DEVELOPING A FRAMEWORK FOR MITIGATION OF PROJECT DELAYS THROUGH IMPACT ASSESSMENT OF CRITICAL FACTORS CAUSING TIME OVERRUNS IN ROADS AND HIGHWAYS SECTOR PROJECTS IN INDIA

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COLLEGE OF MANAGEMENT AND ECONOMICS STUDIES

DEPARTMENT OF ENERGY MANAGEMENT

SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENT OF THE DEGREE OF

DOCTOR OF PHILOSOPHY

TO

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
DEHRADUN
(FEBRUARY 2019)

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I dedicate this research study to my beloved parents who taught me that there is no substitute for hard work

ACKNOWLEDGEMENTS

I bow to Goddess Shri Saraswati devi and Godess Shri Kamakshi devi for her inspiration to keep the quest for knowledge so burning and lighted that inspired me to pursue this research program.

I share my sincere gratitude to the University of Petroleum & Energy Studies (UPES) for giving me the opportunity to pursue the research study.

I would like to express the deepest appreciation to my internal guide Dr. Ankur Mittal and my co- guide Dr. Neeraj Anand for being constant source of inspiration and guidance throughout my research process. My guides have been very meticulous in guiding me at every step of this exciting process. They are immensely knowledgeable and have been very patient in explaining various concepts all through the research work. I am fortunate to have them as my mentors.

I am very thankful to my external guide Dr. Indrasen Singh, for offering alternative prospective and for his constant source of encouragement during the several hours spent with him discussing my research work. I am highly indebted to Dr. Mangesh G. Korgaonker (Director General at National Institute of Construction Management and research) for encouraging and providing this valuable opportunity for conducting research study.

I thank Faculty Research Committee for guiding me to do the research on a topic of my interest. I express my deepest gratitude to all industry experts from roads and highways sector in India who provided their valuable time to share their comments on the questionnaire. My special thanks to Dr. Parag Diwan, Founder Vice Chancellor UPES, for his inspirations to undertake this study. I

am indebted to faculty and staff of CCE, UPES who as a department has acted like a pillar of strength to me.

I owe a debt of gratitude to my parents Shri. Kashinath Pai and Smt. Pramila Pai for their continual support and encouragement towards completing my research. I owe a special thanks to my in laws Shri. Mahesh Kaissare and Smt. Uma kaissare for their immense support and motivation to ensure that I completed every day‘s task with perfection. I owe a big thanks to my wife Mrs. Saurabhi Pai who stood by me at every step during the entire journey. Her continuous motivation acted like a fuel to drive me towards attaining my final goal. My special thanks to my daughters Janavi and Saanvi and my siblings Ashwini and Jaiwant whose silent support again was a big motivator for me.

Dehradun, (February 2019) **Siddesh Kashinath Pai**

DECLARATION BY THE AUTHOR

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

Siddesh Kashinath Pai
(February 2019)

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EXECUTIVE SUMMARY

Project completed on time is considered as one of the most critical factor defining the project's success. Time delay is a common phenomenon associated with nearly all road construction projects in India but very little effort and studies are being done to amputate the phenomenon. The Roads and Roads sector is a key sector for economical development and growth of a country, a developing country like India. The project delay in road projects implementation in India is widespread and recurring phenomenon. Project delays can occur as a result of various factors or causes leading to delays in construction and negative repercussions on the road sector growth. Project delays in the road and road industries have many impacts, including the expansion of time, overcoming costs, disputes, awards and litigation. Consequently, the reasons for the delays are so vital and considerable for the benefit of most construction projects

The research problem that the study has addressed is “How to develop a framework for mitigation of project delays by managing the project constraints through impact assessment of Critical factors causing time overruns in Roads and Highways Sector projects in India.”

The research questions answered in this research are:

What are the critical delay factors in Roads and highway sector in India causing project delays?

What is the severity of these identified critical factors causing project delays in Roads and highway sector in India?

What is the impact of these identified critical factors on project delays and how to mitigate them?

To answer these research questions mixed methodology has been which involved used of qualitative method for first objective and quantitative method for second objective. The research design and methodology has been discussed with all the details pertaining to both the objectives.

With an exploratory approach, this research study aims in depth the severity of critical factors that cause project delays through literature studies and interaction with experts. The objective of this study is to provide industry and policymakers with a suggestive framework and possible solutions to mitigate project delays, generating cascading effects in the implementation of R&H projects in India. The evocative image provides more detailed information on successful implementation of projects. Using mixed methods and analytical procedures, a detailed explanation of the process will reach the essence of the research problem. The outcome of the thesis aims to propose factors of influence and development of the framework for this context and to offer new forms of academic research.

The research study contributes to the existing research by providing contemporary insight based on qualitative research methods, quantitative research methods and analysis. The conclusions from this study will shed light on developing a framework for mitigation of project delays through impact assessment of critical factors causing time overruns in roads and highways sector projects in India. This study helps puts forward tentative guidelines for project managers, as well as research propositions for further qualitative and quantitative research.

Given that the India’s economy is largely agricultural, roads are a critical element of transport infrastructure leading to significant employment opportunities which has gained major importance with population and workforce growth, while better roads also save fuel and improve overall.

LIST OF ABBREVIATIONS

1	MORTH	Ministry Of Road Transport And Highways
2	NHAI	The National Highways Authority Of India
3	CPWD	Central Public Works Department
4	SPWD	State Public Works Department
5	PMC	Project Management Consultants
6	GOI	Government Of India
7	R&H	Roads & Highways
8	PPP	Public Private Partnership
9	DPR	Daily Progress Report
10	DBFOT	Design Built Finance Operate Transfer
11	NH	National Highway
12	GDP	Gross Domestic Product
13	3PL	Third Party Logistics
14	NRDP	National Rural Development Programme
15	NSEW	North South East West
16	MOSPI	Ministry Of Statistics And Programme Implementation
17	TOC	Theory Of Constraints
18	PMBOK	Project Management Body Of Knowledge
19	KMO & BT	Kaiser-Meyer-Olkin & Bartlett's Test
20	PCFA	Principle Component Factor Analysis
21	RII	Relative Importance Index
22	Cα	Cronbach's Alpha
23	KPI	Key Performance Index
24	EPA	Environmental Protection Agency
25	OSHA	Occupational Safety And Health Administration
26	EHS	Environment Health And Safety
27	WBS	Work Breakdown Structure
28	KM	Kilometer
29	MN	Million
30	BN	Billion

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CHAPTER 1:

INTRODUCTION

1.1 OVERVIEW

Road transport in India plays a principal role, contributing 5% to India's GDP. It helps to carry 50% of freight traffic and 90% of passenger traffic. It is one of the foremost components of the infrastructure for sustained economical development and plays an imperative role in supporting national integration. The transport system also contributes to the growth of backward regions and to their integration with the mainstream economy by opening up trade and investment opportunities (ADB, 2007).

1.2 OVERVIEW OF INDIAN ROAD NETWORK

Indian road network is world's second largest road network with more than 5,603,393 kilometers (3,491,725 mi), as on 31 March 2017. India's road network density is estimated to be 1.70 km of roads per square km of land that is highest in comparison with United States (0.67) and Japan (0.91) and a lot higher than Brazil (0.18), Russia (0.08) or China (0.46). Indian road density is 4.63 kilometers of roads per one thousand people, adjusted for its huge population. As of 31 March 2017, 63.4% of the roads were paved in India. (MORTH, 2015).

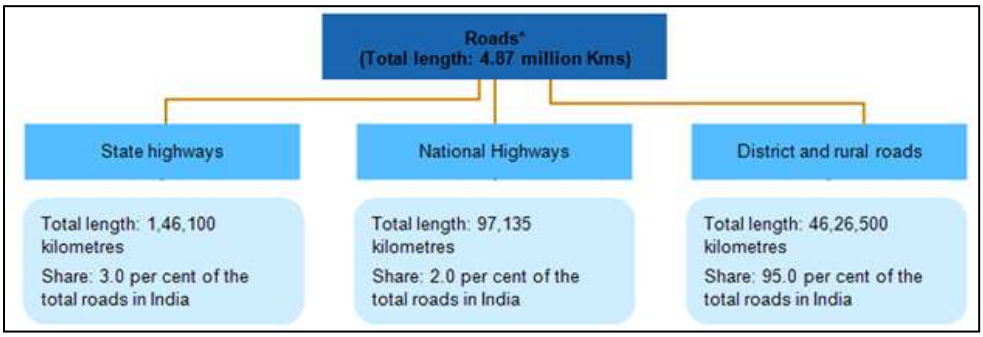
India did not allocated adequate resources for construction or maintenance of its road network in the past. Major efforts have been made to modernize the country's road infrastructure after 1995 and India's domestic roads increased to 102,011 km in 2015-16 from 70,834 km in 2010-11.

Source: National Highways Authority of India

Fig 1: Indian road network

India has completed and operated more than 28,800 kilometers of new 4 and 6-lane roads connecting many of its foremost production, shopping and cultural centers as of May 2017. The core projects are executed through the NRDP arm of the Government. India had approximately 1,02,011 kilometers of national roads and motorways plus 1,75,166 kilometers of national roads (as on March 2016), as per MORTH. Motorway operators and private builders also implement complex projects like the Yamuna motorway between Delhi

and Agra was commissioned within budget and before schedule, while the KMP motorway lags behind the budget and is unfinished. (MORTH, 2015).



Source: Ministry Of Road Transport And Highways (MORTH), Technical research

Fig 2: Indian road network classification

India's average lane per 100,000 inhabitants was 7.8 km, compared to 49 km in Japan and 114 lanes per 100,000 in the United States. The lowest kilometer density in India was found in Bihar, Uttar Pradesh and West Bengal (Prokerala, 2015).

Class	Length (km)
Expressways	1,000 km (620 mi)
Total national highways	92,851.05 km (57,694.97 mi)
National highways (already 4/6 laned)	22,900 km (14,200 mi)
National highways (being 4/6 laned)	25,000 km (16,000 mi)
State highways	154,522 km (96.016 mi)
Major and other district roads	2,577,396 km (1,601,520 mi)
Rural & other roads	1.433,577 km (890,783 mi)
Total (approx)	4,245,429 km (2,637,987 mi)

Source: NHAI 2014 estimates (www.nhai.org)

Fig 3: Indian road network length

By 2020 to meet its economic needs and to improve the Indian road network, India will have to invest $1.8 billion in road infrastructure projects according to Goldman Sachs 2009 estimates. National motorway investments increased to $98,788.05 ($14 billion) in 2015-16 from $15895.87 ($2.0 billion) in 2005-

06., Gross outlay in national highways during the same phase was 475,589.37 million rupees. Overseas players' involvement in the construction of the road network has helped to engage 40 design / engineering consultants and 45 international contractors including the USA, Malaysia, UK and South Korea. The Indian government is encouraging foreign investment in road projects. (The World bank, 2007).

1.4 HISTORICAL DEVELOPMENT OF ROADS AND HIGHWAYS

India had dilapidated road infrastructure during independence (1947). The roads were poorly managed. Moreover, between 1947 and 1988, India did not witness any upcoming new major projects. Most of the roads project were dirt roads and single lane coupled with just 200 kilometers of four lane motorways.

Indian government established an autonomous organization called National Highway Authority (NHAI) in 1988, under a parliamentary law which came into force on 15th June 1989. The law allowed this NHAI to develop the national highways and also maintain and manage it simultaneously. In the early 1990s, India witnessed extensive economic liberalization and NHAI has privatized the development of the Indian road network since 1995. (NHAI, 2015). NHDP is a road improvement project in India and it was launched by then prime minister Atal Bihari Vajpayee. NHDP implemented some core projects like the Golden Quadrilateral (5,846 km) 4/6 motorways costing Rs. 300 billion connecting the 4 major cities of Chennai, Mumbai , Delhi and Calcutta .It was financed by government debt and tax revenues of the special oil products. NHDP announced the completion of the GQ four-lane highway network in 2012 (NHAI, 2015).

Table 1: Growth of Road Network by Categories (in km)

Road Category	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2010-11	2015-16
National Highways	19811(4.95)	23798(4.54)	23838(2.61)	31671 (2.13)	33650(1.45)	57737(1.71)	70934 (1.52)	101011(1.80)
State Highways	^	^	56765 (6.20)	94359(6.35)	127311 (5.47)	132100(3.92)	163898 (3.50)	176166 (3.14)
District Roads	173723 (43.44)	257125 (49.42)	276833 (30.26)	421895 (28.40)	509435 (21.89)	736001 (21.82)	998895 (21.36)	561940 (10.03)
Rural Roads	206408 (51.61)	197194 (37.60)	354530 (38.75)	628865 (42.34)	1260430 (54.16)	1972016 (58.46)	2749804 (58.80)	3935337 (70.23)
Urban Roads	0	46361(8.84)	72120 (7.88)	123120 (8.29)	186799 (8.03)	252001 (7.47)	411679 (8.80)	509730 (9.10)
Project Roads	0	0	130893 (14.31)	185511 (12.49)	209737 (9.01)	223665 (6.63)	281628 (6.02)	319109 (5.70)
Total	**399,942**	**524,478**	**914,979**	**1,485,421**	**2,327,362**	**3,373,520**	**4,676,838**	**5,603,293**
Figures in parenthesis indicate percent to road length.								

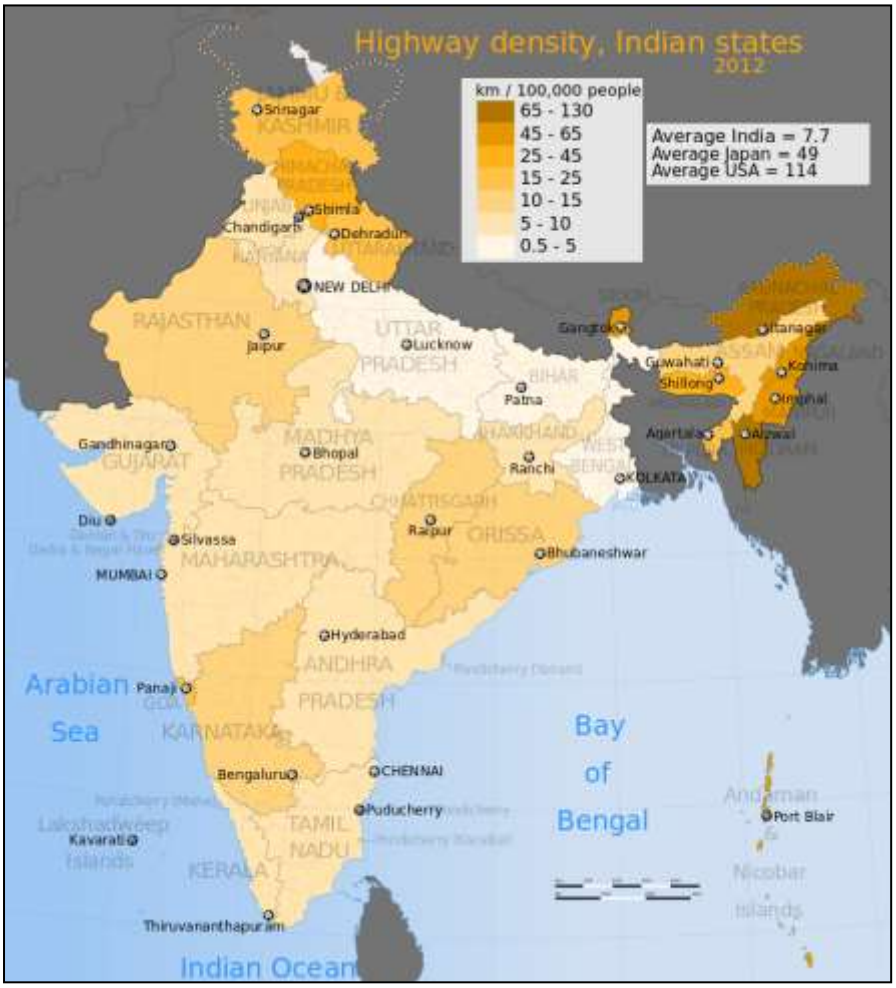
Source: NHAI estimates (www.nhai.org)

North-South and East-West (NSEW) Corridor, one more significant project was the 7,142 km long which included the NHs connecting country's four extreme points. North-South connecting Srinagar north to Kanyakumari south and Porbandar in the east to Silcharin in the west. From May 2017, approximately 28,915 km of 4/6 lanes (including GQ starter EW / NS) were built under the NHDP, with a total stretch of 48,793 km of road lanes scheduled for 4/6 departure from the NHDP. As of October 31, 2016, 90.99 percent of the project was completed, 3.52 percent of the total length remains and 5.47 percent of the project work is underway. (NHAI, 2015).

In recent years ,the construction rate of the roads in India has pick up the pace and average construction rate is 27 kilometers(17 miles) per day in 2017- 18 from 12 kilometers (7.5 miles) per day in the 2014- 15 period. The goal is to construct every day 40 kms of road. Bharatmala is a project of road development with financial support from Indian Central Government which is estimated cost at Rs. 5.35 trillion (US$ 74 billion) to construct 83,677 km of new roads. 34,800 km of roads is planned for phase 1. (MORTH, 2015).

1.5 OVERVIEW OF NATIONAL HIGHWAYS

Indian road network, given India's federal form of government, is administered by various government authorities. The following table as on 31st March 2016 illustrates the total length of road network by road type in India. India's road network comprises of state highways, national highways, district roads, rural roads, with national roads stretching 70,548 kms across different states and union territories throughout the country. Fig. 4 shows India's road density map (as of 2012) in kilometers per one thousand people (MORTH, 2010).



Source: National Highways Authority of India

Fig 4: India highway density map

Given that national roads cover 40 percent of total road traffic and that this percentage is expected to increase in the future. Through the NHAI, the GOI launched the National Motorway Development Project (NHDP) for expansion, improvement and construct new roads nationwide. The NHDP project is supposed be executed in seven phases. There are currently four phases of implementation i.e. I, II, III and V, which will help in improvement of over 32,754 km of arterial routes in the NH network, build according to international standards. The details of the four NHDP project phases are as follows (NHAI, 2015).

National highways represent 1.9 percent of India's total road network .they expected to touch 100,000 km by 2017, compared to 97,135 km in fiscal year 2015. The Indian Government has developed a seven-step program which is the NHDP, allotted to the NHAI body for development of R&H in the country (Wright & Gupta, 2011).

Table 2: India's road network classification

Road Classification	Authority responsible	Length (Km)	Share of network length
National Highways	Ministry of Road Transport and Highways	101,011	1.80%
State Highways	Public works Department State/Union Territory	176,166	3.14%
Other PWD roads	Public works Department State/Union Territory	561,940	10.03%
Rural roads	Panchayats, JRY and PMGSY	3,935,337	70.23%
Urban roads	Local goverments and municipalities	509,730	9.10%
Project roads	Various State/Union territory government departments, and SAIL,NMDC and BRO	319,109	5.70%
Total	**N/A**	**5,603,293**	**100%**

Source: NHAI estimates (www.nhai.org)

The private entities are becoming a crucial in road infrastructure growth and development in India. The growth in industrial sector coupled with the growing amount of two and four-wheel vehicles fuelled the intensification of growth in road transport infrastructure development. It has been a blessing for the Indian infrastructure sector with supportive Government policy to augment

private sector contribution through the Public Private Partnership Model (PPP).

Projects valued US $ 32.69 billion were granted via PPP model In March 2015 and 165 PPP projects still under execution process. The investment via PPP route is anticipated to be 31 billion dollars in next five years (Wright & Gupta, 2011).

Table 3: NHDP & NHAI Projects

NHDP and other NHAI projects (As on Feb 28, 2010)										
	NHDP							Port Connectivity	Others	Total by NHAI
	GQ	NS-EW Ph. I & II	NHDP Phase III	NHDP Phase V	NHDP Phase VI	NHDP Phase VII	NHDP Total			
Total Length (kms)	5,846	7,300	12109	6,500	1000	700	33,455	380	965	34,800
Already 4 -Laned (kms)	5,766	4,863	1478	163	-	-	12,270	274	899	13,443
Under Implementation (kms)	80	1,689	3926	1068	-	41	6,804	100	46	6,950
Contracts Under Implementation (No.)	13	113	59	8	-	-	193	6	9	210
Balance length for award (kms)	-	590	6705	5269	1000	659	14223	6	20	14249
Source : NHAI										

Source: NHAI estimates (www.nhai.org)

several overseas business entities have collaborated with Indian operators to take advantage of on the roads and highways sector's growth due to 100 percent of foreign direct investment (FDI) allowed by GOI in R&H sector

1.6 FUTURE MILESTONES TO BE ACHIEVED IN R&H SECTOR IN 2014-17

- National motorways should be increased to 100,000 kilometers by the end of 2017 from 92,850 kilometers in 2013-14
- India accomplished 100 PPP projects out of which 165 are ongoing as on March 2014.

- The PPP models used in the road and highways sector are the BOT annuity model and Build Operate Transfer (BOT).
- For the next five years, public-private partnerships investments are anticipated to be $31 billion for national motorways in the region.
- The MORTH & NHAI approved projects for 3,700 km in 2013-14
- $3.8 billion investment in motorway disbursements.
- 4.86 mn kms of roads and motorways.
- Infrastructure development of $ 19 billion between 2012 and 2012.
- 100 public-private partnership projects completed (IBEF, 2017).

1.7 **GOVERNMENT INITIATIVES – KEY INVESTMENTS**

Various key investments and developments factors in India's road and highways sector are as follows: (IBEF, 2017).

- In the period 2013-2014, an outlay of 3.8 billion dollars was foreseen for the road sector.
- During 2014-15, approximately 8,470 km of national roads will be improved along with 10 detours.
- The objective of the NHAI is to guarantee 5,000 km of projects in 2014-15 and MORTH will grant another 400 km directly
- For the next three years, the government has declared $ 93 billion value of road projects with an outlay of $ 45 billion
- MORTH, in consultation with state governments for Bharatmala Pariyojana, has commenced the progress of approximately 7,000 kms of national roads at an anticipated outlay of Rs. 80,000 million (US$ 12 billion). NHAI has encouraged proposals for preparing DPRs for the improvement of border and also coastal roads related to Bharat Mala project.

- The Economic Affairs Committee (CCEA) of the Cabinet authorized the hundred percent divestment of investment after two years of construction completion, by private developers BOT projects, not considering the year of the project granted.
- The GOI has accepted the building of approximately 1,000 km of motorways, at an expenditure of 16.68 million rupees (USD 2.5 million) in DBFOT model. The approved provisions are Baroda-Mumbai (400 km), Delhi-Jaipur (261 km), Bangalore-Chennai (334 km) and Delhi-Chandigarh (249 km). The GOI also plans to undertake 135 km long expansion of the Peripheral East Highway at an projected cost of 5,763 Rs crore (US$ 868 million).
- MORTH in fiscal year 2015-2016, will award 273 highway projects for roughly 12900 km at projected outlay of Rs 1,26,700 cr.
- Chhattisgarh will invest Rs 9,500 million (USD 1,430 million) to develop 44 roads in the state.
- The GOI proposes to construct 64,340 km of NHs in a variety of programmes, such as the Special Program for the Development of Accelerated Motorways for the North-Eastern Region and Sinistra (SARDP-NE), the National Motorway Interconnection Project (NHIIP) and the National Highway Development Project (NHDP).
- NHDP, a $60 billion 7 phase program which is one of the largest in the world will focus on the expansion and rehabilitation national highways of 4,754 km.
- Increased two-and four-wheel vehicles, increased freight traffic, strong trade and tourism flows between states are all ready to increase growth.

1.8 IMPORTANCE OF ROAD TRANSPORT SYSTEM IN INDIAN ECONOMY

Indian road transportation system is of prime significance in the economic development of the country (PCI report, 2002).

1. Road transport can open the country's remote and internal remote areas. In India, a large area is still completely isolated by water or rail transport. In these circumstances, road transport can more accessible to remote areas where penetration of railways is less.
2. Road transport extensively contributes to the country's GDP growth conversely Road transport in India is very much backward.
3. Road transport compliments rail and other modes of transport. Railways do not connect the villages of the country, but road transport via secondary roads easily connects the railway stations with distant villages.
4. Road transport In comparison to railways is cheaper, faster and flexible. Motorized transport is the ideal mode of transport for short distance travel, as passengers and goods can be transported everywhere. In addition, motorized transport can provide personalized service which railway cannot provide.
5. Road transport is very useful for the country's agricultural sector, providing fast and easy marketing services for agricultural products, particularly perishable products such as vegetables, fruit, transport, etc. road transport system assists farmers obtaining inputs, such as seeds, fertilizers, etc. for the agricultural sector and to provide a stable and ready market for their products.

6. Road transport contributes to industrial development of the country. construction of a well-developed road network in the country has made possible the development of Modern and giant industries
7. The road transport system generates huge employment opportunities in the country by creating a good number of working days for ordinary workers.
8. Road transport is crucial in defense of the country. A well-built defense system is only possible with the well-developed road network. The road construction in inaccessible areas allows the country's defense forces to take control of these areas.

Given that the India's economy is largely agricultural, roads are a critical element of transport infrastructure leading to significant employment opportunities which has gained major importance with population and workforce growth, while better roads also save fuel and improve overall

1.9 BUSINESS PROBLEM

Project delays are adversely affecting the economic viability of road and highways infrastructure development in India resulting in increased costs and ultimately causing project failures.

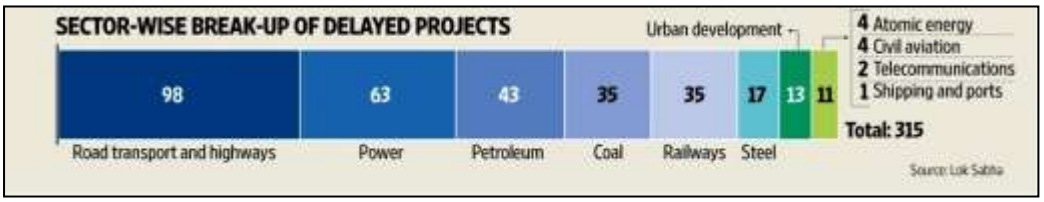
1.10 NEED FOR STUDY

Road infrastructure is the most important of all public goods.

- The streets are the arteries through which the economy pulsates.
- Roads provide significant social benefits and contribute to economic development and growth.
- Making a road network of crucial importance in the fight against poverty, to employment, social services, health and education.

- For successful growth and development, a good road system is crucial for any country.

The acquisition of land, delays in shipping and financial restrictions have affected road construction. Of the 315 projects delayed, 98 are national road projects, the highest number in a single sector. The linear nature of the projects has had an impact on the construction of national roads. According to the ministry, which monitors the progress of public works projects that cost millions of rupees and much more, it has been monitoring 738 projects since 1 January 2015. Some 5,100 km of BOT road projects are in a limbo, according to a study conducted by a CRISIL rating agency. Of these, 315 were beyond their implementation date, which led to rising costs. With a sanctioned debt of 45.9 million people are at high risk of not completed with the total cost exceeds Rs. 1,975 million rupees that have already negatively affected the economic profitability of the development of motorway infrastructure. (Figure 5: Sect oral breakdown of late projects). Despite recent government steps to alleviate road construction problems, 53 percent of road projects under construction under construction, operation and transfer (BOT) are at risk of never being completed (MOSPI, 2016).



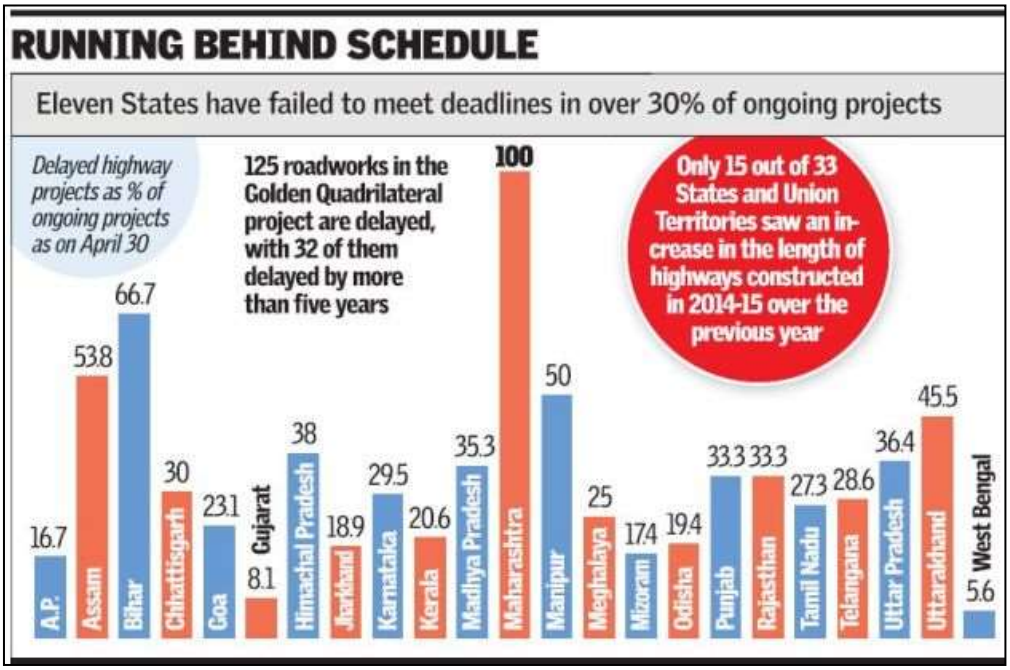
Source: Data shared by MOSPI for projects of Rs.100 crore and above (presented in Lok Sabha on 18 March 2014)

Fig 5: Sector wise break up of delayed projects

In 11 states, according to data, over 30 percent of ongoing projects have been delayed. Four out of ten central government road infrastructure projects are

delayed or experiencing cost overruns due to delays in regulatory approvals, financial restrictions and land purchase paralyzed.

According to data shared MOSPI and the Lok Sabha on 18 March 2014, the cost of one of these projects will inflate 20 times and one will lose the original completion date in 21 years. (Hindu, 2014).



(Data provided by the MORTH in the Lok Sabha 2015 published in national daily "The Hindu" on July 24, 2015)

Fig 6: Road Projects running behind schedule in India.

5,100 km high-risk projects were delayed and suffered cost overruns which amount to nearly 80 percent of the total. 92 BOT motorway projects were analyzed, which were allocated from 2010 and 2012, reveals that they faced risk of implementation with a total cost overrun of Rs. 1,975 crores. According to the 2014 NHAI Annual Report, sponsors should organize about 28,500 Rs crores to complete the projects under construction. The financial health of the sponsors was matter of concern for their capacity to provide

capital for these operational BOT projects. Higher risk was encountered in projects valued Rs 12,500, as capital can be met via increased installments and loans. As of now there is no solution is in sight to bridge the gap (MOSPI, 2016).

Of 767 projects in the MOSPI Monitor, 136 belong to the Transportation and Roads Sector (MOSPI, 2016).

Table 4: Extent of time overruns in R&H projects

Extent of the time overruns with respect to original schedule								
S.No.	Sector	No. of Projects	Total cost (Rs. Crore)					
			Projects wth time overruns					
			Original	Anticipated Cost	No.	Original Cost (Rs. Crore)	Anticipated Cost Rs. Crore)	Range (in months)
1	ATOMIC ENERGY	4	40,442.0	46,726.0	4	40,442.0	46,726.0	17 -71
2	CIVIL AVIATION	8	6035.5	6,926.8	4	1,207.0	1259.9	10 -71
3	COAL	64	46,558.8	56,675.2	39	30,313.9	40,801.6	1 -120
4	STEEL	22	66,857.1	73,042.3	16	64,638.5	70,892.5	3 - 73
5	PETROCHEMICALS	1	5,460.6	8,920.0	0	0.0	0.0	-
6	PETROLEUM	84	191,155.4	207,615.4	52	131.007.5	145,134.4	2 - 110
7	POWER	103	244,730.6	259,466.5	58	187,413.0	201,769.0	1 -106
8	RAILWAYS	291	163,873.5	274,821.5	34	28,809.3	76,914.7	3 -247
9	ROAD TRANSPORT AND HIGHWAYS	136	102,321.4	104,388.4	96	67,308.3	69,375.8	2 -120
10	SHIPPING AND PORTS	19	15,617.1	18,541.0	5	6,356.3	8,355.3	5 - 91
11	TELECOMMUNICATIONS	9	4,742.5	4,582.1	4	2,018.2	1,843.9	37 -71
12	URBAN DEVELOPMENT	25	82,686.3	87,959.2	13	8,545.4	8,545.4	2 - 55
13	WATER RESOURCES	1	542.9	1,187.0	0	0.0	0.0	-
Total		767	971,023.7	1,150,851.3	325	568,360	671,618.4	

Source: MOSPI report 2014 (Qtr – II) of central sector projects costing 150 crore

- Of the 136 projects, no project is ahead of schedule, 16 projects are planned and 96 projects are delayed. There are 24 projects without an appropriate start date.
- Of the 96 projects delayed, 17 have a general delay of 1 to 12 months, 30 have a delay of 13 to 24 months, 22 have a delay of 25 to 60 months and 27 have a duration of 61 months or more (MOSPI, 2016).

In the current scenario, projects are financed at an interest rate of 13% and will affect the economic viability of infrastructure development. Delays in the implementation of infrastructure projects lead to financial losses of Rs. 300-400 crore per day for interest costs (MOSPI, 2016).

1.11 RATIONALE AND MOTIVATION

This research study highlights the critical success factors causing delays in projects in the R&H sectors in India and measures to mitigate these project delays by the developing a robust management framework. With an exploratory approach, this research study aims in depth the severity of critical factors that cause project delays through literature studies and interaction with experts. The objective of this study is to provide industry and policymakers with a suggestive framework and possible solutions to mitigate project delays, generating cascading effects in the implementation of R&H projects in India. The evocative image provides more detailed information on successful implementation of projects. Using mixed methods and analytical procedures, a detailed explanation of the process will reach the essence of the research problem. The outcome of the thesis aims to propose factors of influence and development of the framework for this context and to offer new forms of academic research. The motivation of the investigation is summarized:

- The delays in the motorway project have negative effects for both motorway agencies and contractors (both in the form of loss of revenue and additional expenses) which lead to conflicts that lead to expensive legal disputes.
- Delay in the project limits the potential growth of an economy and reduces current economic resource efficiency.

- There is a risk that perceptions assume and mislead policy formulation in the absence of adequate identification and understanding of the causes behind project delays,

1.12 OUTLINE OF THE STUDY

Using a qualitative approach, the study tries to explore critical factors that cause delays in the project and develop a suggestive framework to mitigate the delays of this project in the road and highway sector in India. Using a quantitative technique, we find the severity of critical factors causing project delays and classifying factors to understand the impact of these factors causing delays. As some of the significant factors are identified from the literature review, there is a deliberate intention to look for new and last critical factors together with the interaction with experts in the road and highway sectors.

1.13 ORGANISATION OF THE REPORT

The research has been compiled in the following sections:

Chapter 1:- Introduction

This chapter discusses the research study adopted and underlines the need to mitigate delays in road and highway projects in India. The chapter includes business problems along with various facts and figures. The inclusions also show different ratios that were used to collect relevant study data. The creation of a commercial issue has given way to lay the foundations for the carrying out of the literature review. End of the chapter summarizes the entire survey.

Chapter 2:- Literature Review

This section includes four general topics in which a rigorous literature review was conducted. These topics include: review of the selection of the integrated

marketing communication channel and its challenges in automotive lubricants companies in India, review of the factors that lead to the selection of integrated marketing media, review of the factors leading to the selection of social networking and the revision of the theoretical communication process premise integrated marketing planning. The chapter summarizes the results in the form of research gaps that have increased from the literature seen.

Chapter 3:- Research Design and Methodology

Research methods and research design used to perform this study are highlighted in this chapter. This chapter highlights the problem of research, research objectives and the general approach adopted for achieving the objectives. The methodology and design for the research were designed differently for both purposes. The research involved using qualitative and quantitative methods, depending upon the nature of the research problem. The techniques and tools have been explained in detail in this chapter.

Chapter 4:- Data Analysis results and Interpretation

The execution of the research study and the methodology adopted to achieve the result to meet the research objectives are discussed in this chapter. The analysis of the research objectives was made for both objectives. The analysis of the process was detailed and the use of SPSS was highlighted to achieve the factors. The interpretations of the process and factors have been made in detail. The chapter ends with validity and reliability.

Chapter 5:- Establishing Framework Procedure

In the research process, the researcher has identified the problem currently in action. The researcher attempts to explore and fully understand the nature of the problem through a systematic study. To understand the problem logically, research questions and research projects are developed. The existing theory of

the problem has been explored. Data analysis and the empirical research design approach are developed on the basis of the conceptual objective. For understanding of the process according to the defined design methodology, the researcher begins the research with the data collection. Specific factors form the results of the study. Subsequently, with the help of the questionnaire, the variables were used together to arrive at the factors. The data collected for the process are analyzed based on the research objectives and the outcome of the data analysis constitutes the initial results of the study.

Chapter 6:- Findings, Conclusions and Recommendations

The chapter highlights the whole process of automotive lubricant companies in India towards the integrated marketing communications channel selection mechanism. The chapter shows several elements taken into account when making this selection. The factors that have are important for the adoption of social networks that have been discussed. Recommendations were made for the future research of academics and the adoption of social networks for marketing professionals.

1.14 CONTRIBUTION OF THE STUDY

The research study contributes to the existing research by providing contemporary insight based on qualitative research methods, quantitative research methods and analysis. The conclusions from this study will shed light on developing a framework for mitigation of project delays through impact assessment of critical factors causing time overruns in roads and highways sector projects in India. This study helps puts forward tentative guidelines for project managers, as well as research propositions for further qualitative and quantitative research. The below are some of the valuable contribution of the research study.

- Extensive review of literature does not segregate the critical causes of project delays in roads and highways sector pertaining to stakeholders like client, consultant and contractor. These causes will affect the project performance differently depending upon the nature of work of each of these stakeholders. Is was imperative that the we study these causes in isolation for the three stakeholders (Client, Consultant and Contractor) mentioned to design in depth the framework strategy to mitigate the factors causing delays.
- Also the literature review does not bring out any research to develop a systematic framework to mitigate these delays to finish the projects within time and cost schedule.
- The research provides a comprehensive framework for mitigating the project delays in roads and highways sector in India. It has enriched the overall understanding about mitigation of project delays Indian context by elaborating the focus on factors that has emerged from suggestive framework
- As seen from framework, Economic growth of India can be stimulated by if Government focuses on expenditure on strategic infrastructure projects, especially those in the R&H sector. Funding model needs to undergo a change with the institutions supporting project execution through external borrowings Unless profit growth improves by leaps and bounds by better tolling rates and traffic or improved margins in the construction sector, news of allowing 100% FDI in the sector, will not be a game changer
- The research suggests big push criterion should be preferred over Gradualist approach. The big push criterion is when large investments are injected into the economy, which leads to a massive boost in the nation's economic growth. The big push approach is ideally the best approach, but nevertheless requires a huge capital inflow into the economy for infrastructure growth and especially for developing countries.

- Government, regulators and business can use this framework getting additional insights to mitigate the project delays in roads and highways sector in India that will help boost the country's economy.

1.15 CONCLUDING REMARKS

The establishment of business problem has given direction to the research to be conducted and gives roots to the existence and need of the research conducted. The literature review discussed in the subsequent chapter shall allow the researcher to find research gaps and strengthen the need of the study. The outline of all the chapters has been discussed in this chapter. Overall six chapters have been designed that justify the overall study. Each chapter outline gave a blue print of what the chapter comprises of. The need of the study has been established with the business problem. The themes have been discussed under which the literature review will be carried out.

CHAPTER 2:
LITERATURE REVIEW

2.1 OVERVIEW

This chapter presents a detail literature review, which comprises academic and practitioner literature in the areas of project delays in roads and highways sector in India and internationally focusing the theoretical premise. Topics of the chapter are reviewed in the following order: literature review on project delays has been done internationally for other construction projects and not specifically for highway projects in India, literature review on International research on project delays on Roads and highways projects, literature review on project delays on construction and infrastructure projects in India and not specifically for highway projects sector, literature review on causes of delays are identified by existing literature available, literature review on Roads and highway projects in India, literature review on taking into consideration all other important stakeholders perspective like the client, contractor and the consultant and literature review on Shortage of resources like labor, equipment, finance, skills, time, etc affects the project delays. The chapter concludes by providing research gaps leading to research questions.Key concepts are synthesized to provide a background to the research framework and research questions.

Four types of Literature have been used

I. Research reports by individuals in journals.

II. Articles in Journals and Agency reports on the Subject.

III. Research papers available across different databases

IV. Literature available on theory of constraints related to project delays.

2.2 SUMMARY

Time is considered as one of the most critical factor defining the project's success. Time being key factors has to be considered seriously during project implementation in the construction sector and also project life cycle as a whole. Time delay is a common phenomenon associated with nearly all construction projects but very little effort and studies are being done to amputate the phenomenon. (Zainal & Rozlin, 2017).

The Roads and highways sector is a most crucial infrastructure sector for economical development and growth of a developing country like India. The project delay in road projects implementation in India is widespread and recurring phenomenon. Project delays can occur as a result of various factors or causes leading to delays in construction and negative repercussions on the road sector growth (Ahmad, Issa, Farag, & Abdelhafez, 2013).

In most countries, the existing literature shows that successful road construction projects have to be carried out within schedule and budget limits. The key characteristics of a project's are time, cost, and quality. Safety controls are affected negatively by the impact of such project delays (Doloi, Sawhney, Iyer, & Rentala, 2012).

Project delays in the road and road industries have many impacts, including the expansion of time, overcoming costs, disputes, awards and litigation. Consequently, the reasons for the delays are so vital and considerable for the benefit of most construction projects (Gardezi, Manarvi, & Gardezi, 2014).

Many researchers like (Fallahnejad, 2013), (Haseeb, 2011), (Aziz, 2013), and (M.M. & Rasas, 2014) recognized these problems as factors. These factors cause the affect the overall economy of the country and dent the performance of the company due to irreparable delays in road construction projects.

Delays in road and road projects are generally associated with efficiency of the total cost, execution time and project quality. However, identification and assessment of the factors causing delays in road construction projects for the last decade require extensive research improve it (Rahman, Memon, & Karim, 2013).

A project in the road and road sector is generally recognized as successful if carried out within time and budget, in agreement with specifications. In the road construction industry, contractors will try to improve their profits for increasing their market growth. For achieving this, contractors have to carefully specify the factors which will influence the project success to estimate the effects before the tendering phase. Roads and projects in the road sector vary in size, duration, targets, ambiguity, complications, speed and other dimensions (Aziz, 2013).

Delay indicates failure to complete the project within the assigned period agreed in the contract. The success of the project is influenced by the planning of the construction project and is very likely to play a key role in the project management (M.R., Rahman, & Azis, 2010).

Delayed projects are a major economic loss for individuals and states, failure of business, loss of investment and resort to the judiciary to disputes resolution. This is mainly because of wrong policies of the administrative companies and the lack of knowledge for planning for unpredictable future possibilities, financial mismanagement and weak management of resources (Jammaz, 2010).

Most of the factors involved in delayed or cancelled R&H projects include poor management and poor engineering planning by contracting companies due to a poor identity of goals, policies and plans, the development of

strategies that are important for the logical process of project implementation (Aldari, 2011).

2.3 THEME BASED LITERATURE REVIEW

Following seven themes emerge from literature review pointing to the research gaps and leading to need for research:

Table 5: The Study on project delays has been done internationally for other construction projects and not specifically for highway projects in India.

Sr. No	Research paper title	Authors/ year	Inference	Research gaps
1	Factors affecting costs overrun in road construction projects in Saudi Arabia	(Alghonamy, 2015)	The study aims to classify factors which result in cost overruns in Saudi Arabia's road building projects from contractor's viewpoint. The 41-factor risk mapping is based on a study and is identifiable as the main factors that cause cost overruns in road construction.	Factors affecting cost overruns under study are from earlier literature reviews from journal papers pertaining to general infrastructure projects and not specifically road projects
2	Causes of delay in Gulf Cooperation Council (GCC) construction	(Ruqaishi & Hamdi, 2015)	A systematic review of the quantitative literature was conducted that identified 18 published articles on the	Future research efforts should be aimed at covering geographical

	projects		topic. These articles have been discussed in detail and analyzed accordingly. The analysis led to the identification of various variables in which the causes of the delay are correlated, being these; time, geographical location, types of industry, project complexity and type of owners.	positions for various types of projects with different complexity levels. Furthermore, the delay change over time should be thoroughly examined to check and understand the reasons for these changes.
3	Cost and time overruns in highway projects in Pakistan	(Choudhry, Nasir, & Gabriel, 2012)	This study looks at key factors driving overtime and cost overruns in Pakistan's road projects. The factors that triggered project delays were investigated via a questionnaire circulated of 21 consultants, 10 clients and 25 contractors. A relative importance index (RII) classified a maximum of 30 delay factors.	This research has been done internationally for other construction projects in Pakistan and not for specifically for highway projects in India.
4	What causes	(Flyvbjerg,	This research takes	This study on the

	cost overrun in transport infrastructure Projects?	Holm, & Buhl, 2004)	sample of 258 roads, bridges, rail projects and tunnels worth $ 90 billion. The spotlight is on rising costs due to: (1) project duration implementation phase (2) The project size and (3) the type of ownership	issue of ownership (public or private) is missing, as this is a very important issue for the decision on the institutional configuration and the regulatory regime for the provision of infrastructure.
5	Risk matrix for delay causes in construction projects in Saudi Arabia	(Mahamid, Ibrahim; Al-Ghonamy, A.; Aichouni, Mohamed, 2015)	The overall objective is to create a risk matrix for project delays in construction projects in Saudi Arabia from the consultant's viewpoint. A survey of 51 consultants in the northern province of Saudi Arabia was undertaken for present on construction projects.	Research has been conducted internationally for other construction projects in Saudi Arabia and not specifically for highway projects in India.
6	Factors affecting time overruns in public construction	(Sweis, 2013)	In this study, the time - consuming elements of construction projects were classified in Jordan. Analysis	The results are generalized as relatively small sample size used in this study. Future

	projects: the case of Jordan		revealed that there was agreement on a single cause, namely weather conditions.	precise studies could be conducted using a larger sample.
7	Problems of projects and effects of delays in the construction industry of Pakistan	(Haseeb, M.; Xinhai-Lu; Bibi, Aneesa; Maloof-ud-Dyian; Rabbani, Wahab, 2011)	The research aims to identify factors of delay and their impact on project success. This paper focuses on factors that cause delays and recommendations to decrease these delays.	This study has been done internationally for other construction projects in Pakistan and not for specifically for highway projects in India.
8	Causes of delay in road construction projects in Malawi	(Kamanga & Steyr, 2013)	This paper examines the reasons behind delays in Malawi's road building projects. Recommendations have also been made to prevent delays in the future.	Principally, most delay causes aren't exclusive to Malawi and have also been examined in other South African countries including South Africa, Botswana and Swaziland.
9	Cost overruns in large-scale transportation infrastructure projects: explanations	(Flybjerg, Molin, Wee, & Cantarelli, 2010)	This article investigates the explanations of the overrun costs found in the existing literature. Four categories are classified that is	The consolidated research has been done for Dutch transport infrastructure projects and not for

	and their theoretical embeddedness		psychological, technical, economic, and political.	specifically for highway projects in India.
10	Causes of contractor cost overrun in construction projects: The case of Ethiopian construction sector	(Zewdu & Aregaw, 2015)	Five main factors of cost overload are researched and conducting survey on 140 respondents using a convenience sampling method. Primary data were collected through the survey of related materials using questionnaires and secondary data. Analysis was performed using SPSS version 20.	Research has been done internationally for Ethiopian construction projects and not specifically for highway projects in India.
11	factors causing cost overruns in construction of residential projects; case study of turkey	(Durdyev, Ismail, & Bakar, 2012)	A concise investigation was done to classify causes of delay in Turkey. The method of relative significance index was used to examine quantitative data.	The research has been done internationally for Ghanaian based residential projects and not for specifically for highway projects in India.
12	the cause factors of large project's cost	(Memon, Rahman, Ismail, &	Data collection was done through structured questionnaire among	This research has been done internationally for

	overrun: a survey in the southern part of peninsular Malaysia	Asmi Abdul Aziz, 2012)	client, consultants and contractors in Malaysia.	construction projects in Malaysia and not for specifically for highway projects in India. The research is restricted only to southern part of peninsula Malaysia and can be further extended to whole of Malaysia
13	Factors affecting cost overruns in micro-scaled construction companies - Turkey	(Polat, Okay, & Eray, 2014)	The overall aim of this investigation is to assess the importance for the projects carried out by micro- construction companies of factors causing cost overruns. An exhaustive literature review was undertaken and 38 factors were recognized.	The research has been done internationally for turkey micro scaled construction companies and not for specifically for highway projects in India.
14	Investigation into the Causes of Delays and Cost Overruns in Uganda's Public Sector	(Alinaitwe, Apolot, & Tindiwensi , 2013)	The ultimate goal of the survey was to explore and characterize the reasons for unjustified costs in Uganda based on its frequency,	This research has been done internationally for other construction projects in Uganda and not for

	Construction Projects		severity and importance.	specifically for highway projects in India.
15	Identifying causes of cost overruns and effective cost control measures of public projects in the free state province of South Africa	(Monyane, Godfrey, & Okumbe, 2012)	Identify the leading causes of the losses incurred in South Africa's construction sector and successful control measures.	The research has been done internationally for public sector projects in south Africa and not for specifically for highway projects in India.
16	Causes and effect of delay on project construction delivery time in Nigeria	(James, et al., 2014)	The main purpose of this investigation is to identify the causes and effects of project delays in the delivery time.	The research has been done internationally for other construction projects in Nigeria and not for specifically for highway projects in India.
17	Causes of delays in Saudi Arabian public sector construction projects	(Al-Kharashi, Skitmore, & Martin, 2009)	The research seeks to classify the leading causes of the delays involved. A number of similar studies have been reported, but they all use different variable	The research has been done internationally for construction projects in Saudi Arabia and not for specifically for

			types. Additionally, nobody has tried to identify potential improvements in practice.	highway projects in India.
18	The evaluation of the delays in the Portuguese construction	(Couto & Teixeira, 2007)	The lack of competitiveness of the Portuguese construction industry has been repeatedly mentioned in the press and in the technical literature. Several symptoms of this have been accentuated by different parts and their causes are often linked to the lack of compliance with the essential management functions in construction projects. In consideration of this, a research project has been launched to help clarify the causes and find possible solutions to the problem.	The research has been done internationally for Portuguese construction projects and not for specifically for highway projects in India.

19	Cost escalation, schedule overruns and quality shortfalls on construction projects - Zambia	(Muya, Kaliba, Sichombo, & Shakantu, 2013)	The study aimed to identify clearly significant causes of higher costs, large quantities of qualitative failures, and to discuss ways of approaching causal factors.	The results focus on public projects in Zambia. Private sector projects should also be considered, as they may present other challenges than those highlighted in this study.
20	Factors affecting the performance of construction Projects in the GAZA strip	(Enshassi & Abushaban , 2009)	The paper's overall objective is to identify factors determining the performance of local building projects and their relative importance. Accordingly, a comprehensive and detailed literature review has been conducted, creating a number of factors that impact project performance.	The research has been done internationally for other construction projects in Gaza strip and not specifically for highway projects in India.
21	Explaining cost overruns in infrastructural	(Lind & Hans, 2014)	The paper is focuses on using a questionnaire survey, which usually includes experienced	The research has been done internationally for infrastructure

	projects: A new framework with applications to Sweden		project managers, to focus on the cost overrun framework for construction projects across Sweden.	projects in Sweden and not specifically for highway projects in India.
22	Avoiding cost Overruns in construction projects in the united kingdom	(Arcila & Gomez, 2012)	A detailed literature review was carried out to study the root causes of unjustified construction costs. the author also studied some existing publications on critical success factors (CSF)	The research has been done internationally for other construction projects in united kingdom and not specifically for highway projects in India.
23	Significant causes and effects of project delays in the NIGER delta region, Nigeria	(Sunjka & Jacob, 2013)	This research examines the main causes and consequences of the delay in building projects in the Niger Delta regions. The continued increase in t inflation rate in Nigeria would increase the costs of projects if they were not completed by the scheduled time.	This study has been done internationally for other construction projects in Nigeria and not for specifically for highway projects in India.
24	A Conceptual Model of	(Van, Sang, &	In order to analyze the effects of the delay on	Projects undertaken by the private

	Delay Factors affecting Government Construction Projects	Viet, 2015)	the success of public construction projects, the research seeks to develop a conceptual model of delay factors.	sector should also be considered as they may present other challenges than those highlighted in this study.
25	Analysis of Time and Cost overruns in Educational Building projects in Egypt	(Kholif & Ahmed, 2015)	The aim of this research is to classify and analyze these factors according to their relative importance and severity in costs and times.	The research has been done internationally for building projects in Egypt and not specifically for highway projects in India.
26	Influence Factors on Cost and Time Overruns in Mozambicans Construction Projects: Preliminary Findings	(Muianga, Granja, & Ruiz, 2014)	This research seeks to characterize and maintain criticality in Mozambique 's projects on the Factors that influence the cost and overrun phenomena.	The research has been done internationally for other construction projects in Mozambique and not specifically for highway projects in India.
27	Study of Factors Causing Time and Cost	(Ismail, Rahman, & Memon, 2013)	This paper analyzes the time and cost factors in the life cycle of the project. It was found	The research has been done internationally for other construction

	Overrun throughout Life Cycle of Construction Project		that no researcher has investigated this problem based on the construction phases.	projects in Malaysia and not specifically for Indian highway projects
28	Delay and Cost Overruns in Vietnam Large Construction Projects: A Comparison with Other Selected Countries	(Le-Hoai, Lee, & Lee, 2008)	Building projects in Vietnam have been regularly delayed and overrunning costs. In an interview with 87 Vietnamese experts under construction, In order to find the causes of the situation, the research used a questionnaire.	The research has been done internationally for construction projects in Vietnam and not specifically for Indian highway projects.
29	Evaluation of Cost Overrun Factors in the Construction Projects in Developing Countries: Cameroon as Case Study	(Elanga, Elanga, Louzolo-Kimbembe, & Pettang, 2014)	This study aimed to understand the weight of the factors that create additional costs in Cameroon.	The research has been done internationally for other construction projects in Cameroon and not specifically for highway projects in India.
30	Three-Stage Least-Squares Analysis of Time and Cost	(Bhargava, Anastasopoulos, Labi, & Sinha,	The results of this research show empirical evidence that the connection between	Specific study has not done on highways sector. Paper deals with

	Overruns in Construction Contracts	2010)	excessive cost and time is simultaneous with data from Indiana highway projects. The three - stage least square technique showed that the efficiency of these variables varies according to the attributes of the number of factors which significantly influence over costs and time.	study on Maintenance Projects ,Roadway Reconstruction, , Bridge Projects, Pavement resurfacing ,Projects Traffic

Table 6: International research on project delays on Roads and highways projects

Sr. No	Research paper title	Authors/ year	Inference	Research gaps
31	The root causes of delays in highway construction	(Jr. & Thomas, 2003)	An analysis of project records was performed to identify factors causing project delays. On-site visits and in-depth interviews were conducted with SHA staff and contractors in six states. Case studies on specific time	The research has been done internationally for highway projects in Pennsylvania and not for specifically for highway projects in India.

			extensions of the contract have been developed as a tool to discover the root cause of delays.	
32	Causes of project cost overruns within the Ghanaian road construction sector	(Chileshe & Berko, 2010)	The research analyzes key factors that influence cost overruns and its relative importance in the Ghana road construction sector.	The research has been done internationally for Ghanaian road projects and not for specifically for highway projects in India.
33	Study On The Cost Overruns In Road Construction Projects In Sri Lanka	(Wijekoon & Attanayake, 2013)	The purpose of this study is to determine the main factors contributing to cost overruns, classify the factors identified based on their importance and make recommendations to avoid delays in future road projects	The research has been done internationally for road construction projects in Srilanka and not for specifically for highway projects in India.
34	Cost overruns and time delays in highway and bridge projects in	(Akoa & Bella, 2011)	This research examined the impact of project characteristics on costs and unwarranted delays at all stages of project development.	Road maintenance and construction contracts could study separately to achieve better precision in their overpasses.

	developing countries- Experiences from Cameroon			Additionally, the categorization of survey responses by industry experts and professionals would provide remarkable results.
35	An Investigation into the Delays in Road Projects in Bahrain	(Hasan, Suliman, & Malki, 2014)	This study examined delays in road projects in Bahrain, where the frequency and severity of delays were actually studied.	It is necessary to examine and evaluate the associated cost of delays in road projects.
36	Using Risk Assessment to Improve Highway Construction Project Performance	(Diab, Varma, & Nassar, 2012)	The research is a comprehensive research study to scrutinize and estimate the various risk factors in highway construction projects in the United States.	The paper explains theoretically how to use the risk assessment technique but practical application how to implement the technique is missing

Table 7: Study conducted on project delays on construction and infrastructure projects in India and not specifically for highway projects sector.

Sr. No	Research paper title	Authors/ year	Inference	Research gaps
37	Identification	(Salunkhe	By means of a thorough	Project Delay factors

	of Critical Construction Delay Factors	A. , 2014)	literature review and interviews, Factors for building delays were grouped into seven classifications, providing variables that directly affect the project's success.	identified is for general infrastructure projects. Delay factors specifically for sector specific highway project are not identified
38	literature review on causes of delay in building construction projects		The main aim is to identify the views of the three main parties with a questionnaire on delay causes and to suggest possible ways to minimize them.	The study is based on residential building projects and not on highway projects.
39	Causes, Effects and Minimization of Delays in Construction Projects	(Divya.R & S.Ramya, 2015)	This study is conducted based on bibliographic reviews and a questionnaire. The main objective of this study is to correctly identify the main causes, effects and mitigation of building delays.	The general causes of delays have been identified by literature review for general construction projects. The study can be done more precisely using questionnaire survey.
40	Time and Cost Overruns in Implementati	(J.L.Narayan, 2012)	The analysis of MOSPI projects in the central sector, many of the projects are not viable for	The study has been done I for general infrastructure projects in India and

	on of Infrastructure Projects, Problems and Remedies		the formulation and implementation which translates time and cost inflation.	not specifically for highway projects.
41	Delay Analysis in Construction Project	(Dinakar, 2014)	This thesis focuses on the analysis of central factors that cause delays and daily recording in order to reduce delays. The current study is conducted in the construction of the new district prison in the Kurnool district of Andhra Pradesh. The study was conducted on several factors that caused delays in the project.	The study has been done for other construction projects in India and not specifically for highway projects in India.
42	Qualitative analysis of Time delay and Cost overrun in Multiple Design and Build	(Chidambaram & Potty, 2014)	The study focuses on multiple design and building projects (D&B) with a fixed sum of high-risk contracts.	The study has been done for other construction projects in India and not specifically for highway projects in India.

	Projects			
43	Investigation of Significant Factors Influencing Time and Cost Overruns in Indian Construction Projects	(Shanmugapriya & Subramanian, 2013)	The research paper identifies the principal factors that lead to time and excess costs in Indian building projects.	The study has been done for other construction projects in India and not specifically for highway projects in India.
44	Causes of Cost Overrun In Construction	(T.Subramani, Sruthi, & M.Kavitha, 2014)	Most infrastructure projects are cost- cutting and encompass an enormous financial burden for companies. The study thus identified the causes of excessive construction costs.	The study has been done for other construction projects in India and not specifically for highway projects in India.
45	Analysis of Construction Project Cost Overrun by Statistical Method	(Tejale, Khandekar, & Patil, 2015)	The statistical method of cost override methodology in this study calculates the impact of excess project costs. This helps the project manager to address critical causes	The study has been done for other construction projects in India and not specifically for highway projects in India.

			and tries to further cut the project cost.	
46	Analysis Of Critical Factors Affecting The Construction Projects In Pune Region, India	(Mali & Warudkar, 2016)	This study is very important as per Indian construction industry point of view. This paper deals with the study of unnecessary delay occur in construction projects to find the Importance Index of critical factors affecting the project productivity	The study has been done for residential construction projects in India and not specifically for highway projects in India.
47	A Study of Factors Caused for Time & Cost Overruns in Construction Project & their Remedial Measures	(Mulla & Waghmare, 2015)	This study mainly aims at correctly identifying and proposing appropriate remedies for the factors that account for the time and surplus costs of the road project.	The study has been done for residential construction projects in India and not specifically for highway projects in India.
48	Effect Of Construction Delays On Project Time Overrun: Indian	(Salunkhe & Patil, 2014)	This paper underlines the types of construction delays pertaining to time and costs. Building delays are considered a recurrent problem for the	Data on roads and highways sector is not considered. Data is more related to railways and petroleum projects.

	Scenario		construction industry and The impact on the development of the project is negative in terms of time, costs and quality.	The study has been done not specifically for highway projects in India.
49	Indian construction projects-constraints and delays: stakeholders perspective	(Rego, Gupta, & Rao, 2015)	Delay factors were analyzed based on 116 valid responses by stakeholders. Delay factors were categorized and evaluated based on RII and ranked accordingly. To find significant relationships between limitations in the study, anova and spss statistical tools are used.	The study has been done for other construction projects in India and not specifically for highway projects in India.

Table 8: The causes of delays are identified by existing literature available. The causes can be more accurately identified using questionnaire survey with sector experts.

Sr. No	Research paper title	Authors/ year	Inference	Research gaps
50	Study on Construction Sequence Delay for	(Ram & Paul, 2015)	This paper examines the causes and delay factors which contribute to the delay in building road	Factors under consideration are very few. More factors affecting

	Road Infrastructure Projects		infrastructure projects and how future forecasts can be anticipated by trying to manage the value achieved.	project delays need to be considered for precise study
51	A Theoretical Review of the Causes and Effects of Construction Projects Cost and Schedule Overruns	(M.J, C.O., & W.D., 2014)	The aim of this study is to categorize the causes and effects of unnecessary cost to building projects in the previous literature on the costs of development projects	The causes of delays are identified by existing theoretical literature available. The causes can be more accurately identified using questionnaire survey with sector experts.
52	An empirical classification of cost overrun in infrastructure projects by using cluster analysis	(Allahaim, 2009)	The paper aims to help develop an empirically based classification of cost overrun causes in the infrastructure project.	Only classification of cost overrun factors is done. The actual delay factors are not identified
53	Financial-related causes contributing to project	(Abdul-Rahman, Takim, & Min, 2009)	This document deals with the problems related to construction projects' financial delays. Identify root	The study is restricted to only financial related causes. The study need to take into

	delays		causes and analyze suitable mitigation measures for financial-related project delays.	consideration other category of delay causes like material ,labor ,social, etc

Table 9: Study on Roads and highway projects in India

Sr. No	Research paper title	Authors/ year	Inference	Research gaps
54	causes of delay in Indian transportation infrastructure projects	(Patil, A.K.Gupta, Desai, & A.S.Sajane, 2013)	The final objective of this research is to examine the major causes of delays in transport infrastructure projects. The literature is carefully examined and a questionnaire is drawn up containing 64 possible causes of delays in the construction of transportation infrastructure projects.	The study is conducted only for western Maharashtra region. the study can further be extended to Maharashtra state or whole of India
55	Study of Delay in Execution of Infrastructure Projects – highway projects	(Honrao & D.B.Desai, 2015)	Researchers and experts use several methods to analyze project delays and share responsibility amongst the involved parties, addressing the causes that negatively	It is also necessary to study and analyze the associated costs for delays in road projects. The questionnaire prepared and

			affect infrastructure projects in India.	distributed to the interviewees is very short and is limited to only 5 questions. A complete questionnaire can be prepared to obtain more effective survey results.

Table 10: The study is restricted only to particular stakeholder's perspective on project delays.

(The study need to be conducted also taking into consideration all other important stakeholders perspective like the client, contractor and the consultant.)

Sr. No	Research paper title	Authors/ year	Inference	Research gaps
56	Implications of cost overruns and time delays on major public construction projects	(Abderisak, Per-Erik, & Lindahl, 2015)	This article explores from the customer's perspective the phenomenon and reasons for the excessively high costs and delays in major infrastructure initiatives and their repercussions for unwarranted costs and delays to assist	The study is restricted only to clients' perspective on project delays. The study need to be conducted also taking into consideration other stakeholders perspective like the contractors and

			understand the relationship between cost, time and sustainability variables.	consultant's perspective.
57	Causes and Effects of Delay in Iranian Construction Projects	(Pourrostam & Ismail, 2012)	Overall, this study aims to identify the real root causes and effects of the delay in Iranian building projects correctly. An investigation has been carried out to inquire from the consultants and contractors about the causes and effects of the delay. In a list of 28 different causes of delay and six various effects of delay this study clearly identified ten main reasons for delay.	The research has been done internationally for Iranian construction projects and not for specifically for highway projects in India. The study is restricted only to clients' perspective on project delays. The study need to be conducted also taking into consideration other stakeholders perspective like the contractors and contractors perspective
58	causes, effects and methods of minimizing delays in	(Wei, 2010)	The main objective of this research project was to clearly identify the underlying causes of delays in construction,	The research study is limited to consultants and contractors only with regard to

	construction projects - MALAYSIA		the effect of delays and techniques to mitigate delays in construction.	project delays. The study must also take into consideration other important stakeholders, such as the customer perspective.
59	Cost Overrun Causes in Road Construction Projects: ‘’Consultants Perspective’’	(Mahamid, Ibrahim; Bruland, Amund, 2011)	This study was based on the categorization of the cause of overcoming the cost of building the country in Palestine. The literature review also stated 51 factors, which are labelled according to the degree of importance analysed by the survey respondents.	The study is restricted only to consultants’ perspective on project delays. The study need to be conducted also taking into consideration other important stakeholders like the client and contractors perspective
60	Modeling Causes of Cost Overrun in Large Construction Projects with Partial Least	(Rahman I. A., Memon, Azis, & Abdullah, 2013)	The overall cost is a result of one or more causes that are very important for efficient cost performance to be studied. This research study focuses on the	The study is restricted only to contractor’s perspective on project delays. The study need to be conducted also

	Square-SEM Approach: Contractor's Perspective		survey of the fundamental relationship between cost overload factors using the SEM method of partial lowest squares.	taking into consideration other important stakeholders like the client and consultants perspective

Table 11: Shortage of resources like labor, equipment, finance, skills, time, etc affects the project delays

Sr. No	Research paper title	Authors/ year	Inference	Research gaps
61	Causes of Delay in Road Construction Projects	(Mahamid, Ibrahim; Bruland, Amund, 2011)	In this study, a questionnaire survey was carried out to assess the total performance of road construction projects in the West Bank of Palestine in order to find factors that influence delays and their severity.	
62	Risk variation assessment of Indian road PPP projects	(Gupta, Trivedi, & Kansal, 2013)	The main risks for ongoing road projects in PPP(under NHAI and MPRDC) were identified in this study. The cumulative impact of the risks and their	

			fluctuations at diverse stages of the life of the BOT project has been analyzed..	
63	A project report on case study of Mumbai-Pune expressway	(Mathkari, 2017)	The case of MSRDC and Coimbatore Bypass shows that the current policy of attracting private participants has many reservations. A country with scarce resources such as the Indian government alone will not be able to withstand the enormous demands of infrastructure projects. Therefore, the government should actively seek to attract private sector investment in this sector, simplifying projects with clear regulation and authorizations and reducing externalities.	
64	Indian road construction industry capacity	(Bandyopadhyay, Swaminathan, &	This study helps to understand in part the true concerns of the Japanese government	

	issues, constraints & recommendations	Rohatgi, 2008)	about the road construction sector's capacity and, in part, the growing need for the Bank to understand the impact of large - scale road investment on industrial capacity in South Asia. It is based on past studies, official reports, questionnaires and workshops by stakeholders all across the industry. It recommends key steps to improve capacity and efficiency for central and state governments and industry.	
65	Delay and Cost Overrun in Road Construction Projects in Jordan	(Al-Hazim & abusalem, 2015)	The aim of this investigation is to determine the main factors which cause road building delays in Jordan, which may lead to costs and overruns of the project and to critical problems for the developer and contractor.	

2.5 THEORETICAL UNDERPINNING

THEORY OF CONSTRAINTS (TOC)

Theoretical term is generally seen to be synonymous with hypothetical. If something is theoretical, it may not yet have happened but due to various sources, it is believed to happen in this way. The sources may be predictions based on case studies, investigations and observations or mathematical evaluations. It is usually more than a simple guess; there will be foundations beneath a theoretical expectation. Following theories were studied to match the relevancy with this study:-

• Stakeholder theory

• Theory of Constraint (TOC)

• Resource value based theory (RVBT)

These theories were studied to deliberate the theoretical premise for this study. After due deliberation it was concluded that theory of constraints (TOC) was more relevant for this research.

The TOC was extended to project management to resolve the typical significant problems of project managers which eventually have to deal with project delays and failures (Pittman, 1994). Designed by Dr. Eliyahu Goldratt, within the TOC constraints are defined as anything that restricts a system so that it would not achieve the best possible performance towards its ultimate objective.

PMBOK is the fundamental understanding you need to manage a project, divided into 10 areas of knowledge:

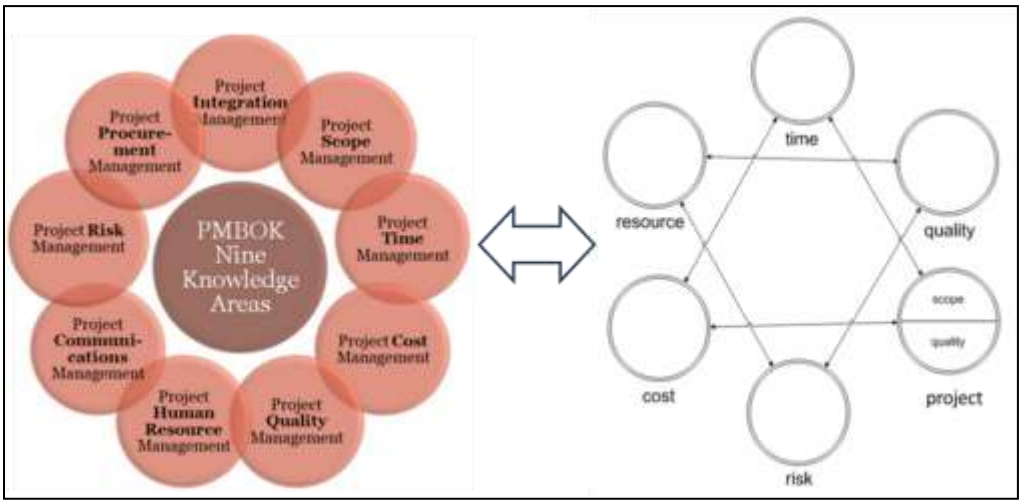


Fig 7: Framework for Managing Projects (PMBOK)

TOC is a necessary prerequisite for this research project because of its direct influence on the way in which the researcher studying projects in the R&H sectors actively works to alleviate delays which are directly linked to the management of project restrictions. This is the vital framework for project management, but if you want to be efficient in project management, you need to be efficient in managing each of the ten knowledge areas that make up the PMBOK.

Theory of constraints actually provides a powerful and effective array of tools to achieve those goals, including:

• Five focusing steps (framework for categorizing and eradicating restrictions)

• Thinking processes (methods for evaluating and resolving problems)

• Throughput accounting (strategy for improving efficiency and actually driving management decisions)

2.6 RESEARCH GAPS

The current literature is reviewed in an attempt to understand the key factors that cause project delays in the road and road industry in India which is vital to build the foundation of development of framework for mitigation of project delays and identifying the research gas that exists. The research gap turns out to be the starting point of this research work.

The central research gaps as found from the literature indicated two major ones which are as under

- Project delays in roads sector has been studied internationally but very few studies have been done in India related to project delays in Indian roads and highway sector and are mostly descriptive based not considering all stakeholders perspectives.
- Presently Literature is available related to factors causing project delays in general construction and infrastructure projects but the study on critical delay factors causing project delays in roads and highway sector in India has remained unsubstantiated.
- Studies done previously in India are not helpful in understanding the nature and impact of delays factors causing projects delays in Roads and highway project sector in India and how to mitigate these delays for successful project delivery within estimated time and cost.

2.7 CONCLUDING REMARKS

The literature survey has helped in the establishment of broad gaps related to the research. The impact of the critical factors causing project delays in roads and highways sector in India needs to be answered in detail. Thereafter, development of framework to mitigate these project delays has to be studied carefully. This chapter also highlighted the various themes categorizing the

literature review topics and also discussing a few literatures in detail. The theory of constraints is the underpinning theory used for this research work.

CHAPTER 3:

RESEARCH DESIGN AND METHODOLOGY

3.1 OVERVIEW

In this chapter, the researcher will discuss the comprehensive research methodology and in depth design for the research study. The research design and techniques for each objective are discussed extensively as well as the tools and techniques used to perform the study.

3.2 INTRODUCTION

In other words research design is the framework providing the blueprint of the study. In particular, the research design includes various science concepts, scientific methods, research techniques, statistical methods, research strategy, and processes for data collection and data analysis. The research design actually describes the direct connection between the preliminary research questions of the study and empirical data leading to logically and finally to the conclusions of the research study. (Yin, 2003).

The research design is classified as exploratory research design and conclusive research design. Conclusive research is further classified as descriptive research and causal research. Exploratory research involves qualitative studies, while conclusive research is associated with quantitative research. Both the research designs were used in different roles in this thesis.

The qualitative method was used while carrying out literature survey, formation of research objectives, validation and achievement of first objective of the study. An explanation of the overall approach and rationale for the selection of qualitative method has been given. An explanation of the data collection method used in the study for qualitative work has been given. The

description about construct validity, data analysis strategy, data reliability and internal and external validity (Yin, 2003) has been discussed with respect to qualitative research method. Discussion on the use of Interview protocol, conceptual lens has been presented.

The quantitative method was used to address the second objective, where the research questions were accompanied by identification of the sampling procedure (sample size, sampling frame), scale formation; pilot testing, validity and reliability testing of the instrument, questionnaire design, data collection and analysis.

3.3 BACKGROUND

Roads and highway-project delays have detrimental effects on both road organizations and contractors (either in the form of lost profits or extra costs) and sometimes raise sensitive issues pertaining to delay liability, which can also create a conflict that eventually lead to costly legal lawsuits. Cost overruns and time delays of highway projects in India have severely reduced the economic viability of highway projects, causing an increase in the capital output ratio for the entire economy, restricting the potential for growth and decreasing the competiveness of the economy and lowering the efficiency of available economic resources. There are also some problems with extended working zones and concurrent safety and roadwork delays, road user discontent and political ramifications. Project delays have negative results on project success in terms of time, cost, safety and quality. Delays has a negative effect on project stakeholders causing hostile relations, lack of trust, lawsuits, arbitration, working capital problems and a general impression of apprehension towards one another.

Many factors influence delays in the road projects, some within the accountability of the contractor and a few within the responsibility of the

client. Mainly due to the conflicting nature of the events, it is hard to distinguish between the parties responsible and the ingredients of the significant delay cause. Delays cause disagreements, negotiations, lawsuits, arbitrations and project abandonment.

Project delays lead to:

- Traffic-delays
- Political ramifications
- Adverse relationships between stakeholders
- Mistrust among stakeholders.
- Road-user dissatisfaction
- Litigations & arbitrations
- Cash-flow problems
- Adverse effect on project success in terms of cost, quality, and safety

The effects of delays are different with different parties. The overall consequences are economic loss, time and capacity. For the contractor, delay means loss of revenue for additional expenditure on materials and equipment and recruitment of labor and loss of productivity. For the customer, delay means economic losses and lack of availability of facilities. By means of claims, the parties included in the contract tend to agree on extra funds and additional time typically associated with R&H project delays.

3.4 RESEARCH PROBLEM STATEMENT

How to develop a framework for mitigation of project delays by managing the project constraints through impact assessment of Critical factors causing time overruns in Roads and Highways Sector projects in India.

3.5 RESEARCH QUESTIONS

1. What are the critical delay factors in Roads and highway sector in India causing project delays?
2. What is the severity of these identified critical factors causing project delays in Roads and highway sector in India?
3. What is the impact of these identified critical factors on project delays and how to mitigate them?

3.6 NATURE OF RESEARCH QUESTION

The research problem as mentioned above is exploratory in nature as it seeks to arriving on the critical factors and understanding its impact on project delays. These factors influence the development of framework to mitigate the project delays in roads and highways sector in India. The study is aimed to highlight the possible guidelines by developing a framework to mitigate the project delays by analyzing the severity of each factor and ranking them accordingly to understanding their impact on project delays.

3.7 RESEARCH OBJECTIVES

1. To identify the critical factors influencing project delays in Roads and Highway projects in India.
2. To assess relative importance levels and severity of these identified critical factors causing project delays in Roads and highway sector in India.
3. To develop a framework to mitigate the project delays by analyzing the impact of these identified critical factors causing project delays in Roads and highway sector in India.

3.8 RESEARCH APPROACH

In this research study, the researcher has stated clearly the research problem to be studied. The existing underpinning theory pertaining to the research problem has been discussed. The researcher seeks to examine and fully understand the nature and scope of the problem through a systematic study. Research questions are developed under research design to logically understand the problem. The researcher begins data mining using a survey questionnaire according to a delineated design methodology. The data gathered for research are assessed applying statistical techniques, and the results of data analysis form the initial findings of the study. With the help of the questionnaire the variables have been put together to arrive at the factors. The specific factors form the findings of the study. Based on that, a conceptual lens is developed using empirical research design and data analysis approach. The conceptual lens forms a input for the final framework development through qualitative analysis. The overall research design for the three objectives have been shown separately.

3.9 RESEARCH DESIGN

A research design is essentially a master plan involving data research project collection and analyzes(Kinnear & Taylor, 1987). It offers the framework that designates the sort of information to be gathered, its sources and the collection strategy. Research design is described as "it is the blueprint that is actually followed to successfully complete the study ".

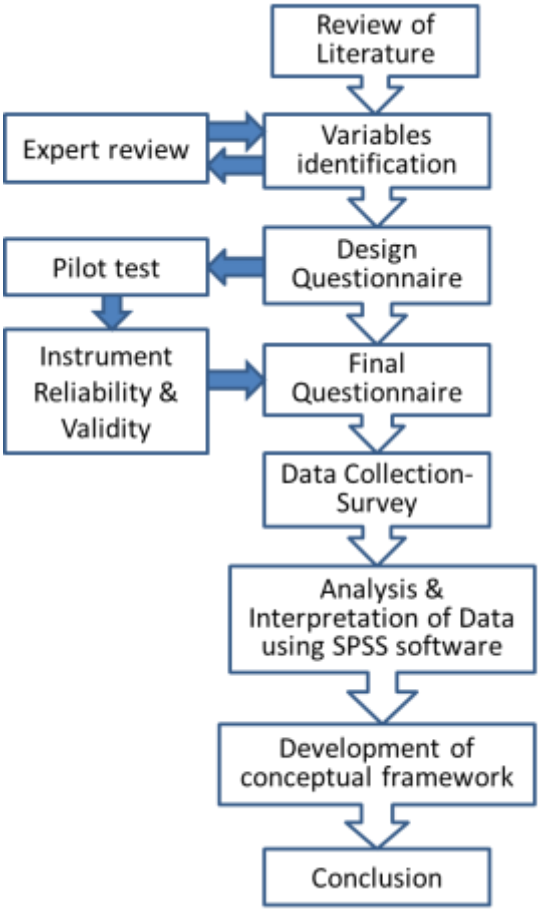


Fig 8: Research design Process

Several frameworks for research design can be identified into two main categories: exploratory and conclusive. The conclusive research can be further subdivided into descriptive and informal research. (Bramble & Callahan, 1987). During the current study, care has been actually taken to implement these concepts into the research design.

Quantitative research aims to quantify the data and usually uses some form of statistical analysis. Qualitative study forms exploratory research and quantitative study forms conclusive research. Qualitative research gives knowledge and understanding of the problem. When addressing a new research problem, appropriate qualitative research must follow quantitative

research (Gahtani & Mohan, 2005). In these studies, research designs have been used in varying degrees.

A suitable research model is developed to answer the research questions. All variables are identified by means of expert reviews, literature review and secondary information. A questionnaire is then prepared in line with the identified variables. A pilot test is carried after preparing the questionnaire out, to check the reliability and validity of the questionnaire (Cronbach's Alpha Test). Data collection is started in the form of surveys once this test is successful. Statistical techniques are used for data processing. Inferences are drawn and conclusions and recommendations are made from the analyzed data.

Inputs are taken from literature surveys and expert reviews for the preparation of the questionnaire. 5-point Likert's scale is used for rating each question. This provides data for processing using statistical tools. The qualitative research methodology is used to develop the conceptual framework to minimize delays in road and highway projects in India, based on literature surveys, empirical variables and factor analysis. The research process has been explained in the following flow diagram:-

3.9.1 MIXED METHODOLOGY

A mixed method strategy combines both qualitative and quantitative aspects and utilizes them in parallel, so that the overall strength of a study is significantly greater than either qualitative or quantitative research. Mixed methods use the strength of both qualitative and quantitative research. (Creswell, Clark, & Plano, 2007).

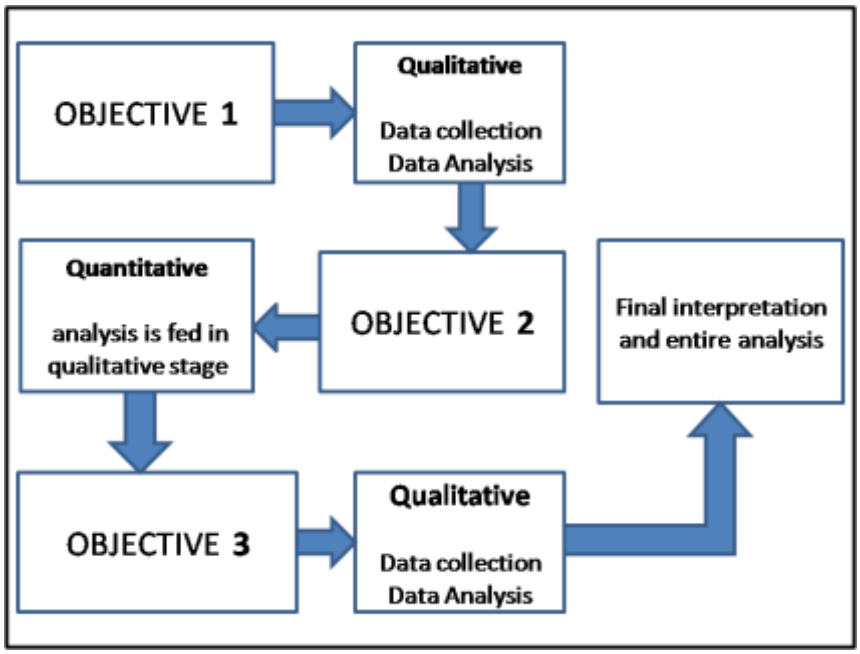


Fig 9: Research design – Mixed method

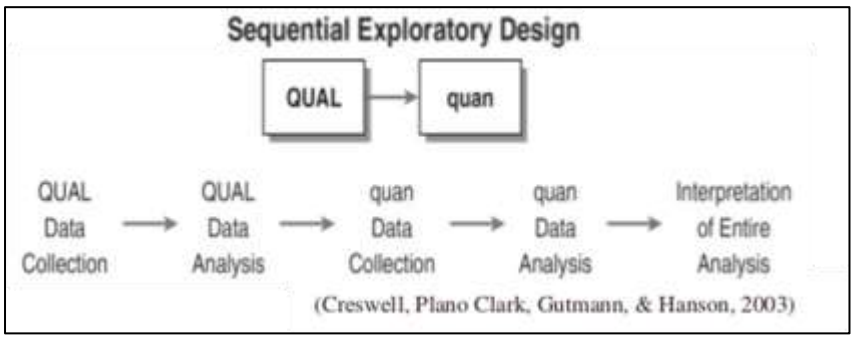


Fig 10: Sequential exploratory design

Mixed method or sequential exploratory design characterized by first phase involves quantitative data collection and analysis followed by the second phase of qualitative data collection and analysis, based on initial 1st phase output results. Combined use provides an expanded understanding of research problems. The main disadvantage of this methodology is the extended duration of data collection with two separate phases consuming time (Creswell, Clark, & Plano, 2007).

3.10 RESEARCH METHODOLOGY AND DATA ANALYSIS

3.10.1 RESEARCH VARIABLES

Identify a list of major research variables from the literature survey to develop a framework to mitigate project delays.

3.10.2 RESEARCH DESIGN - EXPLORATORY DESIGN

The List of variables obtained above through literature survey is then strengthen and finalized after conducting Structured Interviews with expert in the field

3.10.3 PREPARATION OF QUESTIONNAIRE

Questionnaire will designed based on questions from related to identified variables. The variables would be clubbed based on key attributes. To record participants ' responses via a questionnaire, a 5 point Likert's scale will be applied.

During questionnaire survey, the respondents will be told to rank the variables causing project delays in roads and highways sector in India on the scale of 1 to 5 based on the severity of impact of [x].

Responses on likert's scale were measured on 1 to 5 scale were the numbers indicating:

1 – The chances of occurrence is *very low*,
2 – The chances of occurrence is *Low*,
3 **-** The chances of occurrence is *moderate,*
4 **-** The chances of occurrence is *High* and
5 **-** The chances of occurrence are *Very high.*

3.10.4 PILOT SURVEY

Pilot survey will provide additional ideas and insights on key variables causing project delays in roads and highways sector in India. Pilot survey as a

pre testing instrument is used for testing reliability of questionnaire (20 respondents for each stakeholder). Cronbach's Alpha measure is used for studying output of Pilot study (Hair, Anderson, Tatham, & Black, 1998). Cronbach's Alpha measure is used testing reliability that range between 0 to 1, of which of 0.60 to 0.70 values specify lower limit of acceptability.

3.10.5 SAMPLING DESIGN

The sampling design will be non-probabilistic if research is exploratory in nature. Since people have limited expertise and domain knowledge in this field of research. Thus, the selection technique however is restrictive in nature and carried out through judgment sampling.

3.10.6 RESPONDENT'S PROFILE

Survey respondents are selected from experienced professionals working in the roads and highways sector in India particularly (Clients, Consultants & Contractors).

The participants to the questionnaire will be chosen from the following background considering judgmental sampling

1. Technical Executives and project managers at the NHAI, MORTH, CPWD, etc
2. Management level persons from Roads and highways industry
3. Project management Consultants from the Roads and highways industry
4. Contractors/Site execution engineers from the Roads and highways industry

Questionnaire was distributed both by email as well as hard copies wherever requested, out of which 142, 462 and 123 responses valid responses were obtained from Clients, Contractors, and consultants respectively.

The responses were deemed to be extremely trustworthy for data analysis due to precise understanding of questionnaires among respondents, personal interactions and pertinent industry experiences (Vaus, 2001). From the responses received, the highest proportions (38 percent) were contractors, followed by clients (33 percent) and consultants (29 percent).

3.11 CALCULATING SAMPLE SIZE

For sample size calculation, use the following formula: Yamane (1967)

Statistic	Description	Value
n	Sample size	?
e	Margin of Error (as a decimal)	5%
N	Population Size	10000

$$n = \frac{N}{1 + N(e)^2}$$

$$n = \frac{10000}{10000(0.05)^2}$$

$$= 384 \text{ respondents}$$

Equation 1: Calculating Sample Size

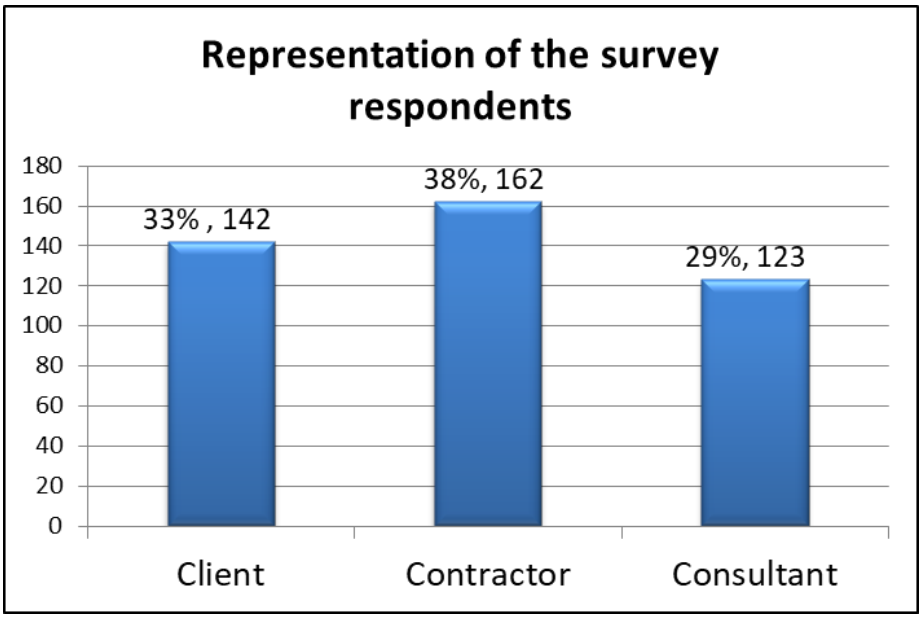


Fig 11: Representation of the respondents:

3.12 RESEARCH METHODOLOGY AND DATA COLLECTION PROCESS

The survey data for the research study pertaining to key variables will be gathered in a structured manner and further analyzed systematically from the above sources.

Sources of Primary data will be:

I. Personal interactions and filling up the questionnaire
II. mailing the questionnaire to probable respondents

3.12.1 RM FOR OBJECTIVE 1

"To identify the critical factors influencing project delays in Roads and Highway projects in India"

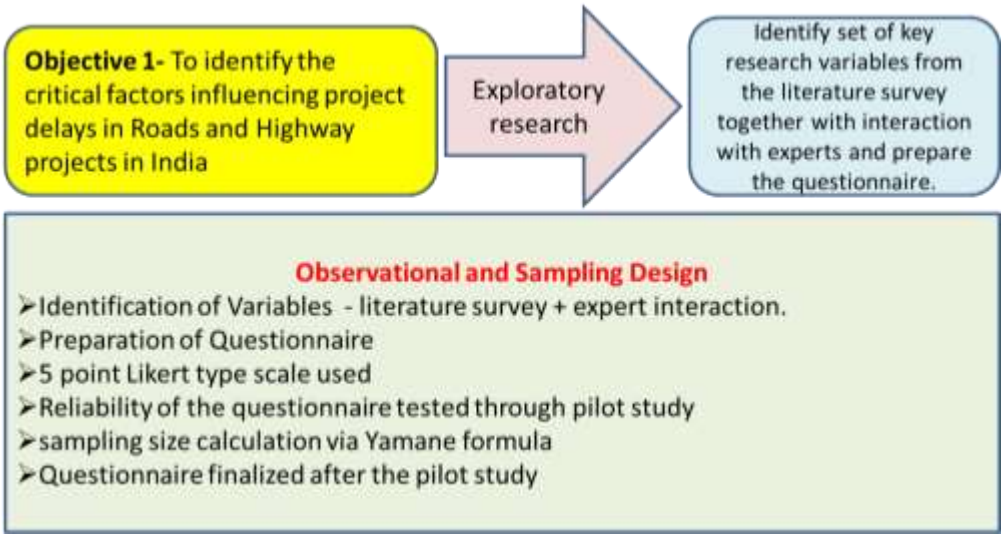


Fig 12: Research Methodology for Objective-1

Focus will be on the project delay causes and development of framework for highways sectors to complete the projects within budgeted cost and time schedule.

The causes of project delays pertaining to Roads and highway sector will be identified from extensive literature review, published research papers like annual reports and interaction with industry experts. Other preliminary data will be collected by questionnaire survey.

The factors of delay will be classified into categories. These factors categories will be further evaluated based on the questionnaire survey with stakeholders namely the Clients, consultants and contractors of Indian R&H sector.

The questionnaire survey will help to gather information related to the major constraints and projects delay factors in R&H projects in India. The respondents will be asked to grade the main constraints and factors of delay. Questionnaire survey will help to get relevant responses from clients, consultants and contractors towards delay factors that will affect performance of roads and highway project in India.

3.12.1.1 DATA ANALYSIS METHOD

The purpose of the research is to study in depth what factors delay project in road projects in India is relatively important. For this specific purpose, the appropriate literature on project delays in the road and highway sector in India will be evaluated. A questionnaire survey is framed on information collected from the literature review and expert interviews. The reliability analysis of the data collected will be carried out in order to ascertain the relative importance of these factors respectively.

To achieve this objective, the researcher

- Analysis of reports published by NHAI, CRISIL, MOSPI and other statutory bodies with is done to understand how the highway projects in India have reacted to the identified barriers & challenges for development of roads and highway infrastructure in India.
- In-depth data analysis will be done through secondary source of information & through data collected from key stakeholders from various fields related to highway projects
- The study will be qualitative and quantitative.
- Focus will be on the time overruns of major highway projects in India so as to find out the factors responsible for delays of projects.
- The study will be conduct in the natural environment.

3.12.1.2 DATA COLLECTION TECHNIQUE

- Triangulated data - documents & interviews
    - data will be collected through secondary source of information
        - Government Documents
        - Published documents
        - Reports
        - Archival records

- Interviews of experts in roads and highways sector

3.12.1.3 SOURCES OF DATA

Primary or secondary or both the kinds of data may be used.

Primary data - The sources of primary data will be the questionnaire survey administered to

- Scientists of CSIR-Central Road Research Institute
- Indian Academy of Highway Engineers (formerly NITHE)
- Publications of Indian Roads Congress
- The Institute of Highway Engineers (IHE)
- Important policy makers in National highways, Govt. of India
- Reports published by CRISIL, ASSOCHAM, PMI, IBEF, etc
- Contractors in execution of highway projects in India
- Consultants in execution of highway projects in India
- Public Works Department, State government
- Key independent thought leaders in the field of Highway sector in India
- Leading academicians in India involved in studies related to highways sector

Secondary data - data will be collected from publications and reports of the below following organizations

- MOSPI reports
- World Bank reports
- NHDP reports
- MORTH reports
- Reports of Planning Commission of India
- NHAI reports

- Ministry of Surface Transport reports
- Asian Land Transport Infrastructure Development (ALTID) project
- Transportation Research Group of India
- The Road Engineering Association of Asia & Australasia
- Scholarly journals

3.12.2 RM FOR OBJECTIVE 2

"To assess relative importance levels and severity of these identified critical factors causing project delays in Roads and highway sector in India"

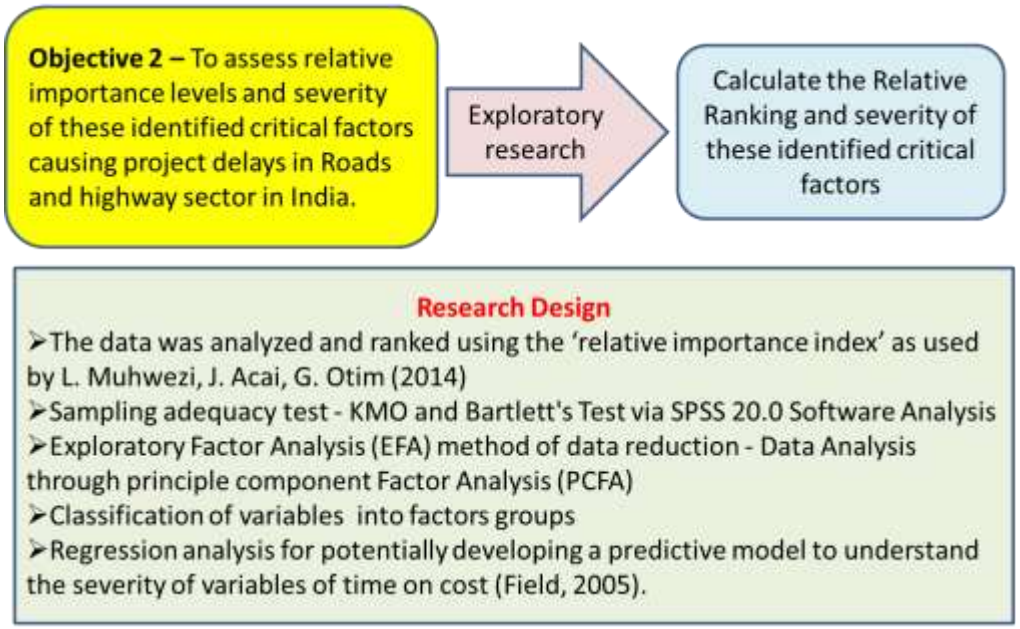


Fig 13: Research Methodology for Objective-2

The research study used the methodology that was employed by (Muhwezi & J. Acai, 2014) for measuring the weighted indices for the frequency of overrun variables. Relative Importance Index (RII) will rank the attributes depending on their criticality as responses submitted by survey participants which will be calculated using the below equation.

$$RII = \frac{\sum W}{A*N} (0 \leq RII \leq 1)$$

Equation 2: Relative Importance Index (RII)

Where:

W –weight allotted to each factor by the respondents ranging from 1 to 5 (where 1 is less severe and 5 is more severe);

A –Highest weight (i.e. 5 in this case)

N – Total number of respondents

The Relative importance index (RII) method will rank the critical factors causing project delays in terms of degree of occurrence to determining relative importance of identified delay factors followed by testing the severity through regression analysis of the delay causes from stakeholder's perspective namely clients, consultants and contractors. Analytical analysis through RII method will help to identify the critical factors causing project delays.

3.12.2.1 DATA ANALYSIS TECHNIQUE

Regression analysis investigates the relationship between the project delays and these identified critical factors by developing regression model using SPSS software.

The main reasons for the delay in the Indian R&H sector coming out through PCFA were further evaluated using linear multiple regression model for the potential development of a predictive model to understand the severity of impact. Factor analysis will suggests forming categories having significant correlation coefficients with underlying dimensions which are quantifiable having no predictive power on the measured data set. R2 presents a measure of the extent of the relationship between predicting independent variables and the dependent variable. Multiple regression models have characteristics of a

predictive model that will combine a set of independent variables not considering the common variance (R2) in the entire dataset. (Field, 2005).

The dependent variable here is the total project delay. The independent variables are the factors coming out of factor analysis. They are entered as categorical variables step by step in the regression model. Thus, the overall impact of project delay resulting from factor categories will be measured by the regression model and can be generally expressed as below. To formulate the regression model Forward stepwise process is used.

$$Y = a + b_1X_1 + b_2X_2 + \ldots b_mX_m \pm e$$

Equation 3: Multiple regression equation

Where

Y: Independent variables

$\mathbf{X^1}$ to $\mathbf{X^m}$: Independent variables

a: constant and intercepts at Y axis

$\mathbf{b^1}$ to $\mathbf{b^m}$: regression coefficients

e: error

3.12.3 RM FOR OBJECTIVE 3

"To develop a framework to mitigate the project delays by analyzing the impact of these identified critical factors causing project delays in Roads and highway sector in India"

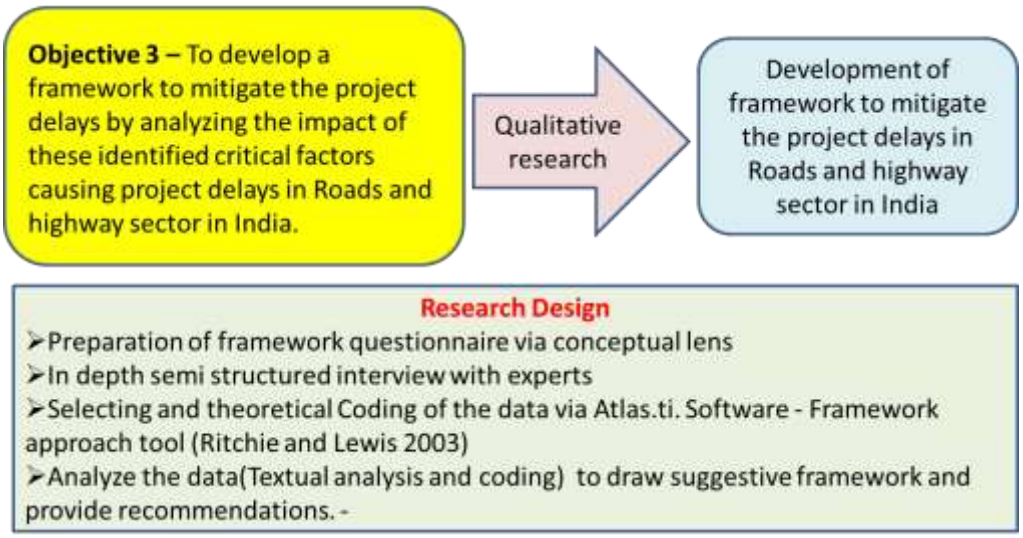


Fig 14: Research Methodology for Objective-3

This research study deals with development of theoretical framework which helps in determining the variables to be measured and statistical relationships to be used. There are two areas involved in research methods - theory and observation. There are called as two realms in research. Theory is something which articulates inside the heads of researchers, while observation happens in the real world. Theory helps in guiding research holistically, from the formulation of the research question to discussion. (Trochim, 2006)

The theoretical framework helps connecting the researcher with present knowledge. Expressing the theoretical assumptions of a research study enables the researcher to answer questions about how and why. It allows researchers to generalizing various aspects of that phenomenon rather than simply describing a phenomenon observed

A suitable theoretical framework will be developed after identifying the factors causing project delays and assessment of impact of these identified critical factors. Suitable measures for mitigation of project delays will be developed once the severity analysis and assessment of each of these factors on project delays is done.

3.12.3.1 DATA ANALYSIS TECHNIQUE

Framework approach tool was found to be suitable for the qualitative analysis (Ritchie & Lewis, 2003).

Qualitative Research was used for the purpose of development of conceptual

- Developed questionnaire based on inputs from conceptual framework
- Experts (Highly experienced) from R&H sector were selected based on judgmental sampling
- conducted In Depth Semi Structured Interviews with the expert group
- Interview was recorded, transcribed and fed into software Atlas TI
- Coding with Atlas TI
- Suggestive framework based on the output of transcribed conversation

Procedure followed for Interview Protocol for interview

1. Introduction
2. Giving background Information- narrating the study and the purpose of it
3. Promising confidentiality
4. Asking for concern and permission
5. Putting the first mandatory question.
6. Putting probing questions
7. Asking further leading and probing questions
8. Asking for something they wish to tell or know more.
9. Asking for lead, and checking whether the participant is comfortable letting his name used.
10. Thanking for the support

Rules-

1. Informing the participant about the topic and process

2. Ensuring that the place of interview be comfortable enough for the participant to share information.
3. Making a point to paraphrase the responses for capturing the thoughts of the participant correctly and checking your understanding.
4. Transcribing, the interviews immediately after the interviews are done.
5. Checking for saturation levels

The steps that were followed while conducting data analysis are given as under;

1. Open Coding
3. Selective / Focused Coding
2. Axial Coding
4. Theoretical coding

The qualitative analysis and use of this coding to for framework development is explained in detail in the next chapter.

3.13 CONCLUDING REMARKS

In this chapter, research design and methodology have been discussed extensively. Data collection was done by developing a questionnaire on 5 point Liked scale. Questionnaire was administered with respondent's client, consultants and contractors in the roads and highways sector in India. Interview data was transcribed and later on analyzed using Atlas TI software. Questionnaire was sent by email as well as hard copies wherever asked by respondents, of which 142, 162 and 123 responses valid responses were obtained from Clients, Contractors, and consultants respectively. The aim of the survey was to determine the key factors that cause project delays in Indian roads and highways. Among the survey respondents, the highest percentage (38 percent) were contractors engaged in construction, followed by clients (33

percent) and consultants (29 percent).The data analysis approach for each of the objective has been discussed in detail. Overall approach and rationale for this research study discussed in detail logically by explaining the research methods and research study.

CHAPTER 4:

DATA ANALYSIS RESULT AND INTERPRETATION

4.1 OVERVIEW

This chapter focuses on the statistical data analysis of the data gathered from the questionnaire survey. SPSS software tool is used to validate the questionnaire with the help of suitable statistical tests and application in (PCFA) principle component factor analysis. The analysis has been done in 3 parts each for client, consultant and contractor respectively. The researcher had identified 36 variables for client, 40 for consultant and 42 for contractor with the help of literature survey and expert interaction and then designed a questionnaire using these variables. The input received from the respondents was further statistically analyzed and processed using relative ranking method technique, PCFA and multiple regression technique to meet the objective of the research study.

4.2 RANKING OF ATTRIBUTES

Several researchers like (Farid & El-Sayegh, 2006) , (Sadi A. Assaf, 1995), (Kumaraswamy & Chan, 1998) and (Iyer & Jha, 2005) think That the standard deviation and mean of the individual attribute are not suitable for evaluating the variables ' rankings because they do not symbolize any relation between themselves, and therefore the relative importance index or RII is used.

From the following equation is calculated the relative importance index (RII):

$$\text{RII(Relative Importance Index)} = \frac{\Sigma w}{AxN}$$

W	Weight given to each attribute by respondent
A	Highest weight
N	Total number of respondents

The variables are arranged in ascending order as per their RII. The variable with the highest rank suggests having greatest impact on the delay, whereas the lowest rank specifies having the minimum amount of impact on the delay.

Relative importance index was used to examine and ranked the data collected from the questionnaire survey. The five- point scale was used to convert the ranks for relative importance (RII) calculations expressed as relative indexes of importance for each factor. (Simon T. Kometa, 1996).

4.3 PART A - CLIENT

4.3.1 RELATIVE IMPORTANCE INDEX (RII) CALCULATIONS

Table shows the ranks and relative importance indices as perceived by the *clients* for all the 36 causes for the delays in the implementation of highway project in India

Table 12: *Calculation of RII – CLIENT*

Variable no	Causes of delays (Variables)	Total Weight ($\sum W$)	Highest Weight (A)	Total No. of Responses (N)	RII = $\frac{\sum W}{A*N}$	Rank
18	Issues in client procured materials	560	5	132	0.848	**1**
24	Geological problems on site	553	5	132	0.838	**2**

8	Price fluctuations due to Inflation	545	5	132	0.826	**3**
3	Change in government policies affecting project	532	5	132	0.806	**4**
9	Global/National Economic crises	530	5	132	0.803	**5**
13	Change/Transfer of project personnel during project execution	516	5	132	0.782	**6**
34	Lack of competent/expert project domain people	508	5	132	0.770	**7**
1	Law and order situation/Security threats/Local Agitations	491	5	132	0.744	**8**
10	Lack of project funding	485	5	132	0.735	**9**
25	Poor site access	478	5	132	0.724	**10**
2	Land acquisition problems	465	5	132	0.705	**11**
33	Slow decision making process	455	5	132	0.689	**12**
11	Improper project feasibility study	443	5	132	0.671	**13**
32	Frequent project scope/Design changes	432	5	132	0.655	**14**
36	Lack of client representatives at site	424	5	132	0.642	**15**
5	Change in political power at State/ Center	404	5	132	0.612	**17**
28	Severe weather conditions	411	5	132	0.623	**16**

	at site					
29	Ambiguous project requirements	393	5	132	0.595	**18**
31	Delay in progress payments	384	5	132	0.582	**19**
12	Project complexity (Project type, project scale, etc)	378	5	132	0.573	**20**
15	Unrealistic contract/project duration	363	5	132	0.550	**21**
4	Delay in Center/State government document clearance process	351	5	132	0.532	**22**
14	Force majeure activities/unforeseen circumstances	335	5	132	0.508	**23**
30	Improper contractor/Consultant selection	327	5	132	0.495	**24**
27	Improper conflict resolution process adopted	317	5	132	0.480	**25**
17	delay in selection of PMC/contractors/suppliers	314	5	132	0.476	**26**
35	Delay in finalizing rates for additional items	311	5	132	0.471	**27**
23	Environmental concerns and restrictions	302	5	132	0.458	**28**
6	Excessive bureaucracy with organization	286	5	132	0.433	**29**

22	coordination with foreign consultants	279	5	132	0.423	**30**
20	Wrong Type of project award (Turnkey, BOT, etc)	271	5	132	0.411	**31**
26	lack in follow-up procedure with government to start project	271	5	132	0.411	**32**
7	Favoritism in consultant/ contractor selection	262	5	132	0.397	**33**
16	haste in preparing project design	250	5	132	0.379	**34**
21	Lackadaisical attitude towards work completion	248	5	132	0.376	**35**
19	Ignorance in penalizing for delay	238	5	132	0.361	**36**

4.3.2 PILOT TESTING– CLIENT SAMPLE

In pilot tests, a survey of 20 people was undertaken and the reliability was checked using Cronbach Alpha test which was 0.735. The Cronbach Alpha test and the end results attained in pilot tests are stated below.

Furthermore, when the Cronbach Alpha test was successful, the questionnaire was mailed to the NHAI, MORTH and CPWD road and highway officials. A total of 142 responses were obtained which was further reduced in number using factor analysis method.

Internal consistency of data is checked by Cronbach's Alpha test. Internal consistency represents closeness of set of variables associated as a group and the degree to which these variables measure the same concept. SPSS 20.0

software is used for carrying out Cronbach Alpha test and for further analysis. The Cronbach Alpha value increases as the correlation between the items increases (Murphy, 1988).

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Fig 15: Cronbach's alpha internal consistency interpretation.

If the Cronbach's Alpha in the internal consistency test is 0.7 or more than 0.7 than the reliability of the instrument is considered high.

Table 13: Pilot testing analysis results for client sample

Reliability Statistics		
Cronbach's Alpha value	Cronbach's Alpha Based on Standardized Items	Number of Items
.735	.763	36

The consistency value of Cronbach Alpha is 0.735 which indicates high internal consistency of data. This value confirms the highly reliable instrument.

4.3.3 EXPLORATORY FACTOR ANALYSIS (EFA)

Data reduction method also called as factor analysis or exploratory factor analysis (EFA). The EFA method is intended for scenarios that do not recognize or uncertain on the links between observed and latent variables. The analysis of exploratory factor (EFA) tends to focus on how and to what extent the variables observed are actually associated with their subordinate latent

factors. After formulating questionnaire items, EFA will be conducted to determine how much the measured items relate to the latent constructs. The main objective of EFA is to measure the degree to which the underlying latent structures obtain observed variables and to thus assess the strength of regression paths from the factors to the observed variables (factor loadings) (Byrne, 2010).

4.3.4 EFA RESULT - CLIENTS

In this section, the perception of clients on the causes for the delay in causing time overruns in Roads and Highways Sector projects in India is presented. Firstly, a set of 36 questions were asked to the clients and measured using likert's scale to rate them for the chances of occurrence of delays of highway projects. A total of 26 variables are selected out of the 36 variables, based on correlation. Rests of the 10 variables are excluded from further analysis as they have no significant correlation with each other.

The Principal Component factor Analysis (PCFA) is used in the factor analysis method here for data reduction. The adequacy of the sample must be validated before using the PCFA method. KMO & BT tests is used for checking sample adequacy. The sampling adequacy below 0.50 it is unacceptable and more than 0.90 is excellent, while. KMO and Bartlett tests value was found to be 0.632 which was acceptable. This means that the variables are interdependent and correlated, which is a mandatory precondition to conduct factor analysis.

Table 14: Sampling adequacy test- Client sample

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.632
Bartlett's Test of Sphericity	Approx. Chi-Square	974.961
	df	630

	Sig.	.000

(SPSS V20.0 software analysis)

The Eigen value technique is being used to determine the factors In the PCFA method. Using PCFA, 5 factors are defined whose cumulative percentage of total variance is actually explained by 70.332 percent. In layman's terms, it suggests that 70.332 percent of variance is actually explained by 5 factors.

Table 15: Total variance explained from SPSS software

Total Variance Explained - Client									
Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.192	21.867	21.867	6.192	21.867	21.867	2.589	16.192	16.192
2	2.589	17.193	39.060	2.589	17.193	39.060	2.494	15.929	32.121
3	2.214	14.151	53.211	2.214	14.151	53.211	2.359	14.553	46.674
4	1.916	10.321	63.532	1.916	10.321	63.532	2.203	12.119	58.793
5	1.235	6.790	70.322	1.235	6.790	70.322	1.991	11.529	70.322
6	.975	3.858	74.180						
7	.960	1.680	75.860						
8	.935	1.430	77.290						
9	.911	1.260	78.550						
10	.878	1.130	79.810						
11	.855	1.080	80.940						
12	.821	.999	82.020						
13	.805	.995	83.019						
14	.793	.991	84.014						
15	.758	.988	85.002						

16	.729	.965	85.867						
17	.690	.932	86.799						
18	.644	.911	87.710						
19	.623	.898	88.608						
20	.589	.872	89.480						
21	.535	.856	90.336						
22	.521	.801	91.132						
23	.516	.775	91.912						
24	.502	.752	92.664						
25	.494	.741	93.405						
26	.487	.689	94.146						
27	.484	.672	94.818						
28	.474	.652	95.470						
29	.436	.616	96.086						
30	.387	.597	96.683						
31	.358	.588	97.271						
32	.308	.574	97.845						
33	.288	.563	98.408						
34	.267	.555	98.963						
35	.244	.525	99.488						
36	.184	.512	100.000						
Extraction Method: Principal Component Analysis.									

Scree Plot is graphical representation of extracting the number of factors. It is the plotline between both number of factors and the Eigen values in their order of extraction. It can be seen from below fig. 16 that 5 factors are sufficient to demonstrate the variance in the variables as it is clear that at first curve drops steeply and after factor 5 it will flatten.

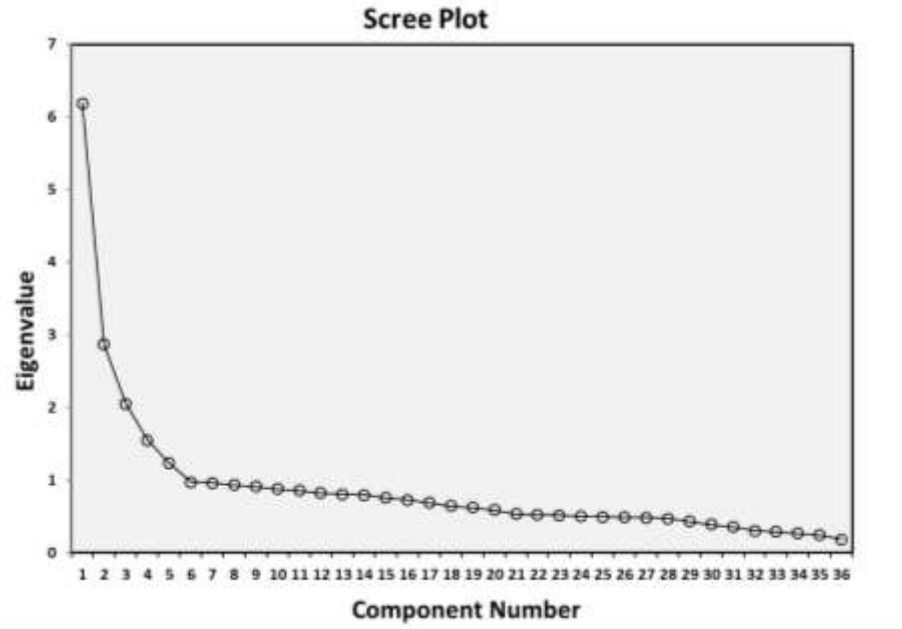


Fig 16: Scree plot from SPSS Software Analysis - Client

After determining that the 5 factors, the rotated component matrix is generated. A total of five factors (components) is formed (see Table 15) extracted through Varimax rotation and Principal component analysis based on the clients' responses. Accordingly, a total 26 of Items have been classified into five factors through PCFA technique and labeling of factors is carried out appropriately based on the factors loadings.

4.3.5 LABEL THE FACTORS

After factor solution has been attained where all variables having substantial factor loading, the researcher manages to designate some meaning in this context to the factor loading pattern.

Variables with significantly higher loading are considered more significant and have a stronger impact on the label chosen to represent a factor. Thus further, the researcher will analyze the entire underlined variable for a factor and emphasize those variables with significantly higher loads. Assignment of

a name or label to a factor is done that accurately represents the variables loaded on that factor.

Table 16: Output of (PCFA) & Factor categories

Variable ID	**Variables**	**Factor loading**	**Factor category**	**%Variance explained**
14	Force majeure activities/ unforeseen circumstances	0.624	**Contract management related Delays (F1)**	16.19%
12	Project complexity (Project type, project scale,etc)	0.556		
27	Improper conflict resolution process adopted	0.502		
11	Improper project feasibility study	0.482		
32	Frequent project scope/ Design changes	0.475		
30	Improper contractor/ Consultant selection	0.431		
33	Slow decision making process	0.404		
29	Ambiguous project requirements	0.356		
15	Unrealistic contract/project duration	0.312		
25	Poor site access	0.592	**Site management related Delays (F2)**	15.93%
26	Lack of client representatives at site	0.584		
28	Severe weather conditions at site	0.500		

24	Geological problems on site	0.475		
13	Change/Transfer of project personnel during project execution	0.364		
31	Delay in progress payments	0.602	**Financial management related delays(F3)**	14.55%
8	Price fluctuations due to Inflation	0.579		
10	Lack of project funding	0.576		
9	Global/ National Economic crises	0.397		
3	Change in government policies affecting project	0.655	**Political related delays (F4)**	12.12%
1	Law and order situation/ Security threats/Local Agitations	0.536		
4	Delay in Center/State government document clearance process/ bureaucratic delays	0.422		
5	Change in political power at State/ Center	0.328		
18	Issues in client procured materials	0.539	**Resource related delays (F5)**	11.539
34	Lack of competent/expert project domain people	0.451		
2	Land acquisition problems	0.434		
17	Delay in selection of PMC/contractors/suppliers	0.328		

The reliability analysis used for this research study actually provides consistency of the calculated attributes and scale that ensuring construction of model over time for reliability. As shown in Table 17, the Cronbach alpha test was performed in which there is no defined interpretation for the acceptable limit, as the value can be magnified variables increase in size (Zhang, 2005).

Cronbach's Alpha test is performed in SPSS V20.0 software for reliability analysis and results are listed below in table 17.

Table 17: Reliability Cronbach's alpha for the variables. (SPSS V20)

Factor label	Total no. of variables	Cronbach Alpha (Cα)
F1	9	0.886
F2	5	0.745
F3	4	0.758
F4	4	0.821
F5	4	0.729
Overall	**26**	**0.864**

Fig. 15 shows Cronbach's alpha (Cα) internal consistency interpretation. (Murphy, 1988) Cronbach's Alpha consistency value is 0.864 which specifies high level overall internal data consistency. Generally, when the Cronbach alpha in the internal consistency test is 0.7 or more than 0.7, the reliability of the instrument is considered high.

4.3.6 REGRESSION ANALYSIS – CLIENT

Assumptions: Before the regression analysis methodology is performed, some of the fundamental assumptions related to the predictor variables should be accomplished. In this research study, prior to conducting the multiple regression analysis for analyzing the homogeneity of variance, the parametric test was performed (Levene's test) on the chosen variables (Field, 2005).

Ho = variances between the variables are zero

Table 18: Output for Levene's test -Client

Test of Homogeneity of Variances				
Factor	Levene Statistic	df1	df2	Sig.
REGR factor score 1 for analysis 1	10.352	25	126	.006
REGR factor score 2 for analysis 1	10.591	25	126	.012
REGR factor score 3 for analysis 1	11.424	25	126	.042
REGR factor score 4 for analysis 1	13.573	25	126	.025
REGR factor score 5 for analysis 1	12.959	25	126	.016

Result: The null hypothesis of equal variance is dismissed as shown in Table 18. We reasonably conclude that the variances are not the same as Significance value (p) is less than 0.05. The Levene's significant test ($p < 0.05$) recommends that the regression analysis is feasible as the null hypothesis is rejected and the variances between variables are zero.

As shown in Table 18, stepwise entering of categorical variables into regression model is done. The regression model thus structured measuring the overall impact of the delay caused by the identified factors.

Table 19: Model Summary[b] - Client

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.842[a]	.811	.774	.03896

a. Predictors: (Constant), REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1
b. Dependent Variable: DY

Interpretation of the model summary

- The value of R signifies simple correlation as shown in Table 19
- The value of R square reveals the total variation explained by the dependent variable on the independent variable
- The regression model has a strong correlation coefficient R equal 0.842 and the coefficient of determination R square equal 0.811 which is a best fit. This implies that 81.1 percent of the total variation could be explained by the model, and 3.89 percent as an average percentage error.
- F count (F test) measures the impact of independent variables concurrently on the delay of the road construction project. If the value of F test is greater than the F table value, it implies that the independent variable has a positive and noticeable impact on the project delay. Test results can be seen in Table 20: F test (12.998) > F table value (0.38).

Table 20: ANOVA[a] - Client

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.283	25	.457	12.998	.003[b]
	Residual	19.194	126	.152		
	Total	23.737	131			
a. Dependent Variable: DY						

b. Predictors: (Constant), REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1

Table 21: Coefficients table - Client

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.081	.725		2.870	.000
	REGR factor score 1 for analysis 1	0.417	.042	.205	1.929	.000
	REGR factor score 2 for analysis 1	0.622	.046	.028	.265	.001
	REGR factor score 3 for analysis 1	0.884	.144	.002	.020	.001
	REGR factor score 4 for analysis 1	1.749	.048	.104	1.010	.000
	REGR factor score 5 for analysis 1	1.050	.051	.098	.990	.003

The ultimate regression model for understanding **severity of impact of delay factors on project delay** is given by: $\mathbf{Y= a + b_1X_1 + b_2X_2 +….b_mX_m \pm e}$

- Y = Dependent Variable (Project Delay)
- X = Independent variable (delay factors)
- b_1 to b_m = estimated regression coefficients;
- a = constant and intercepts at Y axis;
- X_1 to X_m = values of predictor or independent variables,

- e = error

Interpretation of regression model output (CLIENT)

$\mathbf{Y}_{CLIENT} = 8.241 + 0.468\mathbf{F_1} + 0.676\mathbf{F_2} + 0.924\mathbf{F_3} + 1.530\mathbf{F_4} + 1.180\mathbf{F_5} \pm \mathbf{e}$

F1 - Contract related Delays

F2 - Site management related Delays

F3 - Financial management related delays

F4 - Political related delays

F5 - Resource management related delays

- While the regression coefficients of the independent variables are positive, this signifies that the delay factors have a positive relationship with the delay of R&H projects from the client's perspective.
- When analyzed for regression, the coefficient of the independent variable indicates the extent of the effect on dependent variable and gives the direction of the effect by indicating the coefficient, either positive or negative.
- The coefficient tells you how much the dependent variable will increase in regression with multiple independent variables, as the independent variable will increase by one, thus maintaining all the other independent variables constant.
- In the regression model above, all beta coefficients are positive. The interpretation is that, the output variable increases by the beta coefficient value for every one unit increase in the predictor variable.
- In the above regression analysis (Client stakeholder perspective), The prediction equation is project delay telling you that
    - Project delays are predicted to increase 0.468 when Contract related Delays factor (F1) factor goes up by one.

- Project delays are predicted to increase 0.676 when Site management related Delays (F2) factor goes up by one.
- Project delays are predicted to increase 0.924 when financial management related delays (F3) factor goes up by one.
- Project delays are predicted to increase 1.530 when Political related delays (F4) factor goes up by one.
- Project delays are predicted to increase 1.180 when Resource management related delays (F5) factor goes up by one.

- it can be interpreted from the output multiple regression analysis and the values of estimated regression coefficients that, Political related delays (1.530 x F4) & Resource related delays (1.180 x F5) has severe impact on project delays in roads and highways sector in India followed by Financial management related delays (0.924 x F3), Site management related Delays (0.676 x F2) and Contract management related delays (0.468 x F1) respectively from clients stakeholder perspective.

4.4 PART B - CONSULTANT

4.4.1 RELATIVE IMPORTANCE INDEX (RII) CALCULATIONS

Table 22 shows the ranks and relative importance indices as perceived by the *clients* for all the 40 causes for the delays in the implementation of highway project in India.

Table 22: Calculation of RII – CONSULTANTS

Variable no	**Causes of delays (Variables)**	**Total Weight (W)**	**Highest Weight (A)**	**Total No. of Respondents (N)**	**RII = $\frac{\sum W}{A*N}$**	**Rank**
4	Delay in RA bill	489	5	117	0.836	1

	certifications leading to contractors fund shortage					
11	Ignoring safety compliances/PPE at site leading to accidents	474	5	117	0.810	2
5	Delay in quality check inspections/approvals of materials at site	464	5	117	0.793	3
22	Poor site management, supervision & control	456	5	117	0.779	4
12	Improper project monitoring and tracking site progress	445	5	117	0.761	5
23	Delay in issue of work permits to contractor	438	5	117	0.749	6
16	Staff shortage due to holidays/staff leaves/absenteeism	432	5	117	0.738	7
31	Lack of monitoring of availability of equipment at site	428	5	117	0.732	8
37	Delay in issue of EOT/Approvals to contractor	422	5	117	0.721	9
26	Lack of participating in site meetings	419	5	117	0.716	10
21	Delay in approvals of drawings/documents	412	5	117	0.704	11
35	Lack of consultation with	404	5	117	0.691	12

	client/contractor					
38	Rework due to frequent revisions in drawings	397	5	117	0.679	13
39	Delay in site inspection and handover	391	5	117	0.668	14
13	Lack of responsibility /accountability for site related issues	385	5	117	0.658	15
19	Change in scope of work/Additional work	380	5	117	0.650	16
6	Incompetence to contractor's technical queries	375	5	117	0.641	17
1	Change in material type/specifications after BOQ finalization	368	5	117	0.629	18
3	Improper settlement of contractors claims leading to arbitration	360	5	117	0.615	19
20	Delay in provisions of utilities at site (water, electricity, etc)	356	5	117	0.609	20
33	Poor project planning/project tracking by consultant	352	5	117	0.602	21
28	Rework due to design errors in drawings	343	5	117	0.586	22
18	Delay in finalizing rates for additional items	338	5	117	0.578	23

2	Noncompliance to contract clauses /conditions	330	5	117	0.564	24
34	Unclear lines of responsibility	324	5	117	0.554	25
8	improper project feasibility/technical study	319	5	117	0.545	26
9	Inaccurate project cost/budget estimation	314	5	117	0.537	27
40	Low constructability or an Impractical designs	312	5	117	0.533	28
36	work slowdown due to delay in progress payments to consultant	310	5	117	0.530	29
29	Poor leadership skills of project manager	303	5	117	0.518	30
14	Lack of control and authority over contractor	301	5	117	0.515	31
25	Delay in providing Right of way	293	5	117	0.501	32
30	Lack of staff motivation	284	5	117	0.485	33
15	Behavioral issues /Arrogance/dictatorship	275	5	117	0.470	34
7	lack of incentives for early work	263	5	117	0.450	35
32	wrong type of project bidding and award	253	5	117	0.432	36
27	Poor Selection of	249	5	117	0.426	37

	Contractors during tender selections					
10	Unethical practices / Red tapism	233	5	117	0.398	38
24	Large number of participants in the project team	223	5	117	0.381	39
17	Inadequate provision of housing and domestic facilities for labor	219	5	117	0.374	40

4.4.2 PILOT TESTING– CONSULTANT SAMPLE

In pilot tests, a survey of 20 people was undertaken and the reliability was checked using Cronbach Alpha test which was 0.772. The Cronbach Alpha test and the end results attained in pilot tests are stated below.

Furthermore, when the Cronbach Alpha test was successful, the questionnaire was mailed to the NHAI, MORTH and CPWD road and highway officials. A total of 123 responses were obtained which was further reduced in number using factor analysis method.

Internal consistency of data is checked by Cronbach's Alpha test. Internal consistency represents closeness of set of variables associated as a group and the degree to which these variables measure the same concept. SPSS 20.0 software is used for carrying out Cronbach Alpha test and for further analysis. The Cronbach Alpha value increases as the correlation between the items increases (Murphy, 1988).

Pilot analysis – consultant

Table 23: Pilot testing analysis results for consultant sample

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No of Items
0.772	0.775	40

In general, the instrument's reliability is high when the Cronbach Alpha test is 0.7 or higher than 0.7 in the inner consistency test. The consistency value of Cronbach Alpha is 0.772, indicating high internal data consistency. This value confirms that the instrument is highly reliable.

4.4.3 EXPLORATORY FACTOR ANALYSIS (EFA)

In this section, the perception of clients on the causes for the delay in causing time overruns in Roads and Highways Sector projects in India is presented. First, the customer was asked a set of 40 questions and measured using a 5-point likert's scale to assess them in the event of delays in highway projects. A total of 28 variables are selected out of the 40 variables, based on correlation. Rests of the 12 variables are excluded from further analysis as they have no significant correlation with each other.

PCFA is used in the factor analysis method here for data reduction. The adequacy of the sample must be validated before using the PCFA method. The KMO & BT is used for checking sample adequacy. The sampling adequacy below 0.50 it is unacceptable and more than 0.90 is excellent. KMO and Bartlett tests value was found to be 0.787 which was acceptable. This means that the variables are interdependent and correlated, which is a mandatory precondition to conduct factor analysis.

Table 24: Sampling adequacy test - consultant

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.787
Bartlett's Test of Sphericity	Approx. Chi-Square	1066.390
	df	780
	Sig.	0.000

(SPSS V20.0 software analysis)

The Eigen value technique is being used to determine the factors In the PCFA method. Using PCFA, 4 factors are defined whose cumulative percentage of total variance is actually explained by 64.318 percent. In layman's terms, it suggests that 64.318 percent of variance is actually explained by 4 factors.

4.4.4 EFA RESULT - CONSULTANTS:

Table 25: Total variance explained from SPSS software

Total Variance Explained - Consultants									
Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.184	27.459	27.459	9.184	27.459	27.459	2.564	18.411	18.411
2	4.570	19.425	46.884	4.570	19.425	46.884	2.555	16.388	34.799
3	2.391	10.977	57.881	2.391	10.977	57.881	2.505	15.262	50.061
4	1.175	6.437	64.318	1.175	6.437	64.318	2.495	14.257	64.318
5	.982	4.915	69.213						
6	.965	3.254	72.467						
7	.921	2.358	74.825						
8	.903	2.015	76.840						
9	.893	1.862	78.702						
10	.876	1.657	80.359						

11	.854	1.354	81.713						
12	.826	1.125	82.838						
13	.811	.984	83.822						
14	.779	.962	84.784						
15	.751	.946	85.730						
16	.737	.932	86.662						
17	.708	.882	87.544						
18	.692	.847	88.391						
19	.678	.826	89.217						
20	.654	.792	90.009						
21	.632	.776	90.785						
22	.606	.736	91.521						
23	.583	.714	92.235						
24	.562	.685	92.920						
25	.528	.668	93.588						
26	.512	.626	94.214						
27	.498	.596	94.810						
28	.489	.574	95.384						
29	.477	.551	95.935						
30	.452	.513	96.448						
31	.424	.486	96.934						
32	.403	.468	97.402						
33	.343	.415	97.817						
34	.340	.399	98.216						
35	.303	.376	98.592						
36	.283	.349	98.941						
37	.245	.311	99.252						
38	.227	.289	99.541						

39	.188	.246	99.787						
40	.162	.213	100.000						
Extraction Method: Principal Component Analysis.									

Scree Plot is graphical representation of extracting the number of factors. It is the plotline between both number of factors and the Eigen values in their order of extraction. It can be seen from below Fig. 17 that 4 factors are sufficient to demonstrate the variance in the variables as it is clear that at first curve drops steeply and after factor 4 it will flatten.

After determining that the 4 factors, rotated component matrix is generated. A total of five factors (components) is formed (see Table 16) extracted through Varimax rotation and Principal component analysis based on the clients' responses. Accordingly, a total 28 of Items have been classified into 4 factors through PCFA technique and labeling of factors is carried out appropriately based on the factors loadings.

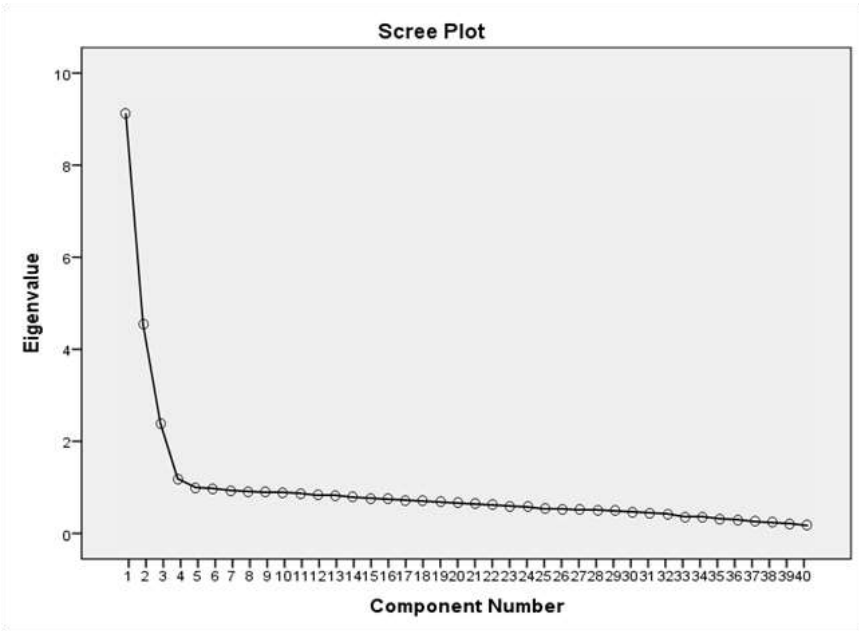


Fig 17: Scree plot from SPSS Software Analysis - Consultant

4.4.5 LABEL THE FACTORS

Items have been classified into four factors through Principal Component Factor Analysis (PCFA) technique and labeling of each factor is done appropriately based on the factors loadings.

Variables with significantly higher loading are considered more significant and have a stronger impact on the label chosen to represent a factor. Thus further, the researcher will analyze the entire underlined variable for a factor and emphasize those variables with significantly higher loads. Assignment of a name or label to a factor is done that accurately represents the variables loaded on that factor.

Table 26: Output of (PCFA) & Factor categories

Variable ID	Variables	Factor loading	Factor category	%Variance explained
39	Delay in site inspection and handover	0.737	**Design and site related delays (F6)**	18.41%
12	Improper project monitoring and tracking site progress	0.718		
22	Poor site management, supervision & control	0.682		
38	Rework due to frequent revisions in drawings	0.643		
13	Lack of responsibility /accountability for site related issues	0.641		
23	Delay in issue of work permits to contractor	0.637		
28	Rework due to design errors in drawings	0.629		

40	Low constructability or an Impractical designs	0.592		
19	Change in scope of work /Additional work	0.587		
20	Delay in provisions of utilities at site (water, electricity,etc)	0.574		
11	Ignoring safety compliances /PPE at site leading to accidents	0.564		
21	Delay in approvals of drawings/documents	0.561		
6	Incompetence to contractor's technical queries	0.524		
5	Delay in quality check inspections /approvals of materials at site	0.845	**Resource management related delays (F7)**	16.39%
4	Delay in RA bill certifications leading to contractors fund shortage	0.828		
16	Staff shortage due to holidays/staff leaves /absenteeism	0.692		
31	Lack of monitoring of availability of equipment at site	0.579		
35	Lack of consultation with client/contractor	0.834	**Communication related**	15.26%
34	Unclear lines of	0.699		

	responsibility		**delays (F8)**	
37	Delay in issue of EOT/ Approvals to contractor	0.636		
26	Lack of participating in site meetings	0.630		
33	Poor project planning/ project tracking by consultant	0.522		
2	Noncompliance to contract clauses/conditions	0.754	**Contract management related delays (F9)**	14.26%
1	Change in material type/ specifications after BOQ finalization	0.702		
8	Improper project feasibility /technical study	0.604		
18	Delay in finalization of rates for extra items	0.573		
9	Inaccurate project cost/ budget estimation	0.556		
3	Improper settlement of contractors claims leading to arbitration	0.535		

The reliability analysis used for this research study actually provides consistency of the calculated attributes and scale that ensuring construction of model over time for reliability. As shown in Table 17, the Cronbach alpha test was performed but no defined interpretation for the acceptable limit, as the value can be magnified variables increase in size (Zhang, 2005).

Cronbach's Alpha test is performed in SPSS V20.0 software for reliability analysis and results are listed below in table 27.

Table 27: Reliability Cronbach's alpha for the variables. (SPSS V20)

Factor label	Total no. of variables	Cronbach Alpha (Cα)
F6	13	0.712
F7	4	0.830
F8	5	0.766
F9	6	0.685
Overall	**28**	**0.729**

Fig. 15 shows Cronbach's alpha (Cα) internal consistency interpretation. (Murphy, 1988) Cronbach's Alpha consistency value is 0.729 which specifies high level overall internal data consistency. In general, if the Cronbach Alpha in the internal consistency test is 0.7 or more than 0.7, it is considered highly reliable.

4.4.6 REGRESSION ANALYSIS – CONSULTANT

Assumptions: Before the regression analysis methodology is performed, some of the fundamental assumptions related to the predictor variables should be accomplished. In this research study, prior to conducting the multiple regression analysis for analyzing the homogeneity of variance, the parametric test was performed (Levene's test) on the chosen variables (Field, 2005).

Ho = variances between the variables are zero

Table 28: Output for Levene's test - Consultant

Test of Homogeneity of Variances

Factor	Levene Statistic	df1	df2	Sig.
REGR factor score 1 for analysis 2	14.443	32	112	.008
REGR factor score 2 for analysis 2	13.744	32	112	.039
REGR factor score 3 for analysis 2	11.482	32	112	.027
REGR factor score 4 for analysis 2	13.810	32	112	.010

Result: The null hypothesis of equal variance is dismissed as shown in Table 18. We reasonably conclude that the variances are not the same as Significance value (p) is less than 0.05. The Levene's significant test ($p < 0.05$) recommends that the regression analysis is feasible as the null hypothesis is rejected and the variances between variables are zero.

As shown in Table 31, stepwise entering of categorical variables into regression model is done. The regression model thus structured measuring the overall impact of the delay caused by the identified factors.

Table 29: Model Summary[b]- Consultant

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.821a	.804	.775	.07183
a. Predictors: (Constant), REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1				
b. Dependent Variable: DY				

Interpretation of model summary

- The value of R signifies simple correlation as shown in Table 29

- The value of R square reveals the total variation explained by the dependent variable on the independent variable
- The regression model has a strong correlation coefficient R equal 0.821 and the coefficient of determination R square equal 0.804 which is a best fit. This implies that 80.4 percent of the total variation could be explained by the model, and 7.183percent as an average percentage error.
- F count (F test) measures the impact of independent variables concurrently on the delay of the road construction project. If the value of F test is greater than the F table value, it implies that the independent variable has a positive and noticeable impact on the project delay. Test results simultaneously can be seen in Table 30: F test (13.500) > F table value (0.53)

Table 30: ANOVA[a] - Consultant

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.203	32	.051	13.500	.002[b]
	Residual	11.353	112	.101		
	Total	31.556	144			
a. Dependent Variable: DY						
b. Predictors: (Constant), REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1						

Table 31: Coefficients table - Consultant

Coefficients[a]				
Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.

		B	Std. Error	Beta		
1	(Constant)	4.889	.029		3.199	.000
	REGR factor score 1 for analysis 2	2.017	.030	.054	.572	.006
	REGR factor score 2 for analysis 2	0.811	.030	.033	.356	.022
	REGR factor score 3 for analysis 2	1.254	.030	.074	.790	.043
	REGR factor score 4 for analysis 2	0.928	.030	.090	.959	.034
a. Dependent Variable: DY						

The ultimate regression model for understanding **severity of impact of delay factors on project delay** is given by: $\mathbf{Y = a + b_1X_1 + b_2X_2 + \ldots b_mX_m \pm e}$

- Y = Dependent Variable (Project Delay)
- X = Independent variable (delay factors)
- b_1 to b_m are estimated regression coefficients
- a is constant and intercepts at Y axis
- X_1 to X_m are values of predictor or independent variables,
- e is error

Interpretation of regression model output (CONSULTANT)

$\mathbf{Y}_{CONSULTANT} = 4.899 + 2.017\mathbf{F_6} + 0.811\mathbf{F_7} + 1.254\mathbf{F_8} + 0.928\mathbf{F_9} \pm \mathbf{e}$

F6 - design and site related delays

F7 - Resource management related delays

F8 - Communication related delays

F9 - Contract management related delays

- While the regression coefficients of the independent variables are positive, this signifies that the delay factors have a positive relationship with the delay of R&H projects from the client's perspective.
- When analyzed for regression, the coefficient of the independent variable indicates the extent of the effect on dependent variable and gives the direction of the effect by indicating the coefficient, either positive or negative.
- The coefficient tells you how much the dependent variable will increase in regression with multiple independent variables, as the independent variable will increase by one, thus maintaining all the other independent variables constant.
- In the regression model above, all beta coefficients are positive. The interpretation is that, the output variable increases by the beta coefficient value for every one unit increase in the predictor variable.
- In the regression model above, (Consultant stakeholder perspective), The prediction equation is project delay telling you that
    - Project delays are predicted to increase 2.017 when design and site related delays (F6) factor goes up by one.
    - Project delays are predicted to increase 0.811 when Resource management related delays (F7) factor goes up by one.
    - Project delays are predicted to increase 1.254 when Communication related delays (F8) factor goes up by one.
    - Project delays are predicted to increase 0.928 when Contract management related delays (F9) factor goes up by one.
- It can be interpreted from the output multiple regression analysis and the values of estimated regression coefficients that , design and site related delays (2.017 X F6) & Communication related delays (1.254 X F8) has severe impact on project delays in roads and highways sector in India followed by Contract management related delays (0.928 X F9) and

Resource management related delays (0.811 X F7) respectively from consultant stakeholder perspective.

4.5 PART C - CONTRACTOR

4.5.1 RELATIVE IMPORTANCE INDEX (RII) CALCULATIONS

Table shows the ranks and relative importance indices as perceived by the *clients* for all the 42 causes for the delays in the implementation of highway project in India

Table 32: Calculation of RII – CONTRACTORS

Delay factor	**Total Weight ($\sum$ W)**	**Total Weight (W)**	**Highest Weight (A)**	**Total No. of Respondents (N)**	**RII = $\frac{\sum W}{A*N}$**	**Rank**
4	Lack of timely decision and corrective actions by the contractor team	621	5	151	0.823	1
18	improper project design /constructability	615	5	151	0.815	2
2	conflict on ambiguous contract clauses framed	608	5	151	0.805	3
1	poor project technical feasibility study during bidding stage	599	5	151	0.793	4
19	Failure to utilize Project management tools (MSP , P6, EVM, etc)	593	5	151	0.785	5
12	Delay in provision of	582	5	151	0.771	6

	utilities at site (Water, electricity, etc)					
10	Disagreement on design /specifications with consultants	573	5	151	0.759	7
39	Labor absenteeism at site	570	5	151	0.755	8
27	Poor site supervision and control	560	5	151	0.742	9
34	Frequent Equipment Breakdowns	546	5	151	0.723	10
11	Material shortage at site /Quality issues	531	5	151	0.703	11
17	Delay in submission of RA bills	519	5	151	0.687	12
33	Inappropriate construction methods used	508	5	151	0.673	13
28	Unrealistic project schedule bided by the contractor team	494	5	151	0.654	14
37	Rework due to errors during execution	484	5	151	0.641	15
40	Accidents during construction /Safety not followed	479	5	151	0.634	16
23	Low labor productivity	473	5	151	0.626	17
20	Poor site mobilization	470	5	151	0.623	18
6	Lack of equipment	469	5	151	0.621	19

	availability					
14	Delay in request for approvals of Documents /drawings	468	5	151	0.620	20
31	Unclear lines of responsibility /authority	465	5	151	0.616	21
5	Lack of /poor communication with client/consultant	458	5	151	0.607	22
38	Poor manpower planning/lack of expertise	451	5	151	0.597	23
26	Improper Geological study	445	5	151	0.589	24
15	Improper selection/ Change of sub-contractors	436	5	151	0.577	25
16	Bitter relationship with consultant/Client	427	5	151	0.566	26
13	Delay in work permits to sub-contractors/Labors	417	5	151	0.552	27
30	Unavailability of Qualified staff	411	5	151	0.544	28
41	Improper selection of sub-contractors	406	5	151	0.538	29
22	Lack of experience of contractor staff/ labor (Low skill levels)	396	5	151	0.525	30

3	Thefts at site	388	5	151	0.514	31
25	Improper framing of contract clauses causing conflicts	381	5	151	0.505	32
35	No planning before project starts	377	5	151	0.499	33
9	Unrealistic planning and scheduling of projects	370	5	151	0.490	34
36	Outdated construction equipment used	365	5	151	0.483	35
42	Conflict between labor and project team	359	5	151	0.475	36
32	Frequent changes of client staff	353	5	151	0.468	37
7	Lack of management commitment towards project issues	344	5	151	0.456	38
21	Delays related to sub-contractors work	332	5	151	0.440	39
29	Labor accommodation/ Utility provision issues	324	5	151	0.429	40
8	Large number of participants within the project	313	5	151	0.415	41
24	Behavioral issues within team	305	5	151	0.404	42

4.5.2 PILOT TESTING –CONTRACTOR SAMPLE

In pilot tests, a survey of 20 people was undertaken and the reliability was checked using Cronbach Alpha test which was 0.809. The Cronbach Alpha test and the end results attained in pilot tests are stated below.

Furthermore, when the Cronbach Alpha test was successful, the questionnaire was mailed to the NHAI, MORTH and CPWD road and highway officials. A total of 162 responses were obtained which was further reduced in number using factor analysis method.

Internal consistency of data is checked by Cronbach's Alpha test. Internal consistency represents closeness of set of variables associated as a group and the degree to which these variables measure the same concept. SPSS 20.0 software is used for carrying out Cronbach Alpha test and for further analysis. The Cronbach Alpha value increases as the correlation between the items increases (Murphy, 1988).

Table 33: Results obtained in analysis of Pilot testing - contractor sample

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.809	.793	42

In general, the instrument's reliability is high when the Cronbach Alpha test is 0.7 or higher than 0.7 in the inner consistency test. The consistency value of Cronbach Alpha is 0.809, indicating high internal data consistency. This value confirms that the instrument is highly reliable.

4.5.3 EXPLORATORY FACTOR ANALYSIS (EFA)

In this section, the perception of clients on the causes for the delay in causing time overruns in Roads and Highways Sector projects in India is presented. Firstly, a set of 36 questions were asked to the clients and measured using likert's scale to rate them for the chances of occurrence of delays of highway projects. A total of 28 variables are selected out of the 42 variables, based on correlation. Rests of the 14 variables are excluded from further analysis as they have no significant correlation with each other.

PCFA is used in the factor analysis method here for data reduction. The adequacy of the sample must be validated before using the PCFA method. The LMO & BT is used for checking sample adequacy. The sampling adequacy below 0.50 it is unacceptable and more than 0.90 is excellent. KMO and Bartlett tests value was found to be 0.685 which was acceptable. This means that the variables are interdependent and correlated, which is a mandatory precondition to conduct factor analysis.

Table 34: Sampling adequacy test - contractor

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.685
Bartlett's Test of Sphericity	Approx. Chi-Square	1372.337
	df	861
	Sig.	0.000

(SPSS V20.0 software analysis)

The Eigen value technique is being used to determine the factors In the PCFA method. Using PCFA, 4 factors are defined whose cumulative percentage of total variance is actually explained by 67.167 percent. In layman's terms, it suggests that 67.167 percent of variance is actually explained by 4 factors.

4.5.4 EFA RESULT - CONTRACTOR:

Table 35: Total variance explained from SPSS software

Total Variance Explained - Contractors									
Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.117	22.421	22.421	7.117	22.421	22.421	3.627	15.969	15.969
2	3.790	17.743	40.164	3.790	17.743	40.164	3.368	14.637	30.606
3	2.274	13.415	53.579	2.274	13.415	53.579	3.327	13.540	44.146
4	1.868	9.163	62.742	1.868	9.163	62.742	3.294	12.462	56.608
5	1.256	4.419	67.161	1.256	4.419	67.161	2.680	10.553	67.161
6	.987	3.963	71.580						
7	.972	2.590	74.170						
8	.958	1.034	75.204						
9	.931	1.025	76.229						
10	.925	.998	77.254						
11	.905	.986	78.240						
12	.885	.977	79.217						
13	.853	.958	80.175						
14	.826	.931	81.106						
15	.811	.929	82.035						
16	.778	.917	82.964						
17	.757	.906	83.870						
18	.722	.896	84.766						
19	.705	.889	85.655						
20	.683	.878	86.533						
21	.672	.849	87.382						

22	.655	.832	88.214						
23	.628	.814	89.028						
24	.598	.785	89.813						
25	.574	.767	90.580						
26	.552	.749	91.329						
27	.529	.736	92.078						
28	.507	.725	92.803						
29	.492	.695	93.498						
30	.478	.678	94.176						
31	.480	.629	94.805						
32	.426	.612	95.417						
33	.409	.597	96.014						
34	.391	.574	96.588						
35	.380	.540	97.128						
36	.355	.525	97.653						
37	.320	.493	98.146						
38	.285	.478	98.624						
39	.267	.436	99.060						
40	.260	.362	99.422						
41	.209	.348	99.770						
42	.139	.230	100.000						
Extraction Method: Principal Component Analysis.									

Scree Plot is graphical representation of extracting the number of factors. It is the plotline between both number of factors and the Eigen values in their order of extraction. It can be seen from below Fig. 18 that 5 factors are sufficient to

demonstrate the variance in the variables as it is clear that at first curve drops steeply and after factor 5 it will flatten.

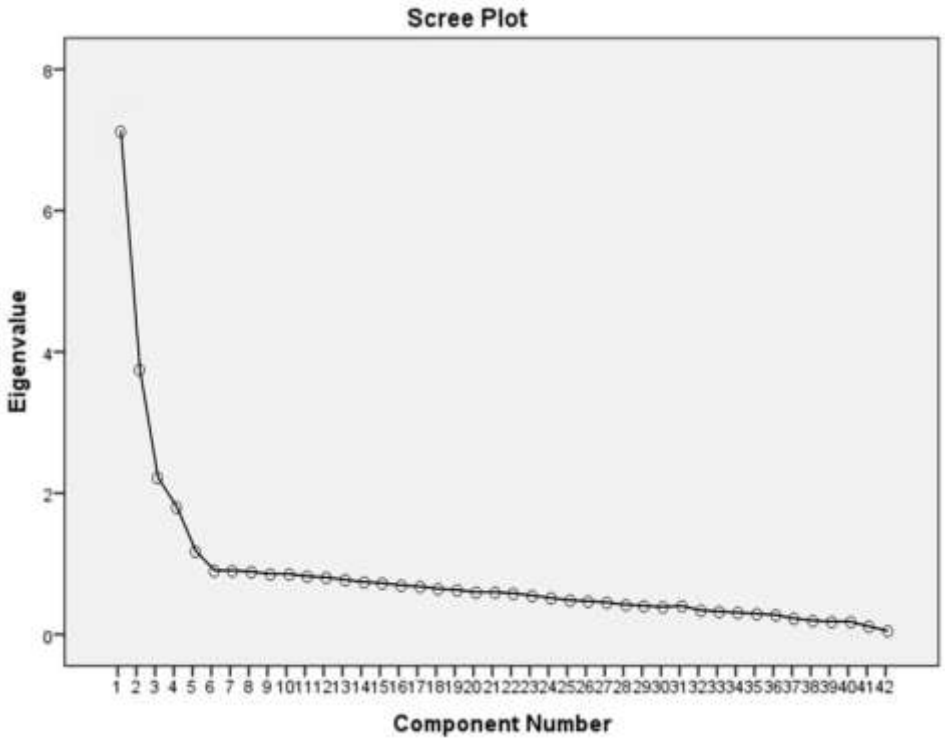


Fig 18: Scree plot from SPSS Software Analysis - Contractor

After determining that the 5 factors, rotated component matrix is generated. A total of five factors (components) is formed (see Table 35) extracted through Varimax rotation and Principal component analysis based on the clients' responses. Accordingly, a total 28 of Items have been classified into 5 factors through PCFA technique and labeling of factors is carried out appropriately based on the factors loadings.

4.5.5 LABEL THE FACTORS

Items have been classified into four factors through Principal Component Factor Analysis (PCFA) technique and labeling of each factor is done appropriately based on the factors loadings.

Variables with significantly higher loading are considered more significant and have a stronger impact on the label chosen to represent a factor. Thus further, the researcher will analyze the entire underlined variable for a factor and emphasize those variables with significantly higher loads. Assignment of a name or label to a factor is done that accurately represents the variables loaded on that factor.

Table 36: Output of (PCFA) & Factor categories

Variable ID	**Variables**	**Factor loading**	**Factor category**	**%Variance explained**
33	Inappropriate construction methods used	0.730	**Site execution delays (F10)**	15.97%
37	Rework due to errors during execution	0.695		
26	Improper Geological study	0.675		
27	Poor site supervision and control	0.615		
34	Frequent Equipment Breakdowns	0.608		
40	Accidents during construction /Safety not followed	0.559		
23	Low labor productivity	0.547		
15	Improper selection/ Change of sub-contractors	0.758	**Planning related delays (F11)**	14.64%
28	Unrealistic project schedule bided by the contractor team	0.733		

14	Delay in request for approvals of Documents/drawings	0.674		
20	Poor site mobilization	0.666		
19	Failure to utilize Project management tools (MSP, P6, EVM, etc)	0.581		
13	Delay in work permits to sub contractors/Labors	0.535		
12	Delay in provision of utilities at site (Water, electricity, etc)	0.518		
38	Poor manpower planning /lack of expertise	0.506		
5	Lack of/poor communication with client/consultant	0.816	**Communication related delays (F12)**	13.54%
4	Lack of timely decision and corrective actions by the contractor team	0.803		
16	Bitter relationship with consultant /Client	0.727		
31	Unclear lines of responsibility/authority	0.538		
2	Conflict on ambiguous contract clauses framed	0.742	**Contract management related delays (F13)**	12.46%
1	Poor project technical feasibility study during bidding stage	0.739		

18	Improper project design /constructability	0.665		
10	Disagreement on design /specifications with consultants	0.599		
17	Delay in submission of RA bills	0.538		
39	Labor absenteeism at site	0.776	**Resources management related delays (F14)**	10.55%
6	Lack of equipment availability	0.667		
11	Material shortage at site /Quality issues	0.557		
30	Unavailability of Qualified staff	0.532		

The reliability analysis used for this research study actually provides consistency of the calculated attributes and scale that ensuring construction of model over time for reliability as shown in Fig.15, the Cronbach alpha test was performed. In the Cronbach alpha test, there is no defined interpretation for the acceptable limit, as the value can be magnified variables increase in size (Zhang, 2005).

Cronbach's Alpha test is performed in SPSS V20.0 software for reliability analysis and results are listed below in table 37.

Table 37: Reliability Cronbach's alpha for the variables. (SPSS V20)

Factor label	Total no. of variables	Cronbach Alpha (Cα)
F10	7	0.738
F11	8	0.718
F12	4	0.643

F13	5	0.877
F14	4	0.833
Overall	**28**	**0.841**

Fig. 15 shows Cronbach's alpha (Cα) internal consistency interpretation. (Murphy, 1988) Cronbach's Alpha consistency value is 0.841 which specifies high level overall internal data consistency. In general, when the Cronbach Alpha is 0.7 or more or 0.7 in the internal consistency test, the reliability of the instrument is considered high.

4.5.6 REGRESSION ANALYSIS – CONTRACTOR

Assumptions: Before the regression analysis methodology is performed, some of the fundamental assumptions related to the predictor variables should be accomplished. In this research study, prior to conducting the multiple regression analysis for analyzing the homogeneity of variance, the parametric test was performed (Levene's test) on the chosen variables (Field, 2005).

Ho = variances between the variables are zero

Table 38: Output for Levene's test - Contractor

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
REGR factor score 1 for analysis 3	1.908	15	130	.034
REGR factor score 2 for analysis 3	1.677	15	130	.041
REGR factor score 3 for analysis 3	1.710	15	130	.009
REGR factor score 4 for analysis 3	1.249	15	130	.006
REGR factor score 5 for analysis 3	1.208	15	130	.014

Result: The null hypothesis of equal variance is dismissed as shown in Table 39. We reasonably conclude that the variances are not the same as Significance value (p) is less than 0.05. The Levene's significant test ($p < 0.05$) recommends that the regression analysis is feasible as the null hypothesis is rejected and the variances between variables are zero.

As shown in Table 41, stepwise entering of categorical variables into regression model is done. The regression model thus structured measuring the overall impact of the delay caused by the identified factors.

Table 39: Model Summary[b]- Contractors

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.772[a]	.749	.724	.037796
Predictors: (Constant), REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1				
b. Dependent Variable: DY				

The interpretation of model summary

- The value of R signifies simple correlation as shown in Table 39
- The value of R square reveals the total variation explained by the dependent variable on the independent variable
- The regression model has a strong correlation coefficient R equal 0.772 and the coefficient of determination R square equal 0.749 which is a best fit. This implies that 74.9 percent of the total variation could be explained by the model, and 3.779 percent as an average percentage error.

- F count (F test) measures the impact of independent variables concurrently on the delay of the road construction project. If the value of F test is greater than the F table value, it implies that the independent variable has a positive and noticeable impact on the project delay. Test results simultaneously can be seen in Table 40: F test (1.230) > F table value (0.22)

Table 40: ANOVA- Contractor

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.170	15	.334	1.230	.001[b]
	Residual	21.354	130	.147		
	Total	35.523	150			
a. Dependent Variable: DY						
b. Predictors: (Constant), REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1						

Table 41: Coefficients table - Contractor

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.828	.031		6.508	.000
	REGR factor score 1 for analysis 3	2.734	.013	.019	.434	.008

	REGR factor score 2 for analysis 3	1.024	.023	.063	.759	.004
	REGR factor score 3 for analysis 3	0.820	.021	.053	.641	.001
	REGR factor score 4 for analysis 3	2.057	.031	.015	.181	.000
	REGR factor score 5 for analysis 3	0.609	.011	.023	.579	.002
a. Dependent Variable: DY						

The ultimate regression model for understanding **severity of impact of delay factors on project delay** is given by: $\mathbf{Y = a + b_1X_1 + b_2X_2 + \ldots b_mX_m \pm e}$

- Y = Dependent Variable (Project Delay)
- X = Independent variable (delay factors)
- b_1 to b_m are estimated regression coefficients
- a is constant and intercepts at Y axis
- X_1 to X_m are values of predictor or independent variables
- e is error

<u>Interpretation of regression model output (CONTRACTOR)</u>

$\mathbf{Y}_{CONTRACTOR} = 3.828 + 2.734\mathbf{F_{10}} + 1.024\mathbf{F_{11}} + 0.820\mathbf{F_{12}} + 2.057\mathbf{F_{13}} + 0.609\mathbf{F_{14}} \pm \mathbf{e}$

F10 - Site execution delays

F11 - Planning related delays

F12 - Communication related delays

F13 - Contract management related delays

F14 - Resources management related delays

- While the regression coefficients of the independent variables are positive, this signifies that the delay factors have a positive relationship with the delay of R&H projects from the client's perspective.
- In the case of regression analysis, the coefficient associated with the independent variable gives you the size of the effect that the variable has on your dependent variable and the sign on the coefficient (positive or negative) gives you the direction of the effect.
- When analyzed for regression, the coefficient of the independent variable indicates the extent of the effect on dependent variable and gives the direction of the effect by indicating the coefficient, either positive or negative.
- The coefficient tells you how much the dependent variable will increase in regression with multiple independent variables, as the independent variable will increase by one, thus maintaining all the other independent variables constant.
- In the above regression analysis, (Contractor stakeholder perspective), The prediction equation is project delay telling you that
    - Project delays are predicted to increase 2.734 when site related delays (F10) factor goes up by one.
    - Project delays are predicted to increase 1.024 when planning related delays (F11) factor goes up by one.
    - Project delays are predicted to increase 0.820 when Communication related delays (F12) factor goes up by one.
    - Project delays are predicted to increase 2.057 when Contract management related delays (F13) factor goes up by one.
    - Project delays are predicted to increase 0.609 when Resources management related delays (F14) factor goes up by one.

It can be interpreted from the output multiple regression analysis and the values of estimated regression coefficients that, Site execution delays (2.734 X F10) , Contract management related delays (2.057 X F13) & Planning related delays (1.024 X F11) has severe impact on project delays in roads and highways sector in India followed by Communication related delays (0.820 X F12) and Resource management related delays (0.609 X F14) respectively from contractor stakeholders perspective.

4.6 CONCLUDING REMARKS

The analysis has been done in 3 parts each for client, consultant and contractor respectively. In the analysis and ranking of data, the Relative Importance Index (RII) was used. The 5-point likert's scale has been turned into relative indices of importance for each factor to determine the ranks of the different cause of the delay. Survey of 20 people was conducted in each category for pilot testing, and then using Cronbach alpha the reliability of the instrument was verified. Factor analysis was carried out for reduction of data and put the variables in factor categories. The analysis was performed in 3 parts for the client, consultant and contractor respectively. The sample adequacy test was performed using KMO and Bartlett test, which means that the variables are mutually dependent and correlated, which is a mandatory pre condition to carry out factor analysis. The multiple regression analysis has been used to measure the particular impact of the delay caused by PCFA factors. In a regression analysis, the coefficient indicates the degree to which the dependent variable increases by one, keeping all the other independent variables constant.

CHAPTER 5:

ESTABLISHING FRAMEWORK PROCEDURE

5.1 INTRODUCTION:

In this chapter, the researcher has represented the research problem currently in studied. Through a systematic scientific study, The researcher attempted to explore and fully comprehend the nature and scope of the research problem To logically understand the research problem, research questions and research design is developed The undermining theory pertaining to the research problem has been discussed. The empirical research design and data analysis approach is actually developed mostly on the grounds of the conceptual lens framework. The researcher starts data collection for the understanding of process as per defined design methodology. Thereafter with the help of the questionnaire the variables have been used together to arrive at the factors. The specific factors form the findings of the study. Conceptual lens is used to analyze the processed data and the out of the analysis form the initial findings of the study.

5.2 MAPPING OF CATEGORIES ON THE CONCEPTUAL LENS

A conceptual framework will certainly help to elucidate and explain fluid ideas and help fill lacunas. In this way, a conceptual framework provides insight that would otherwise not be achieved without a deeper understanding of the concepts stated in the framework. The main purpose of the qualitative investigation is to ensure that the investigation has been systematic and the analysis of the data is also systematic in nature in order to present the complete interpretation and findings which are meaningful in nature. The challenges in data analysis are: reducing the amount of information, sensing

huge amounts of data, trying to identify major issues and creating a framework for communicating the essence of what the data reveals (Patton, 1990). Data analytics for this research are based on researcher interpretations and process descriptions. The interpretations presented in this study are subjective, based on the experiences of experts. Below Fig: 21, Fig: 22 and Fig: 23 show the conceptual lens emerging from the output of data analysis of objective 2.

The conceptual lens will serve as an input for developing the framework questionnaire to build up the final framework to mitigate the project delays in roads and highways sector in India. The data analysis has been executed with the Textual Analysis carried out with the help of Atlas TI software.

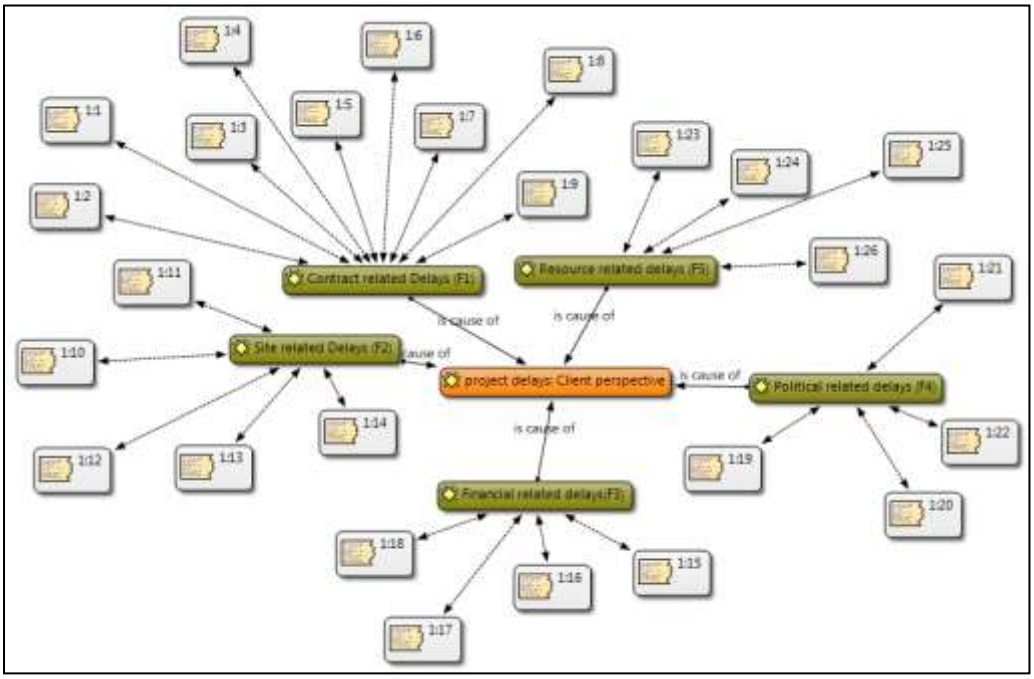


Fig 19: Conceptual lens – Client (output of objective 2)

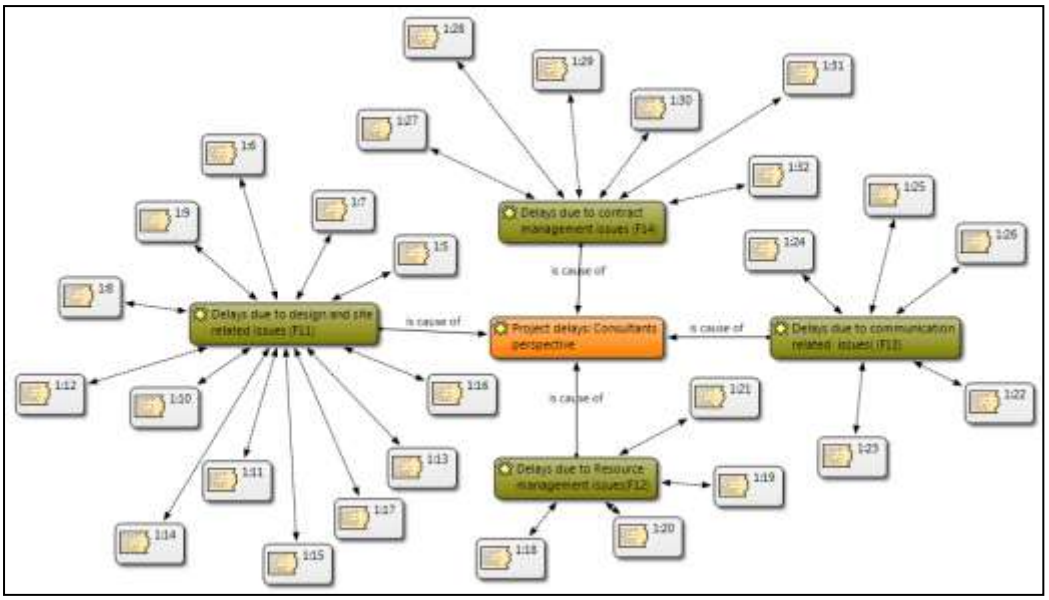


Fig 20: Conceptual lens – Consultant (output of objective 2)

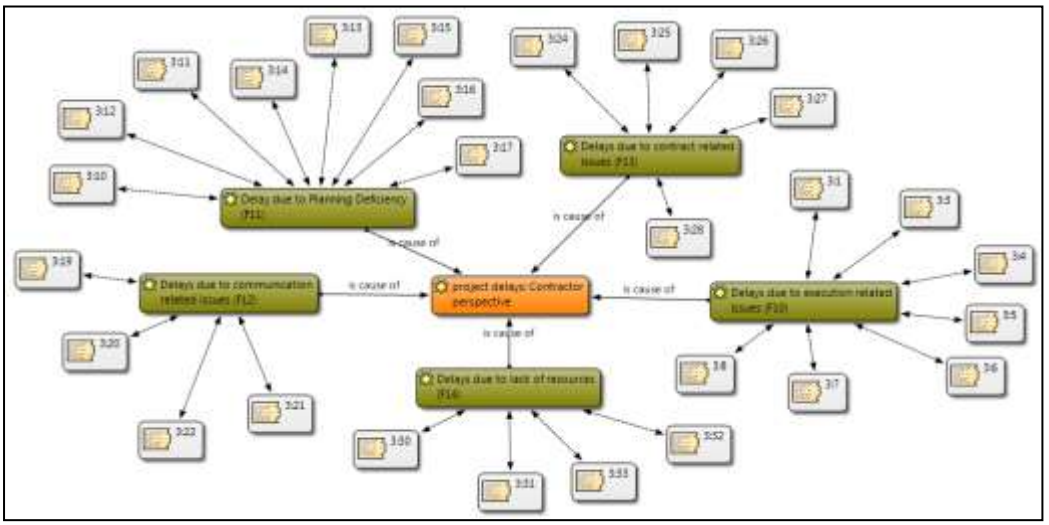


Fig 21: Conceptual lens – Contractor (output of objective 2)

5.3 METHODOLOGY FOR DEVELOPMENT OF SUGGESTIVE FRAMEWORK:

Qualitative Research was used for the purpose of development of conceptual In-depth semi structured interview with experts in the roads and highways

sector were conducted. Interview was recorded, transcribed and fed into software Atlas.TI that provided a suggestive framework based on the output of transcribed conversation.

Following are the basic parameters for developing a theoretical framework for the developing the framework for mitigation of project delays in roads and highways sector in India. All Inputs from objective one and two are considered for the development of conceptual framework.

The steps followed are given as follows.

1. Experts in respective field of work were selected based on judgment sample consisting of

CLIENT:

- NHAI
- MORTH
- CPWD

CONSULTANT:

- Rail India Technical and Economic Service (RITES)
- M/s. Intercontinental Consultants and Technocrats Pvt. Ltd.
- M/s. Artefact Projects Ltd
- SA. Infrastructure Consultants Pvt. Ltd.
- M/s. Consulting Engineers Group Ltd.
- M/s. K&J Projects Pvt. Ltd.
- M/s SMEC India Pvt. Ltd.

CONTRACTORS:

- Ashoka Buildcon Limited
- Sadbhav Engineering Limited

- JMC Projects (India) Ltd
- Gayatri Project Ltd
- Gammon Infrastructure Projects Limited
- MBL Infrastructures Limited
- MVR Infra Projects Private Limited

2. Semi Structured Interviews with the expert group
3. Transcribe the recorded interview
4. Coding with Atlas TI
5. Suggestive Framework based on Atlas TI output

5.4 FRAMEWORK QUESTIONNAIRE

Based on the inputs from the conceptual framework, the framework questionnaire is developed separately for the three stakeholders namely the client, consultant and the contractor.

Framework questionnaire is developed as discussed below

Moderator: Good morning sir, Myself Mr. Siddesh Pai. I am carrying out research on the topic of "Developing a framework for mitigation of project delays through impact assessment of critical factors causing time overruns in Roads and Highways Sector projects in India" at UPES, Dehradun.

I must identify the critical factors that overrun time in India and highway projects as part of research. With the help of extensive literature review and expert opinion, I have identified certain variables. The variables concluded in the form of factors. Now I am developing a framework to mitigate the project delays with the help of expert interviews on the said topic. Kindly cooperate to share your expertise and knowledge when answering the questions.

CLIENT:

Q1: Decision making is an important function of management and delays in making quick and right decision results in project delays. How can we improve decision making process?

Q2: conflicts may arise between project stakeholders during project execution. What are the possible measures these conflicts can be avoided?

Q3: In project management, site execution stage demands maximum time, effort and money. How can the site execution issues as discussed, can be reduced?

Q4. What is the impact of global or national economic policies on highway projects related to project financing and investment?

Q5. Political situation in the country or state plays important role in project implementation. What measures can be taken to reduce delays arising due to political instability?

Q6. Land acquisition delay is major a factor which hampers project implementation. How can these delays be alleviated??

Q7. In the project execution process, the availability raw materials both quantity and quality play important role in project's success. How can project delays relating to material resources be reduced?

Q8. In your opinion, apart from above questions asked, what should be the other considerations in developing framework to mitigate project delays in roads and highway sector in India?

CONSULTANTS

Q1. Both Quality Control and Quality Assurance will run from the being of the project till the end of the project. How cans quality related issues are tackled in projects?

Q2. There is sometimes lack of accountability or responsibility in projects by concerned stakeholders. What measures can be taken to overcome this issue?

Q3. Safety plays an important role in project execution and success as accidents at site can lead to stoppage of work casing delay. What measures can be taken to overcome this safety issue?

Q4. In all facets of the project life cycle, effective communication plays an essential role. What are your thoughts on enhancing communication strategies in projects?

Q5. Conflicts result between project stakeholders and escalate to arbitration and tribunals causing project delays. What measures can be taken to overcome conflict related issue?

Q6. There are frequent revisions in project scope and drawings during project execution causing rework. What measures can be taken to overcome scope change related issue?

Q7. In your opinion, apart from above questions asked, what should be the other considerations in developing framework to mitigate project delays in roads and highway sector in India?

CONTRACTORS

Q1. Labor skilled or unskilled, is an important factor of production. How can we increase labor productivity to complete projects within schedule?

Q2. In project management, site execution stage demands maximum time, effort and money. How can the site execution issues as discussed, can be reduced?

Q3. The role of technology in project execution is commendable. What is the influence of technology (IT & technical) affecting project execution?

Q4. In all facets of the project life cycle, effective communication plays an essential role. What are your thoughts on enhancing communication strategies in projects?

Q5. Conflicts may arise between project stakeholders during project execution. What are the possible measures these conflicts can be avoided?

Q6. Resources particularly, labor materials and equipments play vital role in success of project. What measures can be taken to reduce project delays related to these resources?

Q7. In your opinion, apart from above questions asked, what should be the other considerations in developing framework to mitigate project delays in roads and highway sector in India?

5.5 INTERVIEW PROTOCOL

Below are the probing questions to have detailed insight from the expert.

- Could you elaborate...?
- What contributed to...?
- How...?
- Tell me more...?
- Could you throw more light on...?
- Is this also the factor...,?
- Is this also important…?

Procedure-

- Introduction
- Giving background Information- narrating the study and the purpose of it.
- Promising confidentiality

- Asking for concern and permission
- Putting the first mandatory question.
- Putting probing questions
- Asking further leading and probing questions
- Asking for something they wish to tell or know more.
- Asking for lead, and checking whether the participant is comfortable letting his name used.
- Thanking for the support

Rules-

- Informing the participant about the topic and process
- Ensuring that the place of interview be comfortable enough for the participant to share information.
- Making a point to paraphrase the responses for capturing the thoughts of the participant correctly and checking your understanding.
- Transcribing the interviews immediately after the interviews is done.
- checking for saturation levels

5.6 QUALITATIVE DATA ANALYSIS

5.6.1 THE PROCESS OF FRAMEWORK DEVELOPMENT

A suggestive framework has been created to minimize project delays in Indian road construction projects, to develop methodologies and actions to reduce delays and to analyze the results and output obtained. The framework construction also included a number of the thoughts and suggestions suggested by the group of experts. The proposed management framework was verified and validated through face-to-face discussions and personal interview techniques.

Data analysis helps researchers get a handle to massive data, reduce its volume, capture emerging patters and generating framework for communicating what data the tells. The process of analysis may begin while the data are being gathered, and immediately after the interviews are transcribed. The study used constant comparison method at each stage of the analysis, at first compared data with data to identify similarities. It help in comparing the statements and events within the same interview and then compares them in different interviews. The statement and incidents that seemed conceptually similar were given the same code.

Data analyzes were performed using Atlas.ti quality analysis software. The software helped in coding, linking codes and text segments, creating memos, searching, revising and reorganizing. It also helped in visual display of data and findings (Creswell, Clark, & Plano, 2007).

5.6.2 DATA ANALYSIS PROCESS

- Judgmental sampling was used for selecting initial respondents (experts in the area) (Etikan, Musa, & Alkassim, 2015).
- Conducted semi structured interviews with 18 domain experts in roads and highways sector (using developed interview protocol) (Strauss, 2008) till saturation level was reached.
- The interview protocol was used to guide the process - The protocol included the interview style, procedure and general rules to be followed. (Patton, 1990).
- Generated transcript and used codes to analyze the data (Charmaz, 2008)
- Constant comparison method used for data collection and analysis.
- Analyze data using Atlas.Ti software

- Develop framework for roads and highways sector to mitigate project delays

5.7 SAMPLING FOR QUALITATIVE ANALYSIS.

5.7.1 PURPOSEFUL SAMPLING

Purposeful sampling also known as selective sampling is a sampling technique used by researchers engaged in qualitative research for engaging participants, which can provide in- depth and detailed information regarding the phenomenon to be investigated, is also referred to as a selective sampling in quality research (Patton, 1990). This technique is largely subjective on the part of qualitative researcher, who generates the qualification criteria that each participant must meet to be actually considered for the research study. Total 18 experts and senior officials were interviewed using framework questionnaire (Clients, consultant and contractor) from roads and highways sectors in India till the saturation level was reached. The data from interview was fed into Atlas.ti software for coding process.

As per (Strauss, 2008), the participants in the study should have experienced the process. Since roads and highways sector is a very specialized subject, therefore the sample of this study consisted of technical experts, senior government functionaries, big consultants, etc. As the study progressed the participants were theoretically sampled based as per the question that arose from the data. Sampling procedures of qualitative research differ from those of quantitative research — it they are based on concept of theoretical sampling rather than statistical sampling (Strauss, 2008).

5.8 EXPERT INTERVIEWS

conducted semi structured interviews with 18 domain experts (15 years + experience) in roads and highways sector in India (using developed interview

protocol) (Strauss, 2008), till saturation level was reached. Transcripts were recorded in the form of Audio, video and email where ever allowed. Some experts denied using any recording devices due to confidentiality issues. The transcribed coding provided certain keywords and parameters which were instrumental in the formulation of conceptual framework

5.9 CODING OF TRANSCRIBED DATA

Coding which is an essential element for framework development extracts and develops concepts from raw data in terms of its characteristics and dimensions (Strauss, 2008). Coding categorizes data segments with a short label to sum up and account for each data component simultaneously (Charmaz, 2008).

5.9.1 OPEN CODING

The transcribed coding provided certain keywords and parameters which were instrumental in the formulation of conceptual framework. These keywords and parameters were utilized in the development of conceptual framework. The output of Atlas TI is as below

• Line by line initial coding was done resulting in 601 initial codes

• The words and actions of the participants were used in the codes to preserve the fluidity of their experience.

• Rather than applying pre existing categories to the data, actions were seen in every segment of data

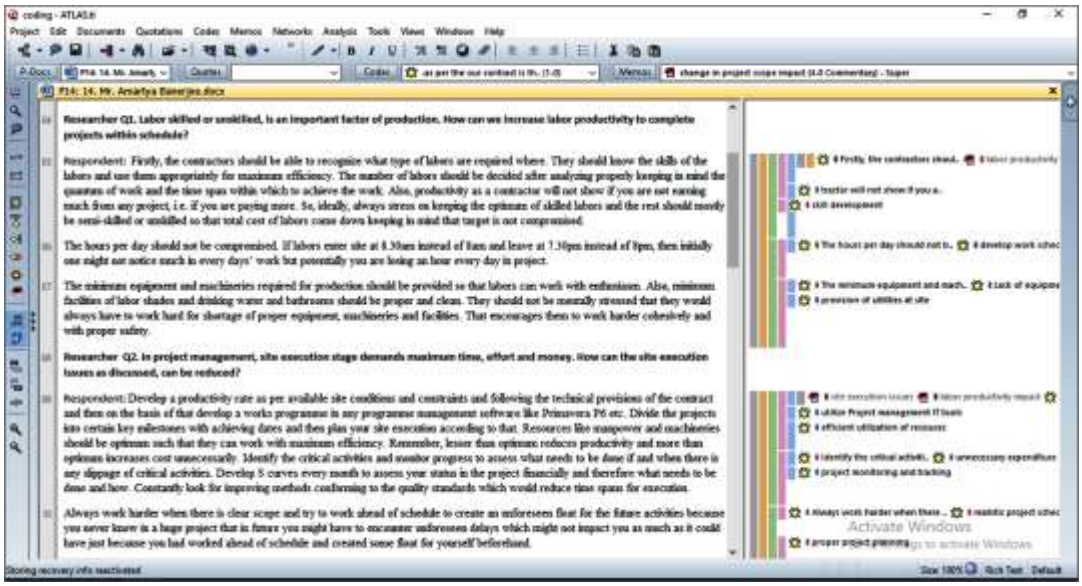


Fig 22: Snapshot of coding of interviews

5.9.2 FOCUSED / SELECTIVE CODING

Focused coding generates codes that are more directed, selective, and conceptual than initial codes (Glaser, 1978).

The study merged together the codes with common features to create conceptual categories. The consolidation made it possible to reduce the data from 601 initial codes to 82 focused codes by constant comparism of categories and revising them

For example, codes related to labor/machine productivity were grouped into one category and codes related to communication gap issues were grouped into other category from all interviewers

5.9.3 AXIAL CODING

The category properties and dimensions are specified by axial coding relating categories to subcategories The aim of axial coding is to sort, synthesize and organize huge volumes of data and recompile them in a manner that ensures coherence for emerging analyses after open coding (Charmaz, 2008).

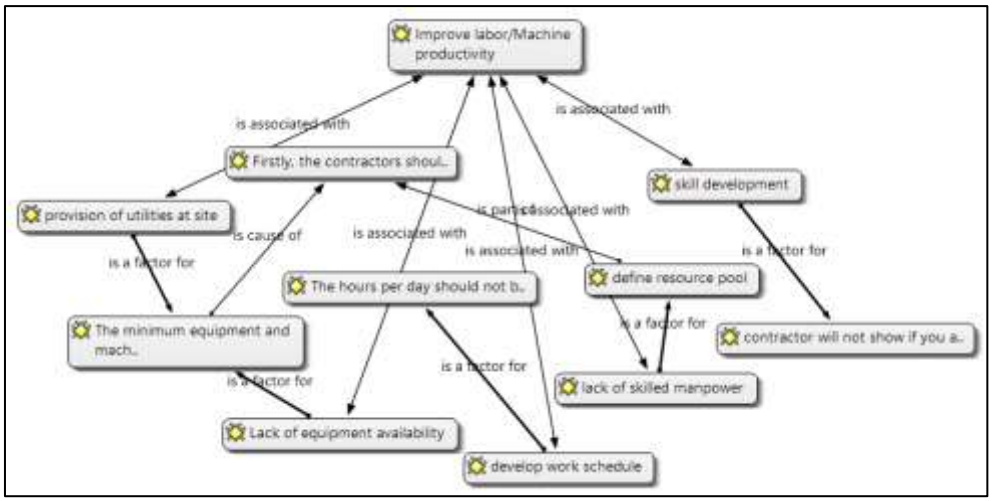


Fig 23: Axial coding

5.9.4 THEORETICAL CODING

Introduced theoretical codes need to be conceptualized on how substantive codes can actually relate to each other as a hypothesis to be incorporated into a theory. In short, theoretical codes determine reasonably possible relationships between categories that have been developed during focused coding (Charmaz, 2008). Theoretical coding is an advanced coding level technique that follows the codes chosen during focused coding (Glaser, 1978).

In this study the focused codes are integrated and organized into a logical emerging framework to help develop a suggestive framework to mitigate the project delays in roads and highway sectors in India.

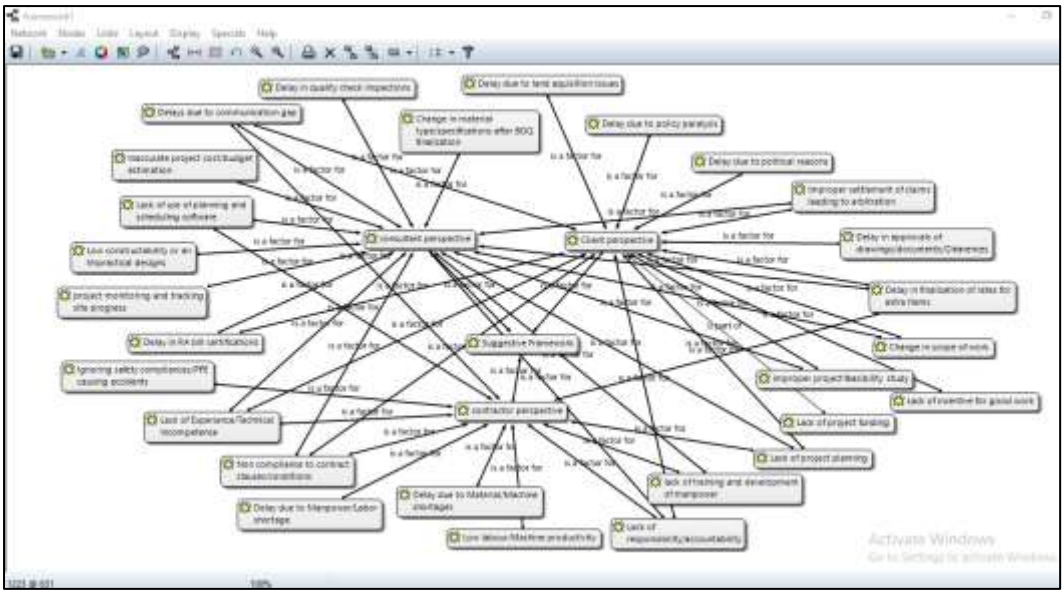


Figure 1: Theoretical coding output from Atlas.Ti

5.10 SUGGESTIVE FRAMEWORK

The main purpose of the qualitative investigation is to ensure that the investigation has been systematic and the analysis of the data is also systematic in nature in order to present the complete interpretation and findings which are meaningful in nature. The objective of the data analysis is to develop a framework to mitigate project delays in the Indian roads and roads sector.

The transcribed coding provided certain keywords and parameters which were instrumental in formulation of suggestive framework

Following framework outline below is suggested based on data generated through semi structured interviews and processing the same using Atlas.ti software

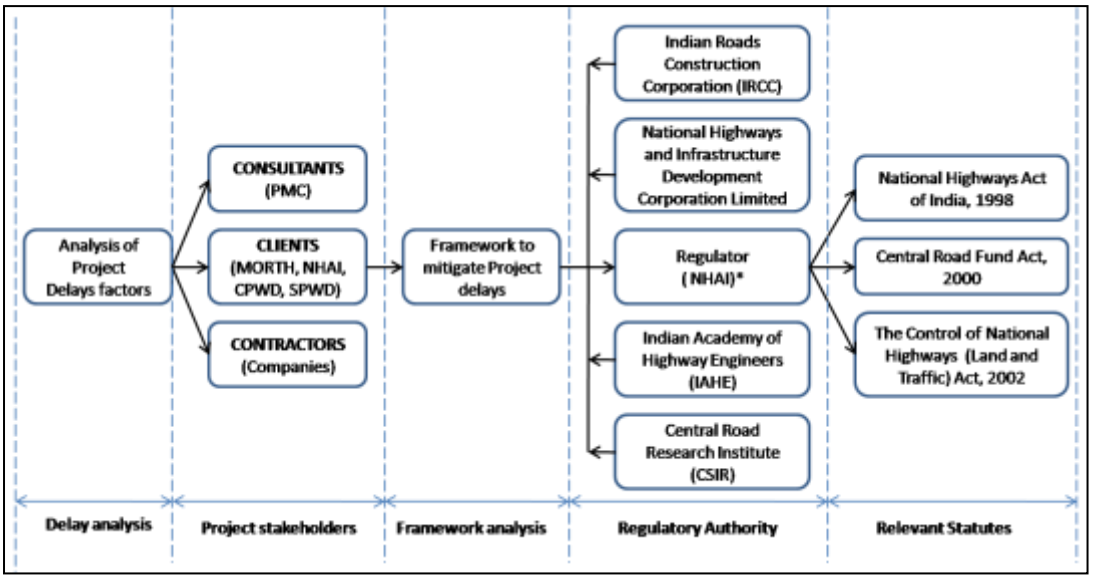


Fig 24: Framework outline

*Absence of regulatory authority. Investors have no recourse to an independent regulator States have floated their own corporations or agencies. NHAI only acts as the regulator as well as the operator.

Completing the projects on time has always been a major challenge for Client, consultant and contractors. Project to be completed within schedule are commonly affected by several factors, such as regulatory changes, labor or material shortages, abnormal weather, public opposition, funding, conflicting site conditions, and a countless other factors that are not in control of project stakeholders.

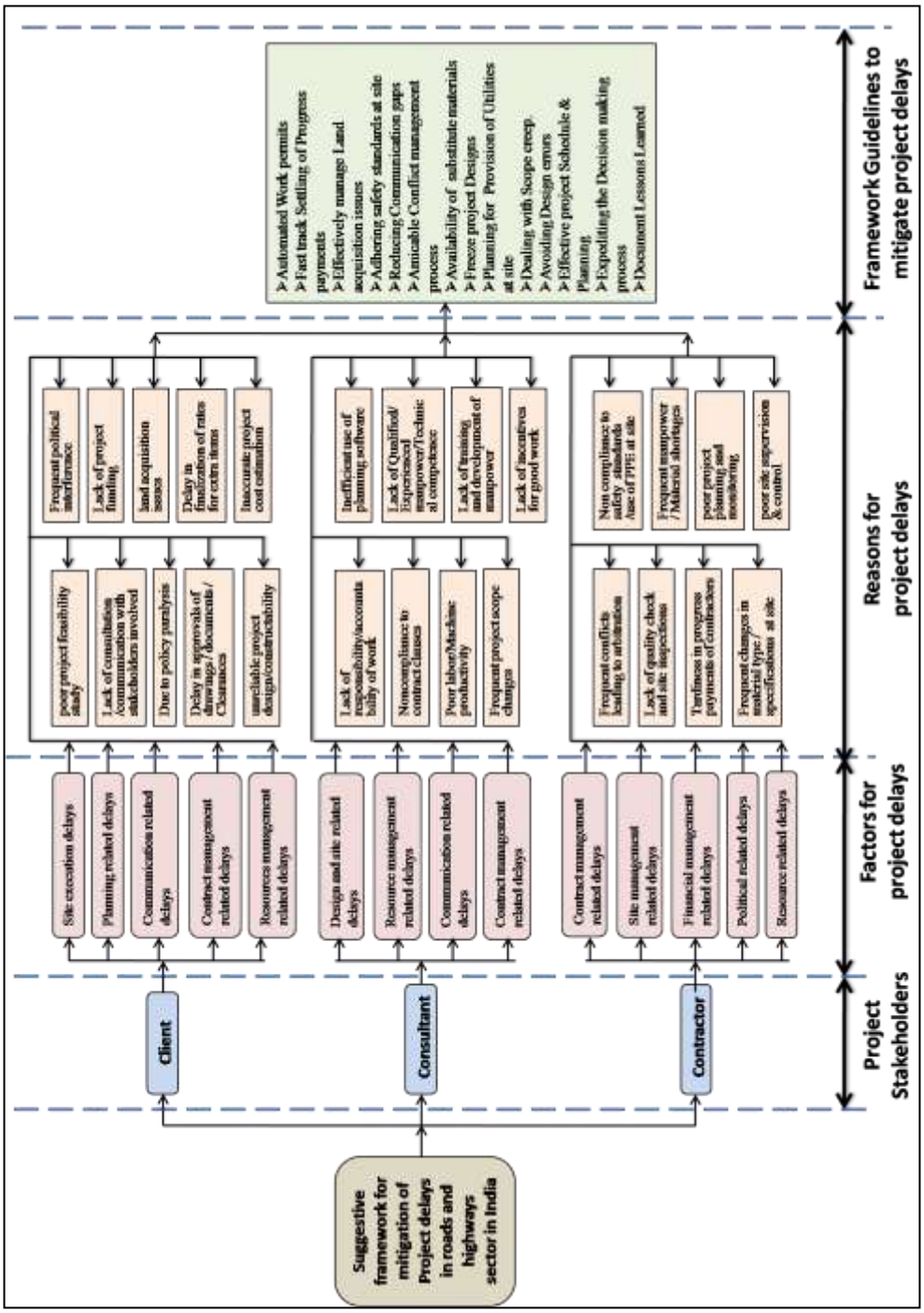


Fig 25: Suggestive framework

The proposed management framework will be a guiding principle for stakeholders to tackle the challenges they face during any road building project in India more effectively. The study will provide new dimensions to minimize delays and efficient management of road building projects. The use of the management framework will contribute to efficient project supervision and serve as an early warning system for the prevention of imminent budget and planning problems. It is also necessary to timely problem management and support project managers in project monitoring. This will also actually help to enhance the management process by using resources effectively and in planning the design and implementation of the project. It promises to be an invaluable tool in mitigating losses and maximizing profits. In order to assure that the project is carried out in minimal delays and completed within the contractual time period, the company will also guarantee staff quality, financial budgeting, and suitable mechanisms for executing its work, as well as all appropriate planning and monitoring.

5.11 CONCLUSION:

Based on the inputs from the conceptual framework, the framework questionnaire is developed separately for the three stakeholders i.e.: client, consultant and the contractor. The data is recorded using audio, visual or email wherever permitted to do so by the expert. The data analysis has been executed with the Textual Analysis using Atlas.Ti from the inputs received from the conceptual framework. Using proper coding method like open coding, axial coding focused coding and theoretical coding the final suggestive framework is developed. The final framework is classified as per the stakeholders, factors and reasons for project delays and guidelines to mitigate the project delays which have been explained in detail in the next chapter.

CHAPTER 6:

FINDINGS, CONCLUSION AND RECOMENDATIONS

6.1 OVERVIEW

This chapter presents the guidelines to emerging from the final framework to mitigate the project delays in roads and highways sector in India. The guidelines are explained in detail with possible solutions for mitigation of project delays. The chapter explains the major parameters to be kept in mind while implementing framework

6.2 FRAMEWORK GUIDELINES TO MITIGATE PROJECT DELAYS

The following guidelines emerging from framework are suggested to overcome these challenges and maintain the projects on track.

- **AUTOMATED WORK PERMITS-**

  Work permits are formal procedures for the control of high- risk activities. Permits allow authorized staff to conduct such activities in a manner set out in the permit and as pet the standard documents published. Progress of public road projects can be affected by government regulations in issuing of work permits. The contractor is bound to attain work permits from all concerned Government authorities to satisfy the contractual obligations. These statutory authorities have their own rules and regulations for issuing work permits. Contractor often face great difficulties in obtaining these permits resulting in project delays. The issuance of work permits can be a time-consuming and complicated process and should therefore be notified before a work authorization is required. Allowing work systems does not make activities safer, only the correct procedures can be

achieved. It is therefore important for systems to be not box-ticked, explained at the site inductions, monitored, examined and up-to-date on an ongoing basis.

As per interaction with experts, permit to work system should:

- Consider whether any other work will affect the authorized work or be affected by it.
- Ensure monitoring and monitoring measures are in place.
- Only allow authorized and competent staff to issue permits.
- Provide other parties affected by the work with information.
- Provide statements of methods and emergencies.
- Prevent high-risk work without undertaking any risk assessment.
- Include a return and cancelation permit system.
- Ensure that the work is checked and re-established.

Implementing E- Permits - automated Permit Control process

An automated control process stores the active and operating permits of your organization. The review and approval process is monitored by the documentation which is absolutely necessary to obtain new licenses and to renew them. The control of permits is very important in order to prevent fines, sanctions, delays or legal ramifications of invalid or outdated work permits. By automating authorization control processes in your EHS, you can keep a record of the permit schedules and keep track on regulations implemented by responsible issuing governmental agencies such as the EPA and OSHA. Your organization can ensure that all the permits are readily available and up- to- date and that compliance is always achieved by identifying relevant dates and responsible personnel.

- **SETTLING PROGRESS PAYMENTS** –

In construction, a payment for progress is a partial payment which covers the amount of work done to date. Delay in progress payments can transpire resulting from unavailability of financial resources for other projects. The project will show only in papers with no execution started as there is no budget allocated. Reduction in the financial resources was encountered by some contractors as a result of the "Credit Crunch" causing Payment problems between contractor and his employees. Additional funds required to purchase materials and many other items could lead to a very volatile situation for the contractor that could hamper work growth and delay the project's completion.

Most respondents agreed that contractual or statutory rights should be exercised as a means of avoiding or decreasing delayed payment. It has been found that application of interests or overdue charges on delayed payments are extremely rare in the construction industry. The existing standard contract clauses need to be examined and amended by professional boards and government agencies to safeguard and foster a balanced risk allocation and a completely fair contract for all related parties. The less likely choice was also arbitration or litigation, since disputes were usually resolved by means of these methods for a lengthy period.

All stakeholders in the road construction industry need to address the results and output of this research in a jointly to improve matters of late payments.

That requires:

- In order to enable contractors to select the credit worthy employers and to improve the chances of a contractor being paid it must be made mandatory to transparent financial capacity and credit rating by employers.

- In order for contractors to choose trustworthy employers and enhance opportunities for payment to a contracting firm, transparent financial capacities and credit ratings of employers must be mandatory.
- Develop payment departments to report delayed payment problems for each contractor. This service would maintain a history of delayed payments by maintaining records of each customer. Such customers would be susceptible to sanctions if they did not pay in the contract on time. The department should be aware that time is essential and should be able to solve problems in this regard as quickly as possible.
- Enforcing of delayed contract payment clauses. In accordance with the application of delayed delivery charges the application of service charges for delayed payments could be established.

➢ **DEALING WITH LAND ACQUISITION ISSUES: -**

Land acquisition is viewed as a sensitive subject, therefore systematic, transparent and humane approach has to be adopted for early and peaceful acquisition. The acquisition process should be such that it fully safeguards the interests of land-owners and because their livelihood depends on the land being acquired. Hence satisfactory compensation package must be designed and measures for realistic compensation for land, resettlement and rehabilitation to alleviate the sufferings of the concerned projects and people.

The research study taking in inputs from framework analysis provide following suggestions to issues related to land acquisition problems.

- LARC and Super LARC if the estimated amount of money is not sufficient for their property. In paying the compensation to the land owners' .In the event

that, after examining all alternatives, an outright sale is acceptable to the landowners it should be ensured that the price is set by open bidding with a base price that would be the minimum price acceptable to the landowners. Governments should not engage in the process except perhaps as facilitators.

- The land to be purchased from the landowners should either be acquired on a long lease or as equity in the proposed enterprise. The ownership of the land would not be marginalized in either case. Even in public financing schemes, the same configuration should apply. This option guarantees the affected families a stable income.
- The role of governments should be restricted to ensuring that adequate provisions are made for the protection of interests of the land owners. Especially in order to serve the public interest, the Government must strike a balance between growth and interest of landowners.
- An independent expert committee must be in place to make the recommendations within two months from the date of its constitution, either for the acquisition or not for the acquisition of a given piece of land, for the purpose to serve the public purpose.
- A law should be enacted to deny governments ability to buy any private land. The study showed that, in many cases, more than the necessary land was obtained for public purposes and used inappropriately by politicians and officials.

➢ ENSURING MANPOWER SAFETY

Road Construction work is a hazardous land-based job. Construction health and safety is not an thing to take lightly. Indeed, in every aspect of construction, health and security must always be a priority. The building industry is prone to

numerous dangers and potential accidents. Building materials, tools and machinery are all equipped with their own hazards. Crashes, incidents with on-site vehicles and material collapsing causing project delays are the major types of fatalities that lead to death or serious injury on construction sites.

The research study taking in inputs from framework analysis provide following suggestions to issues related to worker safety.

- Safety must be the core value of your business from the CEO downward, and Top management must take the lead in participating in safety meetings and training sessions.
- An efficient and effective way of improving safety can be the use of safety councils which combines both the managers and site workers. The budget should also include an in-house safety manager, however, if the job is large enough to justify it. This tends to make safety an intrinsic part of the work.
- Safety must be the core value of your business from the CEO downward, and Top management must take the lead in participating in safety meetings and training sessions.
- A job safety analysis for each part of the project should be carried out in the project plan process to ensure that adequate controls are carried out before work begins. It will ensure safety as a part of the project planning process.
- Train employees for the use of safety equipment, safety risks, safety expectations and safety precautions that pertain to their tasks.
- All staff should be responsible for safety and security provisions, and the creation of responsibility at all levels should be uniformly enforced.
- As part of your procurement process, the safety performance of potential subcontractors should be assessed. This would include a evaluation of OSHA

recording rates and a security management system audit. The contractors are therefore prepared for safety.

- Regular field security inspections are carried out to improve safety. Checks may detect security risks due to used and worn out machinery, hazardous behaviors, or ill placed instruments and provide you with an opportunity to fix them before an accident can happen.
- Falling from height is a potentially leading cause of injury and possible death. For each project where the risk of fall occurs, you should have a precise fall management plan ensuring the effectiveness of your drop protection programme.
- Check that you have policies on alcohol and drugs to prevent such inflicted labors from working there. This will avoid substance of abuse in the workplace.
- Ensure that the safety is addressed during shift changes, weekly meetings, and during job change. This ensures security is part of the daily conversation.
- To investigate and use this relevant information to better safety procedures to determine the root causes of all accidents and near misses, to avoid future incidents.

➢ REDUCING COMMUNICATION GAPS

The road contractors must be very concerned about the methods they use to communicate with others in their business activities. There are numerous technologies available, both traditional and more modern and innovative. Moreover, communications should be of high quality which needs to be transmitted to a large group of professionals as the information provided must be also of high quality.

During collaboration on projects, various professionals from diverse building areas often need to combine expertise and knowledge. It is also crucial to notify potential client, consultants and contractors cautiously of such information.

In several areas, miscommunication can have a negative effect on the construction sector in general. It could have a adverse impact on the project schedule, the budget, the legal aspects, the quality of the project and even on people's security.

The following measures to be taken to improve communication between the project participants in roads and highways projects.

- Transmit messages in different ways of ensuring clearer understanding. Set reasonable communication lines and command chain for messages and information.
- To communicate with all devices it is important to use updated project management software.
- Use software for document tracking revisions throughout project stages and with all stakeholders.
- Correct writing, avoid slang, and keep it direct, straightforward and readable.
- All stakeholders are concerned about feedback, whether we speak of architects, contractors or construction workers. Ensure that both ways the feedback is understood and follow-up regularly
- Continuous training on new equipment, software, applications, security and regulatory features, and best on-and off-site project management practices.
- The choice of qualified employees and contractors facilitates effective and easier communication for the whole team.
- Ensure that proper links and operating networks even at very remote locations are available.

- Determine whether second or third languages are needed and how they are used explicitly for safety and logistics

➢ AMICABLE CONFLICT MANAGEMENT

Project targets disagreed, conflict on project priorities and conflicting work hours are the primary drivers of conflict among project teams. Personality and interpersonal problems can also lead to conflicts, especially in high-tech circles where cross-functional and self-managed teams with highly technical backgrounds have to rely on work done by others. In order to reduce the probability of a dispute, every facet of the construction process should be optimized, at all stages. Dispute resolution process starts with the construction contract and clarifying the dispute clauses. Other preventive measures to be considered during the project planning and execution include:

The research study taking in inputs from framework analysis provide following suggestions to issues related to land acquisition problems

- Read and understand the contract carefully.
- Make significant early planning before work starts.
- Negotiate provisions which are confusing or potentially trouble- free.
- Provide greater transparency of information to all parties to identify risks and consult with specialists in advance.
- Be cautious with pre- construction work such as the preparation of budgets, schedules, contacting subcontractors, making important orders, etc.
- Dealing with problems as they arise, not postponing them;

- Stress on the resolution of disputes in real time–friendly dispute resolution saves huge sums of time and money.
- Document major problems and challenges during implementation.
- Control on frequent changes in scope
- Arrange frequent review meetings increase communication and to alleviate misunderstandings of project objectives and priorities.
- Encourage a mutual respect environment. Without mutual respect and readiness to disagree and resolve differences no method of handling conflict will work.
- Encourage mutual respect in the social environment. no method to deal with conflict is effective if there is no mutual respect and if there is no readiness to agree and solve differences.
- Train team members on soft skills and promote more active effort in team building.

- **AVAILABILITY OF CONSTRUCTION MATERIALS: -**

The contractor is obliged to organize the necessary materials and equipment for the execution of a project within a time limit. The scarcity or lack of crucial equipment or materials may impede the progress of work that leads to project delays.

Alternative / recycled materials use this natural rock material for road construction projects. Aggregate, smashed rock, sand and gravel materials can be replaced completely or partially by recycled materials. The alternative material is a potential future source of domestic and industrial waste products. These materials are available inexpensively. In addition, their use in road construction offers an efficient solution to the related pollution and waste disposal problem.

The following typos of wastes used in the construction of roads: packing waste, industrial ash (bottom ash and fly ash) and plastic waste materials. In the hot mixing plant, the mixing of waste plastic with bitumen and thin pieces of stone will provide additional protection against rainfall water and thus improve longevity.

Many road agencies habitually permit the use of glass in the asphalt concrete flooring to replace the aggregate. Recycled glass is an acceptable alternative for rocks. It is typically used in embankment material. The Contractor can use crushed glass in the base material.

Some of these materials include:

- Steel slags and blast furnace
- Glass.
- Coal ash byproducts, like fly ash, bottom ash,etc
- Carpet Fibers.
- Roofing Shingle Wastes.
- Rubber Tires.
- Recycled Plastic.
- Municipal Solid Waste Combustion Ash.

Many of this analysis were investigated in the lab. To assess how these materials are viable and perform in actual road projects it is necessary to conduct systematic program to implement these ideas.

- **AVOIDING DESIGN CHANGES**-

Change management is a critical road construction industry problem. The effort to manage changes has put an enormous burden on the project. frequent changes are

identified as the main cause of project delay, overruns, or even project failure. More seriously, frequent project changes causes the industry serious ethical problems and disputes. It is observed that this cause is connected to insufficient experience of the consultant. When consultant makes the changes in design, the contractor will face problems in construction or in arranging budget since these changes were not initially planned. Furthermore, under estimating the project costs may result in termination of the project by the client due to his incapacity to finance extra costs. As a result, delay in approvals by consultant can cause delay in the progress of work causing delay in project completion time. Table below summarizes sources and impacts of construction changes and the actions to be taken.

Table 42 : Impacts and action taken in design changes in road construction

Stage	Stakeholder	Types of changes	Impacts	Actions
Specification	Owner/Client/User or architect	Changes to requirements including specification, scope of projects, design brief, etc. changes in codes and regulations	changes in design and construction process	Carefully provide detailed specification documents before bidding
Design	Design engineering consultant	Incomplete inconsistent drawings, design/error defect, design change, omission of site conditions and build ability	Rework of design and drawings, rework in construction change orders.	Better control of design versions, drawings; site investigation; consider build ability in design

- **PROVISION OF UTILITIES AT SITE-**

Services shall generally include: gas, electricity, water and sewage services and on- site communication services. Utilities which are unidentified or wrongly located may result from poor planning, poor site mobilization, unavailability of

designs and precise location maps. Unclear or unidentified location of services in drawing will result in delays causing change in schedule and the newly discovered cable or pipe is desired to be shifted or diverted provisionally which demands extra time and money.

From this research study and input from framework it can be suggested that delays can be avoided by:

- Proper communication of dates, locations, access procedures, and so on.
- Frequent discussions, ideally with a single point of contact with project stakeholders.
- Access to and availability of the appropriate staff
- Early information exchange and feasibility and capacity to supply confirmation.
- Proper e-mail or phone notification.
- Overestimating loads can result in the unnecessary strengthening of the existing infrastructure.
- Routes for utilities and barriers are identified.
- Timely approval of the designs, or timely request from the supplier for the designs.
- Developers will need to ensure that existing site information is available to them and surveys are made to identify existing service positions, scope and capacity in the event of demolitions.
- Mobilization planning of the site before the project begins execution. Ex. installation of meters, testing, inspection, connection, certification, etc.

- **DEALING WITH SCOPE CREEP**. –

Any changes to the scope of the project require a complete review during implementation of the initial project plan. Ex. quantity, budget review and project quality. This will require additional time and resources for the original baseline. We should realize that changes in a project can lead to the success or failure of the entire project to obtain proper control of the scope change. Thus a proper change management plan must be integrated, the proactive approaches taken by the project parties involved should be adopted and their prerequisites incorporated in the life cycle of the project. The key success factor related to the client and the KPI in the project planning phase is recognized in the form of a milestone to analyze the success of project scope. In order to avoid disputes, it is equally important that the customer continually seeks consent in respect of changes in the project scope and communicates changes appropriately. The other option during the contractual agreement it is advisable to initially freeze the scope of project, so that the contractor concentrates on the deliverable expected.

Before changing your project scope, you have to take two steps:

1. Understand the change clearly and
2. Determine how your project will impacted by the scope change

Steps for developing a realistic approach towards managing scope creep

Step 1: Be Lean – avoid complex, highly mature process

Step 2: Define Preliminary Scope - Start to establish limits on which effective planning can be initiated- systematic approach for preliminary work documentation, assessment and approval.

Step 3: Gain an understanding of what the project sponsor or sponsor's final acceptance means-helps avoid difference in perceptions about what was needed versus documentation.

Step 4: Define, document and communicate the Approval of Change Requests-risk assessments is a integral part change control processes which will Assess the potential risk of a request for change being approved or disapproved.

Step 5: The full scope of the work (creating WBS) is documented and validated. Breaking our business goals into definable work packages can act as a catalyst for changes and should from the beginning be included in natural planning processes.

In order to avoid scope creep, a systematic process with a proper planning and understanding of customer demands is significantly better for determining project objectives (cost, schedule, quality). Make practical assumptions on the availability of resources and time limits for quality results. In fact, 100% remedy for scope-creep is not available, but it may help to document the events and communicate challenges in advance to stakeholders, staff and management.

- **TACKLING DESIGN ERRORS** –

Design errors constitute errors in field investigation, plan errors, error in design & specifications, design changes etc. Design errors causes investigated in current projects are inadequate in controlling project delay and cost overrun. The vital thing to be considered is application of competent tools throughout the project and the involvement of professional skills. to achieve error free design process, high-quality communication with the entire design team is important. Design process should be planned such that it allows sufficient time for corrections, broad reviews and inquiries. Accurate site inspections are to be conducted to ensure that all conditions of the site are prominent in design and value management to achieve the best cost effective design options.

There is a clear relationship between errors and waste. Errors in design documents do have a detrimental effect on the design and construction phases and can negatively affect the post- construction phase.

From this research study and input from framework it can be suggested that delays can be avoided by:

- Selection of technically competent, Qualified and experienced staff
- There should not be any ambiguity in describing project aims and objectives
- All parties should strictly communicate in written form and not verbally
- Sharing all drawings with contractors about the potential design
- Transparency in project financing and avoid overestimating budget value
- Avoid hiding any facts related to design and budgeting from contractors
- Client requirement should not exceed potential budget
- Avoid selecting different materials from those specified in contract
- Follow timelines for design process completion
- Avoid insufficient internal details (i.e. Pavement design) on the architectural drawings, which results inappropriate allocation of resources
- Avoid using different sets of drawings; ex one of permitting and one for construction
- Avoid contractor selecting material without consulting with design engineer.
- Misinterpreting or ignoring building codes

- **EFFECTIVE PROJECT SCHEDULE & PLANNING-**

The project manager uses the schedule for planning, performing, and controlling and monitoring project work. The project schedule sets timetables for the main deliverables and sets project progress and completion expectations. Design should ideally be advanced to at least the 30% level to develop a meaningful construction schedule, which is not always possible. However, a milestone needs to be established before the design is sufficiently advanced and the client is required to build detailed plan as possible. The project schedule should be constructed based on logical sequencing of work with durations based on production schedule, impacts on operating systems, proper allowance for time and weather constraints, etc. The time and cost spent on preparing an inclusive and sensible schedule evades many problems.

Use of project Management Software tools

It is found from this research that many of the road and highways company refrain from using project planning and scheduling softwares. The main reasons inferred from this research study are:

- Lack of awareness related to benefits of software tool related to resource management
- Road companies see it has high cost of investment but practically the benefits outweigh the costs in long run.
- The companies are used to Microsoft excel and their mindset is not ready for change
- They don’t want to invest in training and development as consider it expenditure.
- They consider software as a tool of scheduling only to submit project plan to client and not interested in tracking and monitoring of resources.

This might waste a great amount of time and energy on things that can be easily automated or managed better.

Benefits of Implementing Resource Management Software

- Automated Planning
- Increased Accountability
- Reduced Admin Costs
- Conflict Resolution
- Increased Revenue

The stakeholders should understand that PMS tools helps to control project delays by better monitoring and tracking - Makes project and cost monitoring easy by enabling you to immediately monitor and report progress. The surveillance and control process supervises all necessary tasks and measures to make sure that the project approved and authorized is within the scope, timeframes and budget, so that the project advances with a minimum risk. We need to keep ourselves continuously updated with the identification of variances, the quality of our efforts, the progress of the project, and determination of necessary corrective action and the implementation of the corrective measures during the monitoring and control process. Project monitoring and control costs and schedule are of utmost importance.

- **EXPEDITING THE DECISION MAKING PROCESS –**

  In a construction company, decision is often needed at every stage, from the planning of a new building project to the execution of a ready structure. In general, due to certain situations specific to civil engineering, the decision making process is made more complicated. Delay in decision making is one of the severe

causes related to Client and consultants as signified by framework analysis results. Sluggishness in decisions making may retard the progress of project activities, resulting in delay of settlement of contractor's claims like approval of new work materials, extra costs for changes in design, etc. resulting in hindrances in the project progress and will cause delay. You must monitor the situation once the decision is implemented to ensure that actual implementation is successful. Most of the meetings have three elements: sharing information, discussion and decision-making. The interviewees say they spend 90% of the time in the first two meetings and only 10% of the time in which they make the actual decision. The sharing of information must take place early. Start sending the relevant information before the meeting and digest it before the meeting. The decision can be made quickly once the meeting has begun without wasting time.

- **DOCUMENT LESSONS LEARNED –**

  Project teams often feel blessed and relieved when significant project closeout is realized, but failure to bring the same stringency to closeout as was brought during construction phase. To evade this situation, the contractor should include activities for detailed closeout and continuously update them. Meetings every week should also be conducted to press for completion of work within schedule. Lessons learned from what went wrong should be documented and published that will help team planning the next similar project, to avoid the same mistakes. Three process groups: analyze, store, and retrieve for applying lessons learned to be formulated.

  After starting a project, reviewing and examining the successes and improvements required (or needed) during the entire process is good practice. You can lay the groundwork for the lessons learnt template by taking insight from those

discussions and applying them to global lessons throughout your team. This lesson template allows you to look back on projects and teamwork to understand what you have done well, and what your team has taken away from the project in general. These briefings always produce a lot of useful information which prevents companies from committing the same stupid mistakes again.

Projects must be used by companies as learning experiences. All of us must learn from project to project. We have to understand the root causes and then become part of the solution for project delays and failures. This proactive thinking helps us move from simply learning to actually applying the lessons learned. Lastly, we need senior management to institutionalize the process of applying learning throughout the organization.

6.3 SUMMARY AND CONCLUSION

The research work undertaken here is concerned about the grave problem of the road construction projects delays in India. These project delays results in numerous repercussions namely degrading the quality of completed roads, cost and time overruns, major disruptions in movement of physical goods, and cancellation / abandonment of few projects. This combination leads to additional costs and does not forget the restricted budget available for national and state road construction projects. The exorbitant costs arising from delays in road constructions results in considerable decline in the entire stretch of roads constructed and repaired yearly or it may lead to substandard quality of construction work.

In this research study, the main factors that have an impact on road construction delays in India were identified, and the key factors were linked to determine

whether they have an impact on project delays. This research was based on a questionnaire and personal interviews. With factor analysis and regression modeling, the significance of delay factors was analyzed. The findings will play a key role in the management of time spans when Indian highways and roads are being built. A number of Indian road-building professionals (clients, consultants and contractors) were selected.

The cause of project delay in roads and highways construction projects was listed down thorough extensive literature review and personal interviews. Delays were categorized into three categories of stakeholders- client, consultant and contractor. The significance of time factors was studied in each category. Through relative importance index method the importance index of each cause is calculated. 36 causes of delay client, 40 causes of delay for consultant and 42 causes of delay for contractor were found through research study. The identified causes are classified in 5, 4 and 5 groups respectively through factor analysis.

The suggested framework of this research provides fresh dimensions in project management of road projects and guides the stakeholders to successfully encounter challenges occurring during the implementation of any road construction project in India. This research framework is relevant to reducing delays, handle challenging and problematic matters in a timely way, maintain effective project monitoring, serve as a prior warning system for time and cost overruns, and help project team to take timely decisions and the monitor projects so as to upgrade, continue and/or terminate a project.

This framework a valuable and promising tool in minimizing the losses and maximizing the profits. It will also assist in the effective use of resources to improve the project management process. Additionally, it will ensure workforce

quality, appropriate methods for project execution and financial budgeting, as all the necessary planning and monitoring is systemized for ensuring flawless project implementation with minimum project delays and completing it within the contracted time.

6.4 RECOMMENDATIONS

All stakeholders may recommend the following points in order to minimize and control delays in construction projects:

6.4.1 RECOMMENDATIONS FOR CLIENT:

- Minimize construction change orders to prevent delays.
- Paying progress payment on time to the contractor as it undermines the capacity of the contractor to finance his work.
- Avoid delaying as anticipated in examining and approving design documents.
- The owner must be autonomous before starting the project, both with his funds and with other financial issues.
- Ensure adequate resource sufficiency and financial and technical capabilities before awarding the contract to the lowest bidder.
- Also, the owner must be cautious at the time of selection of contractor/ consultant and make sure they do not have any previous record of illegitimate delays resulting in a loss to the owner.
- Avoid delaying the examination and approval of design documents
- The owner must also have a clear perspective and quick decisions regarding final design so that no change in design is requested once after the start of work.

- Coming to material supply, if there is no time limit in starting a project then start the work at a time when the market is free from inflation and when there are low material costs because at the end it makes a huge difference if the costs of raw materials vary.

6.4.2 RECOMMENDATIONS FOR CONSULTANTS:

- Shortage of labor and Low productivity of labor: sufficient labor and incentives should be allocated to boost productivity.
- Problems of financial and cash flow: contractors should use progress payments to handle their financial resources and plan their cash flow.
- Planning and scheduling: matching the resources and project schedule to avoid inflated costs and related disputes.
- The contractor must hire an experienced staff based on the project requirement and timeline.
- The contractor must make sure whether the work is going as per schedule and under the proposed budget, also as per drawings to avoid re-work or any acceleration at the end which would result in cost overrun.
- Supervision and Site management: as soon as projects are granted, the technical and administrative staff should be assigned to arrange for completion in the necessary quality and estimated cost within a specified time frame.
- The contractor must be self-sufficient with funds before the start of the project to avoid any delay in payments
- accumulate materials as per the requirement by carefully estimating the quantities of materials required for the project

6.4.3 RECOMMENDATIONS FOR CONTRACTORS:

- Design documents are produced on time: engineer should set a schedule for the completion of design documents on time; otherwise the completion of work will be delayed.
- Review and approval of design documents: any delaying in the checking, review and approval of design submissions by a consulting engineer before the construction period could delay the progress of the work;
- Design document mistakes and discrepancies: These are common reasons for re-working designs and drawings and may take longer to correct them.
- Consideration should be given to the compromise between cost and high quality.
- Late review and approval of major work-related and scope changes and design documents would be due to lack of proper design team. To avoid these issues the consultant firm must hire an experienced and dedicated staff who work on keeping the deadline in mind which was set by the owner.
- There must be no lagging in the collection of information from the owner so that design would be done appropriately as expected by owner and also the owner will not suggest any further changes.
- They must also be sure while hiring subcontractors in design also because in large design works main architects hire subcontractors for MEP works, so there should be no discrepancies while transferring information.
- Also in the case of large projects if required they must be aided with E&O insurance, to avoid any future problems.

- Hire a labor supplier who got skilled workers and productive in nature, because labor plays a key role in influencing project productivity and overall completion of work.

6.5 LIMITATIONS OF THE STUDY

The results of this study were largely based on a detailed interview between experts from Indian R&H sector. The part of the research study employed a qualitative approach which is considered to be subjective in nature. (Klein & Myers, 1999)

The output being a substantive conceptual framework, its generalizability is limited to the selected domain and it cannot be generalized for other sectors.

This study does not claim objectivity, but instead argues that emerging theory is one of a few possible explanations of the reality built by the researcher as active instruments, in line with the view of reality as socially constructed.

The topic under study being sensitive, didn't allow the researcher to tape record all the interviews. Most of the interviews were recorded, however being sensitive issue two of the interviews with government / regulator could not be recorded. However the researcher has use the following technique to ensure data is captured correctly and completely

- Paraphrasing
- Questioning
- Checking
- Working on data immediately post interview

The Framework Method, like all qualitative analytical methods, takes time and consumes intense resources.

6.6 FUTURE SCOPE OF WORK

This research does not claim that this is the only possible way to develop framework to mitigate project delays in roads and highways sector in India but one of the ways to develop.

Studies may be conducted on a particular type of construction projects, for example projects for utilities, building bridges, dam projects, etc. Extensive studies can be conducted to assess a specific party's or specific resource's involvement and impact on roads and highway projects on time.

Detailed studies may be undertaken to assess the involvement and effects in building projects of a specific factor or resource on time overruns. Example: the effects of funding and cash flow issues on construction delays may be researched.

7.0 APPENDIX A: BIBLOGRAPHY

Abderisak, A., Per-Erik, J., & Lindahl, G. (2015). Implications of Cost Overruns and Time Delays on Major Public Construction Projects. *19th International Symposium on Advancement of Construction Management and Real Estate.* Berlin.

Abdul-Rahman, H., Takim, R., & Min, W. S. (2009). Financial-related causes contributing to project delays. *Journal of Retail & Leisure Property* , 225–238.

ADB. (2007). *Transport Sector in India – Focusing on Results.* Asian development bank.

Ahmad, S., Issa, U., Farag, M., & Abdelhafez, L. (2013). Evaluation of risk factors affecting time and cost of construction projects in Yemen. *Intl. J.* , 168-178.

Akoa, & Bella, B. (2011). *Cost overruns and time delays in highway and bridge projects in developing countries-Experiences from Cameroon.* Michigan State University: Phd Report.

Aldari, A. (2011). The effect of poor plannin on delay implementation the construction projects in United Arabic Emaraties. *Ph.D Thesis, Arab British Academy of Higher Education, London, England.*

Alghonamy, A. (2015). Factors Affecting Cost Overrun in Road Construction Projects in Saudi Arabia. *International Journal of Engineering & Technology* , 35-42.

Al-Hazim, N., & abusalem, z. (2015). Delay and cost overrun in road construction projects in Jordan. *International journal of engineering and technology* .

Alinaitwe, H., Apolot, R., & Tindiwensi, D. (2013). Investigation into the Causes of Delays and Cost Overruns in Uganda's Public Sector Construction Projects. *Journal of Construction in Developing Countries* , 33–47.

Al-Kharashi, Skitmore, A., & Martin. (2009). Causes of delays in Saudi Arabian public sector construction projects. *Construction Management and Economics* , 3-23.

Allahaim, F. S. (2009). An empirical classification of cost overrun in infrastructure projects by using cluster analysis. *Fourth International Utzon Symposium.* Sydney,Australia.

Arcila, & Gomez, S. (2012). *Avoiding cost overruns in construction projects in the United Kingdom.* The University of Warwick.

Aziz, R. (2013). Ranking of delay factors in construction projects after Egyptian revolution. *Alexandria Eng. J.* , 52: 387-406.

Bandyopadhyay, A., Swaminathan, A. K., & Rohatgi, R. (2008). *Indian road construction industry capacity issues, constraints & recommendations.* South Asia Region: World Bank.

Bhargava, A., Anastasopoulos, P. C., Labi, S., & Sinha, K. C. (2010). Three-Stage Least-Squares Analysis of Time and Cost Overruns in Construction Contracts. *Journal of Construction Engineering and Management* .

Bramble, B. B., & Callahan, M. T. (1987). *Construction Delay Claims,*. New York: Wiley Law Publications.

Byrne, B. (2010). *Structural equation modeling with amos: basic concepts, applications, and programming.* multivariate applications series, 2nd edition.

Charmaz, K. (2008). *Constructionism and the Grounded Theory. In J. A. Holstein & J. F. Gubrium (Eds.).Handbook of Constructionist Research.* New York: The Guilford Press.

Chidambaram, R., & Potty, N. S. (2014). Qualitative analysis of Time delay and Cost overrun in Multiple Design and Build Projects. *International Conference Data Mining, Civil and Mechanical Engineering* , 93-99.

Chileshe, N., & Berko, P. D. (2010). *Causes of project cost overruns within the Ghanaian road construction sector.* Ghana.: Ghana Highway Authority.

Choudhry, R. M., Nasir, A. R., & Gabriel, H. F. (2012). Cost and Time Overruns in Highway Projects in Pakistan. *Conference Paper.*

Couto, J. P., & Teixeira, J. C. (2007). The Evaluation of the Delays in the Portuguese Construction. *CIB world building congress* , 292-300.

Creswell, Clark, J., & Plano, V. (2007). Designing and Conducting Mixed Methods Research. *Sage* , Thousand Oaks, CA.

Diab, M. F., Varma, A., & Nassar, K. (2012). Using Risk Assessment to Improve Highway Construction Project Performance. *48th ASC Annual International Conference Proceedings.*

Dinakar, A. (2014). Delay Analysis in Construction Project. *International Journal of Emerging Technology and Advanced Engineering* , 784-790.

Divya.R, & S.Ramya. (2015). Causes, Effects and Minimization of Delays in Construction Projects. *National Conference on Research Advances in Communication, Computation, Electrical Science and Structures*, (pp. 47-52).

Doloi, H., Sawhney, A., Iyer, K., & Rentala, S. (2012). Analysing factors affecting delays in Indian construction projects. *Intl. J. Project Management* , 30: 479-489.

Durdyev, S., Ismail, S., & Bakar, N. A. (2012). Factors Causing Cost Overruns In Construction Of Residential Projects; Case Study Of Turkey. *International journal of science and management* , 4-10.

Elanga, Elanga, G. B., Louzolo-Kimbembe, P., & Pettang, C. (2014). Evaluation of Cost Overrun Factors in the Construction Projects in Developing Countries: Cameroon as Case Study. *International Journal of Emerging Technology and Advanced Engineering* , 533-538.

Enshassi, A. M., & Abushaban, S. S. (2009). Factors affecting the performance of Construction projects in the Gaza Strip. *Journal of Civil Engineering and Management* , 269-280.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2015). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics* , 1-4.

Fallahnejad, M. (2013). Delay causes in Iran gas pipeline projects. *Int. J. Project Management* , 31: 136-146.

Farid, A., & El-Sayegh, S. (2006). Significant Factors Causing Delay in the UAE Construction Industry. *Construction Management and Economics* , 1167-1176.

Field, A. (2005). *Reliability analysis. In: Field, A., Ed., Discovering Statistics Using spss.* London: 2nd Edition, Sage.

Flybjerg, B., Molin, E. J., Wee, B. v., & Cantarelli, C. C. (2010). Cost overruns in Large-Scale Transportation Infrastructure Projects:Explanations and Their Theoretical Embeddedness. *European Journal of Transport and Infrastructure Research* , 5-18.

Flyvbjerg, B., Holm, M. K., & Buhl, S. L. (2004). What Causes Cost Overrun in Transport Infrastructure? *journal of Transport Reviews* , 5-15.

Gahtani, K. S., & Mohan, S. B. (2005). Total Float management for Delay Analysis. *AACE International Transactions, CDR. 16. AACE International* .

Gardezi, S., Manarvi, I., & Gardezi, S. (2014). Time extension factors in construction industry of Pakistan. *Procedia Eng.*, (pp. 196-204.).

Glaser, B. (1978). *Theoretical sensitivity: Advances in the methodology of grounded theory.* Mill Valley: Sociology Press.

Gupta, A. K., Trivedi, D. M., & Kansal, D. R. (2013). Risk Variation Assessment of Indian Road PPP Projects. *International Journal of Science, Environment* , 1017 –1026.

Hair, J., Anderson, R., Tatham, R., & Black, W. (1998). *Multivariate data analysis.* Prentice Hall, New Jersey: 5th Edition.

Hasan, R., Suliman, S. M., & Malki, Y. A. (2014). An Investigation into the Delays in Road Projects in Bahrain. *International Journal of Research in Engineering and Science (IJRES)* , 38-42.

Haseeb, A. (2011). Causes and effects of delays in large construction projects of Pakistan. *J. Bus. Manage. Rev.* , 1: 18-42.

Haseeb, M.; Xinhai-Lu; Bibi, Aneesa; Maloof-ud-Dyian; Rabbani, Wahab. (2011). *Australian Journal of Business and Management Research* , 41-50.

Hindu, T. (2014). *Road projects running behind schedule*. Retrieved from The Hindu: https://www.thehindu.com/

Honrao, M., & D.B.Desai. (2015). Study of Delay in Execution of Infrastructure Projects – Highway Construction. *International Journal of Scientific and Research Publications* , 1-6.

IBEF. (2017). *Road infrastructure in India*. Retrieved from India brand equity foundation: www.ibef.org

Ismail, I., Rahman, I. A., & Memon, A. H. (2013). Study of Factors Causing Time and Cost Overrun throughout Life Cycle of Construction Project. *Proceedings of Malaysian Technical Universities Conference on Engineering & Technology (MUCET)* .

Iyer, K., & Jha, K. (2005). Factors Affecting Cost Performance: Evidence from the Indian Construction Projects. *International Journal of Project Management* , 283-295.

J.L.Narayan. (2012). *Time and Cost Overruns in Implementation of Infrastructure Projects, Problems and Remedies.* Ministry of Statistics and Programme Implementation.

James, O., Lekan, A., C., O., Olusanya, Olayeni, T., OwolabiDele, et al. (2014). Causes and Effect of Delay On Project Construction Delivery Time. *International Journal of Education and Research* , 197-207.

Jammaz, T. (2010). Evaluating administrative factors causing delay in the completion of construction projects from the reality of the internal environment of the construction companies in Qatar. *Ph.D Thesis, Faculty of Management and Economics, Arab Open University, Denmark.*

Jr., D. R., & Thomas, D. H. (2003). *The root causes of delays in highway construction.* Washington, D.C.: 82nd Annual Meeting of the Transportation Research Board.

Kamanga, M. J., & Steyr, W. J. (2013). Causes of delay in road construction projects in Malawi. *Journal of the South African Institution of Civil Engineering* , 82.

Kholif, & Ahmed, W. A. (2015). *Analysis of Time and Cost Overrun in Educational Building Projects in Egypt.* Arab Academy for Science and Technology.

Kinnear, T. C., & Taylor, J. R. (1987). *Marketing research : an applied approach.* McGraw-Hill.

Klein, H. K., & Myers, M. D. (1999). *A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems.* MIS Quarterly.

Kumaraswamy, M. M., & Chan, D. D. (1998). Contributors to construction delays. *Construction Management & Economics.* , 17-29.

Le-Hoai, L., Lee, Y. D., & Lee, J. Y. (2008). Delay and Cost Overruns in Vietnam Large Construction Projects:A Comparison with Other Selected Countries. *KSCE Journal of Civil Engineering* , 367-377.

Lind, F. B., & Hans. (2014). *Explaining cost overruns in infrastructural projects: A new framework with applications to Sweden.* Royal Institute of Technology.

M.J, M., C.O., A., & W.D., T. (2014). A Theoretical Review of the Causes and Effects of Construction Projects Cost and Schedule Overruns. *International Conference on Emerging Trends in Computer and Image Processing* , 15-16.

M.M., M., & Rasas, E. (2014). Analyzing delay causes in Egyptian construction projects. *Journal of Advanced Research* , 49-55.

M.R., A., Rahman, I., & Azis, A. (2010). Causes of delay in MARA management procurement construction projects. *J. Surv. Constr. Property,* , 4: 168-178.

Mahamid, Ibrahim; Al-Ghonamy, A.; Aichouni, Mohamed. (2015). Risk Matrix for Delay Causes in Construction Projects in Saudi Arabia. *Research Journal of Applied Sciences, Engineering and Technology* , 112-115.

Mahamid, Ibrahim; Bruland, Amund. (2011). Cost Overrun Causes in Road Construction Projects: Consultants Perspective. *2nd International Conference on Construction and Project Management* , 6-15.

Mali, M. L., & Warudkar, M. A. (2016). Analysis Of Critical Factors Affecting The Construction in Pune region of India. *International Journal of Application or Innovation in Engineering & Management* , 306-315.

Mathkari, V. (2017). *Cost benefit analysis of expressways in India A case study of Mumbai Pune expressway*. PhD report.

Memon, A., Rahman, A., Ismail, & Asmi Abdul Aziz, A. (2012). The cause factors of large project's cost overrun: a survey in the southern part of peninsular Malaysia. *International Journal of Real Estate Studies* , 1-15.

Monyane, Godfrey, T., & Okumbe. (2012). An evaluation of cost performance of public projects in the Free State province of South Africa. *2nd Construction Mangament Conference NMMU*. Port Elizabeth South Africa.

MORTH. (2015). *Basic road statistics of India.* Ministry of road transport and highways.

MORTH. (2010). *Road network of India*. Retrieved from Ministry of Road Transport & Highways, Government of India: http://www.nhai.gov.in

MOSPI. (2016). Retrieved from Ministry of Statistics and Programme Implementation: http://www.mospi.gov.in/

Muhwezi, L., & J. Acai, G. O. (2014). An Assessment of the Factors Causing Delays on Building Construction Projects in Uganda. *International Journal of Construction Engineering and Management* , 13-23.

Muianga, E. A., Granja, A. D., & Ruiz, J. A. (2014). *Influence Factors on Cost and Time Overruns in Mozambicans Construction Projects: Preliminary Findings.* Port Elizabeth, South Africa: International Conference on Engineering, Project, and Production Management.

Mulla, M. S., & Waghmare, P. A. (2015). A Study of Factors Caused for Time & Cost Overruns in Construction Project & their Remedial Measures. *Int. Journal of Engineering Research and Applications* , 48-53.

Murphy, K. R. (1988). *Psychological Testing: Principles and Applications.* NJ: Prentice-Hall: Englewood Cliffs.

Muya, M., Kaliba, C., Sichombo, B., & Shakantu, W. (2013). Cost Escalation, Schedule Overruns and Quality Shortfalls on Construction Projects: The Case of Zambia. *International Journal of Construction Management* , 53-68.

NHAI. (2015). *National Highways Development Project*. Retrieved from http://www.nhai.gov.in

Patil, S., A.K.Gupta, Desai, D. B., & A.S.Sajane. (2013). causes of delay in Indian transportation infrastructure projects. *International Journal of Research in Engineering and Technology* , 71-76.

Patton, M. (1990). *Qualitative evaluation and research methods.* Beverly Hills, CA: Sage.

PCI report. (2002). *Vision 2020 Transport*. Retrieved from Planning Commission of India: http://www.planningcommission.gov.in

Pittman, P. (1994). *Project Management: A More Effective Methodology for the Planning and Control of Projects Management.* Athens, GA: University of Georgia.

Polat, G., Okay, F., & Eray, E. (2014). Factors Affecting Cost Overruns in Micro-scaled Construction Companies. *Procedia Engineering* , 428-435.

Pourrostam, T., & Ismail, A. (2012). Causes and Effects of Delay in Iranian Construction Projects. *International Journal of Engineering and Technology* , 598-600.

Prokerala. (2015). *India Road Map - Road Map of India Showing National, State Highways*. Retrieved from prokerala: www.prokerala.com

Rahman, I. A., Memon, A. H., Azis, A. A., & Abdullah, N. H. (2013). Modeling Causes of Cost Overrun in Large Construction Projects with Partial Least Square-SEM Approach: Contractor's Perspective. *Research Journal of Applied Sciences, Engineering and Technology* , 1963-1971.

Rahman, I., Memon, A., & Karim, A. (2013). Examining factors affecting budget overrun of construction projects undertaken through management procurement method using PLS-SEM approach. *Procedia - Social and Behavioral Sciences* , 120-128.

Ram, A., & Paul, D. P. (2015). Study on Construction Sequence Delay for Road Infrastructure Projects. *Journal of Mechanical and Civil Engineering* , 15-18.

Rego, S., Gupta, D., & Rao, V. V. (2015). Indian Construction Projects-Constraints And Delays :Stakeholder's Perspective. *Journal of construction management* , 5-10.

Ritchie, J., & Lewis, J. (2003). Qualitative Research Practice: A Guide for Social Science Students and Researchers. London: Sage Publications.

Ruqaishi, B. M., & Hamdi, A. (2015). causes of delay in Gulf Cooperation Council (GCC) construction projects. *Journal of Management in Engineering* , 1-5.

Sadi A. Assaf, M. A.-K.-H. (1995). Causes of Delay in Large Building Construction Projects. *Journal of Management in Engineering* , 11(2).

Salunkhe, A. A., & Patil, R. S. (2014). Effect Of Construction Delays On Project Time Overrun: Indian Scenario. *International Journal of Research in Engineering and Technology* , 543-550.

Salunkhe, A. (2014). Identification of critical construction delay factors. *International Journal of Latest Trends in Engineering and Technology* , 256.

Shanmugapriya, S., & Subramanian, D. K. (2013). Investigation of Significant Factors Influencing Time and Cost Overruns in Indian Construction Projects. *International Journal of Emerging Technology and Advanced Engineering* , 734-740.

Simon T. Kometa, P. O. (1996). Validation of the model for evaluating client-generated risk by project consultants. *Construction Management and Economics* , 131-145.

Strauss, J. C. (2008). Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. *Sage, Thousand Oaks.*

Sunjka, B., & Jacob, U. (2013). *Significant Causes and Effects Of Project Delays In The Niger Delta Region, Nigeria.* Stellenbosch, South Africa ©: SAIIE25 Proceedings.

Sweis, G. (2013). Factors Affecting Time Overruns in Public Construction Projects: The Case of Jordan. *International Journal of Business and Management* , 120.

T.Subramani, Sruthi, P. S., & M.Kavitha. (2014). Causes of Cost Overrun In Construction. *IOSR Journal of Engineering* , 1-7.

Tejale, D. S., Khandekar, D. S., & Patil, D. J. (2015). Analysis of Construction Project Cost Overrun by Statistical Method. *International Journal of Advance Research in Computer Science and Management Studies* , 349-352.

The World bank. (2007). *The Rural roads.* The World bank.

Trochim, W. (2006). *Types of Reliability. Research Methods Knowledge Base*. Retrieved from social research methods: http://www.socialresearchmethods.net/kb/reltypes.php

Van, L. T., Sang, N. M., & Viet, N. T. (2015). *A Conceptual Model of Delay Factors affecting Government Construction Projects.* ARPN Journal of Science and Technology.

Vaus, D. d. (2001). *Research Design in Social Research.* New Delhi: SAGE.

Wei, K. S. (2010). *Causes, effects and methods of minimizing delays in construction projects.* Universiti Teknologi Malaysia.

Wijekoon, S., & Attanayake, E. A. (2013). *Study on the cost overruns in road construction projects in Sri Lanka.* Sri Lanka: University of Moratuwa.

Wright, T., & Gupta, H. (2011). *India's Boom Bypasses Rural Poor*. Retrieved from The wall street journal: www.wsj.com/

Yin, R. (2003). *Case Study Research: Design and Methods.* Thousand Oaks, California.: Sage.

Zainal, N. A.-F., & Rozlin. (2017). A Theoretical Framework on Factors Causing Delay of Construction Industries Projects. *The Social Sciences medwell journals* , 393-399.

Zewdu, Z. T., & Aregaw, G. T. (2015). Causes of Contractor Cost Overrun in Construction Projects: The Case of Ethiopian Construction Sector. *International Journal of Business and Economics Research* , 180-191.

Zhang, L. (2005). The Value Premium. *The Journal of Finance* , 212-219.

8.0 APPENDIX B: QUESTIONNAIRE SURVEY

Developing a framework for mitigation of project delays through impact assessment of Critical factors causing time overruns in Roads and Highways Sector projects in India

1. Ph.D in Infrastructure Management - Roads & Highways sector

1 / 1 100%

Respected Sir/Madam,

I am **Mr. Siddesh Pai**, a graduate engineer from Mumbai University.I am conducting a research on " Developing a framework for mitigation of project delays through impact assessment of Critical factors causing time overruns in Roads and Highways Sector projects in India" . I have chosen as a topic of research for my Ph.D project.

The aim of the research is to understand the frequency of occurrence of various delay factors with regards to the roads & highways sector in India . I kindly invite you to be a part of this research and request you to assist me in completing the brief questionnaire. I would kindly request you to share this questionnaire survey project team to help me get the valuable inputs for research.

The information provided will be kept confidential and only be used for research on an academic platform.
I thank you for your valuable time and efforts.

Yours Sincerely,
Prof. Siddesh Pai

1. Please enter the Demographic Information requested in the form below.
Your name, the name of your organization and your contact details will be kept strictly confidential.
Summaries and statistical analyses of responses will be presented to the University

Name:	
Designation:	
Company:	
Work experience:	

2. Please indicate the type of organization you are employed:
There are 3 Parts in questionnaire below.Fill the questionnaire Part depending on which category you belong.
Example: If you belong to CLIENT category, fill only PART A. Rest parts you have to skip and end.

- ◯ CLIENT(Government) - (PART A)
- ◯ CONTRACTOR - (PART B)
- ◯ CONSULTANT - (PART C)

3. Project details (OPTIONAL)

Name of the Project:	
Location of project	
Duration of project delay (Days)	
Cost of project delay (RS)	

4. PART A -Chances of occurrence of the Causes of Delays by the **CLIENT**

(Fill this part only if you are CLIENT)

	Very low [1]	Low [2]	Moderate [3]	High [4]	Very High [5]
1. Law and order situation/Security threats/Local Agitations	○	○	○	○	○
2. Land acquisition delays	○	○	○	○	○
3. Change in government policies affecting project	○	○	○	○	○
4. Delay in Center/State government document clearance process	○	○	○	○	○
5. Change in political power at State/ Center	○	○	○	○	○
6. Excessive bureaucracy with organization	○	○	○	○	○
7.Favoratism in consultant/contractor selection	○	○	○	○	○
8. Price fluctuations due to Inflation	○	○	○	○	○
9. Global/National Economic crises	○	○	○	○	○
10. Lack of project funding	○	○	○	○	○
11. Improper project feasibility study	○	○	○	○	○
12. Project complexity (Project type, project scale,etc)	○	○	○	○	○
13. Change/Transfer of project personnel during project execution	○	○	○	○	○
14. Force majeure activities/unforeseen circumstances	○	○	○	○	○
15. Unrealistic contract/project duration	○	○	○	○	○
16. Haste in preparing project design	○	○	○	○	○
17. Delay in selection of PMC/contractors/suppliers	○	○	○	○	○

18. Issues in client procured materials	○	○	○	○	○
19. Ignorance in penalizing for delay	○	○	○	○	○
20. Wrong Type of project award (Turnkey,BOT,etc)	○	○	○	○	○
21. Lackadaisical attitude towards work completion	○	○	○	○	○
22. Coordination with foreign consultants	○	○	○	○	○
23. Environmental concerns and restrictions	○	○	○	○	○
24. Geological problems on site	○	○	○	○	○
25. Poor site access	○	○	○	○	○
26. Lack in followup procedure with government to start project	○	○	○	○	○
27. Improper conflict resolution process apdopted	○	○	○	○	○
28. Severe weather conditions at site	○	○	○	○	○
29. Ambiguous project requirements	○	○	○	○	○
30. Improper contractor/Consultant selection	○	○	○	○	○
31. Delay in progress payments	○	○	○	○	○
32. Frequent project scope/Design changes	○	○	○	○	○
33. Slow decision making process	○	○	○	○	○
34. Lack of competent/expert project domain people	○	○	○	○	○
35. Delay in finalization of rates for extra items	○	○	○	○	○
36. Lack of client representatives at site	○	○	○	○	○

5. PART B -Chances of occurrence of the Causes of Delays by the **CONTRACTOR**

(Fill this part only if you are CONTRACTOR)

	Very low [1]	Low [2]	Moderate [3]	High [4]	Very high [5]
1. Poor project technical feasibility study during bidding stage	○	○	○	○	○
2. Conflict on ambiguous contract clauses framed	○	○	○	○	○
3. Thefts at site	○	○	○	○	○

4. Lack of timely decision and corrective actions by the contractor team	○	○	○	○	○
5. Lack of/poor communication with client/consultant	○	○	○	○	○
6. Lack of equipment availability	○	○	○	○	○
7. Lack of management commitment towards project issues	○	○	○	○	○
8. Large number of participants within the project	○	○	○	○	○
9. Unrealistic planning and scheduling of projects	○	○	○	○	○
10. Disagreement on design/specifications with consultants	○	○	○	○	○
11. Material shortage at site/Quality issues	○	○	○	○	○
12. Delay in provision of utilities at site (Water, electricity, etc)	○	○	○	○	○
13. Delay in work permits to sub contractors/Labours	○	○	○	○	○
14. Delay in request for approvals of Documents/drawings	○	○	○	○	○
15. Improper selection/Change of sub-contractors	○	○	○	○	○
16. Bitter relationship with consultant/Client	○	○	○	○	○
17. Delay in submission of RA bills	○	○	○	○	○
18. Improper project design/constructability	○	○	○	○	○
19. Failure to utilize Project management tools (MSP, P6, EVM, etc)	○	○	○	○	○
20. Poor site mobilization	○	○	○	○	○
21. Delays related to sub-contractors work	○	○	○	○	○
22. Lack of experience of contractor staff/labor (Low skill levels)	○	○	○	○	○
23. Low labor productivity/skilled labour	○	○	○	○	○
24. Behavioral issues within team	○	○	○	○	○
25. Improper framing of contract clauses causing conflicts	○	○	○	○	○
26. Improper Geological study	○	○	○	○	○
27. Poor site supervision and control	○	○	○	○	○
28. Unrealistic project schedule bided by the contractor team	○	○	○	○	○

29. Labour accommodation/Utility provision issues	○	○	○	○	○
30. Unavailability of Qualified technical staff	○	○	○	○	○
31. Unclear lines of responsibility/authority	○	○	○	○	○
32. Frequent changes of client staff	○	○	○	○	○
33. Inappropriate construction methods used	○	○	○	○	○
34. Frequent Equipment Breakdowns	○	○	○	○	○
35. No planning before project starts	○	○	○	○	○
36.Outdated construction equipments used	○	○	○	○	○
37. Rework due to errors during execution	○	○	○	○	○
38. Poor manpower planning/lack of expertise	○	○	○	○	○
39. Labor absenteeism at site	○	○	○	○	○
40. Accidents during construction/Safety not followed	○	○	○	○	○
41. Improper selection of sub contractors	○	○	○	○	○
42. Conflict between labour and project team	○	○	○	○	○

6. PART C -Chances of occurrence of the Causes of Delays by the **CONSULTANT**

(Fill this part only if you are CONSULTANT)

	Very Low [1]	Low [2]	Moderate [3]	High [4]	Very High [5]
1. Change in material type/specifications after BOQ finalization	○	○	○	○	○
2. Non compliance to contract clauses/conditions	○	○	○	○	○
3. Improper settlement of contractors claims leading to arbitration	○	○	○	○	○
4. Delay in RA bill certifications leading to contractors fund shortage	○	○	○	○	○
5. Delay in quality check inspections/approvals of materials at site	○	○	○	○	○
6. Incompetence to contractor's technical queries	○	○	○	○	○
7. lack of incentives for early work	○	○	○	○	○

8. Improper project feasibility/technical study	○	○	○	○	○
9. Inaccurate project cost/budget estimation	○	○	○	○	○
10. Unethical practices /Red tapism	○	○	○	○	○
11. Ignoring safety compliances/PPE at site leading to accidents	○	○	○	○	○
12. Improper project monitoring and tracking site progress	○	○	○	○	○
13. Lack of responsibility/accountability for site related issues	○	○	○	○	○
14. Lack of control and authority over contractor	○	○	○	○	○
15. Lack of participation/ignorance to meetings at site/client	○	○	○	○	○
16. Staff shortage due to holidays/staff leaves/absenteeism	○	○	○	○	○
17. Inadequate provision of housing and domestic facilities for labour	○	○	○	○	○
18. Delay in finalization of rates for extra items	○	○	○	○	○
19. Change in scope of work/Additional work	○	○	○	○	○
20. Delay in provisions of utilities at site (water, electricity,etc)	○	○	○	○	○
21. Delay in approvals of drawings/documents	○	○	○	○	○
22. Poor site management, supervision & control	○	○	○	○	○
23. Delay in issue of work permits to contractor	○	○	○	○	○
24. Large number of participants in the project team	○	○	○	○	○
25. Delay in providing Right of way	○	○	○	○	○
26. Lack of participating in site meetings	○	○	○	○	○
27. Poor Selection of Contractors during tender selections	○	○	○	○	○

28. Rework due to design errors in drawings	○	○	○	○	○
29. Poor leadership on part of the consultant project manager	○	○	○	○	○
30. Lack of staff motivation	○	○	○	○	○
31. Lack of monitoring of availability of equipment at site	○	○	○	○	○
32. Wrong type of project bidding and award	○	○	○	○	○
33. Poor project planning/project tracking by consultant	○	○	○	○	○
34. Unclear lines of responsibility	○	○	○	○	○
35. Lack of consultation with client/contractor	○	○	○	○	○
36. work slowdown due to delay in progress payments	○	○	○	○	○
37. Delay in issue of EOT/Approvals to contractor	○	○	○	○	○
38. Rework due to frequent revisions in drawings	○	○	○	○	○
39. Delay in site inspection and handover	○	○	○	○	○
40. Low constructability or an Impractical designs	○	○	○	○	○

7. Is the project delayed or running behind schedule?

☐ Yes

☐ No

PROFILE OF THE AUTHOR

Mr. Siddesh Kashinath Pai is working as a assistant professor in project management domain at National Institute Of Construction Management And Research (NICMAR), Goa. He has completed Masters Degree in Infrastructure management (MIM) from ICFAI University, Tripura and Post graduation in project engineering and management from NICMAR, Pune. His Bachelor's Degree is in Mechanical engineering from Rajendra Mane College of Engineering & Technology, Ratnagiri from Mumbai University. He has worked as a project lead(operations) with Honeywell Automation India Limited (HAIL) on automation projects with Delhi metro and Mumbai airport India ltd. He has total work experience of 15 years in industry and academics. He has 30 plus research publications in National and International journals and also authored book on Project management for NMIMS University.

LIST OF PUBLICATIONS

1. Prof: Siddesh Pai, Mr. Bijayanand Patnaik, Dr. Ankur Mittal and Dr. Neeraj Anand

Title: Identification Of Risks Causing Time And Cost Overrun In Roads And Highway Projects In India

Journal: International Journal Of Civil Engineering & Technology (IJCIET), 22-March-2018, Impact Factor: 9.7820, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316, Scopus Indexed Journal, IAEME Publication

2. Prof. Siddesh K. Pai, Mr.Avinash Kumar Singh, Dr. Ankur Mittal , Dr. Neeraj Anand

Title: Analysis of time overruns in roads and highways sector in India using AHP ranking technique

Conference: International conference on Research Advancements in Applied Engineering Sciences, Computer and Communication Technologies (ICRAAESCCT-18), July 2018.

Journal: International Journal of Engineering and Technology. Vol 7 (3.29) (2018) Pg: 259-262, Scopus indexed, ISSN: 2227-524X

3. Prof. Siddesh K. Pai, Mr. Patnaik Bijayanand, Dr. Ashish Tripathi and Dr. Neeraj Anand

Title: Implementation Of National Green Highways Mission (NGHM) For Sustainable Environment And Inclusive Growth Of Indian Roads And Highways Sector

Journal: International Journal of Research in Management & Social Science. ISSN 2322 – 0899, Volume 5, Issue 2: April - June, 2017, Pg: 54-58

4. Prof. Siddesh Pai, Dr. Neeraj Anand, Dr. Ankur Mittal, Dr. Indrasen Singh

Title: Developing a framework for mitigation of project delays in Roads and Highways Sector projects in India

Journal: Journal of Management Research and Analysis. Print-ISSN: 2394-2762, Impact Factor: 1.62, Volume: 5, Issue 3, Year 2018, UGC Approved journal.

List of Papers Presented at Various Conferences

- A paper titled “Analysis of time overruns in roads and highways sector in India using AHP ranking technique” was presented at International conference on Research Advancements in Applied Engineering Sciences, Computer and Communication Technologies (ICRAAESCCT-18), July 2018.

- A paper titled “Study of Land Acquisition issues causing delay of NHAI Projects” was presented at 2nd World Conference on Applied Science Engineering and Technology (WCASET-16) held on 29th - 30th December' 2016 at Goa

- A paper titled “Effective Use Of Blast-Furnace Slag In Road Construction Projects In India” was presented at 2nd International Conference on “Latest Innovations in Science, Engineering and Management” (ICLTSEM-16) held at The International Centre Goa, Panjim, Goa (India) on 09 October 2016,

- A paper titled “Case of Bangalore Mysore infrastructure corridor project delay due to land acquisition” was presented in International Conference on Science, Technology, Women Studies, Business & Social Sciences 2016, Nov 03 - 05, 2016, Goa

- A paper titled “Study of Causes of Project Delays in Road and Highways Sector in India” was presented at 1st International conference on construction, real estate, infrastructure and project management (CRIP) organized by NICMAR, Pune on 21st -22nd October 2016

- A paper titled “Application of WR2400 Stabilizer Equipment for High Performance Soil Stabilization Process: A Case of NH7 Nagpur” was presented at National Conference in Challenges in Geotechnical Investigations, Analysis, Design and Construction of Foundations organized by National Conference of Indian Geotechnical Society Goa

- A paper titled “Idle Construction Equipment Impact Assessment on Infrastructure Projects” was presented at NICMAR Industry Academia Conference on Construction Management (IACCM - 2018)