Table1.2. Status of NHDP

Source: NHAI, Aranca Research

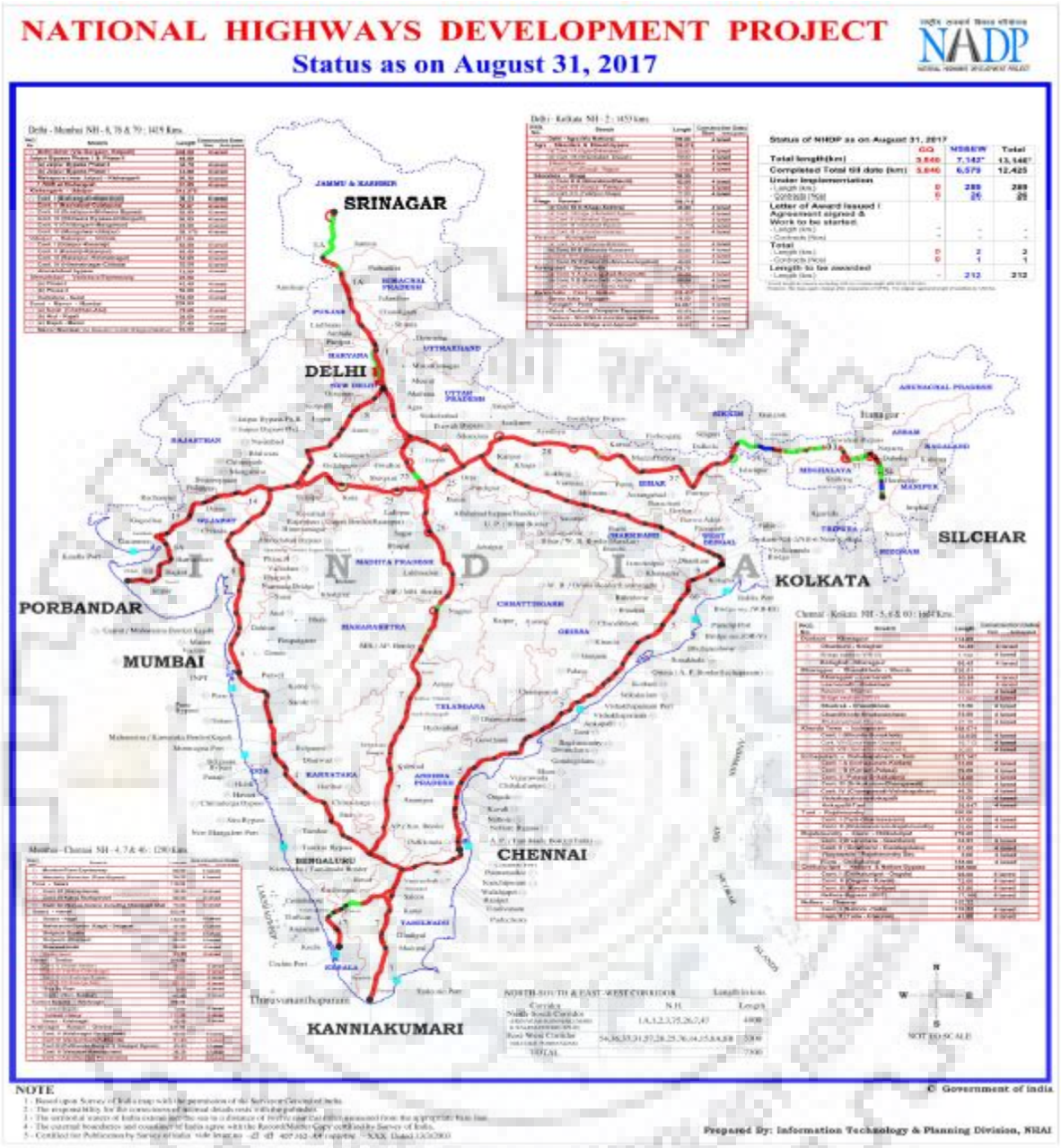

Figure1.1 NHDP project

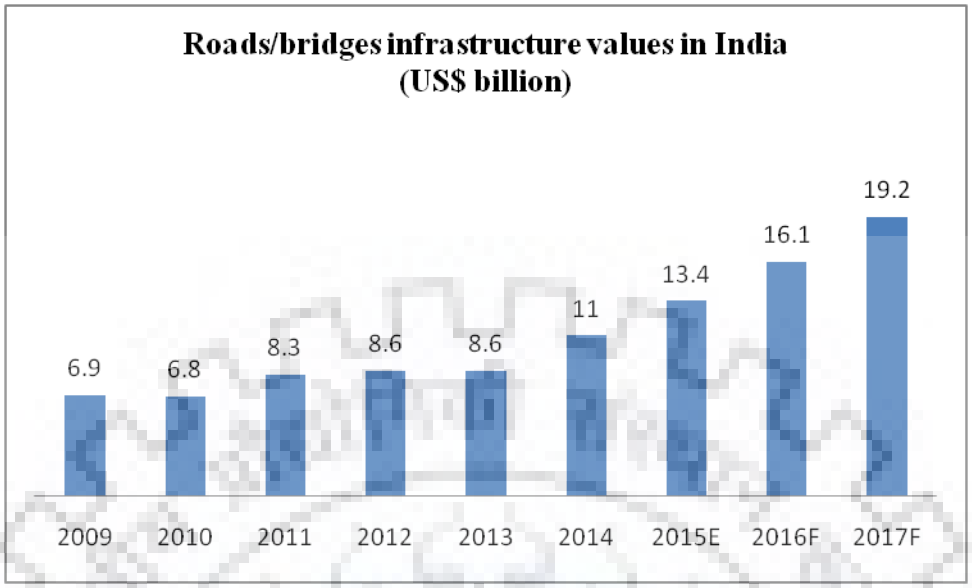

Fig 1.2

Source: ibef report 2018

The total value of highway and bridge infrastructure is expected to expand at a CAGR of 13.6 percent in FY09-17 to US$ 19.2 billion.

1.3. Time and cost overrun:

Indian infrastructure projects are famous for delays and cost overruns. Many reports have instances of prolonged delays and cost overrun in infrastructure projects .According to a report in "THE ECONOMIC TIMES" on 23 Dec 2106 the total cost of 1,174 infrastructure projects worth Rs 150 Crore and above Rs 150 Crore monitored by the Statistics Ministry shows an overrun by Rs 1.7 lakh Crore to Rs 16 lakh Crore due to delays because of many reasons which include land acquisition, green clearances and utility shifting. The anticipated completion cost of 1174 infrastructure projects with worth Rs 150 Crore and above was Rs 16 lakh Crore compared in September 2016 to original cost of Rs 14.4 lakh Crore. 1174 on-going projects were monitored by MOSPI with the total original cost of Rs 14, 46,253 Crore and their anticipated completion cost of Rs 16,16,457 Crore. Out of these, 431 projects of highways sector, 355 of railway sector. The main reasons, as reported by the project implementing agencies, for delay in timely completion of these projects are law and order problems, delay in environment and forest clearances, fund constraints, delay in land acquisition rehabilitation and resettlement issues, local body /municipal permissions, utility shifting, contractual issues, etc. The main reasons for delay in timely completion of the projects are law and order problems, delay in land acquisition, delay in environment and forest clearances, fund constraints, rehabilitation and resettlement issues, local body or municipal permissions, utility shifting, contractual issues, etc. As on December 9, 2016 PMG has accepted 837 projects with anticipated investment of Rs 35 lakh Crore for resolution of various issues related to delay the execution of the project with aim of fast tracking the approvals for setting up and expeditious commissioning of large Public Private and projects. Out of these, 209 projects 78 Highway Transport and Highways projects of Rs 1.44

lakh Crore,51 Railway projects of Rs 2.06 lakh Crore under the consideration of PMG. Only a small number of projects in India are completed within time for example successful implementation of the construction of Delhi metro. Problem of time and cost overrun in India is very vast and severe .But very less techniques are available for this to overcome , due to which causes behind the time and cost overrun have remained under research till date.

Time and cost overrun has significant implications from economical and political point of view. Due to delays in the project implementation, people and the economy have to wait for provisions of public goods longer than required. Therefore time dealy limits the growth potential of the industry. Similarly cost escalation effects the competitiveness of the economy. Services provided by these infrastructure projects serves as input for other sectors .Therefore cost overrun leads to increase in cost-output-ratio of the whole economy and it affects the efficiency of available economic resources and the growth potential of entire economy of a country get limited. Most Indian infrastructure projects are funded by taxpayers' money. So taxpayers should know that how efficiently their income is utilized by the officials while making the provisions of public goods and services. In the absence of proper knowledge and understanding of the causes behind time and cost overruns there is a risk that the perception of officials will not be good and they misguide the policy making in one or more ways. For example, perception that the public sector is not capable of delivering public goods in time and on cost may results in excessive privatization of projects.. The absence of comprehensive India, centric studies apart from this there is availability of a large theoretical and empirical literature on the subject. It suggests that time and cost overruns are basic to transportation infrastructure projects and are present at global level including India. However, the past studies also suggest that the causes and remedies vary from country to country. Therefore there is only much that can be learnt from international experiences, further underscoring the need for a systematic India-based study. The international literature is not helpful for delays and cost overruns observation in India. Several Indian researchers have made interesting contribution. But from their work very few works are empirical studies, most of them are based on case studies. No doubt case studies are helpful in explaining particular instances but they have limited capacity to locate us about the internal problem in the transportation infrastructure system. The main causes behind time and cost overruns in India and their statistical significance have not proven till date.

1.4. Schedule delays:

Schedule delay is a situation in which the construction project does not come to completion within the planned duration. Time is an important part of every contract work .construction projects frequently experience time overrun. Various factors affect completion periods of these projects. There is need to find out the causes of project delays and cost overruns their frequency and their affect to the project delivery. According to Ahmed et al. Delays can be grouped in the following four categories depending on their contractual operation:

- non-excusable delays
- non-compensable excusable delays
- compensable excusable delays
- concurrent delays

The most significant factors influencing construction schedules of infrastructure projects are financing difficulties and payment for completed works, poor contract management by contractor , changes in site conditions than it is mentioned in contract , shortage of materials, and improper

planning, delay included approval of working drawings by consultant, delays in payments to contractors by client and the resulting cash-flow problems during construction, design changes during project, conflicts in work schedules of subcontractors, slow decision making by client and executive bureaucracy in the clients organizations , error in designs, labour shortage and inadequate labour skills.

1.5. Cost escalation:

Cost overrun is the increase in the amount of money which is required for the completion of a projects above and over the original budgeted cost. In India cost overrun is common in government projects .It occurs when original cost is more than estimated cost.

According to Schexnayder et al. and Merewitz reasons for cost overrun is divided into two categories:

- controllable causes
- Uncontrollable causes

Cost escalation is the result of problems such as unexpected problems in supply of raw materials delay in land acquisition, illegal encroachment on project land even during project implementation, due to some internal problems in government organizations. Delays between the planning stage and actual implementation of large infrastructure projects is a common
Problem which results in cost overrun and timely completion of project.

1.6. Status of delays and cost escalation in India:

According to MoSPI report 2016 1174 projects with anticipated cost of Rs.16 lakh Crore were monitored by ministry. For monitoring these projects were divide into two categories:
1. Megaprojects-cost in Rs. 1 Crore and above
2. Major projects- above Rs. 150 Crore but less than 1000 Crore

Out of 1174 central sector infrastructure sector projects costing Rs. 150 Crore and above 333 projects were facing time overruns which ranges from 1-261 months.
The cost overrun in the delayed projects has resulted 20.95% increase in original cost, the anticipated cost for delayed projects together is Rs.6,47,487 Crore.

Time overrun	No. of projects
Less than 12 months	70
Between 13 to 24 months	73
Between 25 to 60 months	110
More than 60 months	80

Table 1.3.delay in projects **Source: MoSPI report 2016-17**

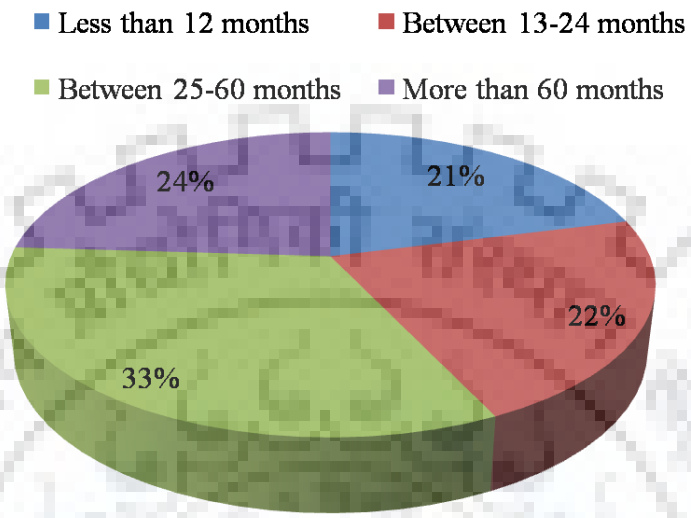

Fig. 1.3. Delays in projects

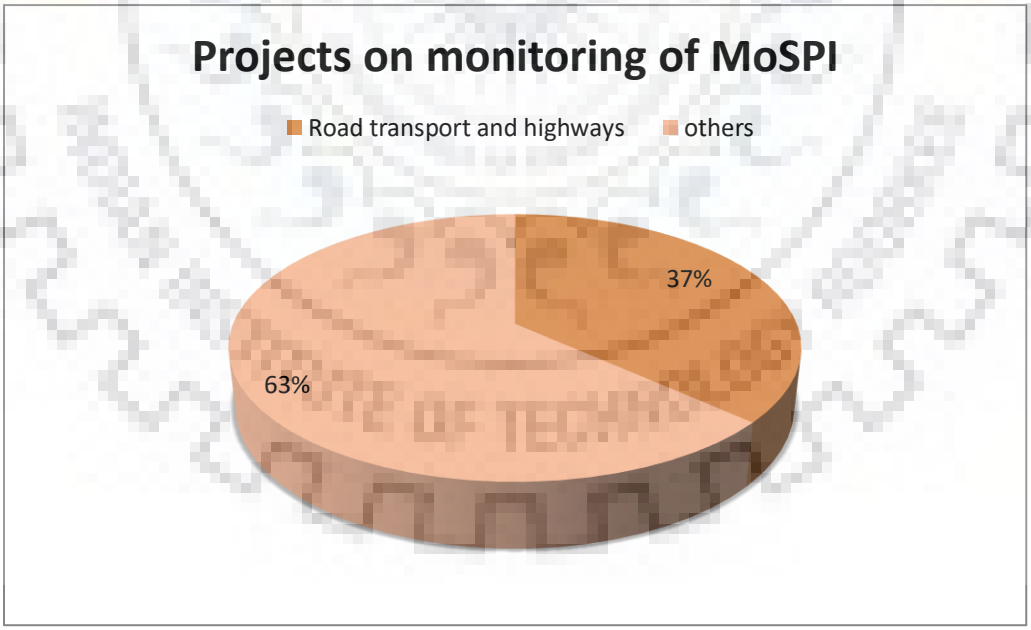

Figure.1.4.Projects on monitoring of MoSPI

The total share of highway transport and highway projects monitored by MoSPI as on October 2016 is 37 percent which have good impact on the transportation sector of India.

1.7. Projects with time and cost overrun:

An analysis of 1174 projects shows that 333 projects are running behind their original schedule as on September 2016. The time overrun is varies from 1-261 months. The cost overrun in the delayed projects has resulted in 20.95% increase in the original cost of the project. The anticipated cost of the delayed projects is Rs. 6,47,487.80 Crore. The below chart shows the percentage of delayed projects during last 16 years:

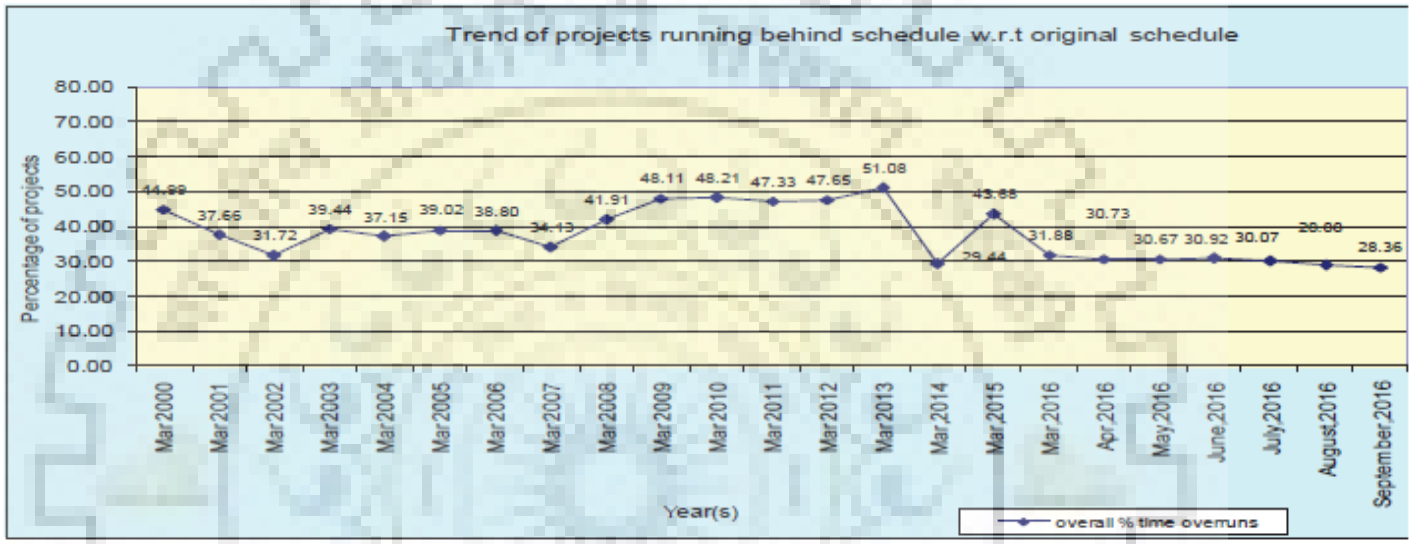

Fig1.5..Time overrun trend from March 1999 to September 2016

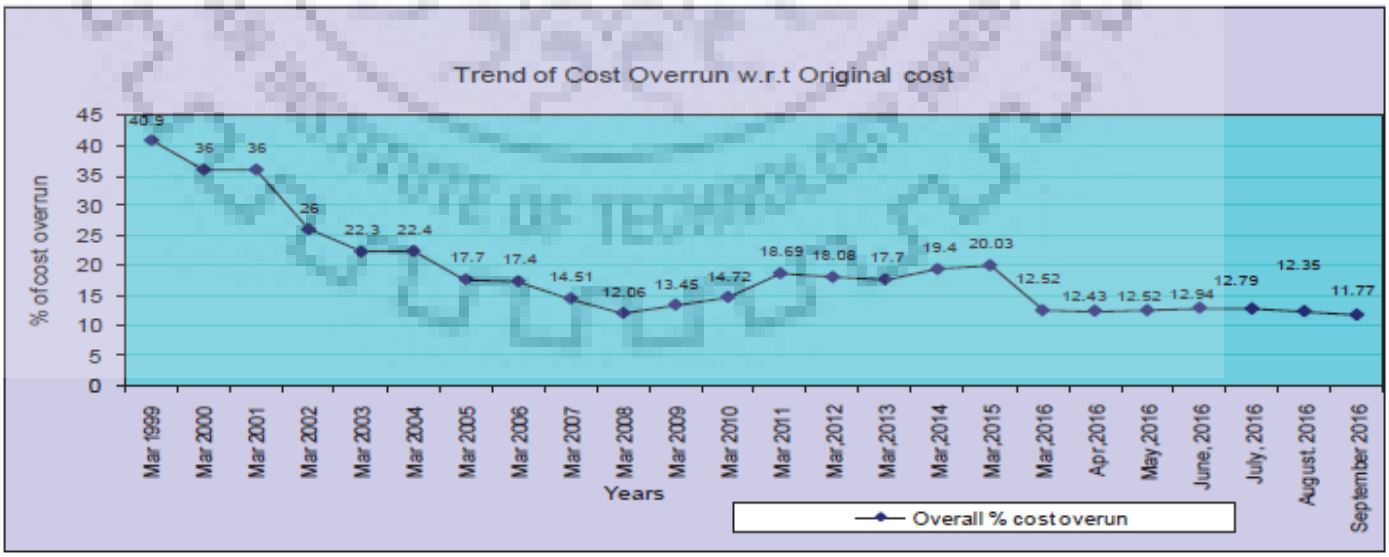

Fig.1.6. cost overrun trend from March 1999 to September 2016

The trend shows a very less decline in delay and cost overrun of projects. Time and cost overrun have been a major problem which is affecting the implementation of central sector infrastructure projects. The trend of last 17 years shows a downfall in time overrun from 40% in march 1999 to 11.77% in September 2016

1.8. Highways:

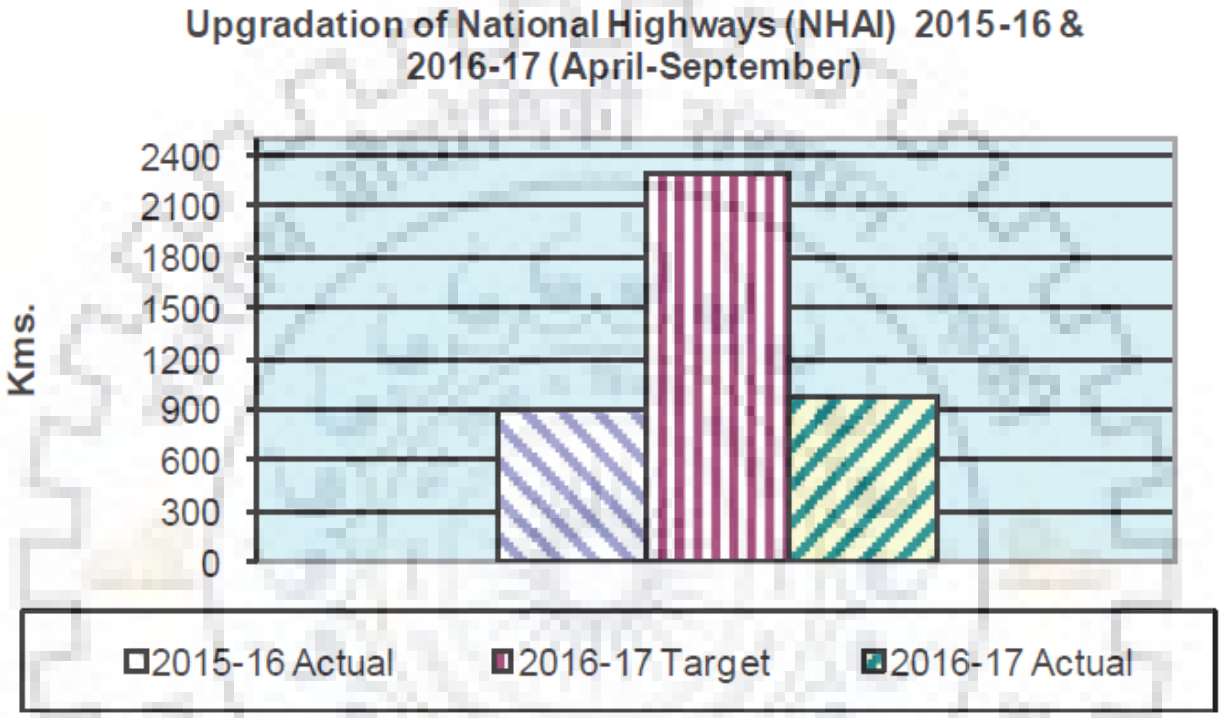

Fig1.7. Status of National highways in 2015-16 and 21016-17

Figure shows that there is huge difference between the actual and target Upgradation of highways and shows large delays in overall highway sector projects.

In year 2016-17 (April-September) NHAI has widened/strengthened 985 kms of highways in comparison to the target of 2300 kms.The state PWD and BRO widened 36kms of 4/6/8 lanes 558 kms to two lanes and strengthened 418 kms of existing weak pavement . They have also improved 287.00 kms of riding quality of highways.

1.9. Parties responsible for the delays and cost overrun:

In the 11th five year plan (2007-12) private sector investment in infrastructure rose from 36.22% from 22.04% in 10th five year plan. It is expected to be increase by 48.14% in infrastructure during 2012-2017.

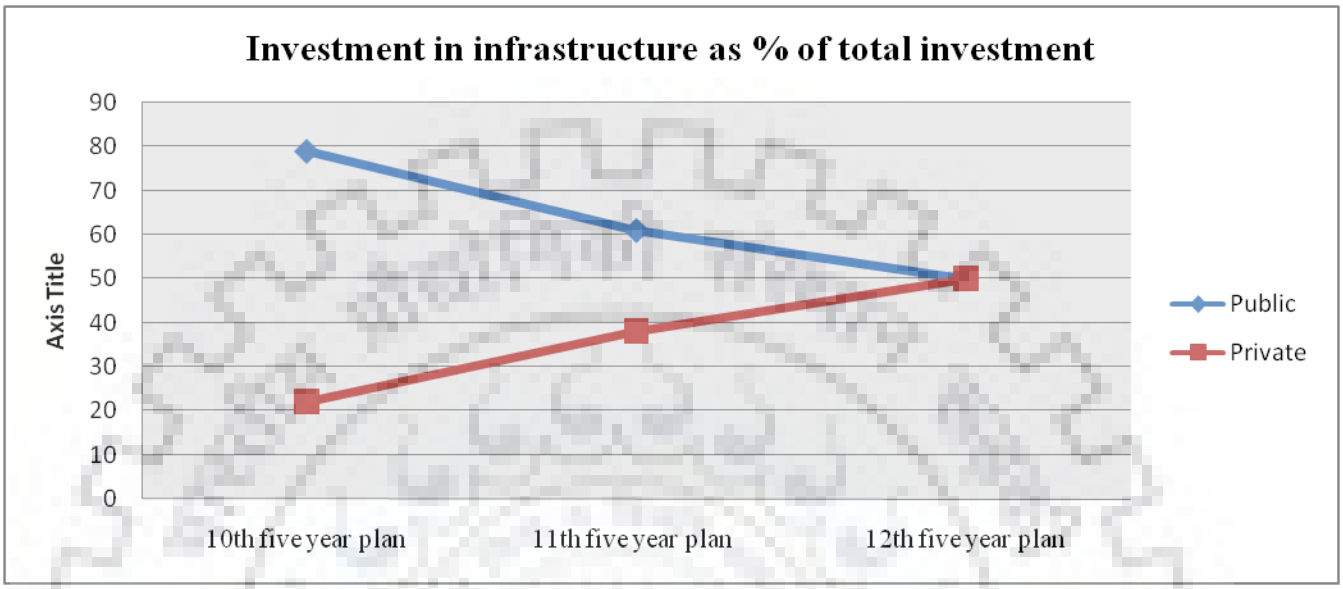

Fig.1.8. Investment in infrastructure as % of total investment

Parties involved in highway construction projects:

Nowadays all infrastructure projects are awarded to private parties. Due to changes in laws, ups and downs in economy, investment scenario and inability in long term demand forecasting, there is a need for renegotiation in many projects. There are many issues which are faced in projects. Many projects are facing time and cost overrun as parties involve are responsible for these delays and some factors might be shared or due to some external reasons. Therefore these factors play an important role in delays and cost escalation of the highway projects. There are three main parties which are involved in execution of construction projects:

1. Client/owner
2. Consultant
3. Contractor

These three parties are responsible for the project execution and construction and some factors may be shared or external which causes delay and cost overrun.

According to MoSPI report main causes of delays and cost overrun in projects are:

- Underestimation of original cost
- Changes in rates of foreign exchange and satutatory duties
- High cost of environmental safeguards and rehabilitation measures
- Spiralling land acquisition costs

- Changes in scope of projects
- Monopolistic pricing by vendors of equipment services
- Inflation
- Disturbed conditions
- Delay in land acquisition
- Delay in obtaining environment clearances
- Lack of infrastructure and support linkages
- Delay in tie up of project financing
- Delay in finalization of detailed engineering
- Changes in scope
- Law and order problems
- Geological surprises
- Contractual issues

Chapter 2

2. STUDY AREA

2.1. Need of study/Problem statement:

Time and cost overrun in Indian highway construction projects is noticeable and widespread. Almost every project in India suffers from delays and cost escalation due to which economy of a country suffers. Yet very few statistical studies exist on this issue in India. Even rarer are the studies based on projects which are completed. Due to this the extents as well as the causes behind these delays and cost overruns have remained under research. .The following questions are to be answered:

1. How common and how large are the delays and the cost overruns?
2. What are the essential causes for these time and cost overruns?
3. Are these underlying causes are statically significant or not?
4. What are the policy implications for the execution of these projects?

The international literature which is available is not much helpful for delays and cost overruns observation in India. Although, several Indian researchers have made very interesting contributions in this field. But very few of these are empirical studies, most of them are case studies. Although case studies are helpful in explaining particular instances but they have limited capacity to find out about the intrinsic problem in the infrastructure delivery system. The main causes behind delays and cost overruns in India and their statistical significance have not proven.

2.2. Aim:

The purpose of this study is to conduct a study of the time and cost overrun factors in the highway projects and prioritize those factors according to their importance index and predict a model to know the effect of these factors on the completion of project by using binary logistic regression.

2.3. Objectives

Following are the objectives of this research:

1. To conduct a comprehensive study of the factors which are responsible for the time and cost overrun in the highway projects in India by doing literature survey.
2. To identify and rate the causes of delays and cost overrun.
3. To compare and analyze the perception difference between the stakeholders on the importance of these factors.
4. To rank these factors on the basis of importance so that the remedial measures can be implemented easily
5. To give a prediction model to identify the effect of these factors on within time and cost completion of the projects by using binary logistic regression.

2.4. Chosen approach:

A questionnaire survey is conducted in which the respondents are asked to rate the 68 factors which are responsible for time and cost overrun in execution of highway construction projects. The respondents are asked to consider any one project that they have handled and answer the following questionnaire depending upon the project completed within estimated time and cost. Hence, the questionnaire survey respondents were divided into two categories one who have handled timely and within cost completed projects and other who have handled projects which were delayed and have cost overruns. This was done in order to apply binary logistic regression.

2.5. Scope:

The scope of this research is only limited to highway construction projects.

2.6. Methodology:

Figure shows the methodology which is adopted for the research .First of all the literature study was done to understand the role of the parties involved in the execution of project from highway sector and the past research done on the factors for delay and cost overrun. Then more crucial factors which affects the timely and within cost completion of highway projects .This list was followed by modification by the consultation to the experts in this field. Then the questionnaire was prepared to rate these factors on a scale of 1 to 5. in this respondents are divided into two categories who handled timely and within cost completed projects and another who handled projects which are delayed and have cost escalation. Data was collected by selecting a sample of respondents (industry professionals) through convenience sampling on basis of:

1. Experience
2. Organization role (client/consultant/contractor)

The analysis involved reliability checking, importance and predicting the role of these factors in delay and cost escalation of highway construction projects.

Finally a list of factors on the basis of its importance level and a logistic regression model was developed.

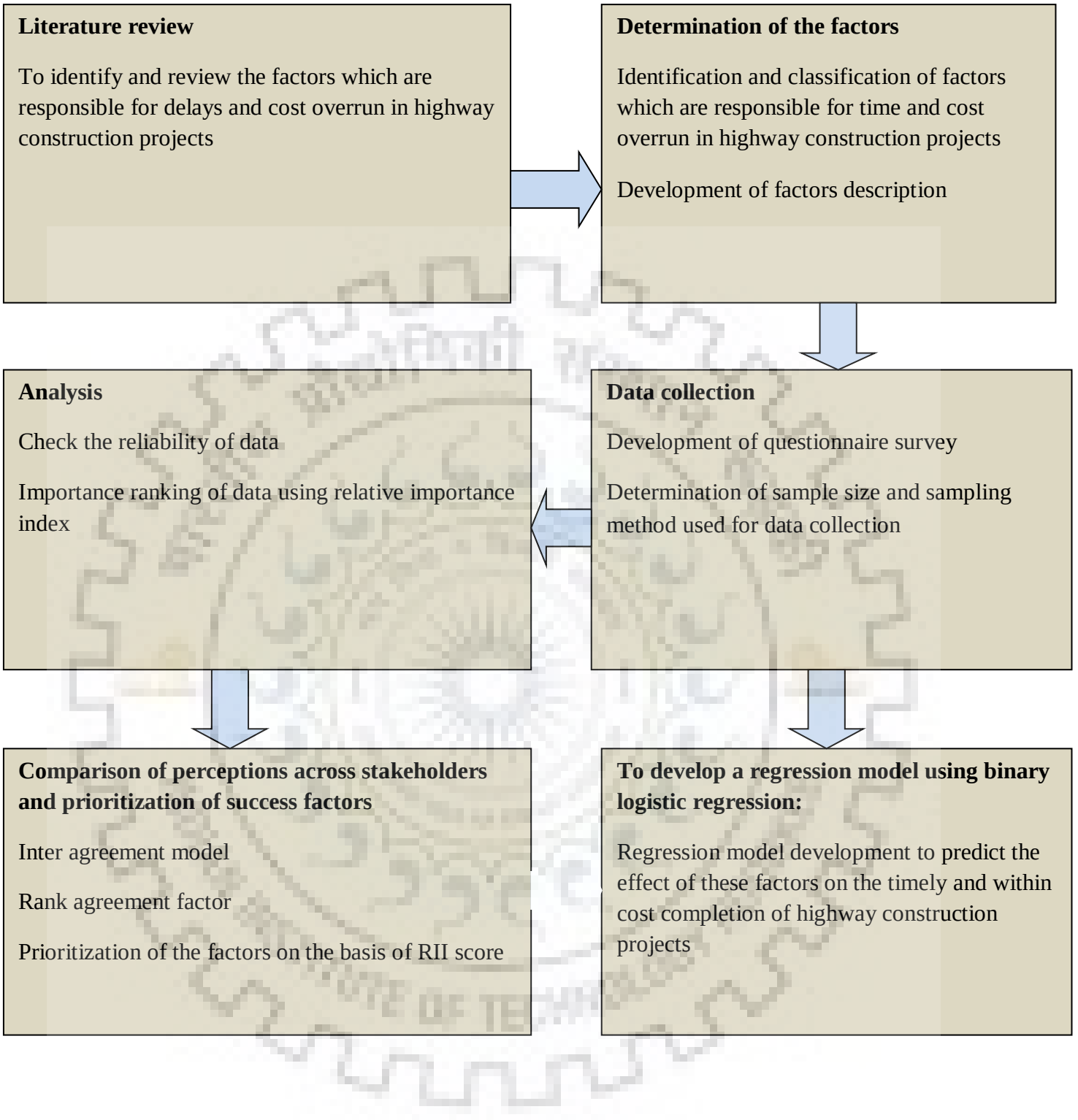

Fig2.1. Methodology adopted for dissertation

Chapter 3

3. Literature Review

Relevant literature was studied to review the past research on the time and cost overrun factors for the highway construction projects.

The main purpose of doing the literature review is to give an insight to the existing literature this is an important pre requisite to find the gaps in existing research and to help in further research.

3.1. International scenario:

Most of the literature is focused on factors which are responsible for time and cost overrun,

According to Rowland (1981) the cost overrun in the construction projects is increased with the contract size, length of channels of communication, complexity of projects and distortion of information associated with the large projects.

In another study **Mansfield et al (1994)** said that overruns are caused due to finance and payment arrangements, poor contract management, overall price fluctuations, material shortages, inaccurate estimating etc. He Gives recommendation on how project management can be improved in developing countries like India by proper action is to be taken in both conceptual and detailed planning stage of the projects. Further he added that proper action should be taken at both government and international level. Changes in the site conditions were considered which are linked to inadequate technical feasibility studies before the authorization of the projects .**Aibu and odeyinka (1994)** studied on the causes of time and cost overrun in highway and building project sand found that there was a very good agreement between the different stakeholders involved in the highway projects. The four most important factors for delay and cost overrun by these professionals were (client, consultant and contractor) are financing and payment of completed works, material shortage, poor contract management and change in site conditions.

Assaf et al (1995) identified 56 factors which are responsible for delays and cost overrun based on the literature review and interviews with local contractors, consultants and clients. The most important factors identified according to contractor were preparation and approval of drawings, schedule delays by contractors, delay in payment by owners, design changes by owners. The most important factor identified according to consultant was cash problem during construction, the relationship b/w different subcontractors, and slowness in decision making process by owner. According to owner the most delaying factors were design errors, labor shortages inadequate labor skills and excessive bureaucracy in organization.

Ogunlana et al (1996) find out that most of the delays were due to inconsistent detailing of the drawings. In this contractors suggested that process inspection is more beneficial instead of the product inspection. Seasonality of employment is also an issue in construction sector. Many workers refused to work for the whole year. They usually go back to their home for crop harvesting and planting of crops. The scarcity of technical person is due to inelasticity in supply.

on- availability of education facilities to meet the demand in boom years is another reason. Non availability of labor in harvesting season is also applicable for Indian context.

Elinwa and Joshua (2000) studied the factors and find out that adverse weather , shortage in material supply and labor, subcontractors, changes after execution of project ,poor site management and government policies are responsible for time and cost overrun.

Al-Khali and Al-Ghafly(1999) studied that public utility projects are more prone to delay and cost overrun because these projects are constructed in public highways and requires much precautionary measures and also the construction of these projects is heavily dependent on the equipments which requires frequent repair and maintenance . Additionally they also require permits from various government authorities which necessitating the good planning to avoid delay. The most important causes found are cash flow problem and financial difficulties by contractor, difficulties in obtaining permits and to select the lowest bidder without considering his pre-qualifications.

Jahren and Ashe (1990) also studied and found that the cost overrun rate of 1 to 12% is generally occurs in large projects as compared to the smaller projects and he added that managers of the large projects make additional efforts to keep the cost overrun rate low. They also determined that that the risk of high rate of cost overrun is greater when the winning bidding amount is less than the amount estimated for the project, they also identified some other factors which include contract document quality, nature of relationship between stakeholders and contractor policies.

Ayman H.Al-Momani (2000) "Construction delay: a quantitative analysis". They concluded that, delay and cost overrun is a crucial function in construction of public projects of a country. It has been of good interest to the researchers but it is not well understood in the case of public infrastructure projects because of their complex nature. Research which is practical is needed for proper management of construction projects. Reliabliability in prediction of duration of construction and controlling the cost within the budget is used in decision making and it is an important part of successful management. They found that, the main causes of delay in construction of public infrastructure projects mainly relate to design team, user changes, weather problem , different site conditions, late deliveries of the material , economic conditions and increase in demand of resources.

Daniel W M Chan and Mohan M. Kumaraswamy (1997) studied and concluded that, the five major and common causes of time and cost overrun are: poor site management and supervision by contractor, unforeseen site conditions, late in decision making involving all project teams,. According to him success of a project depends upon the coordination of the different parties involved in the project. All professionals should have knowledge of their fields. This can be done by providing the different training schemes to different stakeholders and employees involve in the project Kumaraswamy and Chan identified the causes of construction delays in Hong Kong and concluded that there was a difference in perceptions of different stake holders involve in the project. They blame biasing for the delay and cost overrun of the project.

3.**Noulmanee et al**. Studied the causes of delays in highway construction in Thailand and concluded that delays and cost overruns can be caused by all stakeholders involved in the project but main causes come from the side of sub-contractors, organization which lacks of resources , incomplete and complex drawings and gap in communication between consultants and contractors. They suggested that delay can be optimized by discussions between various parties which will increase the understanding between the parties.

4. **Ubaid** studied the performance of contractors for the major causes of time overrun. Thirteen measures were considered. These measures were related to contractor resources and capabilities for different projects. They identified that lack of the experience, poor estimation by the party, bad decisions in maintaining company policy, and slump in the economy at national level are the major factors which causes delay and cost overrun.

Chabota Kaliba *, Mundia Muya, Kanyuka Mumba (2009) studied cost escalation and delays in Zambia highway construction projects. There research was on ongoing projects in Zambia. They found the main causes of cost overrun and time delay and prioritise them on the bias of their severity. Various test used by them like weighted average on the basis of questionnaire survey and secondary data .The conclude that there is no straight and forward solution to avoid cost overrun and delays in these projects but various steps can be taken to minimize it by use of efficient project management tools and practices .On the basis of results they gave some recommendations to avoid delays and cost overrun.

Bent Flyvbjerg, Mette K. Skamris Holm And Søren L. Buhl Bent Flyvbjerg, Mette K. Skamris Holm And Søren L. Buhl (2004) studied on What Causes Cost Overrun in Transport Infrastructure Projects. In this paper the study is based on 258 sample of projects related to transport sector and the main focus is on the cost increase w.r.t. three factors:

1. Length of project implementation phase
2. Size of project
3. Type of project ownership

Tests performed: correlation analysis, regression analysis, box wishker plot, scatter plot

Findings:

a. Cost escalation is highly dependent on the length of the project-implementation phase and at a very high level of statistical significance ($p < 0.001$)

b. the cost escalation do not depend upon the type of project ie. Railway, highway etc

c. For every passing year from the decision to build until operations begin, the

Average increase in cost escalation is 4.64%

d. For bridges and tunnels, larger projects have larger percentage cost escalations than do smaller projects; for rail and highway projects, this does not appear to be the case

e. It is not confirmed that bigger projects have a larger risk of cost escalation than do smaller ones the risk of cost escalation is high for all project sizes and types

f.Projects grow larger over time but significantly for highway projects

g. The data do not support the claim that public ownership is problematic and private ownership a main source of efficiency in curbing cost escalation.

Kirsi Aaltonen (2008) studied on "Salience of stakeholders in the project. They studied and concluded that the strategies to improve salience among stakeholders include strategy of direct withholding, indirect withholding, and strategy of resource building. It is necessary to build the strategy among different stakeholders.

.James Odeck studied "Government vs. toll funding of highway construction projects. He performed various theoretical studies on the highway projects and found that for some projects toll funding is important and for some projects government funding is suitable.

Giorgio Locatelli (2017) studied on "Corruption in the public projects. In this various test were performed to find out the role of corruption in the infrastructure projects and finally it is concluded that it is important to rethink the role of corruption at social and institutional level both and further research is suggested by the author.

Ahmed S Studied on the factors which are responsible for Construction delays in Florida .According to Ahmed et al. delays and cost overrunin construction projects is an universal phenomenon and no project is exception for this . The delays are always followed by cost overrun .These affects the relationship between various parties involved in the project.

Merewitz L. Studied Cost overruns in public works and he identified that factors like remote sites inadequate manpower planning, poor understanding of local labour and poor labour regulations may cause cost increase in the projects. Finally he blamed the poor management as the cause of cost escalation.

Time vs cost overrun

Peter F kaming et al (1997) concluded on the basis of questionnaire survey that cost overruns are more frequent than time overruns on high rise construction in Indonesia. The factors which are responsible for time overruns are changes in design, poor labour, improper planning and shortage of material. Whereas in case of cost overrun the important factors are increase in material cost due to inflation , inaccurate estimates and lack of experience in understanding the project type.

But this is contrary in India according to MoSPI report 2016-17 out of 431 highway projects only 68 projects were completed within time and cost and the projects which completed on time but with cost overrun were 38 and the number of projects which completed within cost but with time overrun were 286 and projects which have both time and cost overrun were 39.This shows that the delays are more than cost overrun in Indian highway construction projects.

3.2. Indian context:

As per MoSPI report 2016 many projects were delayed due to suspension of contracts and time taken for award of new contracts. Due to failure of contracts large sections are rescheduled. Cost overrun due to inflation cannot be avoided but the cost overrun due to delays can be minimized. Various committees are formed to look after the cost and time overrun of projects and to take

action for these overruns.According to MoSPI report main causes of delays and cost overrun in projects are:

- Underestimation of original cost
- Changes in rates of foreign exchange and statutory duties
- High cost of environmental safeguards and rehabilitation measures
- Spiralling land acquisition costs
- Changes in scope of projects
- Monopolistic pricing by vendors of equipment services
- Inflation
- Disturbed conditions
- Delay in land acquisition
- Delay in obtaining environment clearances
- Lack of infrastructure and support linkages
- Delay in tie up of project financing
- Delay in finalization of detailed engineering
- Changes in scope
- Law and order problems
- Geological surprises
- Contractual issues

Parliamentary committee on Public sector undertaking (2016) observed that NHAI and other ministries need to act together. The problem in NHDP was due to lack of proper actions taken by the government for the land acquisition. Committee also stated that the bids should be processed within time limit. It was also asked to make report on the performance of the contractors on day to day basis and enforce penalty on the contractors which are responsible for the delays. For timely land acquisition the NH act 1956 may be amended to provide a time limit for initiation of arbitration proceedings and possibility of urgency in some special cases. The committee also suggested NHAI to strengthen the project supervision methods.

Parliamentary committee on Transport, tourism and culture (2016) recommended that NHAI should ensure the completion of awarded projects and schedules for awarded of contracts of the projects which are pending, by ensuring a strict compliance. The committee was of view that proper bank guarantees should be taken at the initial stage of project from contractors to avoid later termination of project. Committee noted that maximum projects are under implementation; therefore it was recommended to NHAI that it should be vigilant in respect of each project contract and should strictly compensate the non performing contractors. This committee also recommended NHAI not to wait for the targeted date of completion of the project to initiate the action but it should fix short targets for contractors so

that projects can be monitored easily and the issues can be resolved easily and the anticipated delays can be avoided. The committee also suggests NHAI to draw up a database of contractors involved in projects and encourage outstanding contractors, who are comply with standards and maintain quality control and completed project within time.

Pre-Budget economy survey (2016) stated that some problems like delay in land acquisition, removal of structures utility shifting changes in law and order are responsible for restriction in growth of highway sector. In order to provide investment in infrastructure sector government need to ensure long term funding which have long payback period for example pension and insurance funds. This committee promotes the formation of single unified market.

346th flash report on central sector projects (2016) an analysis of 1174 projects shows that 333 projects are running behind their original schedule as on September 2016. The time overrun is varies from 1-261 months. The cost overrun in the delayed projects has resulted in 20.95% increase in the original cost of the project. The anticipated cost of the delayed projects is Rs. 6, 47,487.80 Crore. The below chart shows the percentage of delayed projects during last 16 years. The reasons for this are slow progress by contractor, law and order changes, contract termination and change in law and regulations. Ministerial committee strongly recommended to reconstruct and strengthening the NHAI which is implementing agency for the highways in India. Various institutional mechanisms are required for this. It is expected that implementation of all this will lead to strong and safe highway network in India. To specify policy and regulatory framework as transparent MCA for PPPs is mandated. This framework will be based on international best practices and it will surely increase the pace of project and avoid the risk in the projects.

Narain (2010) focused on the powers of the IE i.e. independent engineer to oversee the owner. He hoped that the in coming days the professionals with high experience and knowledge will be given more important role in decision making and leadership in institutions, which are currently headed by generalists.

Sikdar (2010) state that incomplete DPRs prepared in a hurry due to political interference with incomplete details like absence of service highways, crossing for cattle and pedestrians is responsible for time and cost overrun. Government is showing it seriousness in private funding but not in the timely completion of the projects and without any cost overrun .He suggested to re-examine the contracting principles of contract awarded to the lowest bidder and mechanism to poor and work delivered by the sub contractors.

Al –Momani (2000) tried to establish a relationship between actual time and planned time of the construction projects. He developed a simple linear regression by categorizing the projects as office, administrative building, office school projects, medical centers etc. Although the statistical coefficient Satisfied 99% of confidence interval but the model failed to include intrinsic variables like construction experience of contractors. This model works only on the completed projects..

Ram Singh (2010) covered all infrastructure projects .He developed a general purpose simultaneous equation fro delays incorporating the natural factors, contractual failure and economic factors. Although the model was exhaustive because it covered all infrastructure projects but it fails due to superior performance of some states.

3.3. Factors identified by literature survey and interview of professionals

S.No.	Factors	References
1.	Contract awarded to lowest bidder	Abdulelah Aljohani(2010) Dominic Ahiaga-Dagbui, and David Moore(2001)
2.	Inappropriate procurement contract	Aftab Hameed Memon(2011), Ismail Abdul Rahman (2003) Ade Asmi Abdul Azis(2008)
3.	Acceleration required by client	Guruprasad Chavan, Amit Sharma, Ajay Kumar Nirala(2008)
4.	Price fluctuations (inflation)	Abdulelah Aljohani(2010)Dominic Ahiaga-Dagbui(2007), and David Moore(2001)
5.	Inappropriate government policies	Cantarelli(1997), C. C., Flyvbjerg, B., Molin, E.J.E., and van Wee, B. 2010.
6.	Delayed payment	Odeh(2001), Faridi(2006), Fugar(2010), Rwakarehe, Elinwa,(2009)
7.	Delays in land acquisition	Samvasivan and soon(2007)
8.	Slowness in decision making process	Kaushki et al(2003)
9.	Financial process	Abdulelah Aljohani(2010) Dominic Ahiaga-Dagbui, and David Moore(2001)
10.	Financial difficulties	Odeh(2001), Faridi(2006), Fugar(2010), Rwakarehe, Elinwa,(2009)
11.	Changes in government regulation and laws	Peter F. Kaming , Paul O. Olomolaiye(1997), Gary D. Holt & Frank C. Harris(1997)
12.	Delay to transfer the site to the contractor by the client	Odeh, Koushki, Iyer, Le-Hoai, Sambasivan, Ruqaishi(2009), Doloi(2012)
13.	High Environmental protection and mitigation costs	Ubaid(2007)
14.	Changes in drawings	Abdulelah Aljohani(2010) Dominic Ahiaga-Dagbui, and David Moore(2001)
15.	Contract modification	MoSPI report 2016
16.	Scope changes	Aftab Hameed Memon(2011), Ismail Abdul Rahman (2003) Ade Asmi Abdul Azis(2008)
17.	Difficulties in obtaining work permits	Ram Singh, special article Economic and

		political Weekly(2010)
18.	site conditions differ from contract documents	Kaliba et al(2003)
19.	Ambiguities, mistakes, and inconsistencies in contract specifications and drawings	Ubaid(2007)
20.	Unrealistic imposed initial contract duration	Al-Najjar(2008), Kaliba(2009), Sweis(2008), Doloi,Le-Hoai(2008), Ruqaish(2009)(2012)i, Danso
21.	Appointment of incompetent Consultant/Contractor	Assaf (1993), Chan(1996), Odeh(2001), Faridi, Danso(2003) Sweis(2008)Dolage(2013), Rwakarehe(2014)
22.	Delay in providing services from utilities (such as water, electricity)	Peter F. Kaming Paul O. Olomolaiye(1997) , Gary D. Holt & Frank C. Harris(1997)
23.	Utility shifting	Peter F. Kaming , Paul O. Olomolaiye(1997), Gary D. Holt & Frank C. Harris(1997)
24.	Schedule delays	Chan(1996), Omoregie, Faridi, Lo(2003) Sambasivan(2007), LeHoai, Danso(2003) Rwakarehe(2014)
25.	Technical changes	Ram Singh(2010), special article Economic and political Weekly (2010)
26.	Material procurement	Ahmed et al and boton(2003)
27.	Construction mistakes	Ahmed et al and boton (2003)
28.	Equipment unavailability	Frimpong(2003), Omoregie(2006), Lo, Fugar(2010), Gardezi(2014) , Dolage(2013), Mizanur(2014)
29.	Labor disputes and strikes	Bent Flyvbjerg, Mette K. Skamris Holm And Søren L. Buhl(2004)
30.	Shortage of skilled labor	Bent Flyvbjerg, Mette K. Skamris Holm And Søren L. Buhl(2004)
31.	Incompetent subcontractors	Bent Flyvbjerg, Mette K. Skamris Holm And Søren L. Buhl(2004)
32.	Poor site management by contractor	Kaming(1997), Assaf(1993), Odeh(2001), Elinwa(2001), Frimpong (2003), Kaliba(2009), Gardezi(2014), Faridi (2006)
33.	Defective work	Li et al,2005

34.	Poor contract management	Li et al,2005
35.	Rework due to errors during construction by contractor	Guruprasad Chavan, Amit Sharma, Ajay Kumar Nirala(2008)
36.	Poor qualification of technical staff of contractor	Danial Mirzai Matin(2003)
37.	Accident during construction	Cantarelli, C. C., Flyvbjerg, B., Molin, E.J.E.,
38.	Work suspension owing to conflicts	Danial Mirzai Matin(2003)
39.	Inadequate planning and scheduling by contractor	Faridi and el and syeigh(2006)
40.	Technical Changes	Noulmanee et al(2012)
41.	Changes in specifications	Peter F. Kaming Paul O. Olomolaiye(1997) , Gary D. Holt & Frank C. Harris(1997)
42.	Poor Supervision	Daniel W M Chan and Mohan M. Kumaraswamy (2010)
43.	Inaccurate estimates	Daniel W M Chan and Mohan M. Kumaraswamy(2010)
44.	Inadequate duration of contract period	Noulmanee et al(2012)
45.	Delay of drawings and site instructions	Abdulelah Aljohani(2011) Dominic Ahiaga-Dagbui, and David Moore(2007)
46.	Slow inspection of completed works	Kaliba et al(2003)
47.	Underestimation of original cost	swies et al (2008)
48.	Delay in approving major changes in the scope of work by consultant	Danial Mirzai Matin(2001)
49.	Inadequate design-team experience	Mospi annual report 2016
50.	Complexity of project design	Mospi annual report 2016
51.	Adverse weather	Abdulelah Aljohani(2010) Dominic Ahiaga-Dagbui, and David Moore(2001)
52.	Unforeseen site conditions	Aftab Hameed Memon(2011), Ismail Abdul Rahman (2003) Ade Asmi Abdul Azis(2008)
53.	Inadequate site investigations	Guruprasad Chavan, Amit Sharma, Ajay Kumar Nirala(2008)
54.	Change in foreign exchange rate	Abdulelah Aljohani(2010)Dominic Ahiaga-Dagbui(2007), and David Moore(2001)
55.	Work suspension owing to conflicts	Cantarelli(1997), C. C., Flyvbjerg, B., Molin, E.J.E., and van Wee, B. 2010.
56.	Shortage of materials	Odeh(2001), Faridi(2006), Fugar(2010), Rwakarehe, Elinwa,(2009)
57.	High cost of machinery	Samvasivan and soon(2007)

58.	Fraudulent practices, kickbacks ,corruption	Kaushki et al(2003)
59.	Type of ownership	Abdulelah Aljohani(2010) Dominic Ahiaga-Dagbui, and David Moore(2001)
60.	Length of project implementation phase	Odeh(2001), Faridi(2006), Fugar(2010), Rwakarehe, Elinwa,(2009)
61.	Environmental issues related to project	Peter F. Kaming , Paul O. Olomolaiye(1997), Gary D. Holt & Frank C. Harris(1997)
62.	Legal disputes between various parties	Odeh, Koushki, Iyer, Le-Hoai, Sambasivan, Ruqaishi(2009), Doloi(2012)
63.	Force majeure	Cantarelli, C. C., Flyvbjerg, B., Molin, E.J.E., and van Wee, B. 2010.
64.	Traffic control and restrictions on the job site unclear	Danial Mirzai Matin(2003)
65.	Work hours are limited by imposed rules or site condition	Faridi and el and syeigh(2006)
66.	Effect of social and cultural factors	Noulmanee et al(2012)
67.	Monopolistic pricing by vendors of equipment services	Peter F. Kaming Paul O. Olomolaiye(1997) , Gary D. Holt & Frank C. Harris(1997)
68.	contract termination	Daniel W M Chan and Mohan M. Kumaraswamy (2010)

Table3.1. list of factors with their references

The above factors are classified on the basis of the party which is responsible for it. Therefore these factors are classified into four following categories:

Party responsible	S.No.	Factors name
Client/owner side	**1.1**	Contract awarded to lowest bidder
	1.2	Inappropriate procurement contract
	1.3	Acceleration required by client
	1.4	Price fluctuations (inflation)
	1.5	Inappropriate government policies
	1.6	Delayed payment
	1.7	Delays in land acquisition
	1.8	Slowness in decision making process
	1.9	Financial process
	1.10	Financial difficulties

	1.11	Changes in government regulation and laws
	1.12	Delay to transfer the site to the contractor by the client
	1.13	High Environmental protection and mitigation costs
	1.14	Changes in drawings
	1.15	Contract modification
	1.16	Scope changes
	1.17	Difficulties in obtaining work permits
	1.18	site conditions differ from contract documents
	1.19	Ambiguities, mistakes, and inconsistencies in contract specifications and drawings
	1.20	Unrealistic imposed initial contract duration
	1.21	Appointment of incompetent Consultant/Contractor
	1.22	Delay in providing services from utilities (such as water, electricity)
	1.23	Utility shifting
From contractor side	**2.1**	Schedule delays
	2.2	Technical changes
	2.3	Material procurement
	2.4	Construction mistakes
	2.5	Equipment unavailability
	2.6	Labor disputes and strikes
	2.7	Shortage of skilled labour
	2.8	Incompetent subcontractors
	2.9	Poor site management by contractor
	2.10	Defective work
	2.11	Poor contract management
	2.12	Rework due to errors during construction by contractor
	2.13	Poor qualification of technical staff of contractor
	2.14	Accident during construction
	2.15	Work suspension owing to conflicts
	2.16	Inadequate planning and scheduling by contractor
From consultant side	**3.1**	Technical Changes
	3.2	Changes in specifications
	3.3	Poor Supervision
	3.4	Inaccurate estimates
	3.5	Inadequate duration of contract period
	3.6	Delay of drawings and site instructions
	3.7	Slow inspection of completed works
	3.8	Underestimation of original cost

	3.9	Delay in approving major changes in the scope of work by consultant
	3.10	Inadequate design-team experience
	3.11	Complexity of project design

Shared/External/Other factors	**4.1**	Adverse weather
	4.2	Unforeseen site conditions
	4.3	Inadequate site investigations
	4.4	Change in foreign exchange rate
	4.5	Work suspension owing to conflicts
	4.6	Shortage of materials
	4.7	High cost of machinery
	4.8	Fraudulent practices, kickbacks ,corruption
	4.9	Type of ownership
	4.1	Length of project implementation phase
	4.11	Environmental issues related to project
	4.12	Legal disputes between various parties
	4.13	Force majeure
	4.14	Traffic control and restrictions on the job site unclear
	4.15	Work hours are limited by imposed rules or site condition
	4.16	Effect of social and cultural factors
	4.17	Monopolistic pricing by vendors of equipment services
	4.18	contract termination

Table 3.2. Factors divided into different factor group

The above factors are responsible for delays and cost overrun in highway construction projects. Mainly three parties are responsible for these delays and cost overruns which are clients, contractors, consultants and some factors are external which are shared by all parties like adverse weather, effect of social cultural factors etc. The questionnaire survey was conducted by considering all these factors with the parties responsible for them.

Chapter 4

DATA COLLECTION

After finalising the factors and their descriptions it was required to identify these factors on the basis of their relative importance index. For this the opinion from industry professionals was needed which have good experience and knowledge in the field of highway construction projects. So to get this information it was decided to conduct a survey by using a questionnaire.

4.1. Determination of sample size

The sample size (n) for an unknown population can be determined by using the formula

$$\text{Sample size (n)} = \frac{z2 \times \sigma 2}{MOE2}$$

Where Z=z score corresponding to required confidence level

σ = standard deviation of population

MOE=Margin of error

However , since no previous studies have been carried for the sampling in India, so the value of standard deviation is not available .So in this case to carry out a parametric test a sample size of 30 was required and there were mainly three stakeholders (client, consultant and contractor) therefore the sample size was calculated as 3×30=90.

4.2. Sample composition

Any highway construction project executed typically have 3 major stakeholders, namely client/owner , consultant and client. It was decided to represent the all stakeholders equally.

Organisational role	Number of responses
Client/owner	30
Consultant	30
contractor	30
Total	**90**

Table 4.1.sample composition

4.3. Sampling frame:

Stakeholder	Sampling frame
Client/owner	List of state PWDs ,Highway & buildings departments, NHAI, state highway development corporation
Consultant	List of consultants working for NHAI, list of consultants working for state agencies
Contractor	List of contractors which are pre qualified by NHAI (2016-17)

Table4.2.sampling frame

4.4. Sampling method:

From the above sampling frame, by respondents was selected randomly using stratified sampling. In this case the sampling frame was stratified on the basis of stakeholder type.

4.5. Respondent's criteria:

To maintain the reliability of collected data it was decided that the respondents should have minimum experience of 4 years working on the Indian highway sector from any client, contractor or consultant organisation.

4.6. Preparation of questionnaire survey:

The questionnaire was formatted according to method of analysis and its requisite data. Initially the questionnaire survey was prepared including some descriptive questions too but it failed because it was too lengthy and time consuming after that it was decided to use binary logistic regression and RII (relative importance index) and accordingly questionnaire was prepared.

Firstly the respondents from different categories were divided into two categories :one category contains the respondents who have handled project which was completed within time and cost and another category contains the respondents who have handled the projects which have time and cost overrun. In this way the responses were divided into two categories yes or no. By doing so the data for binary logistic regression data was collected and the same data was used to find RII to rank the factors.

Each element was provided a Likerts scale was provided from 1 to 5 ranging from 'least significant' to 'most significant' with provision of ovals for each option. The questionnaire was created by using Google form and was to be answered online. However printed form was also available in pdf format to collect the data for conditions where internet and system facilities were not available. The respondents could reply for each factor from scale 1 to 5 on the basis of the influence of each factor on the delay and cost overrun of projects. Thus questionnaire was made user friendly and simple as possible. (Refer to annexure questionnaire survey)

4.7. Data collection process:

The questionnaire was sent to the by email to the respondents selected through sampling process. A time period of 15 days was given to answer the questionnaire. Frequent reminders were given to the respondents.

But the rate response from the respondents was very low i.e. about 5%. At the end of 15 days period only 5 responses out of 90 responses were received.

Then it was decided to change the sampling order to attain the required sample size. Then non random snowball sampling was adopted in which initially the data was collected by visiting to person to person after that these respondents were asked to identify others who fulfilled the criterion. Therefore new respondents were selected by referrals from old one and so on. Moreover personal interviews were conducted where it was possible.

The survey has been completed in approx. 60 working days. At the end of this time period, total 82 responses has been collected. Due to unavailability of the qualified professionals and lack of response target sample size could not be attained.

	Client/owner	**consultant**	**contractor**
Remaining	8	3	0
achieved	22	27	33

Table.4.3. Sample composition (achieved vs remaining)

The table4.4. shows the difference in the rate of response for the two methods of sampling. The rate of response differs in two cases. The response obtained by personally contacted the respondent is 10 times more than by email. The personal interview of only 10 personnel's were done because it was very time consuming and expensive.

Mode of contact	**contacted**	**replied**	**Rate of response**
Personal	90	77	85.5%
e-mail	80	5	6.25%

Table.4.4. Comparison of rate of response

4.8. Respondent profile analysis:

The respondents profile can be classified on the following basis:

On the basis of role in the organisation:

Figure shows that there is good contribution of all parties in the collected sample . But the representation of client/owner category is very less. This is due to lack of response from this category.

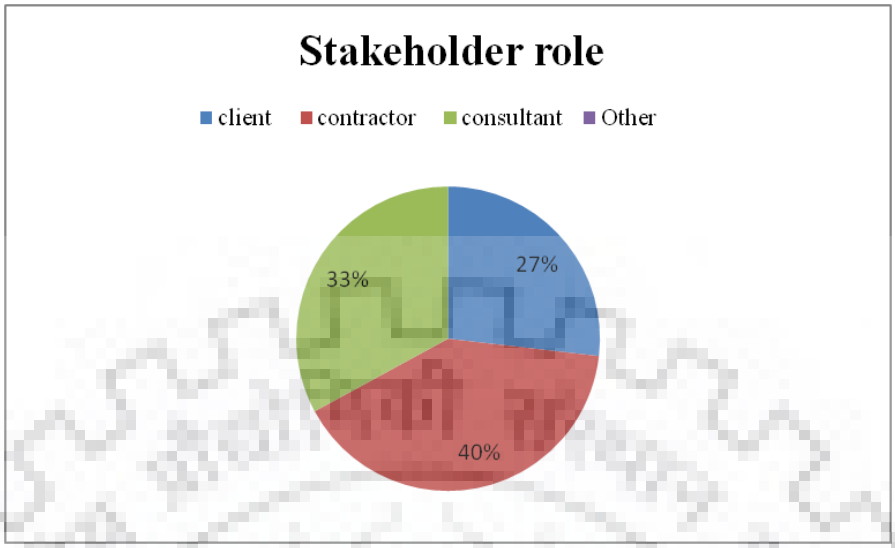

Fig4.1. representation of different parties on the basis of their role in highway sector

On the basis of respondent experience:

Figure shows the distribution of respondents on the basis of their experience in years. The criterion for minimum years of experience was set at minimum 4 years in highway and highway sector. Maximum number of respondents falls in 4-8 years experience category.

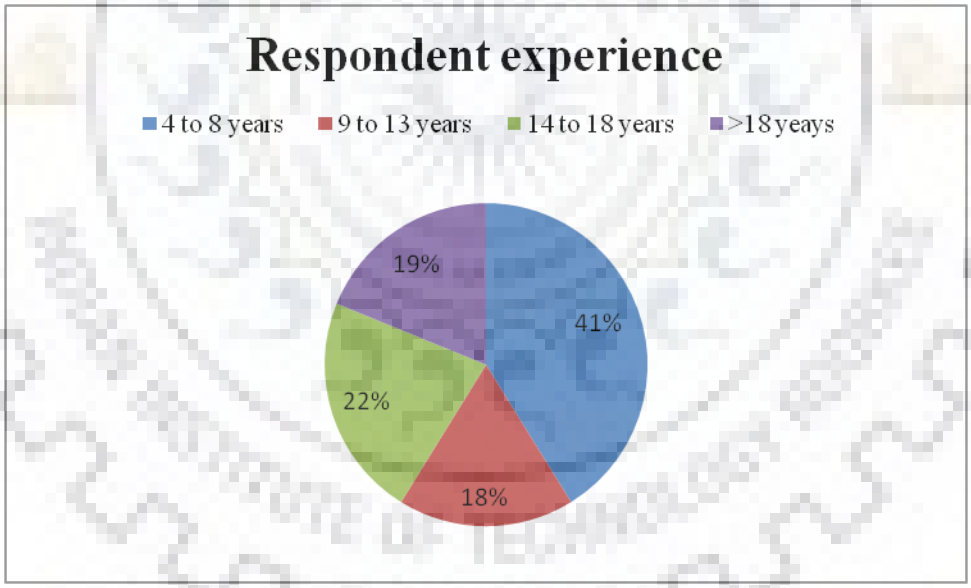

Fig4.2. Classification of respondents on the basis of their experience

On the basis of educational qualification:

Figure shows the distribution of respondents on the basis of their educational qualification which shows that maximum number of respondents falls in two categories namely graduation and post graduation which are having 40% and 36% contribution respectively.

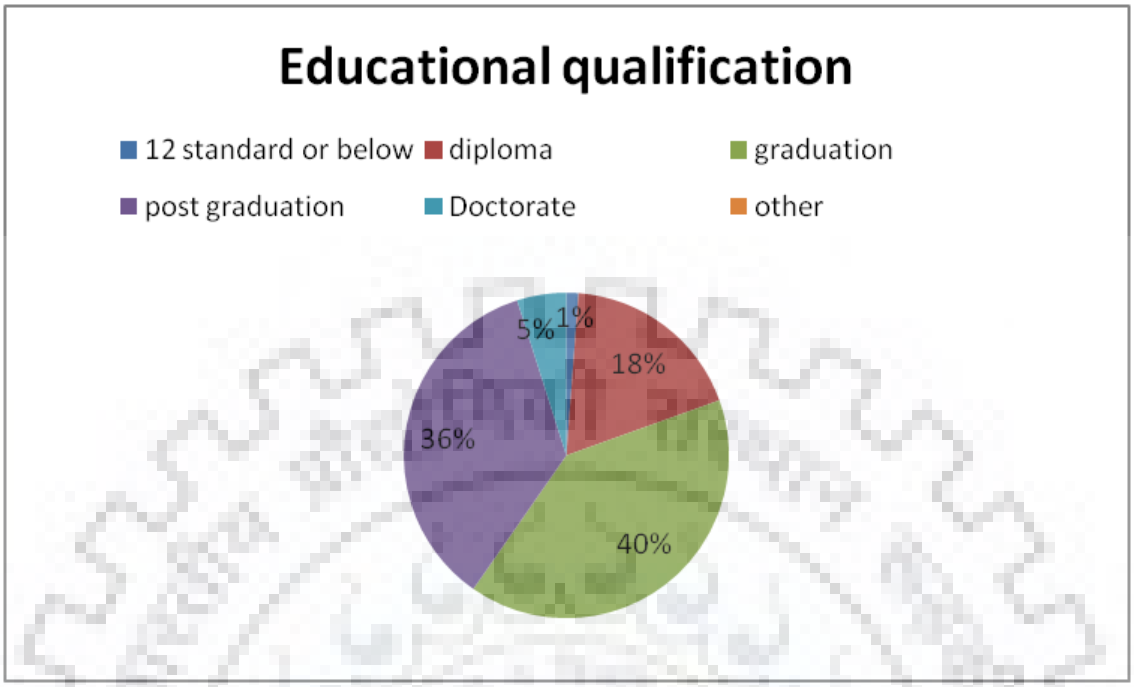

Fig4.3. Distribution of respondents on the basis of their educational qualification

4.9. Organisations covered during the process of data collection:

Client/owner	Consultant	Contractor
NHAI	RITES LTD.	Vedanta group
CPWD	CEG LTD.	Soma Group
CIDCO	IIT KANPUR	Reliance Infra.
STATE PWDs	Themes Engineering Pvt. Ltd.	Era Projects
-	ICT Pvt. Ltd.	L&T Pvt. Ltd.
-	Feedback infra.	IRCON Pvt. Ltd.
-	Tata consulting Engineers	Galfar Engineering & contracting
-	DIMTS	-

Table4.5. Organisations covered in data collection

The survey was conducted by covering wide range of organisations. To maintain the quality of the data the number of respondents was limited to maximum 5 from each organisation but due to time constraint and unavailability of the professionals this rule was not followed.

Chapter 5

IMPORTANCE RANKING

The annexure attached at the last contains the consolidated data collected through survey. The opinions from least significant to most significant were converted to the scale of 1 to 5 as follows:

Score	Meaning
1	Least Significant
2	Less Significant
3	Moderately Significant
4	More Significant
5	Most Significant

Table5.1. Quantification of collected data

As the data was collected through an opinion survey , therefore it was necessary to check the reliability . To check the reliability Cronbach's co-efficient alpha was used.

5.1. Cronbach's co-efficient alpha to check scale reliability of data :

Cronbach's alpha is used to measure the internal consistency of the data. Internal consistency checks that how closely a set of items is related to form a group. It is used to check whether the several items which are used to measure the same purpose will produce similar scores or not.

It can be calculated by using the following formula:

$$\frac{k}{k-1} * \left(1 - \frac{\sum \sigma 2}{\sigma 2}\right)$$

Where, k=number of items

$\sum \sigma 2$= variance of each item

The cronbach's alpha coefficient alpha's value ranges from 0 to 1. Zero value means that the data is not related as a group, whereas 1 mean the fully consistent data. Generally a value greater than 0.6 is considered acceptable, which means that there is a significant relationship between the data as a group.

For this report the analysis was carried out by using spss v21 software

Case Processing Summary

		N	%
Cases	Valid	82	100.0
	Excluded	0	.0
	Total	82	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.927	.927	23

Table5.2.Output of cronbach's coefficient alpha of factors for which client/owner is responsible

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	2.312	1.805	3.049	1.244	1.689	.087	23
Item Variances	.877	.520	1.604	1.085	3.087	.067	23

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.927	.928	17

Table5.3. output of cronbach's coefficient alpha of factors for which contractor is responsible

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	2.133	1.890	2.341	.451	1.239	.019	17
Item Variances	.906	.469	1.421	.952	3.030	.069	17

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.849	.849	11

Table5.4.:output of cronbach's coefficient alpha of factors for which consultant is responsible

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	2.014	1.829	2.195	.366	1.200	.014	11
Item Variances	.657	.271	1.077	.806	3.973	.041	11

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.933	.934	19

Table5.5.Output of cronbach's coefficient alpha for shared/external factors

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	2.331	2.061	2.915	.854	1.414	.049	19
Item Variances	.918	.538	1.181	.642	2.193	.040	19

No.	Factor group	Cronbach's co-efficient alpha
1	From client/owner side	0.927
2	From contractors side	0.928
3	From consultant side	0.849
4	External/shared factors	0.933

Table5.6. cronbach's alpha results for all groups using spss

The values of α for group 1, 2, 3, 4 all are falling in acceptable range i.e. greater than 0.6. These values show that the items in each item are highly related to form a group.

5.2. Importance Ranking to determine the time and cost overrun factors:

Relative Importance Index (RII) was used to identify the critical factors for time and cost overrun.

To find out the relative ranking of factors scores were converted to importance indices by using the following formulae:

$$\text{Relative Importance Index (RII)} = \frac{\sum w}{A * N}$$

Where,

W is the weighting given to each factor ranging from 1 to 5

A=highest weight (i.e. 5)

N = the total number of samples (i.e. 82)

Output and interpretation:

The RII was calculated for the full data set as well as for each stakeholder . This was done to know the perception of each stakeholder as well as the combined to know the difference in perception and to find out the difference and a good ranking for the factors which are critical for the delay and cost overrun in Indian highway construction projects. The below table shows the RII for the client/owner group only.

The success factors were ranked according to their relative importance index in the descending order. By doing this a list of top critical factors was created which was further used to prioritise the factors on the basis of their importance.

Factor		Frequency										
Group	S.No.	R1	R2	R81	R82	1	2	3	4	5	Sum	RII
Client/owner side	1.1	2	2	3	2	21	34	16	7	4	82	0.45122
	1.2	3	2	2	1	34	33	12	3	0	82	0.360976
	1.3	2	1	2	2	20	42	16	3	1	82	0.412195
	1.4	2	2	3	1	15	38	23	4	2	82	0.453659
	1.5	3	3	2	2	15	35	20	7	5	82	0.482927
	1.6	4	4	3	1	19	36	17	6	4	82	0.453659
	1.7	5	5	3	3	8	25	21	13	15	82	0.604878
	1.8	4	2	2	1	22	36	15	8	1	82	0.429268
	1.9	3	5	2	2	7	46	21	4	4	82	0.482927
	1.10	3	4	2	1	10	40	22	8	2	82	0.482927
	1.11	4	2	3	1	12	37	24	9	0	82	0.473171
	1.12	1	2	3	2	18	43	16	4	1	82	0.421951
	1.13	2	1	3	2	8	25	28	17	4	82	0.560976
	1.14	4	2	2	1	14	51	11	5	1	82	0.42439
	1.15	5	3	3	2	11	35	30	4	2	82	0.480488
	1.16	4	2	3	1	9	46	23	4	0	82	0.453659
	1.17	2	1	2	2	15	35	25	5	2	82	0.463415
	1.18	2	2	2	1	16	47	12	7	0	82	0.42439
	1.19	2	2	2	2	15	38	23	5	1	82	0.45122
	1.20	1	2	3	2	23	41	11	5	2	82	0.409756
	1.21	2	2	2	2	14	41	24	2	1	82	0.441463
	1.22	1	1	2	2	22	35	18	6	1	82	0.426829
	1.23	5	4	5	3	8	21	24	17	12	82	0.609756

Table5.7. Sample calculation for RII

RII=(Sum of (product of each rating * its frequency)/(Highest value of rating* No. of responses)

=((1*21)+(2*34)+(3*16)+(4*7)+(5*4))/(5*82)

=0.45122

List of top critical factors responsible for delay and cost overrun (overall)

S.No.	RII	Rank	Factor Name
1.7	0.604878	1	Delays in land acquisition
1.23	0.609756	2	Utility shifting
4.1	0.582927	3	Adverse weather
1.11	0.473171	4	Changes in government regulation and laws
1.17	0.463415	5	Difficulties in obtaining work permits
1.10	0.457988	6	Financial difficulties
3.9	0.419512	7	Delay in approving major changes in the scope of work by consultant
4.11	0.413400	8	Environmental issues related to project
4.12	0.400732	9	Legal disputes between various parties
4.18	0.413659	10	contract termination

Table 5.8.List of top critical factors responsible for delay and cost overrun (overall)

List of top critical factors responsible for delay and cost overrun (Client)

S.No.	RII	Rank	Factor Name
4.1	0.747619	1	Adverse weather
1.23	0.724762	2	Utility shifting
1.4	0.714143	3	Price fluctuations (inflation)
1.7	0.710286	4	Delays in land acquisition
1.11	0.692381	5	Changes in government regulation and laws
4.18	0.625238	6	contract termination
2.9	0.575238	7	Poor site management by contractor
3.2	0.52381	8	Changes in specifications
1.1	0.485714	9	Contract awarded to lowest bidder
4.11	0.461429	10	Environmental issues related to project

Table 5.9. List of top critical factors responsible for delay and cost overrun (Client)

List of top critical factors responsible for delay and cost overrun (Consultant)

S.No.	RII	Rank	Factor Name
1.7	0.848148	1	Delays in land acquisition
1.15	0.681481	2	Contract modification
1.23	0.655556	3	Utility shifting
4.1	0.607407	4	Adverse weather
2.11	0.518519	5	Poor contract management
2.16	0.488889	6	Inadequate planning and scheduling by contractor
3.9	0.477037	7	Delay in approving major changes in the scope of work by consultant
4.7	0.466296	8	High cost of machinery
4.12	0.459259	9	Legal disputes between various parties
4.16	0.444444	10	Effect of social and cultural factors

Table5.10.List of top critical factors responsible for delay and cost overrun (Consultant)

List of top critical factors responsible for delay and cost overrun (Contractor)

S.No.	RII	Rank	Factor Name
1.23	0.752121	1	Utility shifting
3.3	0.712121	2	Poor Supervision by consultant
1.4	0.710606	3	Price fluctuations (inflation)
1.7	0.600000	4	Delays in land acquisition
1.1	0.560303	5	Contract awarded to lowest bidder
2.1	0.553939	6	Schedule delays
2.8	0.547879	7	Incompetent subcontractors
3.1	0.535758	8	Technical Changes
4.2	0.530606	9	Unforeseen site conditions
2.9	0.525455	10	Poor site management by contractor

Table 5.11. List of top critical factors responsible for delay and cost overrun (Contractor)

Results:

The study of top 10 critical for delays in highway construction projects it was found that some factors were common among all stakeholders like delays in land acquisition , utility shifting, poor contractor management by contractor, contract termination etc. So therefore these factors

can be said critical for the delay and cost overrun in highway construction projects. However some factors are different among some stakeholders but almost are common among all. The study shows that in India the factors which are responsible for delays are common among all stakeholders.

5.3. Comparison of these factors with other countries:

Elinwa and Joshua (2000) and Chabota Kaliba (2009) conduct the survey for the same study for Zambia and Nigeria and the result shows that some factors like poor site management by contractor, poor supervision by contractor , financial difficulties and are common and remaining are different like changes in scope by client, delays in land acquisition, utility shifting etc. Therefore most of the factors for delay and cost overrun in India are different from other countries.

Chapter 6

COMPARISON OF PERCEPTIONS AMONG THE STAKEHOLDERS

After finalizing the critical factors by using relative importance index (RII) it was found that there was some difference in perceptions among the stake holders as some factors marked as critical by one stakeholder is excluded in another stakeholders list. Therefore to check the significance of the difference in perceptions across stakeholder's agreement analysis was carried out. Firstly by using an inter rater agreement model the common results among the stakeholders were quantified, then these findings were validated through rater agreement factor model (RAF) technique.

6.1. Inter rater agreement model:

The inter rater agreement model defines the disagreement which composed of three components:

- Association of rater's ratings: when a rater rating a particular factor he consider different components and assign different weight ages to each of them. Also random error for example change in response with time may also affect the rating.
- Rater bias: Due to different interpretation of rating scale by respondents from different organizations rater bias may occur. It concerns about the tendency to rate the factors higher or lower than other respondents
- Rating distribution: Sometimes the respondents from a particular organization may have different distribution of ratings than the ratings of the respondents from different organization combined. This is considered as empirical problem and must be deal on case to case basis.

The study was carried out by using a likerts scale which was rated on a scale of 1 to 5, hence we can assume the data as interval data. The agreement between perspectives of different organizations was measured by using the above components namely rater association, rater bias and rater distribution.

- Rater association was calculated by using correlation. A rater vs. group approach was adopted, in which the mean score of all factors was calculated for each stakeholder then the mean score of each stakeholder was correlated with the mean score of the all stakeholders combined. Table shows the results and calculations for correlation coefficient.

Factor group	S.No.	Mean Score			
		Client/owner	Consultant	Contractor	Overall
Client/owner side	1.1	2.318	2.333	2.152	2.256
	1.2	1.909	1.852	1.697	1.805
	1.3	2.045	2.185	1.970	2.061
	1.4	2.182	2.296	2.303	2.268
	1.5	2.727	2.333	2.273	2.415
	1.6	2.591	2.037	2.242	2.268
	1.7	3.409	2.741	3.000	3.024
	1.8	2.273	2.111	2.091	2.146
	1.9	2.818	2.296	2.242	2.415
	1.10	2.818	2.333	2.212	2.415
	1.11	2.636	2.333	2.212	2.366
	1.12	2.227	2.185	1.970	2.110
	1.13	3.045	2.667	2.758	2.805
	1.14	2.136	2.148	2.091	2.122
	1.15	2.682	2.407	2.212	2.402
	1.16	2.409	2.148	2.273	2.268
	1.17	2.318	2.370	2.273	2.317
	1.18	2.273	2.000	2.121	2.122
	1.19	2.227	2.148	2.364	2.256
	1.20	2.364	1.852	2.000	2.049
	1.21	2.545	2.037	2.121	2.207
	1.22	2.273	1.963	2.182	2.134
	1.23	3.364	2.778	3.061	3.049
From contractor side	2.1	2.727	2.185	1.970	2.244
	2.2	2.000	2.148	1.879	2.000
	2.3	2.227	1.926	2.091	2.073
	2.4	1.818	2.111	1.879	1.939
	2.5	2.409	2.148	2.152	2.220
	2.6	2.318	2.222	2.091	2.195
	2.7	2.182	1.963	1.788	1.951
	2.8	2.273	2.037	1.939	2.061
	2.9	2.364	2.407	1.879	2.183
	2.10	2.136	2.370	1.818	2.085
	2.11	2.591	2.593	1.970	2.341
	2.12	2.364	2.148	1.879	2.098
	2.13	1.818	2.000	1.848	1.890
	2.14	2.227	2.185	2.000	2.122
	2.15	2.273	2.370	2.182	2.268
	2.16	2.591	2.444	2.061	2.329

From consultant side	3.1	2.182	1.926	1.879	1.976
	3.2	2.500	1.963	2.091	2.159
	3.3	2.273	1.815	2.061	2.037
	3.4	1.864	1.556	2.030	1.829
	3.5	1.773	1.889	1.909	1.866
	3.6	2.045	1.815	2.121	2.000
	3.7	2.409	2.037	2.182	2.195
	3.8	2.000	1.630	2.030	1.890
	3.9	2.455	1.852	2.061	2.098
	3.10	2.273	1.926	2.061	2.073
	3.11	2.091	2.000	2.030	2.037
Shared/External/Other factors	4.1	3.091	3.037	2.697	2.915
	4.2	2.455	2.111	2.303	2.280
	4.3	2.318	2.185	2.152	2.207
	4.4	2.364	2.037	1.909	2.073
	4.5	2.591	2.296	2.121	2.305
	4.6	2.500	2.185	2.212	2.280
	4.7	2.864	2.481	2.364	2.537
	4.8	2.000	2.259	2.152	2.146
	4.9	2.318	2.222	2.333	2.293
	4.10	2.227	2.333	2.030	2.183
	4.11	2.727	2.444	2.394	2.500
	4.12	2.773	2.296	2.121	2.354
	4.13	2.000	2.407	2.091	2.171
	4.14	2.273	2.259	2.424	2.329
	4.15	2.000	2.037	2.121	2.061
	4.16	2.318	2.222	2.121	2.207
	4.17	2.455	2.185	2.121	2.232
	4.18	3.318	2.593	2.545	2.768
Correlation coeff.		**0.918**	**0.861**	**0.901**	

Table6.1. Calculation of correlation for rater association determination

Output and interpretation:

The result is in the form of correlation coefficient which may range from -1 to+1 Positive value means that the two data sets are directly proportional and vice-versa. A value 0 means no co relation A value with 0.5 and greater is generally considered to be accepted.

When the respondents from different organization weight different components differently in this case the rater association decreases. If rater association is low training methods like group discussion , conferences etc. must be adopted.

Results:

As seen from the table all the values of correlation coefficient are more than 0.5 which means that perspectives of different organizations are highly correlated. Therefore disagreement on the account of the decrease in rater association is minimal. This may be due to the fact that the detailed description of each factor was provided during the survey and interviews are conducted to confirm the doubts.

- **Rater bias:**

In this method the mean rating of respondent was calculated across all factors. The mean ratings of respondents belong to a particular organization was compared with mean ratings of other stake holders. By adopting rater vs. group approach this test was carried out by using kruskal Wallis method due to sample size<30. Because in this ANOVA cannot be performed. Therefore non parametric omnibus kruskal Wallis test was conducted.

According to Black (2103) this test is non parametric alternative to ANOVA .It is used to check whether the sample come from same or different population. It was assumed that factor groups are independent and respondents are selected randomly.

This check whether the all groups are from same population or whether one group comes from different population

It can be calculated by using formula:

$$K=\frac{12}{n*(n-1)}*\sum_{j=1}^{c}\frac{Tj}{nj})-3(n-1)$$

Where

C= no. of groups

N= total number of items

Tj=total number of ranks in the group

Nj= number of items in the group

Assumptions:

- Dependent variable should be measured at ordinal or continuous level
- Independent w]variable must consist of two or more categorical independent groups
- There must be independence of observations

Limitations:

The kruskal Wallis test used to check that difference between the group of dependent variable is significant or not. But it cannot be determined that which groups are significantly statically

different from each other. It checks whether the difference in perception of organizations is statically significant or not.

The kruskal Wallis test was conducted using spss by taking these two assumptions

Ho= the difference in perceptions among all organizations are not statically significant

H1= the difference in perceptions among all organizations are statically significant

Result of kruskal Wallis test:

Organization role	N	Mean rank
client	22	53.18
Consultant	27	36.26
contractor	33	44.16
Total	82	

Test statistics [a,b]	
	Average rating of each respondent
Chi square	1.893
Df	3
P value	.047

a. Krukal Wallis test
b. Grouping variable: organizational role

Table 6.2. kruskal Wallis result

Output and interpretation:

The mean rank of each organization was used for comparison with other stakeholder organization. The test statistics table represent the differences in the perception of stakeholders are statically significant or not, by knowing the value of chi square, p and degree of freedom value. At a value of p less than 0.05 the difference becomes statically significant.

Results:

The kruskal Wallis test concluded that there is no significance difference in the perceptions of organizations. Chi square 1.893 p=0.047 with mean rating of 53.18, 36.26, 44.16 for client, consultant and contractor respectively. Thus the null hypothesis was accepted.

❖ Rating distribution:

By using rater vs. group approach rating distribution can be checked in two ways. By plotting the graph between the rating distributions of different stakeholder it was concluded that whether the rating is differ or not.

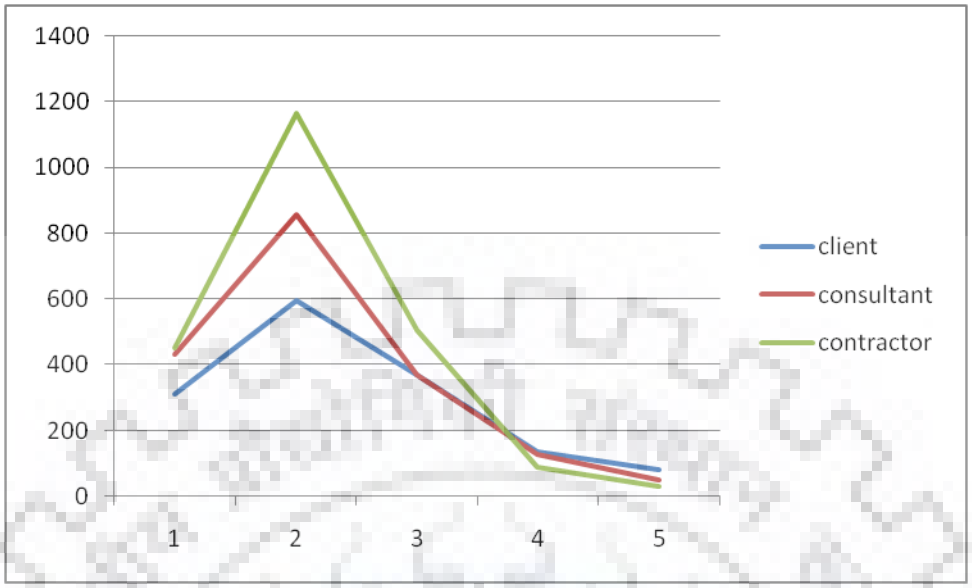

Fig 6.3.:rating distribution using graph

Result:

From the above graph it was concluded that rating distribution for all stakeholder organization is almost similar. Hence it was concluded that there is not so much difference in perception of different stakeholders in the organization.

Thus through inter rater agreement model , agreement between the perceptions of different organizations w.r.t. factors for time and cost overrun was determined.

6.2. Rank Agreement Factor Technique (RAF):

The RAF technique was introduced by Okpala and Aniekwu (1988) to find out quantitative method for rank agreement analysis. The RAF calculates the average absolute difference in ranking of factors between the two groups. Let say the rank of the ith item in group 1 is Ri1 and in group 2 is Ri2 N is the total number of items and j=N-i+1

The RAF is defined as

$$RAF=\sum_{i=1}^{N}\frac{|Ri1-Ri2|}{N}$$

The maximum rank agreement factor is defined as (RAF max)

$$RAFmax=\sum_{i=1}^{N}\frac{|Ri1-Ri2|}{N}$$

The percentage disagreement is defined as:

$$PD=\frac{\sum_{i=1}^{N}|Ri1-Ri2|}{\sum_{i=1}^{N}|Ri1-Ri2|}*100$$

The percentage agreement PA is defined as :

$$PA=100-PD$$

RAF was calculated in order to confirm the agreement of the perception between the stakeholders. RAF was calculated for each factor group individually. Since it follows rater vs rater approach there were total 4 pair wise comparison carried out for each factor . The table shows the RAF method in the form of RAF and PA.

Output and interpretation:

Higher the value of RAF, means lower agreement between the two groups . RAF zero means perfect agreement .if the value is higher it means the lesser lower the agreement between two groups.

Results:

As from table we can see the values of RAF is nearly equal to zero which means that there is good agreement in ranking of success factors between the stakeholders organization and from the p values of the kruskal Wallis test which are all are more than 0.05 shows that difference in mean values is not statically significant implying agreement among stakeholders.

Factor group	**Client-Consultant**	**Client-contractor**	**Consultant-Contractor**
	RAF	RAF	RAF
client/owner side	0.17	0.34	0.15
from contactor side	0.12	0.31	0.20
from consultant side	0.08	0.24	0.07
external/shared factors	0.03	0.08	0.03

Table6.4. Results of Rank Agreement factor technique

RAF= Rank Agreement Factor

Factor group	P value	Difference in mean value is..
1	0.769	Not statically significant
2	0.86	Not statically significant
3	0.488	Not statically significant
4	0.538	Not statically significant

Table6.5. Results of kruskal Wallis test for each factor group

As it was established that the perception of different stakeholders for ranking the factors were in agreement the whole list of the time and cost overrun factors was graded on priority basis level.

S.No.	Name of factors	Party responsible
1.7	Delays in land acquisition	Client
1.23	Utility shifting	Client
4.1	Adverse weather	Shared/external
4.18	contract termination	Shared/external
1.11	Changes in government regulation and laws	Client
1.17	Difficulties in obtaining work permits	Client
1.1	Financial difficulties	Client
3.9	Delay in approving major changes in the scope of work by consultant	Consultant
4.11	Environmental issues related to project	Shared/external
4.12	Legal disputes between various parties	Shared/external
1.15	Contract modification by client	client
2.11	Poor contract management by contractor	contractor
4.5	Work suspension owing to conflicts	Shared/external
4.6	Shortage of materials	contractor
4.7	High cost of machinery	Shared/external
3.7	Slow inspection of completed works	consultant
3.2	Changes in specifications	client
4.2	Unforeseen site conditions	Shared/external
4.3	Inadequate site investigations	Shared/external
1.5	Inappropriate government policies	client
1.13	High Environmental protection and mitigation costs	client
1.9	Financial process	client
4.17	Monopolistic pricing by vendors of equipment services	Shared/external
2.9	Poor site management by contractor	contractor
1.4	Price fluctuations (inflation)	client
1.21	Appointment of incompetent Consultant/Contractor	client
1.6	Delayed payment	client
1.16	Scope changes	client
2.16	Inadequate planning and scheduling by contractor	contractor
2.1	Schedule delays	contractor
2.5	Equipment unavailability	contractor
2.6	Labor disputes and strikes	contractor
3.3	Poor Supervision	consultant
1.8	Slowness in decision making process	client
1.1	Contract awarded to lowest bidder	client
2.15	Work suspension owing to conflicts	Shared/external
4.16	Effect of social and cultural factors	Shared/external

3.1	Inadequate design-team experience	consultant
4.4	Change in foreign exchange rate	Shared/external
4.14	Traffic control and restrictions on the job site unclear	Shared/external
4.15	Work hours are limited by imposed rules or site condition	Shared/external
4.13	Force majeure	Shared/external
1.14	Changes in drawings	Consultant/client
1.2	Inappropriate procurement contract	client
1.3	Acceleration required by client	client
2.3	Material procurement	contractor
3.4	Inaccurate estimates	consultant
3.5	Inadequate duration of contract period	client
3.6	Delay of drawings and site instructions	consultant
3.1	Technical Changes	Consultant/contractor
3.11	Complexity of project design	consultant
3.8	Underestimation of original cost	consultant
4.9	Type of ownership	client
4.1	Length of project implementation phase	Shared/external
4.8	Fraudulent practices, kickbacks ,corruption	Shared/external
2.12	Rework due to errors during construction by contractor	contractor
2.13	Poor qualification of technical staff of contractor	contractor
2.14	Accident during construction	Shared/external
2.1	Defective work	contractor
2.7	Shortage of skilled labor	contractor
2.8	Incompetent subcontractors	contractor
2.4	Construction mistakes	contractor
1.22	Delay in providing services from utilities (such as water, electricity)	client
1.19	Ambiguities, mistakes, and inconsistencies in contract specifications and drawings	Shared/external
1.2	Unrealistic imposed initial contract duration	client
1.18	site conditions differ from contract documents	client
1.12	Delay to transfer the site to the contractor by the client	client

Table 6.6. Prioritization of the factors which are responsible for the time and cost overrun in Indian highway projects

Chapter 7

Binary logistic regression model for prediction

Logistic regression is the extension of simple linear regression. In this the dependent variable is binary in nature in which we can't use simple linear regression. Logistic regression technique is used to predict the relationship between the independent variables (predictors) and a dependent variable (predicted variable) in this the dependent variable is binary .In our case it is the whether the project will be complete within time and cost or not "Y" means yes N means "No"

There should be two or more than two independent variables or predictors in binary logistic regression

The predictors can be continuous or categorical

All predictor variables tested in one block in order to check their predictive ability with controlling the other predictors which are in the model.

Assumptions in binary logistic regression:

1. Sample size should be adequate (there should not be too many predictors and few participants
2. Absence of multicolinearity
3. No outliers in the data
4. The -2 log likelihood is the badness of fit. Therefore its value should be less for the best fit of model.
5. The difference between two values of likelihood is considered as chi square for large sample size (chi square is goodness of fit)

Binary logistic regression function:

$$P(Y) = \frac{1}{1+e^{-(bo+b1x1+b2x2+b3x3.....bmxm)}}$$

$$= \frac{e^{(bo+b1x1+b2x2+b3x3.....bmxm)}}{1+e^{(bo+b1x1+b2x2+b3x3.....bmxm)}}$$

Or $$P(Y) = \frac{odds}{1+odds}$$

Where

$$Odds = e^{logit}$$

Logit= (Bo+b1x1+b2x2+b3x3……. +bmxm)

Logit= Logit is the equation which is generated by the output of the model

Odd is defined as the ratio of success to the failure.

Exp (B) change in the odds ratio of the event of interest w.r.t. change in the one unit of predictor value

If the value of Exp (B) is more than 1 it means the then as predictor increases it means the odds of the out coming increases and if the value is less than 1 indicates that as predictor increase the value of the odds out coming decreases

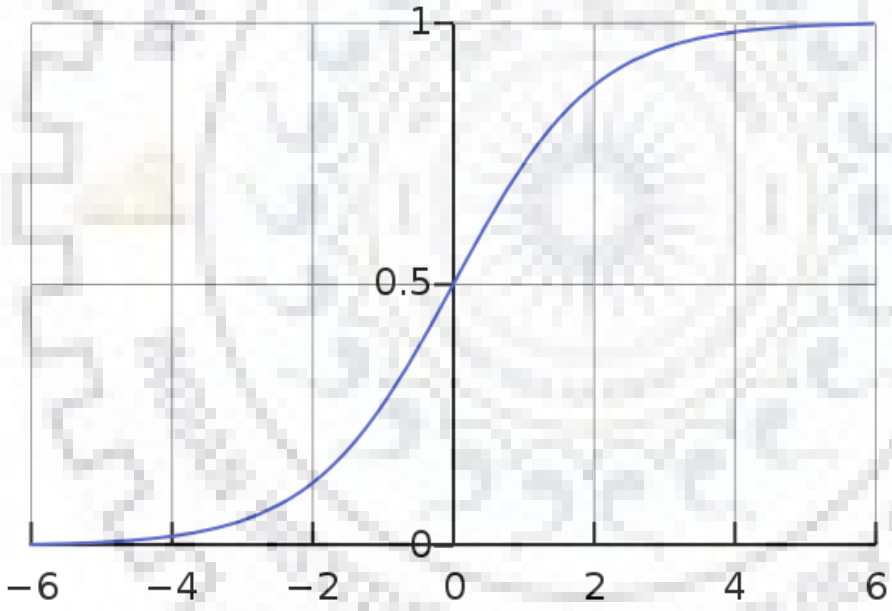

Fig7.1.Logit function graph

The logistic regression in this study was conducted in spss by taking the completion of the project within time and within cost as the dependent variable which is to be predicted. The respondents questionnaire survey were divided into two categories one who have handled within time completed project and another who have handled delayed projects with cost overrun. The "Y" code was given to the respondents who completed their project on time and within cost and "N" code was given to respondents who handled delayed projects with cost overrun. A total number of 37 "N" and 44 of "Y" respondent's data was collected.

As the number of the factors i.e. independent are very large so therefore to reduce the factors cronbach's alpha test was done for each factor group which shows a high value of coefficient of cronbach's alpha which means that the each factor in the group was working same as the group after cronbach's alpha test average of all the factors in each group was taken to reduce the factors after reduction of factors only 4 independent variables are left which were factor group namely factors for which client is responsible, factors for which contractor is responsible, factors for which consultant is responsible and shared factors.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.927	.927	23

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.927	.928	17

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.849	.849	11

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.933	.934	19

Table7.1. Coefficient of cronbach's alpha value

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Client	-3.547	2.069	2.938	1	.047	.029
	consultant	-2.037	1.809	1.268	1	.030	.130
	Contractor	-4.868	2.476	3.864	1	.049	.008
	Shared	-1.076	2.094	.264	1	.047	.341
	Constant	24.952	7.229	11.913	1	.001	68658637047.0

a. Variable(s) entered on step 1: Client, consultant, Contractor, Shared

Table .7.2. Final output of logistic regression

Output and interpretation:

From the above tables it was concluded that the coefficient cronbach's alpha was near to 1 for all factors after that by taking timely project completion of project as dependent variable and four factors group as independent variable namely client, consultant and owner. From the above table the logit equation was formed and the prediction was done by predicting the probability of happening and non happening of the event.

Results:

From the above table it can be seen that all values are significant and the Exp(B)in the above equation is representing the odds value as it can seen with one unit increase in client value the value of odds ratio decreased by 0.029. From the below equation it was concluded that if the value of any independent variable will increase it will decrease the odds ratio value which decreases the probability of timely and within cost completion of project. The predication result shows that 4 cases were misclassified.

Logit=24.952-3.547*client-2.037*consultant-4.868*contractor-1.076*shared

$$\textbf{Odds}=e^{logit}$$

$$P(Y) = \frac{odds}{1+odds}$$

Client	consultant	contractor	shared	Yes or No	PRE	odds	probability	Prediction	PG	T/F
2.435	2.438	2	2.5	N	0.25455	0.34	0.25	0	N	TRUE
3	2.375	2.4	2.5	N	0.0074	0.01	0.01	0	N	TRUE
2.261	1.688	1.6	1.444	Y	0.98453	63.54	0.98	1	Y	TRUE
3.13	2.125	2.7	2.889	N	0.00119	0	0	0	N	TRUE
1.609	1.875	1.5	1.778	Y	0.998	498.25	1	1	Y	TRUE
1.739	1.313	2	1.778	Y	0.98859	86.49	0.99	1	Y	TRUE
3.13	3	2.8	2.333	N	0.00022	0	0	0	N	TRUE
1.739	1.688	2.1	1.833	Y	0.95896	23.33	0.96	1	Y	TRUE
2.348	2.688	2.5	3	N	0.0141	0.01	0.01	0	N	TRUE
1.913	1.625	1.8	2.444	Y	0.96965	31.91	0.97	1	Y	TRUE
3.174	2.875	2	3.056	N	0.00557	0.01	0.01	0	N	TRUE
3	2.813	2	3.111	Y	0.01098	0.01	0.01	0	N	FALSE
3.435	2.375	2.8	3.278	N	0.0001	0	0	0	N	TRUE
1.913	1.563	1.6	2.056	Y	0.9932	145.82	0.99	1	Y	TRUE
2.565	3.438	2.2	2.944	N	0.00652	0.01	0.01	0	N	TRUE
1.913	1.625	1.3	1.5	Y	0.99901	1005.65	1	1	Y	TRUE
3.696	3	2.2	3.333	N	0.00019	0	0	0	N	TRUE
2.913	2.75	1.8	3.056	N	0.04601	0.05	0.05	0	N	TRUE
2.87	3.125	2.9	3.444	N	0.00008	0	0	0	N	TRUE
3	2.75	1.7	2.778	N	0.07214	0.08	0.07	0	N	TRUE
1.87	1.75	1.5	2.167	Y	0.99408	167.67	0.99	1	Y	TRUE
1.478	2.125	1.4	1.889	Y	0.99855	686.62	1	1	Y	TRUE

2.13	1.688	1.3	1.667	Y	0.99709	342.29	1	1	Y	TRUE
2.913	2.688	2.4	2.667	N	0.00447	0	0	0	N	TRUE
1.783	1.438	1.4	2	Y	0.99881	839.78	1	1	Y	TRUE
2.652	2.5	2.2	1.944	N	0.0872	0.1	0.09	0	N	TRUE
2	1.313	1.1	2	Y	0.99954	2158.56	1	1	Y	TRUE
1.913	1.375	1.9	1.667	Y	0.98692	75.36	0.99	1	Y	TRUE
1.957	1.5	1.7	1.667	Y	0.99252	132.57	0.99	1	Y	TRUE
2.13	1.5	1.8	2.167	Y	0.96256	25.67	0.96	1	Y	TRUE
2.522	2.375	2.5	2.944	N	0.01525	0.02	0.02	0	N	TRUE
2.174	1.438	1.4	1.667	Y	0.99668	300.02	1	1	Y	TRUE
1.957	1.75	2.6	2.889	N	0.21128	0.27	0.21	0	N	TRUE
1.957	1.5	1.8	1.667	Y	0.98789	81.47	0.99	1	Y	TRUE
2.783	2.313	2.3	2.889	N	0.01922	0.02	0.02	0	N	TRUE
1.826	2	1.7	1.889	Y	0.9836	59.87	0.98	1	Y	TRUE
2.522	1.875	2.5	2.389	N	0.07233	0.08	0.07	0	N	TRUE
3.391	2.188	2.4	2.722	N	0.00214	0	0	0	N	TRUE
2.348	1.313	1.5	1.611	Y	0.99273	136.26	0.99	1	Y	TRUE
1.826	2	2.2	1.556	Y	0.88273	7.51	0.88	1	Y	TRUE
2.261	1.813	2.1	2.222	Y	0.65194	1.87	0.65	1	Y	TRUE
2.348	1.875	2.1	2.333	Y	0.51805	1.07	0.52	1	Y	TRUE
2.783	2.563	2.4	2.611	N	0.00967	0.01	0.01	0	N	TRUE
1.87	2.125	2.4	2.222	Y	0.47966	0.92	0.48	0	N	FALSE
2.652	2.438	2.6	2.611	N	0.0075	0.01	0.01	0	N	TRUE
2.087	2.25	2.1	2	Y	0.64394	1.81	0.64	1	Y	TRUE
2.217	1.625	1.6	2.333	Y	0.97005	32.35	0.97	1	Y	TRUE

1.913	2.188	1.5	2.222	Y	0.98233	55.52	0.98	1	Y	TRUE
2.174	1.625	1.7	2.222	Y	0.96321	26.14	0.96	1	Y	TRUE
2.565	3.063	3.6	3.778	N	0.00001	0	0	0	N	TRUE
2.652	3.688	2.2	3.333	N	0.0019	0	0	0	N	TRUE
1.696	1.875	1.9	1.833	Y	0.9801	49.18	0.98	1	Y	TRUE
1.652	1.375	1.7	2.278	Y	0.99618	260.78	1	1	Y	TRUE
1.652	1.75	1.4	2.167	Y	0.99831	589.87	1	1	Y	TRUE
1.696	1.688	1.8	1.611	Y	0.99334	148.92	0.99	1	Y	TRUE
3.261	3.813	2.5	4.444	N	0.00001	0	0	0	N	TRUE
3.565	3.5	2.6	3.611	N	0.00001	0	0	0	N	TRUE
2.174	1.563	1.3	2	Y	0.99624	264.38	1	1	Y	TRUE
1.826	1.5	1.5	1.667	Y	0.99821	557.49	1	1	Y	TRUE
1.522	1.625	1.9	1.722	Y	0.99419	170.92	0.99	1	Y	TRUE
3.304	3.375	2.3	3.556	N	0.00017	0	0	0	N	TRUE
3.565	2.938	3	3.556	N	0.00001	0	0	0	N	TRUE
2.522	2.375	2.7	2.778	N	0.00695	0.01	0.01	0	N	TRUE
1.652	1.688	1.4	1.444	Y	0.99932	1457.27	1	1	Y	TRUE
1.478	1.5	1.5	1.556	Y	0.99954	2157.56	1	1	Y	TRUE
2.522	2.313	1.8	2.444	N	0.47629	0.91	0.48	0	N	TRUE
2.348	2.813	2.4	2.778	N	0.0224	0.02	0.02	0	N	TRUE
1.522	1.75	1.5	1.667	Y	0.99899	986.05	1	1	Y	TRUE
2.826	3.125	2.8	2.667	N	0.00036	0	0	0	N	TRUE
2.174	1.75	1.7	1.611	Y	0.97511	39.12	0.98	1	Y	TRUE
2.565	1.813	1.9	2.389	N	0.58474	1.41	0.58	1	Y	FALSE
2.391	2.125	2.2	2.111	N	0.3018	0.43	0.3	0	N	TRUE

1.522	1.25	1.4	1.722	Y	0.99976	4185.03	1	1	Y	TRUE
1.522	1.25	1.4	1.722	Y	0.99976	4185.03	1	1	Y	TRUE
1.783	1.25	1.3	1.556	Y	0.99969	3229.68	1	1	Y	TRUE
1.478	1.063	1.5	1.5	Y	0.99982	5584.2	1	1	Y	TRUE
2.043	1.875	1.8	1.722	Y	0.96338	26.26	0.96	1	Y	TRUE
2.565	2.188	1.9	2.389	N	0.39615	0.65	0.4	0	N	TRUE
2.217	2.438	3.1	2.667	N	0.00291	0	0	0	N	TRUE
2.565	2.375	2.3	2.444	N	0.05677	0.06	0.06	0	N	TRUE
1.696	2.5	2.3	2.333	N	0.53465	1.15	0.53	1	Y	FALSE

Table 7.3.Prediction output result of the binary logistic regression

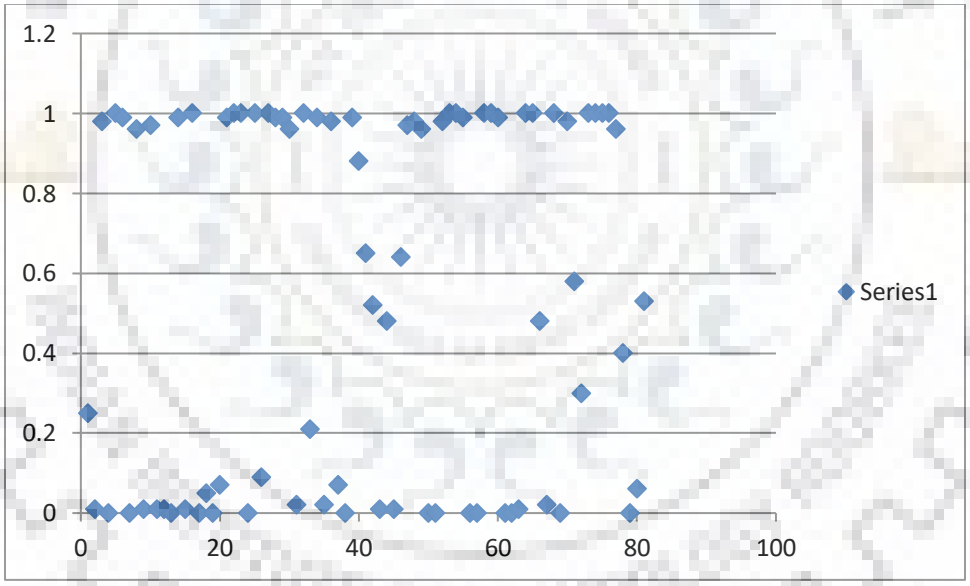

Fig8.1. probability distribution output

7.3. Limitation of binary logistic regression model:

Binary logistic regression only predicts the ordinal data as dependent variable therefore it can only predict the happening and non happening of an event. Another limitation is that the binary logistic regression over fitted the data form example sometimes these may not be the reasons for the delays and cost overrun then this model will not work at all. In this study due to high correlation of the factors within their group leads to factor reduction which leads to the not proper factors inclusion in the model. In this case the multicolinearity is high due to the less independent observations, therefore the important factors got underestimated which reduces the consistency of the model. Also due to small sample size the model is not so robust.

Chapter 8

SAILENT FINDINGS AND RECOMMENDATION

This study was done to identify and prioritize the factors which are responsible for the time and cost overrun in highway construction projects and to develop a model by using binary logistic regression in order to predict the probability of the completion of the project within time and cost in relation with these factors. After doing this research it was identified that the factors which are responsible for time and cost overrun in India are different from other countries.

The research mainly involved the identification of factors and check their severity in the delays and cost overruns of the project which was carried by doing questionnaire survey and after developing the prediction model the influence of various factor group was quantified in order to check the influence of each factor group in the within time and cost completion of the project.

On the basis of results the most critical factors for the delay and cost overrun are delays in land acquisition, utility shifting, high project and mitigation cost adverse weather, contract termination, and change in government laws etc. By comparing with other countries it was found that mostly factors are different to India from other countries.

The first most influencing factor is delay in land acquisition actually in India land acquisition is very difficult and time taking process the reasons may be the public opposition. It is not always sure that land will be acquired in that case alternative routes are adopted which lead to increase in the cost of the project. For timely land acquisition the NH act 1956 may be amended to provide a time limit for initiation of arbitration proceedings and possibility of urgency in some special cases. Digitization of revenue maps may help to overcome the land acquisition problem.

The second most critical factor is utility shifting. This is the main problem which leads to delay and cost overrun in project shifting of utilities like water pipes power cables etc in highway works consumes more time and make the project complex. It's a major hindrance for the highways projects. In this case various parties involved in this may approach to a common understanding and there should be mutual efforts may be taken by each party.

Third most critical factor is adverse weather this problem is natural and cannot be removed but the advance contingency planning and demand for the fast track construction and proper project management .For poor performance of contractors he report on the performance of the contractors on day to day basis and enforce penalty on the contractors which are responsible for the delays can be implemented. **Parliamentary committee on Transport, tourism and culture (2016)** recommended that NHAI should ensure the completion of awarded projects and schedules for awarded of contracts of the projects which are pending, by ensuring a strict compliance. The committee was of view that proper bank guarantees should be taken at the initial stage of project from contractors to avoid later termination of project.

From our analysis it was confirmed that there is no significant difference in the perception of different stakeholders for top delay factors.

As a outcome of study the factors are prioritized, by using this prioritization we can make the proper strategy to reduce the influence of these factors on project delays and cost overrun.

8.1. Limitations:

For identifying the critical delay and cost overrun factors convenience sampling was used instead

of random sampling. The targeted size of the population sample size cannot achieve due to unavailability of respondents and time constraint. Due to which kruskal Wallis test was performed instead of one way ANOVA.

The scale of 1 to 5 was not sufficient to mark the ratings, for the accuracy of the rating the scale may be increased to reflect more varied ratings.

In the binary logistic regression model the sample size was very less which was not enough to predict the probability of the project timely and within cost completion of projects. Due to high multicolinearity between the independent variables the important factors the model was underestimated. Due to high value of cronbach's alpha coefficient the factor reduction was very high due to which the important factor were underestimated.

8.2. Future scope:

The future scope for this research includes:

1. The study can be further carried out for a specific factor group to identify the core problem and provide proper solutions to them.
2. This study can be done for other construction projects which are facing the same issues.
3. The prediction method used here can be used for particular factors separately on a large sample size. In our case due to high value of cronbach's alpha coefficient the factor reduction was high which reduces the inclusion of important factors in the model. So the model can be predicted by considering all important factors in the model.
4. To develop the model other factors like the type of ownership, length of implementation phase can also be included to increase the predictive power of the model.

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10. ANNEXURE

1. Factor descriptions
2. Survey questionnaire
3. spss output for binary logistic regression
4. Responses of survey questionnaire

.

Sample Factor descriptions

1. Delays in land acquisition :

Delay in land acquisition refers to get the land free for the construction purpose legally , this factor affect the timely and within cost completion of the road construction projects.

2. Contract termination

Contract termination is the condition in which the contractor leaves the project in between before its completion due to its inability to handle the project.

3. Poor site management by contractor:

Poor site management by contractor refers to the condition in which the contractor is not working on the contract as per norms and standards

4. Schedule delays by contractor

Due to poor performance of contractor or may be due to some other reason the activities of the project get delayed which further affects the suceeding activity

5. Utility shifting:

Utility shifting means to shift the other facilities like pipe line power cables etc which are obstructing the construction site

6. Type of ownership:

Type of ownership means whether the project owner is government or private party . Generally the construction projects which have private owner are less prone to the delay and cost overrun.

7. Length of implementation phase:

Length of implementation phase means the time in which the project is execute generally larger projects have longer implementation phase due to many reasons

8. Size of project:

Size of project means the cost of project generally projects with high cost are more prone to the cost overrun but in this managers makes well effort to avoid delays and cost overrun.

9. Monopolistic pricing by vendors:

Due to monopoly of the vendor it provides the machinery on a very high rate because other options are not available for the contractors.

10. Incompetent subcontractors:

Sometimes the subcontractors appointed by the contractor are not able to do their job at par which further leads to the poor performance of the projects.

11. Defective work:

Defective work by contractor results in the rework which can delay the project and may increase the cost

12. Adverse weather:

Adverse weather means the weather condition which is not favorable for the construction on the site which results in delay and cost overrun of the project.

13. Scope changes:

Scope changes, means the modification of the previous work which also leads to the delay and cost overrun

14. Inappropriate government policies:

Inappropriate government policies means the policy which restricts the performance of the projects like some state governments not give clearances and the work permits which leads to the delay of the project

15. High environmental mitigation cost:

High mitigation cost refers to the cost which id=s incurred to overcome the loss to the environment which happened due to the construction for example cutting of trees, rehabilitation of animals if site is at forest etc.

MOST TIME AND COST INFLUENCING FACTORS IN CASE OF INDIAN HIGHWAY PROJECTS

Thank you for participating in this survey.Please fill in all the fields so as to enable us to gather adequate data for further analysis.

* Required

1. **Name of respondent** *

2. **Name of the organization you currently employed with:** *

3. **Type of organization** *
   Mark only one oval.
   - Client
   - Contractor
   - Consultant
   - Other

4. **Designation:**

5. **Experience (in years):** *

6. **Types of projects you have worked upon:** *

7. **Average size of projects you have involved (in Crore Rs.):** *

8. **Educational Qualification:** *

Mark only one oval.

- 12th standard or below
- Diploma
- Graduate
- Post graduate
- Doctrate
- Other

9. **Please consider any one project that that you have handled and answer the following questionnaire depending upon the project completed within estimated time and cost:** *

Mark only one oval.

- Yes
- No

SURVEY QUESTIONNAIRE

Shown below are elements that positively influencing the time and cost overrun in indian road projects.The elements are divided into four categories on the basis of party/ies responsible i.e. client , concessionaire,consultant and external reasons Kindly evaluate the relative importance of each of these elements in terms of impact on project time and cost overruns.Please give rating on the basis of whether the project was completed on time or not.

10. **From Client/owner side:** *

Mark only one oval per row.

	Least Significant	Less significant	Moderately Significant	More Significant	Most Significant
Contract awarded to lowest bidder					
Inappropriate procurement contract					
Acceleration required by client					
Price fluctuations (inflation)					
Inappropriate government policies					
Delayed payment					
Delays in land acquisition					
Slowness in decision making process					
Financial process					
Financial difficulties					
Changes in government regulation and laws					
Delay to transfer the site to the contractor by the client					
High Environmental protection and mitigation costs					
Changes in drawings					
Contract modification					
Scope changes					
Difficulties in obtaining work permits					
site conditions differ from contract doccuments					
Ambiguities, mistakes, and inconsistencies in contract specifications and drawings					
Unrealistic imposed initial contract duration					
Appointment of incompetent Consultant/Contractor					
Delay in providing services from utilities (such as water,electricity)					
Utility shifting					

11. **From contractor side:** *

Mark only one oval per row.

	Least Significant	Less Significant	Moderately Significant	More Significant	Most Significant
Schedule delays					
Technical changes					
Material procurement					
Construction mistakes					
Equipment unavailablibity					
Labour disputes and strikes					
Shortage of skilled labour					
Incompetent subcontractors					
Poor site management by contractor					
Defective work					
Poor contract management					
Rework due to errors during construction by contractor					
Poor qualification of technical staff of contractor					
Accident during construction					
Work suspension owing to conflicts					
Inadequate planning and scheduling by contractor					

12. **From consultant side:** *

Mark only one oval per row.

	Least significant	Less Significant	Moderately Significant	More Significant	Most Significant
Technical Changes					
Changes in specifications					
Poor Supervision					
Inaccurate estimates					
Inadequate duration of contract period					
Delay of drawings and site instructions					
Slow inspection of completed works					
Underestimation of original cost					
Delay in approving major changes in the scope of work by consultant					
Inadequate design-team experience					
Complexity of project design					

13. **Shared/External/Other factors:** *

Mark only one oval per row.

	Least Significant	Less Significant	Moderately Significant	More significant	Most significant
Adverse weather					
Unforeseen site conditions					
Inadequate site investigations					
Change in foreign exchange rate					
Work suspension owing to conflicts					
Shortage of materials					
High cost of machinery					
Fraudulent practices, kickbacks ,corruption					
Type of ownership					
Length of project implementation phase					
Environmental issues related to project					
Legal disputes between various parties					
Force majeure					
Traffic control and restrictions on the job site unclear					
Work hours are limited by imposed rules or site condition					
Effect of social and cultural factors					
Monopolistic pricing by vendors of equipment services					
contract termination					

14. **Would you like to add any new elements to the above list?**

15. **Comments/Suggestions/Feedback:**

```
T-TEST
  /TESTVAL=0
  /MISSING=ANALYSIS
  /VARIABLES=Client consultant Contractor Shared
  /CRITERIA=CI(.95).
```

T-Test

```
[DataSet1]
```

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Client	81	2.3054	.57962	.06440
consultant	81	2.1165	.64361	.07151
Contractor	81	2.0074	.50985	.05665
Shared	81	2.3326	.64916	.07213

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Client	35.797	80	.000	2.30542	2.1773	2.4336
consultant	29.597	80	.000	2.11651	1.9742	2.2588
Contractor	35.435	80	.000	2.00741	1.8947	2.1201
Shared	32.340	80	.000	2.33265	2.1891	2.4762

```
LOGISTIC REGRESSION VARIABLES YorN
  /METHOD=ENTER Client consultant Contractor Shared
  /SAVE=PRED PGROUP
  /CASEWISE OUTLIER(2)
  /PRINT=GOODFIT ITER(1)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
```

Logistic Regression

```
[DataSet1]
```

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	81	100.0
	Missing Cases	0	.0
	Total	81	100.0
Unselected Cases		0	.0
Total		81	100.0

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

Dependent Variable Encoding

Original Value	Internal Value
N	0
Y	1

Block 0: Beginning Block

Iteration History[a,b,c]

Iteration		-2 Log likelihood	Coefficients Constant
Step 0	1	111.684	.173
	2	111.684	.173

a. Constant is included in the model.

b. Initial -2 Log Likelihood: 111.684

c. Estimation terminated at iteration number 2 because parameter estimates changed by less than .001.

Classification Table[a,b]

Observed			Predicted		
			YorN		Percentage Correct
			N	Y	
Step 0	YorN	N	0	37	.0
		Y	0	44	100.0
	Overall Percentage				54.3

a. Constant is included in the model.

b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	.173	.223	.603	1	.437	1.189

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Client	46.973	1	.000
		consultant	47.444	1	.000
		Contractor	44.928	1	.000
		Shared	46.617	1	.000
	Overall Statistics		58.916	4	.000

Block 1: Method = Enter

Iteration History[a,b,c,d]

Iteration		-2 Log likelihood	Coefficients				
			Constant	Client	consultant	Contractor	Shared
Step 1	1	43.949	7.431	-1.117	-.761	-1.321	-.181
	2	29.610	12.563	-1.777	-1.161	-2.252	-.572
	3	24.555	17.596	-2.455	-1.529	-3.226	-.899
	4	23.162	21.867	-3.073	-1.828	-4.139	-1.058
	5	22.954	24.318	-3.446	-1.993	-4.711	-1.084
	6	22.946	24.923	-3.542	-2.035	-4.860	-1.077
	7	22.946	24.952	-3.547	-2.037	-4.868	-1.076
	8	22.946	24.952	-3.547	-2.037	-4.868	-1.076

a. Method: Enter

b. Constant is included in the model.

c. Initial -2 Log Likelihood: 111.684

d. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	88.738	4	.000
	Block	88.738	4	.000
	Model	88.738	4	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	22.946[a]	.666	.890

a. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	14.189	8	.077

Contingency Table for Hosmer and Lemeshow Test

		YorN = N		YorN = Y		
		Observed	Expected	Observed	Expected	Total
Step 1	1	8	7.999	0	.001	8
	2	8	7.981	0	.019	8
	3	7	7.922	1	.078	8
	4	8	7.413	0	.587	8
	5	6	4.454	2	3.546	8
	6	0	1.004	8	6.996	8
	7	0	.149	8	7.851	8
	8	0	.055	8	7.945	8
	9	0	.018	8	7.982	8
	10	0	.005	9	8.995	9

Classification Table[a]

			Predicted		
			YorN		Percentage Correct
	Observed		N	Y	
Step 1	YorN	N	35	2	94.6
		Y	2	42	95.5
	Overall Percentage				95.1

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Client	-3.547	2.069	2.938	1	.470	.029
	consultant	-2.037	1.809	1.268	1	0.030	.130
	Contractor	-4.868	2.476	3.864	1	.049	.008
	Shared	-1.076	2.094	.264	1	.047	.341
	Constant	24.952	7.229	11.913	1	.001	68658637047

a. Variable(s) entered on step 1: Client, consultant, Contractor, Shared.

Casewise List[b]

Case	Selected Status[a]	Observed YorN	Predicted	Predicted Group	Temporary Variable Resid	Temporary Variable ZResid
12	S	Y**	.011	N	.989	9.491

a. S = Selected, U = Unselected cases, and ** = Misclassified cases.

b. Cases with studentized residuals greater than 2.000 are listed.

```
GET
  FILE='F:\dissertation analysis\spss\output logistic regression sheet.sav'.
DATASET NAME DataSet2 WINDOW=FRONT.
DATASET ACTIVATE DataSet1.
LOGISTIC REGRESSION VARIABLES YorN
  /METHOD=FSTEP(LR) Client
  /METHOD=ENTER consultant
  /METHOD=ENTER Contractor
  /METHOD=ENTER Shared
  /SAVE=PRED PGROUP
  /CASEWISE OUTLIER(2)
  /PRINT=GOODFIT ITER(1)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
```

Logistic Regression

```
[DataSet1]
```

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	81	100.0
	Missing Cases	0	.0
	Total	81	100.0
Unselected Cases		0	.0
Total		81	100.0

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

Dependent Variable Encoding

Original Value	Internal Value
N	0
Y	1

Block 0: Beginning Block

Iteration History[a,b,c]

Iteration		-2 Log likelihood	Coefficients Constant
Step 0	1	111.684	.173
	2	111.684	.173

a. Constant is included in the model.

b. Initial -2 Log Likelihood: 111.684

c. Estimation terminated at iteration number 2 because parameter estimates changed by less than .001.

Classification Table[a,b]

Observed			Predicted		
			YorN		Percentage Correct
			N	Y	
Step 0	YorN	N	0	37	.0
		Y	0	44	100.0
	Overall Percentage				54.3

a. Constant is included in the model.

b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	.173	.223	.603	1	.437	1.189

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Client	46.973	1	.000
	Overall Statistics		46.973	1	.000

Block 1: Method = Forward Stepwise (Likelihood Ratio)

Iteration History[a,b,c,d]

Iteration		-2 Log likelihood	Coefficients	
			Constant	Client
Step 1	1	58.026	6.246	-2.634
	2	48.246	10.139	-4.343
	3	45.930	13.089	-5.644
	4	45.711	14.355	-6.199
	5	45.708	14.521	-6.271
	6	45.708	14.524	-6.273
	7	45.708	14.524	-6.273

a. Method: Forward Stepwise (Likelihood Ratio)

b. Constant is included in the model.

c. Initial -2 Log Likelihood: 111.684

d. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	65.976	1	.000
	Block	65.976	1	.000
	Model	65.976	1	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	45.708[a]	.557	.745

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	15.105	8	.057

Contingency Table for Hosmer and Lemeshow Test

		YorN = N		YorN = Y		
		Observed	Expected	Observed	Expected	Total
Step 1	1	8	7.988	0	.012	8
	2	7	7.872	1	.128	8
	3	6	5.536	0	.464	6
	4	9	7.276	0	1.724	9
	5	4	4.329	4	3.671	8
	6	1	2.345	7	5.655	8
	7	1	.754	5	5.246	6
	8	0	.486	7	6.514	7
	9	0	.254	7	6.746	7
	10	1	.161	13	13.839	14

Classification Table[a]

			Predicted		
			YorN		Percentage Correct
	Observed		N	Y	
Step 1	YorN	N	34	3	91.9
		Y	3	41	93.2
	Overall Percentage				92.6

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Client	-6.273	1.394	20.241	1	.000	.002
	Constant	14.524	3.205	20.533	1	.000	2029996.409

a. Variable(s) entered on step 1: Client.

Model if Term Removed

Variable		Model Log Likelihood	Change in -2 Log Likelihood	df	Sig. of the Change
Step 1	Client	-55.842	65.976	1	.000

Block 2: Method = Enter

Iteration History[a,b,c,d]

Iteration		-2 Log likelihood	Coefficients		
			Constant	Client	consultant
Step 1	1	49.819	6.509	-1.480	-1.381
	2	37.198	10.748	-2.364	-2.467
	3	33.323	14.433	-3.096	-3.486
	4	32.669	16.680	-3.566	-4.090
	5	32.640	17.280	-3.699	-4.243
	6	32.640	17.313	-3.707	-4.252
	7	32.640	17.313	-3.707	-4.252

a. Method: Enter

b. Constant is included in the model.

c. Initial -2 Log Likelihood: 45.708

d. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	13.068	1	.000
	Block	13.068	1	.000
	Model	79.044	2	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	32.640[a]	.623	.833

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	40.122	8	.000

Contingency Table for Hosmer and Lemeshow Test

		YorN = N		YorN = Y		
		Observed	Expected	Observed	Expected	Total
Step 1	1	8	7.997	0	.003	8
	2	7	7.974	1	.026	8
	3	8	7.780	0	.220	8
	4	8	7.156	0	.844	8
	5	5	3.929	3	4.071	8
	6	0	1.197	8	6.803	8
	7	1	.519	7	7.481	8
	8	0	.266	8	7.734	8
	9	0	.141	8	7.859	8
	10	0	.041	9	8.959	9

Classification Table[a]

			Predicted		
			YorN		Percentage Correct
	Observed		N	Y	
Step 1	YorN	N	34	3	91.9
		Y	1	43	97.7
	Overall Percentage				95.1

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Client	-3.707	1.421	6.807	1	.009	.025
	consultant	-4.252	1.429	8.850	1	.003	.014
	Constant	17.313	3.910	19.603	1	.000	33041410.83

a. Variable(s) entered on step 1: consultant.

Block 3: Method = Enter

Iteration History[a,b,c,d]

Iteration		-2 Log likelihood	Coefficients			
			Constant	Client	consultant	Contractor
Step 1	1	44.060	7.428	-1.180	-.847	-1.367
	2	29.940	12.554	-1.993	-1.394	-2.412
	3	24.904	17.648	-2.840	-1.807	-3.546
	4	23.456	22.090	-3.595	-2.054	-4.617
	5	23.225	24.729	-4.027	-2.188	-5.276
	6	23.216	25.408	-4.133	-2.227	-5.445
	7	23.216	25.443	-4.138	-2.230	-5.454
	8	23.216	25.443	-4.138	-2.230	-5.454

a. Method: Enter

b. Constant is included in the model.

c. Initial -2 Log Likelihood: 32.640

d. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	9.424	1	.002
	Block	9.424	1	.002
	Model	88.468	3	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	23.216[a]	.665	.888

a. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	10.504	8	.231

Contingency Table for Hosmer and Lemeshow Test

		YorN = N		YorN = Y		
		Observed	Expected	Observed	Expected	Total
Step 1	1	8	7.999	0	.001	8
	2	8	7.984	0	.016	8
	3	7	7.911	1	.089	8
	4	8	7.415	0	.585	8
	5	5	4.343	3	3.657	8
	6	1	1.134	7	6.866	8
	7	0	.142	8	7.858	8
	8	0	.055	8	7.945	8
	9	0	.014	8	7.986	8
	10	0	.004	9	8.996	9

Classification Table[a]

			Predicted		
			YorN		Percentage Correct
	Observed		N	Y	
Step 1	YorN	N	34	3	91.9
		Y	2	42	95.5
	Overall Percentage				93.8

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Client	-4.138	1.847	5.020	1	.025	.016
	consultant	-2.230	1.731	1.659	1	.198	.108
	Contractor	-5.454	2.309	5.577	1	.018	.004
	Constant	25.443	7.459	11.636	1	.001	1.122E+11

a. Variable(s) entered on step 1: Contractor.

Block 4: Method = Enter

Iteration History[a,b,c,d]

Iteration		-2 Log likelihood	Coefficients				
			Constant	Client	consultant	Contractor	Shared
Step 1	1	43.949	7.431	-1.117	-.761	-1.321	-.181
	2	29.610	12.563	-1.777	-1.161	-2.252	-.572
	3	24.555	17.596	-2.455	-1.529	-3.226	-.899
	4	23.162	21.867	-3.073	-1.828	-4.139	-1.058
	5	22.954	24.318	-3.446	-1.993	-4.711	-1.084
	6	22.946	24.923	-3.542	-2.035	-4.860	-1.077
	7	22.946	24.952	-3.547	-2.037	-4.868	-1.076
	8	22.946	24.952	-3.547	-2.037	-4.868	-1.076

a. Method: Enter

b. Constant is included in the model.

c. Initial -2 Log Likelihood: 23.216

d. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	.270	1	.603
	Block	.270	1	.603
	Model	88.738	4	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	22.946[a]	.666	.890

a. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	14.189	8	.077

Contingency Table for Hosmer and Lemeshow Test

		YorN = N		YorN = Y		
		Observed	Expected	Observed	Expected	Total
Step 1	1	8	7.999	0	.001	8
	2	8	7.981	0	.019	8
	3	7	7.922	1	.078	8
	4	8	7.413	0	.587	8
	5	6	4.454	2	3.546	8
	6	0	1.004	8	6.996	8
	7	0	.149	8	7.851	8
	8	0	.055	8	7.945	8
	9	0	.018	8	7.982	8
	10	0	.005	9	8.995	9

Classification Table[a]

			Predicted		
			YorN		Percentage Correct
	Observed		N	Y	
Step 1	YorN	N	35	2	94.6
		Y	2	42	95.5
	Overall Percentage				95.1

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Client	-3.547	2.069	2.938	1	.047	.029
	consultant	-2.037	1.809	1.268	1	.030	.130
	Contractor	-4.868	2.476	3.864	1	.049	.008
	Shared	-1.076	2.094	.264	1	.047	.341
	Constant	24.952	7.229	11.913	1	.001	68658637047

a. Variable(s) entered on step 1: Shared.

Casewise List[b]

Case	Selected Status[a]	Observed	Predicted	Predicted Group	Temporary Variable	
		YorN			Resid	ZResid
12	S	Y**	.011	N	.989	9.491

a. S = Selected, U = Unselected cases, and ** = Misclassified cases.

b. Cases with studentized residuals greater than 2.000 are listed.

	Y/N	N	N	N	Y	N	Y	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	N	N	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	Y	N	Y	N	Y	N
Factor group	S.No.	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35	R36	R37	R38
Client/owner side	1.1	2	2	4	3	4	1	1	3	1	2	1	3	2	1	2	1	1	5	4	3	4	1	1	2	3	2	3	1	1	1	1	2	2	3	2	2	2	2
	1.2	3	2	2	1	3	2	2	2	1	3	2	1	1	3	2	2	1	4	4	3	3	1	1	1	4	1	3	1	1	2	2	3	1	2	2	2	2	2
	1.3	2	1	2	2	2	2	1	1	2	2	3	2	3	3	1	3	1	3	5	4	4	2	1	2	2	1	2	2	2	2	1	2	2	1	2	3	2	2
	1.4	2	2	3	1	4	2	3	2	1	2	1	2	3	3	2	4	2	3	3	2	3	2	2	1	3	3	2	1	2	3	2	2	3	2	3	3	3	3
	1.5	3	3	4	3	3	1	2	3	2	3	2	3	5	5	2	3	2	4	4	3	3	2	1	2	4	1	2	2	1	2	1	2	2	3	2	2	2	2
	1.6	4	4	5	1	3	2	1	4	1	2	1	3	2	5	1	2	1	5	1	2	4	1	2	1	5	1	3	1	2	1	2	3	2	2	2	3	3	3
	1.7	5	5	5	1	5	2	2	5	2	4	2	5	3	5	2	4	3	5	5	5	3	1	2	2	5	2	2	1	3	3	3	4	4	3	3	5	1	4
	1.8	4	2	3	1	2	1	1	3	1	3	2	2	2	4	2	3	2	3	2	2	4	1	1	2	3	1	3	1	1	2	3	2	1	2	2	2	1	2
	1.9	3	5	4	2	3	3	1	2	3	2	2	3	3	5	1	2	2	5	3	3	3	2	2	4	2	3	2	2	2	2	2	3	2	2	2	3	1	2
	1.1	3	4	2	1	4	2	3	3	4	3	3	5	2	4	1	2	3	5	2	2	4	2	1	4	3	3	3	2	1	2	2	2	2	1	2	3	1	3
	1.11	4	2	3	1	3	1	2	4	2	2	3	4	4	4	2	4	2	4	2	3	3	2	2	3	4	1	2	2	2	1	1	2	3	2	2	3	2	2
	1.12	1	2	2	4	4	2	1	3	2	1	2	5	2	1	1	2	2	2	3	3	3	2	1	4	2	2	2	3	1	2	1	3	2	2	2	2	1	3
	1.13	2	1	4	1	5	1	2	4	3	4	4	5	4	5	2	3	2	4	2	2	2	2	2	2	4	3	4	4	3	3	3	2	4	4	3	4	3	2
	1.14	4	2	5	1	2	1	1	2	2	1	1	4	2	3	2	2	1	4	4	3	3	3	1	3	2	2	2	2	2	3	2	3	2	2	2	2	1	2
	1.15	5	3	3	2	3	1	2	3	1	3	2	5	3	4	3	3	2	4	3	2	3	2	2	2	3	2	3	3	2	2	3	2	2	2	2	3	2	2
	1.16	4	2	2	4	2	2	2	3	1	2	1	3	4	3	2	2	2	3	2	2	3	2	1	3	2	2	2	2	2	2	2	2	3	2	2	3	1	3
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