

RISK ASSESSMENT , MITIGATION AND MANAGEMENT OF EPC CONTRACT PROJECTS

A Thesis

Submitted in partial fulfillment of the requirements for the award of
Master of Architecture degree in Building Management

by

NIVEDHAA B (40840011)



**DEPARTMENT OF ARCHITECTURE
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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ABSTRACT

EPC contracting projects is an arrangement where contractor is responsible for Engineering, procurement and construction which includes design , procurement , construction , commissioning and handing over the project to the end user . The EPC projects are complex and can be found in various industries which encompasses industrial plants , oil and gas , mining , etc. The client will provide the contractor with defined objectives and scope comprehending all the technical and functional specifications . Since EPC are complex this study set one's sights on determining the nature of the projects and to analyze the risks involving in EPC projects . Buttoning it down in developing management strategies . Taking into account of the available literature study and analytical method to obtain the ground knowledge ,proceeding with the analysis of the risks that constitutes the EPC projects . The aftermath of the study will yield the risk factors and mitigation strategies for efficient management of EPC projects .

TABLE OF CONTENTS

CHAPTER No.	TITLE	PAGE No.
	ABSTRACT	v
	LIST OF TABLES	xiv
	LIST OF FIGURES	xvii
1	INTRODUCTION	1
1.1	INTRODUCTION	1
1.2	DEVELOPMENT OF EPC MODEL	1
1.3	TYPES OF EPC CONTRACTS	2
1.4	FEATURES OF EPC CONTRACT	2
1.5	Need For EPC	2
1.6	EPC OVER PPP IN INDIAN INFRA PROJECTS	2
1.7	NATURE OF EPC COMPANIES	3
1.8	EPC IN INDIA	3
1.9	PHASES OF EPC PROJECTS	4
1.10	AIM	5
1.11	OBJECTIVES	5
1.12	SCOPE	5

1.13	NEED FOR THE STUDY	5
1.14	PROBLEM STATEMENT	6
1.15	METHODOLOGY	6
1.16	DATA COLLECTION AND DATA ANALYSIS	6
1.16.1	PRIMARY DATA COLLECTION :	6
1.16.2	SECONDARY DATA COLLECTION :	6
1.16.3	ANALYSIS	7
2	LITERATURE STUDY	8
2.1	COMPERATIVE ANALYSIS OF THREE MAJOR TYPE OF CONTRACTS WITH CASESTUDY - Abhijit Langhe, Pravin Minde.	8
2.1.2	OBJECTIVES	8
2.1.3	CASE STUDY OVERVIEW-Case study 1	8
2.1.4	COMPARATIVE STUDY – CONTRACT TYPES	9
2.1.5	COMPARATIVE STUDY – CASE STUDIES	10
2.1.6	CONCLUSION	10
2.2	SUITABILITY OF EPC CONTRACTS IN PUBLIC SECTOR BUILDING CONSTRUCTION PROJECTS -Dipanshu Sharma, Retd.Maj Gen TaranSidana, Dr. Virendra.Kumar Paul	11
2.2.1	OBJECTIVES	11
2.2.2	METHODOLOGY	11
2.2.3	PECULIARITIES & SUCCESS FACTORS OF EPC CONTRACTS	11
2.2.4	RISK GROUPS	13

2.2.5	SURVEY CONCLUSION	14
2.2.7	CONCLUSION	15
2.3	DEFINING MITIGATION STRATEGIES FOR RECURRING EPC CONTRACT RISKS-Benyamin Sadeghi ; Mohammad Mehdi Mortaheb; and Hamed Kashani.	15
2.3.1	OBJECTIVE:	15
2.3.2	RESEARCH METHODOLOGY	16
2.3.4	RISK FACTORS	16
2.3.4.1	RISK FACTORS – INTERNAL	17
2.3.4.2	RISK FATORS – EXTERNAL	18
2.3.5	CONCLUSION	19
2.4	ENHANCING RISK MANAGEMENT BY PARTNERING IN INTERNATIONAL EPC PROJECTS- Yujing Yang , Wenzhe Tang , Wenxin Shen and Tengfei Wang .	19
2.4.1	OBJECTIVES	19
2.4.2	INTERFACE MANAGEMENT	20
2.4.3	RISK MANAGEMENT	20
2.4.4	CONCLUSION	23
	OVERVIEW OF LITERATURE STUDY	23
3	LITERATURE CASE STUDY	24
3.1	BIDBOLAND II GAS TREATING PLANT , IRAN.	24
3.1 .1	PROJECT OVERVIEW	24
3.1.2.	SCOPE AND OBJECTIVES	24
3.1.3	FACILITIES	24

3.1.4 RISK FACTORS AND STRATEGIES	25
3.1.5 MANAGEMENT OF RISKS	27
3.1.6 MANAGEMENT PROCESS	28
3.1.7 CONCLUSION	29
3.2 KOLLAM AND ALLAPUZHA BYPASS	29
3.2.1 INTRODUCTION	29
3.2.2 MAJOR DELAYS	29
3.2.3 RISK MANAGEMENT FACTORS	29
3.2.4 RISK ANALYSIS AND ASSESSMENT	30
3.2.5 IMPACT OF RISKS IN THE PROJECT OBJECTIVES	31
3.2.6 RISK SCORES	32
3.2.7 MITIGATION STRATEGIES	32
3.2.8 CONCLUSION	33
3.3 NEW AIPORT , PAKYONG , SIKKIM	33
3.3.1 INTRODUCTION	33
3.3.2 PROJECT OVERVIEW	33
3.3.3 SCOPE OF WORK	35
3.3.4 RISK FACTOR ANALYSIS	36
3.3.5 TIME AND COST OVERRUN	38
3.3.6 CONCLUSION	39

3.4 BARH STAGE 1 , PATNA	39
3.4.1 INTRODUCTION	39
3.4.2 ANALYSIS OF RISK FACTORS	40
3.4.3 COST AND TIME OVER-RUN	43
3.4.4 CONCLUSION	44
3.5 ASSAM RENEWAL PROJECT	44
3.5.1 PROJECT OVERVIEW	45
3.5.2 DELAY FACTORS	45
3.5.3 RISK ANALYSIS	46
3.5.4 CONCLUSION	47
4 LIVE CASE STUDY	48
4.1 MADURAI – KANYAKUMARI SECTION – NH44	48
4.1.1 PROJECT OVERVIEW	49
4.1.2 RISK FACTORS AND THEIR IMPACT	51
4.1.3 RISK FACTORS CAUSING COST AND TIME OVERUN	52
4.1.4 RISK MANAGEMENT	55
4.1.3 INFERENCE	55
4.2 STP AND WTP – 10 MLD , PERUGUDI	56
4.2.1 PROJECT OVERVIEW	56
4.2.2 PROJECT TIMELINE	57
4.2.3 RISK FACTORS AND THEIR IMPACT	58

4.2.4 RISK FEATURES – SUBSTANTIAL COST AND TIME OVERRUN	59
4.2.5 RANKING OF ELEMENTS OF DELAY	59
4.2.6 INFERENCE	61
4.3 LIVE CASE STUDY - INFERENCE	62
5 ANALYSIS AND INFERENCE	63
5.1 CONTOLLABLE AND UNCONTROLLABLE FACTORS	63
5.2 UNDERSTANDING AND DEFINING THE RISK PARAMETERS	64
5.3 CATEGORIZATION OF RISK PARAMETERS IN EPC PROJECTS	69
5.4 RISK FACTORS IMPACTING STAKEHOLDERS	76
5.4.1 RISK FACTORS IMPACTING IA	76
5.4.2 RISK FACTORS IMPACTING EPC CONTRACTING AGENCY	77
5.5 RISK ALLOCATION	78
5.6 RACI MATRIX	80
5.7 SWIM LANES	82
5.7.1 PROJECT INITIATION	83
5.7.2 . BUDGETARY APPROVAL	84
5.7.3 SCHEDULE APPROVAL	85
5.7.4 PROJECT KICKOFF	86
5.7.5 PROJECT EXECUTION	87
5.7.6 . ENGINEERING AND PROCUREMENT	88
5.7.7 CONSTRUCTION PHASE	89

5.8	SECTOR WISE STUDY	90
5.8.1	TIME OVERRUN	90
5.8.3	TIME IMPACT ASSESSMENT	92
5.8.4	COST IMPACT ASSESSMENT	93
6	SUMMARY AND RECOMMENDATIONS	94
6.1	MITIGATION MATRIX	94
6.2	MITIGATION STRATEGIES	96
6.2.1	PRE DEVELOPMENT /PLANNING STAGE	96
6.2.2	ENGINEERING AND CONSTRUCTION PHASE	97
6.2.3	PROCUREMENT PHASE	98
6.2.4	STAKEHOLDERS MANAGMENT	99
6.2.5	PROJECT MONITORING AND CONTROL	100
6.3	PROJECT MANAGEMENT MATURITY ASSESSMENT	101
6.4	INTERFACE MANAGEMENT	102
6.4.1	SCHEDULE AND COST PERFORMANCE	103
6.4.2	INTERFACE MANAGEMENT PROCESS	104
6.4.3	IDENTIFICATION AND RESPONSE	105
6.4.4	SWIMLANE	108
6.5	RISK MANAGEMENT	110
6.5.1	RISK MANAGEMENT PLAN	110
6.5.2	RISK MANAGEMENT PROCESS	113

6.5 RISK MANAGEMENT MATRIX	114
6.6 CHECKLISTS	115
6.6.1 ENGINEERING CHECKLIST	115
6.6.2 PROCUREMENT CHECKLIST	118
6.6.3 CONSTRUCTION CHECKLIST	121
6.6.4 BIDDER SELECTION CHECKLIST	123
6.6.5 BIDDER ASSESSMENT CHECKLIST	124
6.6.7 RISK MANAGEMENT CHECKLIST	125
7 CONCLUSION	126
CONCLUSION	126
References	127

LIST OF TABLES

TABLE No.	TITLE	PAGE No.
2.1	Comparative analysis – Contract types	9
2.2	Comparative analysis – Case study	10
2.3	Overview of literature study	23
3.1	Management of risk factors	27
3.2	Management process	28
3.2	New Airport – Risks analysis	37
3.3	New Airport – Conclusion	39
3.4	Barh stage 1 – Risk analysis	42
3.5	Barh stage 1 – Conclusion	44
3.6	Assam renewal project – delay factors	45
3.7	Assam renewal project – Risk analysis	47
3.6	Assam renewal project – Conclusion	47
4.1	Madurai – Kanyakumari section – Analysis of risk factors	52
4.2	Madurai–Kanyakumari section – overview of cost and time overrun	52
4.3	Madurai–Kanyakumari section – Cost revision	52
4.4	Madurai–Kanyakumari section – Risk ranking	54
4.5	Madurai–Kanyakumari section – Inference	55
4.6	Perungudi STP & WTP – Analysis of risk factors	59
4.7	Perungudi STP & WTP – overview of cost and time overrun	59

4.8	Perungudi STP & WTP – Ranking of risk factors	60
4.9	Perungudi STP & WTP – Inference	61
4.10	Live case studies – Inference	62
5.1	Controllable and uncontrollable factors	64
5.2	Define and understanding of risk factors	69
5.3	Categorization of risk factors	72
5.4	Ranking of risk factors	76
5.5	Risk allocation	80
5.6	RACI Matrix	82
5.7	Sector wise – Time overrun	90
5.8	Sector wise – Cost overrun	91
5.9	Time impact assessment	92
5.10	Cost impact assessment	93
6.1	Model mitigation matrix	94
6.2	Mitigation matrix	95
6.3	Maturity assessment	101
6.4	Schedule performance	103
6.5	Cost performance	104
6.6	Model -excel sheet	107
6.7	Risk management process outline	112
6.8	Risk management matrix	115
6.9	Checklist – Engineering phase	118
6.10	Checklist – Procurement phase	120
6.11	Checklist –Construction phase	122
6.12	Checklist –Bidder selection	124

6.13	Checklist – Bidder assessment	124
6.14	Checklist – Risk Management	125

LIST OF FIGURES

FIGURE No.	TITLE	PAGE No.
1.1	Development of EPC model	1
1.2	Structure of EPC Project	3
1.3	Participants – EPC projects	3
1.4	EPC projects – FYP	4
1.5	Phases of EPC project	4
1.6	NHAI – Push towards EPC projects	5
1.7	Methodology	6
1.8	Data analysis	7
2.1	Methodology	11
2.2	Stages- EPC projects	12
2.3	Risk groups	14
2.4	Case study	15
2.5	Research methodology	16
2.6	Risk factors	16
2.7	Risk factors – Internal	17
2.8	Risk factors –External	18
2.9	Methodology	19
2.10	Frequency of interface problems between stakeholder	20
2.11	Performance of interface management between the contractors and the stakeholders.	20

2.12	Risk factors affecting EPC projects	21
2.13	Barriers to risk management	22
2.14	Application level of risk management techniques	22
3.1	Bidboland Gas treating plant	24
3.2	Major delays	29
3.3	Analysis and assessment	31
3.4	Impact of risks	32
3.5	Risk scores	32
3.6	Mitigation strategies	33
3.7	New Airport – project timeline	34
3.8	New Airport – Scope of work	35
3.9	New Airport – Time overrun	38
3.10	New Airport –Cost overrun	38
3.11	Barh stage 1 – Timeline	40
3.12	Barh stage 1	42
3.13	Barh stage 1 – cost overrun	43
3.14	Barh stage 1 – Time overrun	44
3.15	Assam renewal project	45
3.16	Assam renewal project – timeline	46
4.1	Madurai – Kanyakumari section	48
4.2	Madurai – Kanyakumari section – Project overview	49
4.3	Madurai – Kanyakumari section – Timeline	50
4.4	Madurai – Kanyakumari section – Cost	53

	overrun	
4.5	Madurai – Kanyakumari section - Time overrun	53
4.6	Madurai – Kanyakumari section – Risk matrix	54
4.7	Madurai – Kanyakumari section – Risk management	55
4.8	Perungudi STP & WTP	56
4.9	Perungudi STP & WTP – Project overview	56
4.10	Perungudi WTP	57
4.11	Perungudi STP & WTP – Project timeline	57
4.12	Perungudi STP & WTP – Ranking of risk factors	60
4.13	Functional deployment matrix	61
5.1	Swimlane – Project initiation	83
5.2	Swimlane – Budgetary approval	84
5.3	Swimlane –Schedule approval	85
5.4	Swimlane –Project kick-off	86
5.5	Swimlane –Project execution	87
5.6	Swimlane –Engineering and Procurement	88
5.7	Swimlane –Construction phase	89
6.1	Mobile mapping	96

6.2	Amaravati pooling system	97
6.3	KPMG Lean outcomes	98
6.4	Lean tools	98
6.5	Bidding methods	99
6.6	Invest India web portal	99
6.7	Resource management	100
6.8	Public enterprise	100
6.9	Broadened role of MosPI	101
6.10	ONGC limited Stage gate framework	101
6.11	Maturity assessment	102
6.12	Major project advisory tool	102
6.13	Schedule performance	103
6.14	Cost performance	104
6.15	Interface management plan	105
6.16	Identification sheet	106
6.17	Response sheet	106
6.18	Drop down options	107
6.19	Framework – Interface management	107
6.20	Swimlane – Interface management	108
6.21	Swimlane – Change management	109
6.22	Swimlane – Issue management	109
6.23	Risk management plan	110
6.24	Risk identification	112
6.25	Risk management process	113

LIST OF SYMBOLS AND ABBREVIATIONS

EPC	-	Engineering , Procurement , Construction
NHAI	-	National Highways of Authority
NITI	-	National Institution for Transforming India
DB	-	Design Build
Feed	-	Front End Engineering
Bot	-	Build – Operate – Transfer
MoU	-	Memorandum Of Understanding
GoS	-	Gazzeted Officers
DPR	-	Detailed Project Report
I.A	-	Implementing Agency
QA/QC	-	Quality Assurance / Quality Control
WBS	-	Work Breakdown Structure
RBS	-	Risk Break Down Structure
SCBA	-	Social Cost Benefit Analysis
PPC	-	Plan Percent Complete
LPS	-	Last Planner System
IMP	-	Interface Management Plan
ICF	-	Internet Communication Framework
IA	-	Information Architecture
V& V	-	Verification And Validation
RACI	-	Responsible , Accountable , Consult , Inform Matrix
HAZID	-	Hazard Identification
HAZOP	-	Hazard And Operability Study
FAT	-	Factory Acceptance Test
SAT	-	Site Acceptance Test
KPI	-	Key Performance Index
HSE	-	Health , Safety , Environment
IFC	-	Issued For Construction
EVM	-	Earned Value Management

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

- Engineering - Preparation of design , plans and all the needed specifications . (Equipment , cost estimation and manuals , etc.)
- Procurement - Provision of all the permanent and temporary equipment and materials from third parties and delivering the same to the site .
(Preventive maintenance , Quality, etc.) .
- Construction - Completion the whole project.

1.2 DEVELOPMENT OF EPC MODEL

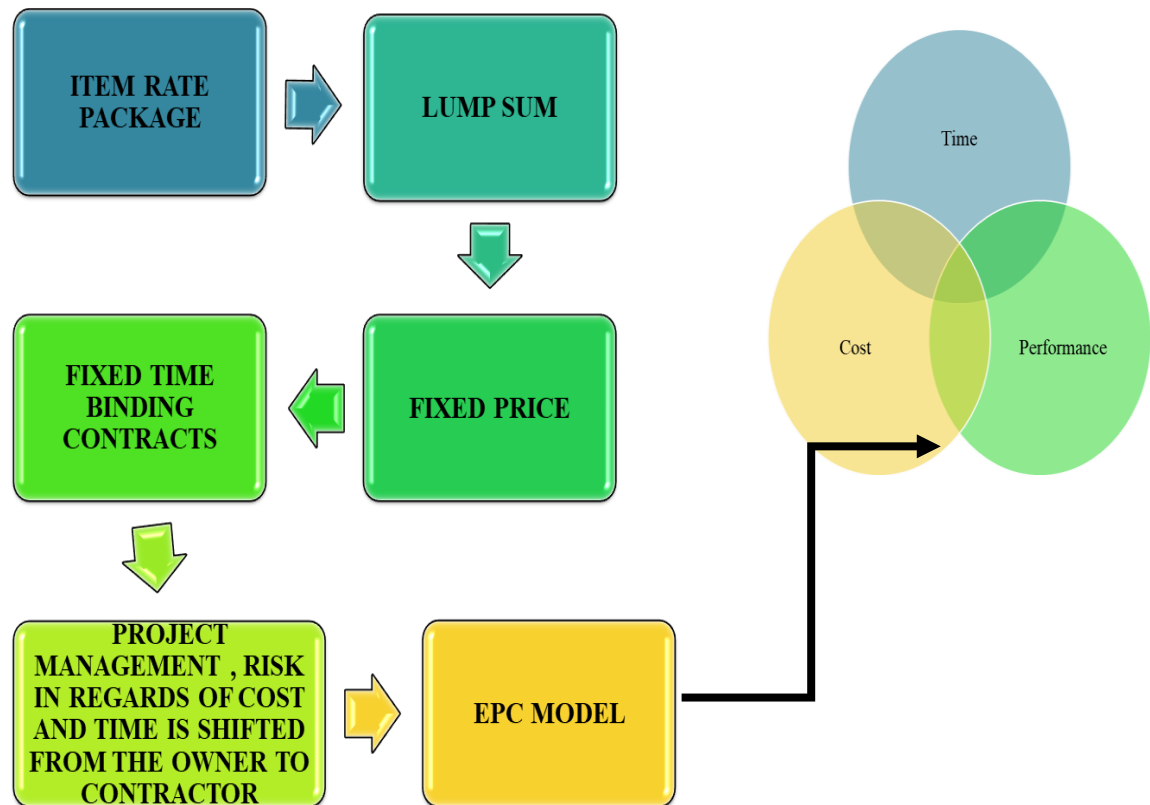


Fig 1.1 Development of EPC model

1.3 TYPES OF EPC CONTRACTS

- Privately Negotiated
- Tendered out
- Issued under Nomination basis
- Single document
- Single document (separate purchase orders for various scopes)

- Multiple document
- Lump sum price – with / without split of various revenue streams
- Split Price

1.4 FEATURES OF EPC CONTRACT

- Single point of Responsibility.
- Fixed time and quality .
- Fixed cost.
- High degree of risk for contractor.
- There is no possibility of cost variation.
- Risk for client are minimized.
- Better performance

1.5 Need For EPC

- Guaranteed Price
- Guaranteed completion time.
- Better level of performance
- Single Point of Responsibility.
- Increased supervision and control.
- Flexibility and certainty.
- Post – Commissioning services

1.6 EPC OVER PPP IN INDIAN INFRA PROJECTS

- Govt is responsible for land acquisition , permissions and mitigation of problems that arise during the project .
- Hence , the EPC party can purely focus on the planning , designing , procurement , engineering which is more efficient way of completing the project .
- Funds are raised by the government – taking the responsibility of raising the capital .

1.7 NATURE OF EPC COMPANIES

- EPC companies have become responsible for Engineering , Procurement and construction and also playing the role of a solution finder .
- Any company taking the project has its sophisticated project management and risk management techniques .
- This helps the company to overlook their projects placed globally in an efficient way .

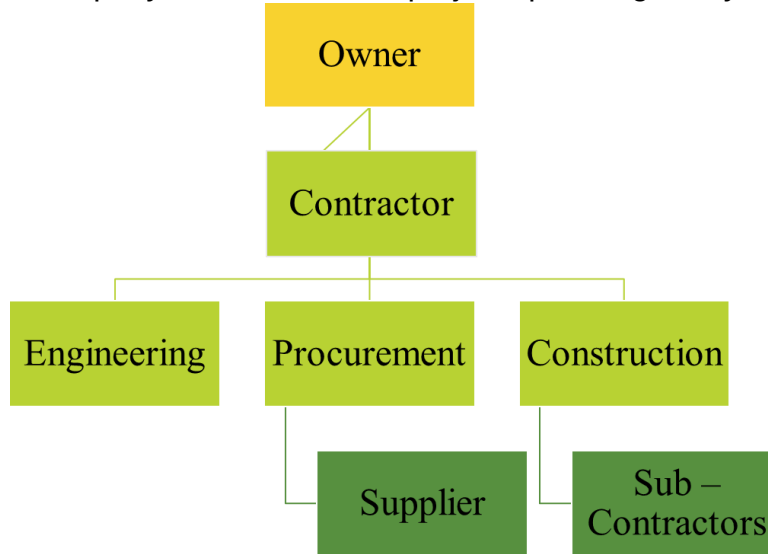


Fig 1.2 Structure of EPC Project

1.8 EPC IN INDIA

India has about 150 participants and a large number of stakeholders .

Segment	Major domestic players	Major foreign players	Insight
Infrastructure / General Contracting	Larsen & Toubro Limited, Hindustan Construction Co. Ltd., Gammon India, IVRCL, Simplex Infrastructure Ltd., Gayatri Projects Ltd., Patel Engineering Ltd., Era Infra Engineering Ltd., Sadbhav Engineering Limited, Nagarjuna Construction Company Ltd.	Isolux Corson, ITD Cementation India Limited, LJM (India) Infrastructure Limited, Leighton, ACS Construction Group Ltd., Vinci Construction	Increasing opportunities in the infrastructure sector have attracted many new domestic as well as new entrants to this space.
Building construction – Residential and Commercial Segments	Larsen & Toubro Limited, Shapoorji Pallonji & Co. Ltd., Ahluwalia Contracts (India) Ltd., B L Kashyap & Sons Ltd., B. G. Shirke Construction Technology Private Limited, B. E. Billimoria & Co. Ltd., BSEL Infrastructure Realty Limited, Consolidated Construction Consortium Ltd., Mackintosh Burn Ltd., Man Infraconstruction Limited, Supreme Infrastructure India Ltd., Unity Infraprojects Ltd., Vascon Engineers Ltd.	Arabian Construction Company, Leighton, Samsung Engineering	Space is unorganized in nature and is dominated primarily by local contractors.
Oil & Gas EPC	Larsen & Toubro Ltd., Punj Lloyd Ltd., Petron Engineering Construction Limited, Essar Projects (India) Limited, McNally Bharat Engineering Co. Ltd., Leighton, Engineers India Limited, Fabtech Projects & Engineers Ltd., Jaihind Projects Ltd.	Aker Solutions, Leighton Welspun Contractors Pvt. Ltd., Bechtel Corporation, Linde Engineering India Pvt. Ltd., Technimont ICB, Samsung Engineering, Uhde India Limited,	Significant competition from foreign participants, especially for offshore contracts; business model focused on project management rather than direct execution
Power EPC General Power EPC and Power Transmission	Power EPC BHEL, Larsen & Toubro Ltd., Tata Projects Ltd., BGR Energy Systems Ltd., Gammon India, Gayatri Projects Ltd., McNally Bharat Engineering Co. Ltd., Shriram EPC Ltd., Tecpro Systems Ltd., Cethar Ltd. Power Transmission EMC Ltd., Jyoti Structures Ltd., Hytho Power Corporation Ltd., GET Power Pvt. Ltd., KEC International Ltd., Kalpataru Power Transmission Limited, JMC Projects (India) Ltd., Techno Electric & Engineering Company Ltd., Unitech Transmission	Doosan Power Systems, Dongfang Electric Corporation, Harbin Power Engineering Co. Ltd., KEPCO, ThyssenKrupp Industries India, Alstom T&D India, Alstom Projects India Limited, Mitsubishi Heavy Industries, Toshiba Thermal and Hydro Power Systems Company, Ansaldo STS, Babcock & Wilcox	Market segmented into niche areas; few players with presence across both BTG and B&P Dominated by equipment manufacturers who have forayed into EPC as forward integration Global players entered the market in JV with Indian players to enhance their equipment business
Specialized EPC Marine, Industrial, Railways, Tunneling, Mining etc.	Shriram EPC Ltd., Coastal Projects Ltd., Navayuga Engineering Company Ltd., Hindustan Construction Co. Ltd., Patel Engineering Ltd., Alcon Infrastructure Ltd., Simplex Infrastructure Ltd., McNally Bharat Engineering Co. Ltd., Petron Engineering Construction Ltd., Kalindee Rail Nirman (Engineers) Limited, AMR Construction Ltd.	ABB India Ltd., Uhde India Ltd., Toyo Engineering India Ltd., Continental Engineering Corporation, Marti India Private Ltd., AG Group, Samsung Engineering, ITD Cementation India Ltd.	Comprises niche players in segments such as hydel tunneling, marine construction, or industrial construction

Fig 1.3 Participants – EPC projects

Sector	Total planned investment in Twelfth FYP (INR billion)	Construction Intensity ¹⁰	Construction opportunity (INR billion)
Roads and bridges	9,694.1	65%	6,301.1
Railways	5,218.0	78%	4,070.0
Mass Rapid Transit System (MRTS)	1,241.6	78%	968.4
Ports and Inland Water Transport (IWT)	1,977.8	50%	988.9
Airports	877.1	42%	368.4
Water supply and sanitation	2,549.5	66%	1,682.7
Irrigation and watershed	5,043.7	75%	3,782.8
Power	18,202.4	38%	6,916.9
Telecommunications*	9,439.0	10%	943.9
Storage*	584.4	50%	292.2
Oil & Gas	1,489.3	25%	372.3
Total	56,316.9		26,687.7

Source: Twelfth Five Year Plan document, Planning Commission, EY research, *Engineering, Procurement and Construction (EPC): Driving growth efficiently*, EY, 2011;

*Construction intensity is assumed with comparison to buildings as per data available in the Planning Commission's report. In the case of telecom, construction intensity of 10% has been assumed.

Fig 1.4 EPC projects – FYP

1.9 PHASES OF EPC PROJECTS

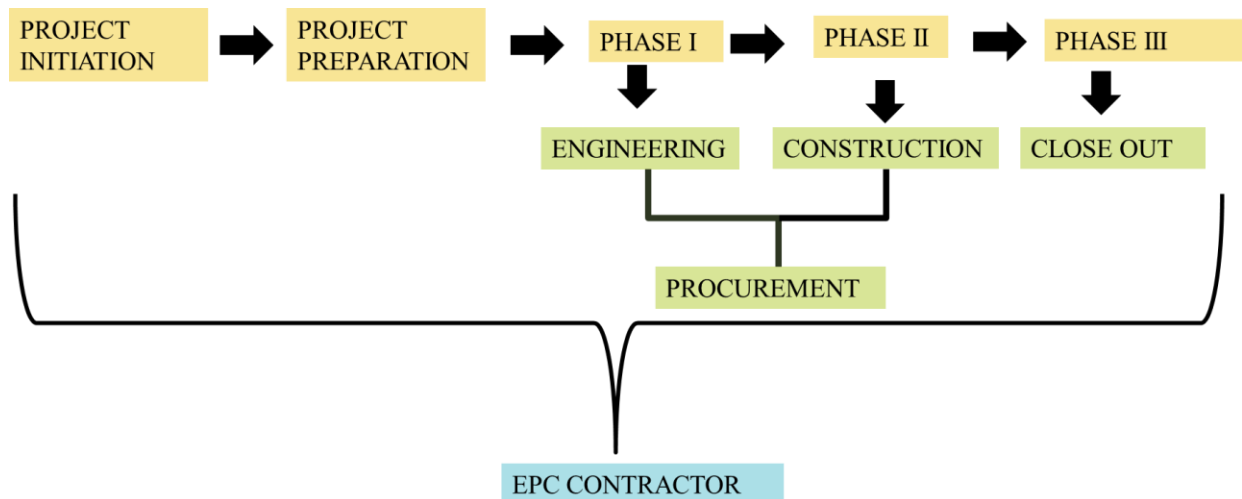


Fig 1.5 Phases of EPC projects

1.10 AIM

To develop strategic management of EPC projects by studying their risk and their applications in the projects .

1.11 OBJECTIVES

- Identify and analyze the fundamentals of EPC projects .
- To investigate and scrutinize the obstacles in EPC projects .
- To determine management strategies for EPC projects to improve effectiveness .

1.12 SCOPE :

- Mitigation strategies will be developed through which unexpected future developments can be mitigated.
- Identification of factors governing the risks will help us to frame the management plan of action .

1.13 NEED FOR THE STUDY :

- The conventional contract (item rate) was found to be causing more cost and time overruns .
- Therefore , NITI AAYOG proposed the ministries to substitute it with EPC contracts .
- In 2019 , NITI AAYOG developed a model agreement for the same .
- As per the 12th five year plan EPC projects were targeted with \$1,020 billion in infrastructure developing .

NHAI to bid out more highway projects on EPC mode to push public spending on infrastructure

Dipak K Dash / TNN / Dec 10, 2020, 00:47 IST

Niti Aayog's Model Agreement for EPC Projects

INFRASTRUCTURE ENERGY 01 Aug 2019

Niti Aayog has now put up the Model Agreement for Engineering, Procurement and Construction (EPC) of Civil Works on its website. It is a detailed document that lists out necessary aspects required to fully manage EPC or turnkey projects.

In terms of infrastructure development, most countries face issues in handling turnkey projects efficiently. The international contract models issued by the International Federation of Consulting Engineers (FIDIC), NEC, JCT, and ICE or their equivalent are put into use to monitor the projects. Revised editions of these

Fig 1.6 NHAI – Push towards EPC projects

1.14 PROBLEM STATEMENT

- The responsibility for contractor in concern with cost and time overrun is added up with design , procurement and construction .
- This leads to various risk factors affecting the project .

1.15 METHODOLOGY :

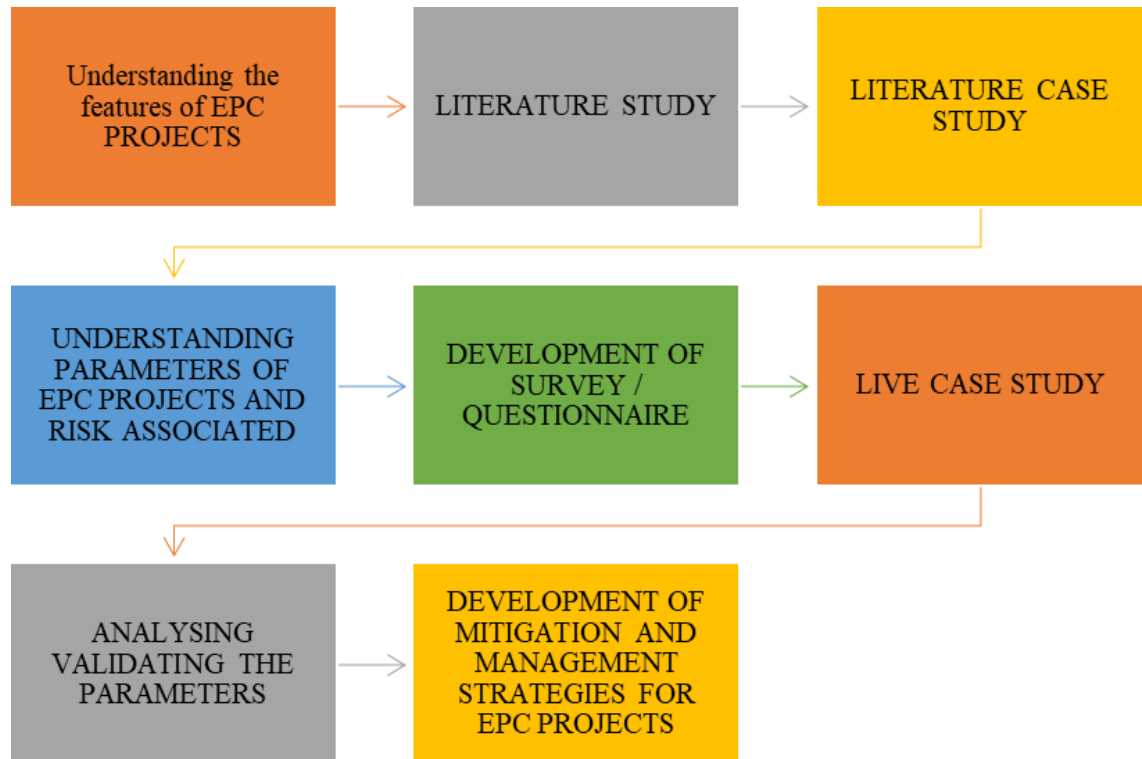


Fig 1.7 Methodology

1.16 DATA COLLECTION AND DATA ANALYSIS

1.16.1 PRIMARY DATA COLLECTION :

- CASE STUDY
- QUESTIONNAIRE

1.16.2 SECONDARY DATA COLLECTION :

- RESEARCH PAPER
- INTERNET SOURCES
- BOOKS
- REPORTS

1.16.3 ANALYSIS

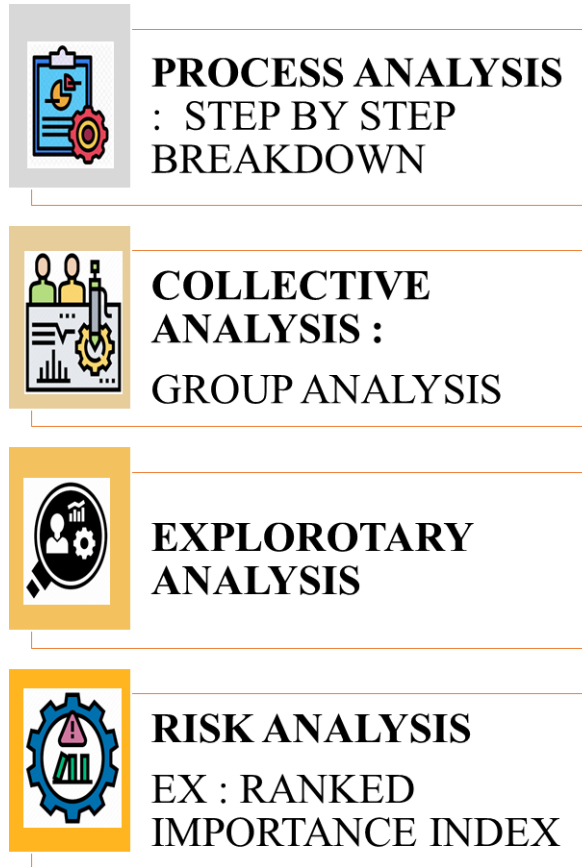


Fig 1.8 Data Analysis

CHAPTER 2

LITERATURE REVIEW

2.1 COMPERATIVE ANALYSIS OF THREE MAJOR TYPE OF CONTRACTS WITH CASE STUDY - Abhijit Langhe, Pravin Minde.

The 13th FYP showed large interest towards infrastructure development .Availability of different contract types can help to satisfy the purpose . EPC contracts are making their way up with being one contracting forms for infrastructure projects by private sector. It is found that EPC contracting scheme could work well if the contractor is able to understand the legal aspects including risk allocation.

2.1.2 OBJECTIVES :

- To analyze 3 types of contracting projects of the same organization .
- To identify factors causing loss and profits of the project .

2.1.3 CASE STUDY OVERVIEW

Case study 1:-

- Department:- Maharashtra State Road Development Corporation Limited Mumbai.
- Name of Work:- Construction of elevated structure, ROB and service roads of NH-4 from Km 24.500 to Km 25.570 in the state of Maharashtra under EPC mode.
- Type of Contract:- Engineering, Procurement and Construction (EPC) Contract
- Length in Km:- 1.07 Km
- Completion Period:- 18 Months
- Estimated Tender Cost:- Rs. 46.1246 Crore

Case Study 2:-

- Department:- Public Works Department (PWD)
- Name of Work:- Construction of Flyover From College of Engineering Pune to Patil Estate, Pune (Balance Work)
- Type of Contract:- Item Rate Contract
- Length in Km:- 0.80 Km • Completion Period:- 15 Months
- Estimated Tender Cost:- Rs.21.83 Crore

Case Study 3:-

- Department:- Pune Municipal Corporation
- Name of Work:- Construction of ROB between S. No. 89 & 71 at Mundhawa Over Pune Solapur Railway line on 24.0 Mtr. HCMTR.
- Type of Contract:- "C" Form (Lump – sum Contract)
- Completion Period:- 24 Months
- Estimated Tender Cost:- Rs. 25.87 Crores

2.1.4 COMPARATIVE STUDY – CONTRACT TYPES

	EPC	ITEM RATE CONTRACT	LUMP SUM
SUITABILITY	For infrastructure project and power projects. The contractor will carryout the design , procurement and deliver the project as per stipulated time	Used for all type engineering works that are financed by public or government . Suitable for works that can be split into separate items and quantities through which accurate estimation can be done	•The contractor does all the work from the drawings and specifications that is provided . This is done for a whole quoted amount . •The schedule of different items of work is not provided and the contractor has to complete the work as per drawings and specifications for the agreed lump sum amount.
ADVANTAGES	a. Reduced total time during the contractual process by having just one process. b. A seemingly “lower cost” when integrating “all” the elements under one provider. c. The main advantage of this service is the peace of mind the owner gets when it hands over full responsibility of the project to “only one contractor”, it is much easier for the owner to manage and communicate with one provider, which means “one neck to choke”. d. EPC minimizes the owner's risks. e. EPC for mega projects is more flexible and efficient delivery method.	a. There is no need for detailed drawings at the time of allotting contract as in the case of lump sum contract. - b.The detailed drawings can be prepared after the contract is awarded. c. The payment to the contractor is made on the actual work done by his at the agreed rates.	a. The owner can decide whether to start or shelve the project knowing the total lump sum price quoted by different contractors. b. The contractor can earn more profit by in depth planning and effective management site. c. Since the contractor has accepted a fixed price for the construction, the owner is not liable for any over expenditure. This is the most important benefit. d. It is much simpler to get construction loan with a Lump sum contract as it provides a high degree of certainty as far as cost is concerned. e. It is much easier to supervise and manage Lump sum contracts.
DISADVANTAGES	a. A higher cost is assumed due to the higher risk that comes with total responsibility, there is less information to prepare proposals and therefore bidders assume more risks. b. There is a greater disparity when comparing offers, both economically, because each provider has different criteria for assessing the risk. c. Usually designs are oversized due to lack of information available at the time when the offer is being prepared.	a. The total cost of work can only be known upon completion. As such, the owner may incur financial difficulty if the final cost increases substantially. b. Additional staff is required to take detailed measurements of work done for releasing payments to the contractor.	a. Quantifying changes is a big challenge. Such contracts demand documentation and record keeping of change orders at all stages that further requires more paperwork. b. Lump sum contracts pose greater risk to contractor. c. The overall construction completion could take longer than other contractual alternatives. d. Since the contract is based on fixed price, the contractor may start using sub-standard means and methods and products. In such a case, the owner should specify building materials well in advance. e. Lump-sum contracts usually end up with higher fixed price to cover unforeseen circumstances. Owners are responsible for unpredicted conditions which are beyond the control of either party

Table 2.1.Comparative analysis – Contract types

2.1.5 COMPARATIVE STUDY – CASE STUDIES

CASE STUDY	DEHU ROAD	COEP	MUNDHAWA
CONTRACT	EPC	ITEM RATE	LUMP - SUM
COST	SCOPE AND BUDGET IS FIXED. EXTRA AMOUNT CAN'T BE CLAIMED . BECAUSE THE SCOPE IS FIXED .	PROJECT AMOUNT IS PROVIDED BY THE CLIENT . EXTRA CAN BE CLAIMED .	AMOUNT IS FIXED. BUT AMOUNT CAN BE CLAIMED AS PER THE WORK EXECUTED
FEASIBILITY	WORK STARTED WHEN THE LAND IS ACQUIRED MORE THAN 90%	STARTED WHEN 25 % WAS ACQUIRED	50% OF THE LAND
TIME OVERRUN	NO TIME EXTENSION	DEPENDS UPON THE REMAINING WORK	TIME IS DEFINED . BUT CAN GET , WITH VALIDE REASONS
COST OVERRUNS	ONLY IF THERE ARE RATE ESCALATIONS OR SHIFTINGS	CAUSES : 1.ESCALATION DUE TO DELAY 2.EXTRA ITEMS	1. ESCALATION COST 2. EXTRA ITEMS 3. CLAIMS

Table 2.2 .Comparative analysis – Case study

2.1.6 CONCLUSION

- In EPC contract single contractor is appointed by the owner for all kinds of construction works. The major difference between lump sum and EPC is that, in EPC the contractor has the responsibility of design and construction.
- Where as in lump sum contract the design and drawings are prepared by the technical team of the owner.
- The EPC contractor hands over a working facility that's ready to go. A design-build contract closes out similarly to design-bid-build contracts, with the owner and its construction manager or designer taking an active role in punching out the facility.
- Design-build contracts tend to take either a traditional design-bid-build approach to unknowns like hidden site conditions, or to share that risk between the owner and the design-builder. In contrast, it's not uncommon for EPC contracts to shift these risks entirely to the EPC contractor.
- Understanding the differences between these two seemingly quite similar design processes is a key step when assessing which delivery system is right for your project.

2.2 SUITABILITY OF EPC CONTRACTS IN PUBLIC SECTOR BUILDING CONSTRUCTION PROJECTS -Dipanshu Sharma, Retd.Maj Gen TaranSidana, Dr. Virendra.Kumar Paul

Niti Aayog (2016) suggested that any projects above 100 crore to go for EPC contracts . But , around 345 infrastructures projects saw cost overruns (2019). This paper aims to find the suitability of EPC for infrastructure projects .

2.2.1 OBJECTIVES

- To understand the contracting strategies and risks/challenges involved in public sector building projects.
- To identify the factors governing the suitability of EPC projects in public sector building construction projects.
- To analyze the high/Less risk factors associated with EPC contracts in implementation in public sector building construction projects through expert opinion.
- To analyze the results of survey and further validate it on case study to find out the suitability of EPC Contracts in Public sector Building construction projects.

2.2.2 METHODOLOGY

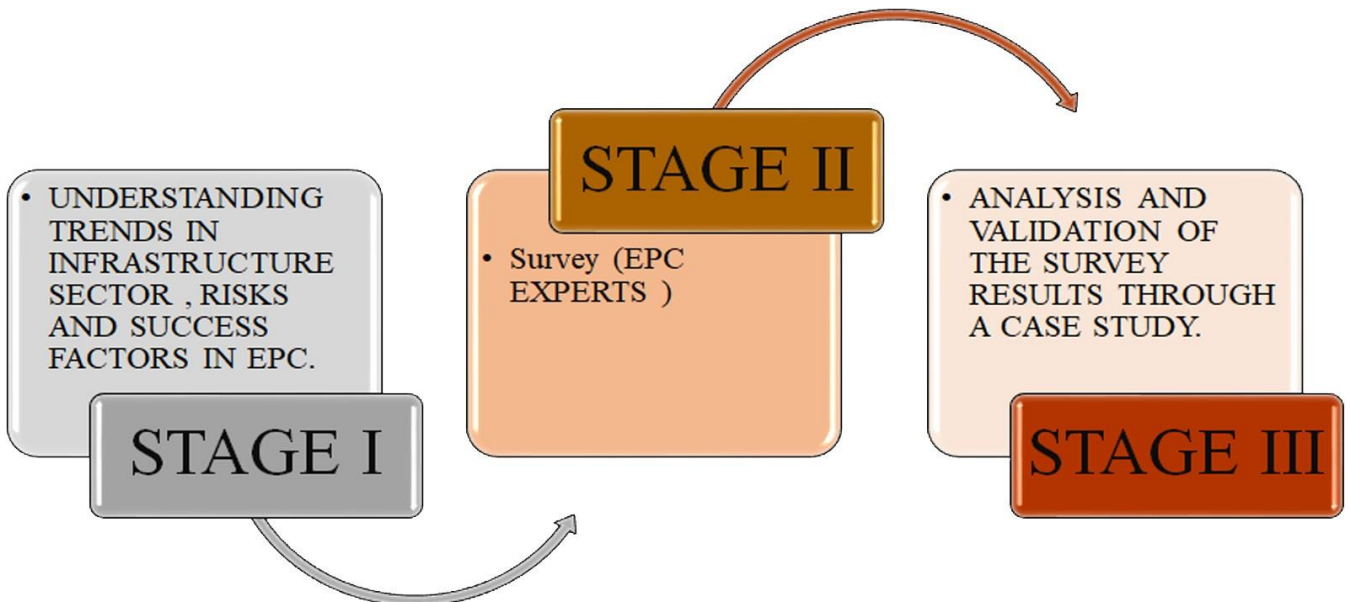


Fig 2.1 Methodology

2.2.3 PECULIARITIES & SUCCESS FACTORS OF EPC CONTRACTS

- 1 Front End Engineering Design
- 2 Base concept/Schematic design
- 3 Statement of Owner requirement vs Detail specifications
- 4 Role of owner consultant

- 5 Design requirement and issues
- 6 Procurement process
- 7 Quality requirements
- 8 Contract schedule issues
- 9 Performance tests
- 10 Contractual Obligations:
 - 10.1 Termination for default
 - 10.2 Performance security
 - 10.3 Third party requirements
 - 10.4 Force majeure
 - 10.5 Change in law
 - 10.6 Commissioning requirements
 - 10.7 Insurance
 - 10.8 Extension of Time

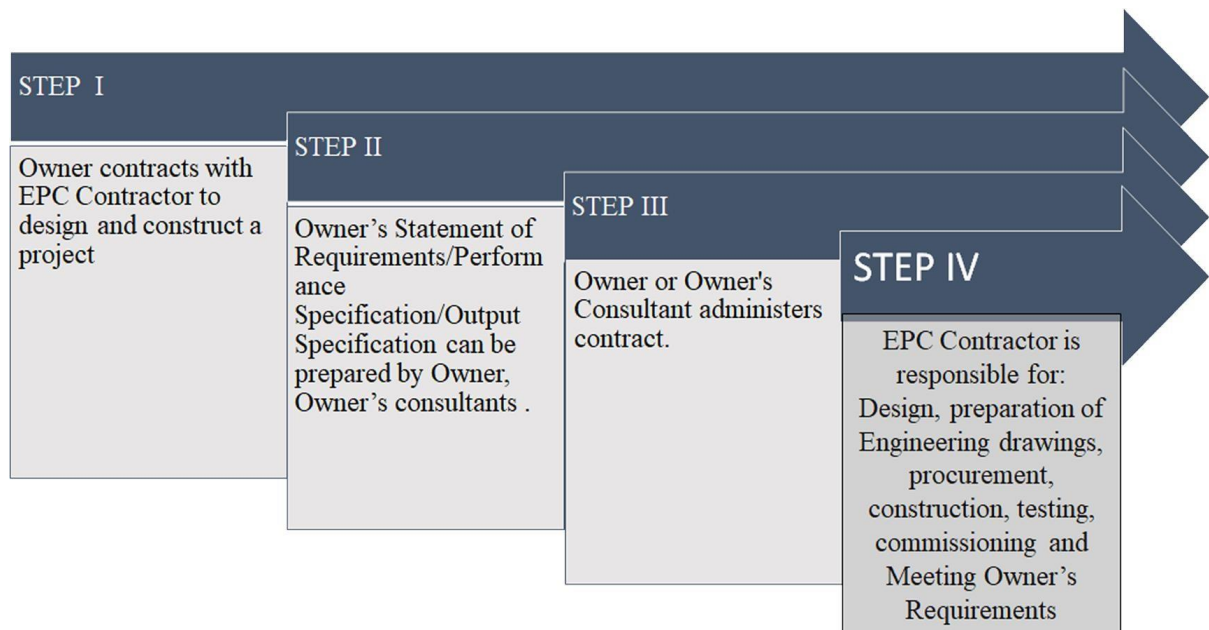


Fig 2.2 Stages – EPC projects

2.2.4 RISK GROUPS

S No	Risk Group	Questions	Analysis	Suitability
1	Pre-FEED/FEED Study	To what extent, should the end user involve (in case of complex buildings like Hospitals) in preparation of Feasibilities studies in EPC Contracts in Public Sector Building construction projects?	1: 20% 2: 40% 3: 60% 4: 80% 5: 100%	Above 3
		FEED study is very crucial stage in EPC projects, on a scale of 1-5 how much its importance is being considered in public sector building projects ?	1: Not considered 2: Considered Less 3: Moderate 4: High 5: Very High	Above 3
		What is the level of completeness of FEED Study in public sector building projects in EPC Contracts?	1: 20% (Incomplete-Lack of Pre-Feed Study) 2: 40% (Ambiguous) 3: 60% (Moderate) 4: 80% (Good: Need one-time clarifications from owner) 5: 100% (Excellent-Fully complete and easy to understand and implement)	Above 3
		Who carries out the FEED Study in Public sector Building Projects?	- FEED Experts - Owners' team - Others	
2	Base concept/Schematic Design (Scope Definition)	On a scale of 1-5, How well the scope is the defined in EPC Contracts? (Intent: Incomplete/unclear Scope definition due to insufficient feasibility study leads to delays and disputes in construction)	1: 20% (Incomplete-because of incomplete feasibility study) 2: 40% (Ambiguous- Requirements are not clear) 3: 60% (Moderate) 4: 80% (Scope is clear, but require one-time modification to make it fit for purpose) 5: 100% (Scope is clear and well defined in terms of owners' requirements)	Above 3
3	Statement of owner's requirement vs Detailed design: (Functionality)	On a scale of 1-5, How clearly are the specifications and details of the project have been specified by the client? (Intent: Inadequate specification and detailing due to unclear scope definition and FEED Study leads to dispute during construction)	1: 20% (Incomplete) 2: 40% (Ambiguous- Specifications and details are not matching) 3: 60% (Moderate) 4: 80% (Specs are clear, but require one-time modification to make it fit for purpose) 5: 100% (Specs are clear and well defined in terms of owners' requirements and needs no modification)	Above 3
4	Quality Requirements	In EPC Contracts the client has to submit only Architectural drawings, to what extent does the quality of Architectural drawing deliverable improved?	1: No improvement- Same as other contracts i.e. More revisions and slow decisions. 2: Slightly Improved- More revisions and fast decision 3: Moderate=Less revisions and fast decisions. 4: Highly improved- Very few one-time modifications. 5: Excellent- (Require No changes)	Above 3

6	Overall	Which of the following parameter still needs to be workout in detail more for successful implementation of EPC Contracts in Building Sector?	• Pre-FEED/FEED Study • Base concept • Project specifications (Functionality) • Quality parameter • Others (Specify)	Answer can be more than 1 also.
7	Role of owner consultant	Is/Should there be role of client's Architect after award of tender?	Yes/No/Maybe	
8	Design requirement (Feasibility/Design Basis report)	Was the Design Basis Report completed and approved before tendering?	Yes/No	
		Does all the statutory approvals have been taken before execution of construction phase?	Yes/No	
		Is it possible for owner to Request for change in design during Engineering and Construction phase of EPC contracts?	Yes/No/Yes with Terms and conditions	
9	Overall	Does EPC Contract help in mitigating cost, time overrun?	• Yes, Both of them • None of them • Time only • Cost only	
		As the building sector is design and Functionality oriented, which contract form would you recommend for Public Sector Building projects like Hospitals, Schools and other high functionality driven buildings?	EPC/DB/DBB	

Fig 2.3 Risk Groups

2.2.5 SURVEY CONCLUSION

- From the responses of experts engaged in various Public sector projects on EPC mode, it has been seen that completeness of “FEED study” and “statutory approvals” are high risk parameters in public sector building projects on EPC contracts, while “clear project specification” is a moderate risk parameter.
- The preferred choice of contract form is EPC Contract form as compare to DB and DBB but on the other hand it has also been observed that EPC contracts do helps in mitigating cost overrun factor but it may not be able to mitigate time overrun because of unforeseen circumstances or unmaintained risk register in FEED Study. Hence From expert opinion, choice of contracts in public sector building projects is:
EPC> DB>DBB

2.2.6 CASE STUDY

To further validate the result of expert opinion, a case study of a Public sector project being constructed on EPC Contracts have been opted to find the suitability of EPC Contracts in public sector building construction project. The duration of project was 6months+ 2 years + 2 years. First 6 months was for planning and taking approvals (Engineering phase). Next 2 years was allocated for construction phase and next 2 years was allocated for Defect liability period and maintenance of project. It was found that the project is more than 1 year behind schedule because of the following reasons:

8.1 Project Issues:

Table 3: Project issues involved in case study.

Sr. no	Issue Description
1	Delay in Tree cutting Approval.
2	Change in Layout Plan in order to retain trees
3	Shortage of Funds

1. All the statutory approvals have been taken except Tree cutting permission (which was in scope of contractor) during the time allocated for taking statutory approvals i.e 6 months from date of award of contract. There are about 349 existing trees at site out of which 109 to be cut. Initial Design consists of 2 basement + stilt + 8 storeys. The design has been revised i.e. Stilt+ 8 storeys in order to reduce the no of trees to be cut. All the approvals were taken again as per new design and it took again 6 months in getting those approvals done.
2. The project has faced "shortage of funds" issues due to which the project is running behind schedule (more than 1 year).

Fig 2.4 Case study

2.2.7 CONCLUSION

- From the Expert opinion survey and the case study taking statutory approvals and shortage of funds from clients contribute to major time delay issues in public sector EPC Contracts.

2.3 DEFINING MITIGATION STRATEGIES FOR RECURRING EPC CONTRACT RISKS- Benyamin Sadeghi ; Mohammad Mehdi Mortaheb; and Hamed Kashani.

EPC contracting projects are commonly used in infrastructure projects . This contracting type is said to have many uncertainties . Several studies have come up with the risks involving in EPC projects but , failed to management strategies for the same .

2.3.1 OBJECTIVE:

- The objective of this study is to define efficient risk mitigation strategies that can be utilized in EPC projects.

2.3.2 RESEARCH METHODOLOGY

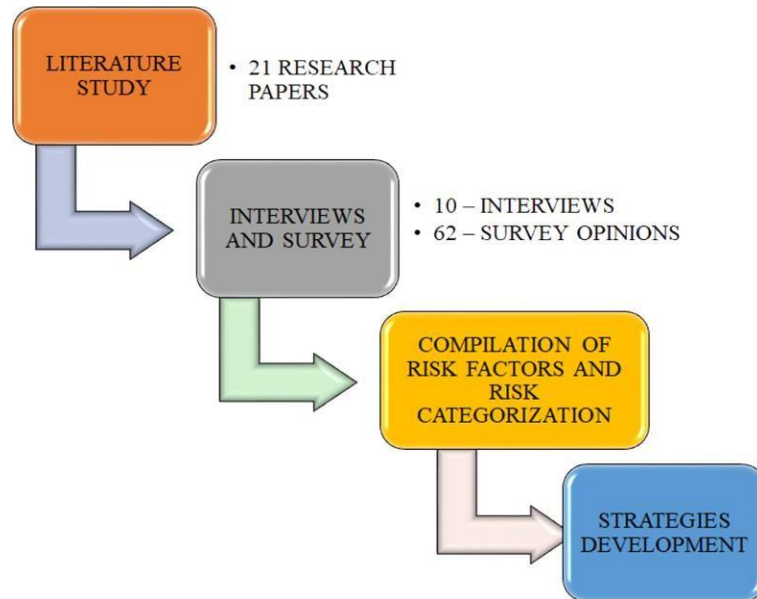


Fig 2.5 Case study

2.3.4 RISK FACTORS

Risk Groups		Risk Factor
External Risks	Economic	1 Inflation or sudden and unforeseen fluctuation of price
		2 Currency exchange rate Fluctuation
		3 Sudden rise in equipment and materials because of economic sanction
	Legal- Political	4 Modification of government policies
		5 Changes in laws and regulations (pollution, safety, etc.)
	Natural-Physical	6 Force majeure (Earthquake, fire, flood)
		7 Unforeseen physical conditions (Geotechnical, environment, pollution)
	Third Party	8 Bureaucratic problems (delays or rigidity in obtaining approvals and permits)
		9 Poor communication between JV partners
Internal Risks	Contract and Scope	10 Inadequate specification and detailing
		11 Vagueness of contract clauses and documents
		12 Inadequate conceptual design
		13 Unfamiliarity with EPC contract conditions for claims and litigations
	Design	14 Incomplete and unclear Scope definition due to insufficient feasibility study
		15 Errors and omissions in contractor's design
		16 Contractor doesn't meet owner's demands (design changes)
	Owner	17 Too many change orders by owner
		18 Financial problems or bankruptcy like lack of/delayed payments
		19 Owner default or delay in delivering construction site or jobsite requirements
	Construction	20 Owner Delay in approvals/change orders
		21 Lack of proper construction techniques/defective work
		22 Insufficiency of contractor management skills and experience
		23 Inadequate quality of work to scoop out profit
		24 Default/incapability of sub-contractors or suppliers
		25 Disturbance/shortage in availability of labor, material and equipment
		26 Different site conditions

Fig 2.6 Risk Factors

2.3.4.1 RISK FACTORS – INTERNAL

Risk group	Response strategy	Owner	Contractor	Total	Asymp. S	Mode (tot	Efficienc	Strategy
Scope and contract	1 An experienced consultant firm provide the contract documents and requirements	4.2	4.3	4.3	0.569	4	High	Transfer
	2 Using experienced contractual experts to write clear contract clauses	4.3	4.3	4.2	0.698	5	Very High	Mitigate
	3 Utilizing the consultant firm for identifying the exact needs of owner and detailed scope definition	4.2	4.3	4.2	0.648	5	Very High	Avoid
	4 Owner should undertake comprehensive site investigation	4.0	4.2	4.1	0.695	4	High	Transfer
	5 Holding enough briefings between project parties for clarification of documents and statements	3.9	4.3	4.1	0.122	4	High	Mitigate
	6 Beginning the project after "Front-End Engineering Design"	4.0	4.1	4.0	0.676	4	High	Avoid
	7 Providing the comprehensive project definition package through RFP	3.8	4.0	4.0	0.362	4	High	Avoid
	8 Contractor's participation in clarification and completion of the conceptual design	3.9	4.0	3.9	0.775	4	High	Transfer
	9 Owners exceed conceptual design and specify the exact objectives of the project	3.5	3.7	3.7	0.843	4	High	Transfer
	10 Spending enough time and precision in conceptual design phase	3.5	3.8	3.6	0.224	4	High	Mitigate
	11 Owner's consultant become manager of contracts (MC) in construction phase	3.3	3.4	3.5	0.857	4	High	Accept
Design	1 Owner should specify all of the rules and standards before the beginning project	3.9	3.8	3.9	0.637	4	High	Avoid
	2 Beginning the project after "Front-end Engineering Design"	4.0	3.9	3.9	0.718	4	High	Mitigate
	3 Specifying the crucial and costly requirements in the contract documents	3.8	3.8	3.9	0.399	4	High	Avoid
	4 Increasing the coordination and interaction between contractor and consultant	3.9	3.8	3.8	0.692	4	High	Mitigate
	5 Providing the comprehensive project definition package through RFP	4.0	3.8	3.8	0.719	4	High	Avoid
	6 Owner should have accurate supervision of the contractor's design	4.1	3.7	3.8	0.082	4	High	Transfer
	7 Evaluation /appraisal of design criteria by one independent and reliable consultant	3.9	3.7	3.7	0.335	4	High	Mitigate
	8 Making a rigid framework that prevent violation of the owner's design	3.7	3.6	3.7	0.354	4	High	Avoid
	9 QC/QA programs	3.8	3.4	3.5	0.183	4	High	Mitigate
	10 Defining thresholds for the possible change orders based on the value engineering	3.4	3.4	3.4	0.213	3	Average	Accept
	11 Adoptable design-construction methods in the case of uncertainties	3.7	3.4	3.4	0.695	3	Average	Avoid
	12 Performing value engineering in the design and construction in the different steps of design phase	3.6	3.3	3.3	0.376	3	Average	Mitigate
Owner	1 Commitment of owner for compensation of contractor's loss	3.9	4.2	4.1	0.099	4	High	Accept
	2 Opening required accounts like LC by owner before the beginning of project	3.8	3.9	3.9	0.648	4	High	Avoid
	3 Termination of contract in the case of owner's financial failure	3.7	3.5	3.6	0.615	4	High	Avoid
	4 Liquidated damages clauses (specifying extension or compensation clauses in contract for delays)	3.4	3.7	3.5	0.364	4	High	Mitigate
	5 Owner should present proof of having enough financial resources to contractor in the specified intervals of project duration	3.5	3.3	3.4	0.655	3	Average	Mitigate
	6 Termination of contract if owner have no proof of financial resources	3.5	3.0	3.2	0.112	3	Average	Avoid
Construction	1 Attention and accuracy in selecting and evaluation of contractor	4.2	4.3	4.3	0.752	5	Very High	Mitigate
	2 Hiring a professional project manager by owner	4.4	4.2	4.3	0.562	5	Very High	Mitigate
	3 Builder's insurance	3.8	4.0	4.0	0.471	5	Very High	Transfer
	4 Proper quality control procedures by owner	4.4	3.7	3.9	0.004	4	Unknown	Avoid
	5 Providing the comprehensive project definition package through RFP	4.0	3.9	3.9	0.56	4	High	Avoid
	6 Increasing the cooperation between contractor and consultant	4.1	3.7	3.9	0.189	4	High	Mitigate
	7 Owner should specify all of the standards before the beginning project	4.1	3.6	3.8	0.068	4	High	Avoid
	8 Comprehensive and detailed conceptual design	3.8	3.6	3.8	0.43	4	High	Mitigate
	9 Beginning the project after "Front-end Engineering Design"	3.8	3.6	3.7	0.444	3	Average	Avoid
	10 Clear contract clauses for dealing with different underground conditions	3.9	3.6	3.7	0.362	3	Average	Mitigate
	11 Contractor should undertake comprehensive site investigation and make enough meetings to clarify site uncertainties before tender	4.0	3.6	3.7	0.089	3	Average	Mitigate
	12 Providing good opportunity for contractor to examine and gather information about site and underground conditions	3.9	3.5	3.6	0.117	4	High	Avoid
	13 Prequalification of sub-contractor	3.4	3.6	3.6	0.379	4	High	Avoid
	14 QC/QA programs	3.9	3.4	3.6	0.064	3	Average	Mitigate
	15 Enough contract bond	3.8	3.2	3.5	0.011	3	Unknown	Avoid
	16 Owner's consultant in the conceptual design phase become manager of contracts (MC) in construction phase	3.6	3.2	3.4	0.412	3	Average	Accept
	17 Owner should provide a vendor list of competent supplier	3.6	3.2	3.3	0.122	3	Average	Avoid
	18 Obtain enough payment bond and performance bond	3.5	2.7	3.0	0.002	3	Unknown	Avoid

Fig 2.7 Risk Factors – Internal

2.3.4.2 RISK FATORS – EXTERNAL

Risk Group	Response Strategy	Mean				Sig.	Mode (total)	Efficiency	Strategy
		Owner	Contractor	Consultant	Total				
Economic	1 Owner cover the cost of sudden fluctuation in the prices	3.9	4.1	4.1	4.1	0.702	4	High	Transfer
	2 Considering price adjustment in the fixed-price contracts	3.9	4.0	4.2	4.0	0.655	4	High	Transfer
	3 Foreign currency payment to contractor for procurement that their prices are dependent on foreign currency.	4.0	3.9	3.6	3.9	0.573	4	High	Transfer
	4 Cost contingency (specifying compensation clauses in contract for payment)	3.6	3.3	3.7	3.4	0.375	3	Average	Accept
	5 Owner purchase the critical equipment having possibility of increase in their price	3.4	3.3	3.4	3.4	0.966	4	High	Avoid
	6 Performing feasibility study in the Specified intervals of project life cycle	3.2	3.2	3.2	3.2	0.986	3	Average	Mitigate
	7 "Guaranteed Maximum Price"	3.5	2.8	2.6	3.0	0.031	3	Unknown	Accept
	8 Forward contracts to hedge economic fluctuations	3.1	2.6	2.8	2.8	0.235	3	Average	Avoid
	9 Termination of contract in the case of heavy and sudden financial fluctuation	2.3	2.6	2.2	2.5	0.567	2	low	Avoid
political-Legal	1 Include clauses for updating the contract for delays and additional payments which occur due to new rules or change in law	3.9	4.0	4.0	4.0	0.895	4	High	Mitigate
	2 Specifying all of the rules and standards before the project by owner	3.7	3.6	3.7	3.7	0.912	4	High	Avoid
	3 Clarification that the criterion of design and construction is always the laws that were established in the time of signing the contract	3.5	3.7	3.2	3.6	0.464	4	High	Avoid
	4 Specifying all of the rules and standards before the project by owner	3.5	3.5	3.2	3.5	0.795	4	High	Mitigate
Natural-Physical	1 Insurance for force majeure	4.2	4.3	4.6	4.3	0.609	5	Very High	Transfer
	2 Include clauses for delays and additional payments in contract, which occur due to happening of unexpected events	3.7	3.9	4.8	3.9	0.007	4	Unknown	Mitigate
	3 Developing contingency plan	3.7	3.6	3.9	3.7	0.778	4	High	Accept
	4 Owner should undertake comprehensive site investigation	3.5	3.5	3.2	3.5	0.802	4	High	Mitigate
	5 Sensitive analysis of "During Recovery" of disasters and weather models	3.1	3.1	3.0	3.1	0.975	3	Average	Mitigate
Third-party	1 Prepare the critical approvals and permissions by owner before tender	4.0	4.2	3.8	4.1	0.509	4	High	Avoid
	2 Pre-package all approvals when signing contract with owner	3.7	4.0	4.3	3.9	0.203	3	Average	Avoid
	3 Commitment of owner in cooperation with contractor in providing licenses	3.4	4.0	3.8	3.8	0.045	4	unknown	Mitigate
	4 Choosing competent and trustworthy JV partners by owner	3.6	3.8	4.0	3.8	0.581	4	High	Avoid
	5 Choosing a contractor who has good relationship with the authorities	3.9	3.6	3.8	3.7	0.449	4	High	Mitigate
	6 Defining all of the required permits and approvals in RFP ¹	3.5	3.7	3.9	3.7	0.469	4	High	Mitigate
	7 defining each staff's scope of work, authority and responsibility under the whole responsibility of one of the project participants	3.2	3.6	4.0	3.5	0.045	3	Unknown	Mitigate
	8 Having Contingency plan for delays in permits	3.4	3.6	3.2	3.5	0.51	4	High	Mitigate

Fig 2.8 Risk Factors – External

2.3.5 CONCLUSION

26 RISKS - 8 GROUPS

- Implementing FEED before bid.
- Extensive clarification meetings between project participants
- Providing comprehensive project definition package through RFP .
- Adding provision in the contract for coverage of unpredictable fluctuation by the owner.
- Proper selection of contractor.

2.4 ENHANCING RISK MANAGEMENT BY PARTNERING IN INTERNATIONAL EPC PROJECTS- Yujing Yang , Wenzhe Tang , Wenxin Shen and Tengfei Wang .

EPC involves a set of participants in the process of project delivery - clients , contractors , designers who have specific interests. However there are limited companies that are able to complete . EPC projects rely on their own capacities . In the above mentioned case , risk management plays an important role in project delivery and decision making .

2.4.1 OBJECTIVES

To study the link between risk management , interface management and project performance in EPC projects .

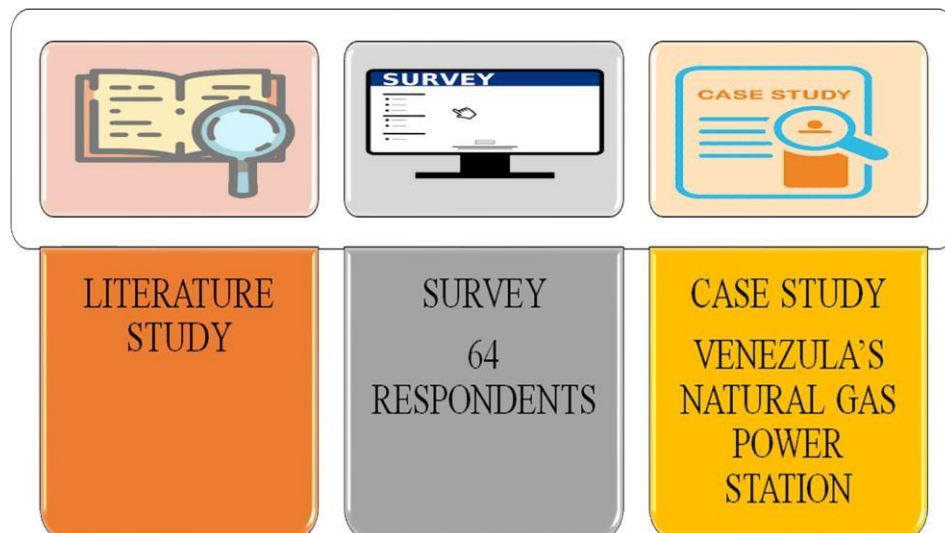


Fig 2.9 Methodology

2.4.2 INTERFACE MANAGEMENT

- Management of communication , relationships and deliverable among interface stakeholders.
- An approach to mitigate the adverse influence of complexity in projects .

Partnering with Stakeholders	Rank	Rating	Cronbach's α
Contractors–consulting engineers	1	6.98	0.915
Contractors–clients	2	6.50	
Contractors–designers	3	6.48	
Contractors–equipment suppliers	4	6.18	
Contractors–subcontractors	5	6.14	
Contractors –material suppliers	6	5.90	
Contractors–financial institutions	7	5.84	
Contractors–local residents	8	5.66	
Contractors–local government	9	5.52	
Average		6.14	

Fig 2.10 Frequency of interface problems between stakeholder

	Rank	Rating	Cronbach's α
Contractors–designers	1	8.04	0.912
Contractors–equipment suppliers	2	7.90	
Contractors–material suppliers	3	7.82	
Contractors–subcontractors	4	7.76	
Contractors–consulting engineers	5	7.38	
Contractors–clients	6	7.28	
Contractors–financial institutions	7	6.80	
Contractors–local government	8	6.58	
Contractors–local residents	9	6.42	
Average		7.46	

Fig 2.11 Performance of interface management between the contractors and the stakeholders.

2.4.3 RISK MANAGEMENT

- The risk for contractor is high in this type of projects . Which can affect the whole project .
- Risks are complex in EPC projects because of the dynamic characteristics .
- EPC contractors should manage various activities that are related .

•This is a challenging task which subjects to prevent losses arising from external environment and project implementation.

Risks	Rank	Rating	Cronbach's α
Unclear design intention	36	5.80	
Natural hazards	38	5.76	
Contractors' opportunism behaviors	38	5.76	
Inappropriate construction planning	40	5.66	
Poor relations among project participants	41	5.62	
Tense relationship between host country and the contractor's home country	42	5.60	
Damage of construction plants	43	5.48	
Incomplete local legal system	43	5.48	
Poor local transportation	43	5.48	
Poor construction condition at site	46	5.44	
Confliction with local communities	47	5.16	
Difficulties in land acquisition and resettlement of migration	48	5.06	
Average		5.87	

Risks	Rank	Rating	Cronbach's α
Exchange rate/inflation risk	1	7.14	0.915
Clients' payment delay	2	6.94	
Contractor's incompetent technology	2	6.94	
Project financing difficulties	4	6.90	
Inefficient processing of client	5	6.72	
Design errors and defects	5	6.72	
Cost control in project implementation	7	6.58	
Quality of work	7	6.58	
Delay of approval from the client	9	6.56	
Force majeure	9	6.56	
Lack of required material and equipment	11	6.52	
Delay of design approval from consultant	12	6.48	
Price change of material and equipment	13	6.44	
Confiscation of the bid guarantee	13	6.44	
Unstable political situation in the host country	15	6.38	
Material or equipment quality	16	6.36	
Incompetence of subcontractors	17	6.34	
Poor economic environment	18	6.28	
Inappropriate design option	19	6.24	
Lack of design optimization	20	6.14	
Change in laws and regulations	21	6.10	
HSE	21	6.10	
Corruption	21	6.10	
Logistics	24	6.08	
Expropriation and nationalization of assets	25	6.04	
Design variation	25	6.04	
Change of quantity	27	6.00	
Insurance is not sufficient	27	6.00	
Adversarial natural environment	29	5.96	
Inconvenient local business trading	29	5.96	
Shortage of labor, materials and equipment	31	5.94	
Inappropriate allocation of risks and rewards	32	5.90	
Work injury accident	32	5.90	
Restrictions from laws and regulations	34	5.86	
The existence of terrorism	34	5.86	
Insufficient project planning	36	5.80	

Fig 2.12 Risk factors affecting EPC

Factors Affecting Risk Management	Rank	Rating	Cronbach's α
Lack of formal risk management system	1	8.24	0.949
Lack of joint risk management mechanism by parties	2	8.20	
Lack of awareness for joint risk management	3	8.10	
Lack of cooperative risk management knowledge and skills	4	7.94	
Ineffective risk monitoring	5	7.90	
Lack of historical data for risk analysis	6	7.62	
Inappropriate risk allocation	7	7.40	
Different understanding of risks among project participants	7	7.40	
Lack of ongoing project information for decision-making	9	7.38	
Lack of incentives for better risk management	10	7.12	
Ineffective implementation of risk control strategy	11	6.48	
Average		7.60	

Fig 2.13 Barriers to risk management

Techniques of Risk Management	Rank	Rating	Cronbach's α
Risk identification			0.906
Brainstorming	1	8.10	
Consulting experts	14	7.16	
Checklist	15	7.02	
Individual assessment	17	6.22	
Risk analysis			
Joint evaluation of key participants	3	7.90	
Qualitative analysis	8	7.50	
Use of consulting experts	12	7.26	
Semi-quantitative analysis	13	7.20	
Quantitative analysis	16	6.70	
Individual analysis	17	6.22	
Use of computers and other modeling methods	20	4.92	
Risk response			
Reduce the likelihood of occurrence	2	8.00	
Avoid the risk	4	7.86	
Transfer the risk	7	7.54	
Reduce the consequences	11	7.40	
Retain the risk	19	5.62	
Risk monitoring			
Periodic document reviews	5	7.82	
Periodic risk reporting	6	7.68	
Establishment of the risk warning system	8	7.50	
Periodic trend reporting	8	7.50	
Average		7.16	

Fig 2.14 Application level of risk management techniques

2.4.4 CONCLUSION

- The status of partnering application, interface management, and risk management, suggesting the needs for project participant to co-operatively manage interfacing EPC activities and to jointly deal with various risks during the project delivery.
- The path analysis show that partnering not only directly contribute to interface management and risk management, thereby improving project outcomes, but also has a positive impact on risk management through enhanced interface management.
- Contractors' success in applying partnership can play an exemplary role for other contractors, and governments can create a favorable environment to stimulate participants' using win-win philosophy for better infrastructure Development.

OVERVIEW OF LITERATURE STUDY

LITERATURE STUDY	OUTCOMES
Case study 1 (comparison)	•Nature of EPC projects •Difference , pros and cons of using EPC in infrastructure projects
Suitability of EPC Contracts in Public Sector Building Construction Projects	•Suitability and preference of delivery method
Defining mitigation strategies for recurring EPC contract risks	•Categorisation of risk factors •Analysis of the risk parameters
Enhancing risk management by partnering in International EPC projects .	•Risk management and interface management •Risk identification and risk response

Table 2.3 . Overview of Literature study

CHAPTER 3

LITERATURE CASE STUDY

3.1 BIDBOLAND II GAS TREATING PLANT , IRAN.

- Client: National Iranian Gas Company (NIGC)
- Location: Behbahan, South West of Iran
- Contract price: 3.3 Billion USD
- Duration of work: 43 months
- Contract : EPC
- EPC Contractor : Sazeh-Jahanpars consortium

3.1 .1 PROJECT OVERVIEW

- Gas Treating Plant with capacity of 56 MMM3/d (million cubic meters per day) of gas processing for production of C1, C2, Naphtha, and Liquefied.

3.1.2. SCOPE AND OBJECTIVES

- Development of all the necessary engineering details .
- Procurement
- Construction of civil, mechanical, electrical, instrumentation, control room and switch rooms .
- Handover and commissioning .

3.1.3 FACILITIES

- Slug Catcher
- High Pressure (HP) Separator
- Acid Gas Removal
- Gas Dehydration
- Gas Refrigeration
- Natural Gas Liquids (NGL) Fractionation
- C3/C4 Treaters
- Liquefied Petroleum Gas (LPG) Tanks
- Sulphur Recovery and Tanks
- Condensate Stabilizer and
- Storages Sour Water Separator



Fig 3.1 Bidboland Gas treating plant

3.1.4 RISK FACTORS AND STRATEGIES

Risk	Strategies to deal with the Risks
A- Development and Procurement Risks	
1-Not win the bidding	-Accurate Evaluation of bid documents
	-Clear process of bidding and elimination of bureaucratic structure
2-Not obtain Licenses	-Select a clear strategy for granting licenses by the government
	-Anticipate responsibilities of parties explicitly
	-Determine accurate scheduling to obtain licenses
3-winner bid price is high	-Select an experienced technical, financial and legal consultant
	-Hold bidding as an international competitive bidding or as a combination of competitive negotiation and bidding along with process of determining eligibility of bidders
	-select accurately and clearly the evaluation criteria of the recommended prices and determine weight and importance of these criteria
B- Construction and Completion Risks	
1-Project has not been completed	-Commitment to prepare financial resources by the project sponsors , under the financial supplementary agreement
2-Delay in completion	-Sign turnkey contract while the date of project completion is specified
	-Employ experienced contractors with good track records

	-Impose financial damages in case of delay and pay early completion bonuses
	-Supervision of construction agreement
	-Constructive contractor will share with the stocks of the project company
	-use familiar method and technology
	-Guarantee the operation of the contractor by a reputable financial institute
3-Cost increase	-Sign contract according to the fixed-price method
	-Establish certain level of investment in the form of stock
	-Stakeholders commitment to maintain the stocks until the completion of construction operation
	-Observe a minimum ratio of Debt/Equity (loan to stock) in a specified limit
	-Monitor and inspect construction stages
	-Control financial process of construction operation
	-Consider contingency credits
4-Quantitative and qualitative criteria have not been observed during building process	-Monitor and inspect construction operation
	-Impose fines and pay compensation by the constructive contractor

Fig 3.1 Risk factors and strategies

3.1.5 MANAGEMENT OF RISKS

STAGE	INPUT	ACTIVITIES	OUTPUT
RISK FEASIBILITY STUDY	PROJECT FEASIBILITY STUDY	•STRATEGIC PLANNING - RISKS •PROJECT LIFE CYCLE STUDY •STUDY OF THE IMPLEMENTATION METHOD •CONTRACTOR TEAM AND CONSULTANTS - ANALYSIS •SELECTION OF DESIRED RISK LEVELS (CLIENT , CONTRACTOR , E /P/C)	•RISK FESABILITY DEVELOPMENT •PROJECT RISK MANAGEMENT
DEVELOPMENT OF STAKEHOLDER'S OBJECTIVES AND EXPECTATIONS	RISK FESABILITY	•INDENTIFICATION- WHAT IS NEEDED BY THE CLINET .	•SPECIFICATIONS AND REQUIRMENT ANALYSIS ACCORDING TO THE RISK MANAGEMENT APPROACH
DEVELOPMENT OF REGULATIONS	RISK FESABILITY AND REQUIRMENT ANALYSIS	•DETERMINATION OF OBJECTIVES AND FORMING THE MISSIONS. •RISK MANAGEMENT TEAM - FORMATION •DEFINING ALL THE TECHNIQUES AND METHODS THAT ARE TO BE USED . •PREPARATION OF RISK BREAK DOWN STRUCTURE	•RISK MANAGEMENT FRAMEWORK
DEVELOPMENT OF DISTINCTIVE PLAN			PROPER SCHEDULE AND COST PLAN IN CONCERN WITH RISK PROCESS
RISK IDENTIFICATION AND RISK MITIGATION	SCHEDULE , RBS AND RISK MITIGATION FRAMEWORK	•RISK IDENTIFICATION •RISK REFINEMENT	•PRIORITIZATION OF RISKS •IDENTIFICATION OF UNCERTAIN RISKS
QUALITATIVE RISK ANALYSIS	•PRIORITIZATION OF RISKS •IDENTIFICATION OF UNCERTAIN RISKS	RISK COST ANALYSIS AND TIME ANALYSIS	PLANNING OF THE WHOLE WBS (RISK)
RESPONSE PLAN	•RISK PLANNING •RISK MANAGEMENT	•PROCEDURE FOR DIFFERENT PHASES •FINALIZE AND APPROVE RISK RESPONSE PLAN	•RISK PLAN BEFORE AND AFTER RESPONSE •ANALYSE COST OF RESPONSE TO THE RISK •RISK RESPONSE PLAN
RISK MONITORING , CONTROLLING AND TRACKING	•RISK PLAN BEFORE AND AFTER RESPONSE •ANALYSE COST OF RESPONSE TO THE RISK •RISK RESPONSE PLAN	•EXECUTION OF RISK RESPONSE PLAN •PERIODICAL UPDATE OF RISK LIST AND RISK PLAN •RECORDING THE LESSON LEARNT DURING IMPLEMENTATIION	•UPDATED RISK PLAN

Table 3.1. Management of risk factors

3.1.6 MANAGEMENT PROCESS

STAGE	OUTCOMES	
Project risk management strategic	- This project is an EPC and the risks existing in the engineering, procurement and construction phases affect the other phases. - Considerable increase of internal gas demand which has made it a critical product. - The country's unique position of possessing the second largest reservoirs of natural gas in the world and desire to export	
Considering to the project implementation method	- The method of project implementation is EPC and all phases consisting of design, purchase, build and operate are under the management and control of the contractor. - Consequently, engineering phase risks will have an effect on the procurement and construction phases and procurement risks will influence the other phases.	
Contractors, consultants and involved parties' assessment	EXPERIENCED EPC PARTICIPANTS - RISK REDUCED	
Decision making about desired level of risk management (client, contractor, E or P or C)	Need in the risk management and risk analysis Without any need to the risk management Risk management at the overall level of the project Risk management along with allowing an expert Risk management along with developing risk procedure	
Development of stakeholders' objectives and expectation	No stakeholders 1. Jahan Pars Company 2. Sarsh Company 3. SNC Lavalin Company 4. RPI 5. Prensnet 6. Ritec 7. Office of the Behbahan governor 8. Citizens of Behbahan and the areas around the treating station 9. Iranian National Gas Company 10. EIED 11. Consortium Management 12. Environment and Natural Resources	No stakeholders Project's expectations from the stakeholders Stakeholders' expectations from the project 1. Jahan Pars Company 2. Sarsh Company 3. SNC Lavalin Company 4. RPI 5. Prensnet 6. Ritec 7. Office of the Behbahan governor 8. Citizens of Behbahan and the areas around the treating station 9. Iranian National Gas Company 10. EIED 11. Consortium Management 12. Environment and Natural Resources
Development of Annual and procedures of the project risk management in the selected scopes and desired level	Name of team member Responsibility Direct or indirect 1. Jahan Pars Company 2. Sarsh Company 3. SNC Lavalin Company 4. RPI 5. Prensnet 6. Ritec 7. Office of the Behbahan governor 8. Citizens of Behbahan and the areas around the treating station 9. Iranian National Gas Company 10. EIED 11. Consortium Management 12. Environment and Natural Resources	
Development of RBS	Based on stakeholders: Based on the project phases: Based on common factors: Project Risks Project Risks in Engineering phase Based on categories of purchased items in procurement phase: Project Risks in Procurement Phase Based on physical activities in the site during construction phase: Project Risks in Construction Phase	
RBS	Risk Identification: Brain storming, Expert method Delphi method are most frequently used during risk identification step. Risk mitigation	

Table 3.2. Management Process

3.1.7 CONCLUSION

Involving proper process and people will reduce the impact and likelihood of the risk. Unique risk management strategies should be developed by the company to mitigate the risk effectively .

3.2 KOLLAM AND ALLAPUZHA BYPASS

3.2.1 INTRODUCTION

I.A : National Highway Authority of India and Ministry of Road Transport and Highways .

Contractor : CherCian Varkey Construction Company(CVCC)-RDS

Kollam Bypass – 1972 – 15Th Jan 2019. – 13.200km

Alapuzzha : 1980 - 2019 -6.70 km .

Funding : 50-50 (State and Central) .

Kollam and Allapuzha bypass were implemented using EPC contract . Direct interviews and survey were conducted by the authors to identify the risk factors and their mitigation strategies .

IMPACT OF THE RISK:

- Cost
- Schedule
- Quality
- Scope of work

3.2.2 MAJOR DELAYS

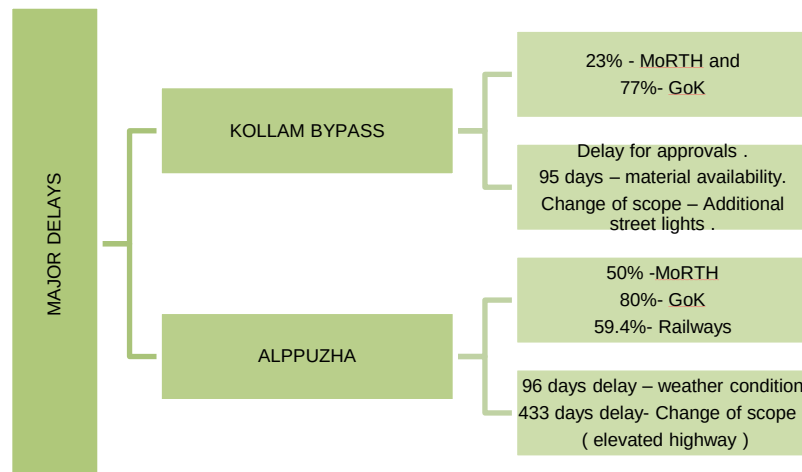


Fig 3.2 Major delays

3.2.3 RISK MANAGEMENT FACTORS

The authors were able to list out 25 factors that could affect the project disastrously . The factors were, 25 factors were found.

1. Availability of material
2. Delay for permits and approvals
3. Unstable political situation
4. Inflation
5. Safety
6. Availability and shortage of equipment
7. Delay in payments
8. Inadequate / incorrect design
9. Exchange rate fluctuations
10. Corruption
11. Poor financial conditions of the contractor
12. Labour availability
13. Design changes
14. Adverse weather conditions
15. Change in law and regulations
16. Improper construction method and quality control
17. change of scope
18. Contractual risk
19. Installation of mechanical and electrical machines
20. Purchase and procurement
21. Acts of God
22. Delay payment on contract
23. Technological issue
24. Legal disputes
25. Poor co-ordination

Through interviews the table was jotted down to 10 risk factors . The project saw ,

- Delay for permits and approvals
- Inflation
- Delay for client payments
- Labour availability
- Adverse weather conditions
- Changes in laws and regulation
- Acts of God
- Delayed payments on contract
- Change of scope

The above said factors overblew the scope and objected of the project .

3.2.4 RISK ANALYSIS AND ASSESSMENT

Risks	Probability of Risks for Kollam Bypass	Probability of Risks for Alappuzha Bypass
Inflation	0.3	0.3
Delay in permits and approvals	0.3	0.5
Labour availability	0.3	0.7
Material availability	0.7	0.3
Change of scope order	0.3	0.5
Adverse weather conditions	0.3	0.7
Acts of God	0.1	0.5

0.1	Rarely
0.3	Sometimes
0.5	Frequent
0.7	Very frequently
0.9	Mostly

Fig 3.3 Analysis and assessment

3.2.5 IMPACT OF RISKS IN THE PROJECT OBJECTIVES

Impact of Risk for Kollam Bypass					
Sl. No.	Project Objectives	a. Cost	b. Schedule	c. Scope	d. Quality
1.	Inflation	0.05	0.05	0.4	0.4
2.	Delay in permits and approvals	0.05	0.1	0.4	0.4
3.	Labour availability	0.05	0.1	0.4	0.4
4.	Material availability	0.05	0.1	0.4	0.4
5.	Change of scope order	0.1	0.1	0.4	0.4
6.	Adverse weather conditions	0.05	0.2	0.4	0.4
7.	Acts of God	0.05	0.1	0.01	0.4

Impact of Risk for Alappuzha Bypass					
Sl. No.	Project Objectives	a. Cost	b. Schedule	c. Scope	d. Quality
1.	Inflation	0.2	0.2	0.2	0.4
2.	Delay in permits and approvals	0.4	0.05	0.2	0.4
3.	Labour availability	0.05	0.2	0.2	0.4
4.	Material availability	0.1	0.05	0.4	0.4
5.	Change of scope order	0.4	0.1	0.4	0.4
6.	Adverse weather conditions	0.05	0.05	0.4	0.4
7.	Acts of God	0.1	0.1	0.4	0.4

Fig 3.4 Impact of risks

3.2.6 RISK SCORES

Risk Scores for Kollam Bypass					
Sl. No.	Project Objectives	a. Cost	b. Schedule	c. Scope	d. Quality
1.	Inflation	0.01	0.01	0.12	0.12
2.	Delay in permits and approvals	0.01	0.03	0.12	0.12
3.	Labour availability	0.01	0.03	0.12	0.12
4.	Material availability	0.03	0.07	0.28	0.28
5.	Change of scope order	0.03	0.03	0.12	0.12
6.	Adverse weather conditions	0.01	0.06	0.12	0.12
7.	Acts of God	0.00	0.01	0.00	0.04

Risk Scores for Alappuzha Bypass					
Sl. No.	Project Objectives	a. Cost	b. Schedule	c. Scope	d. Quality
1.	Inflation	0.06	0.06	0.06	0.12
2.	Delay in permits and approvals	0.2	0.02	0.1	0.2
3.	Labour availability	0.03	0.14	0.14	0.28
4.	Material availability	0.03	0.01	0.12	0.12
5.	Change of scope order	0.2	0.05	0.2	0.2
6.	Adverse weather conditions	0.03	0.03	0.28	0.28
7.	Acts of God	0.05	0.05	0.28	0.28

Fig 3.5 Risk scores

3.2.7 MITIGATION STRATEGIES

Risk	Adopted Mitigation Measures	Suggested Mitigation Measures
Inflation	Acceptance of the risk. No serious measures taken	Contract has to be carefully drafted
Delay in permits and approvals	Contractor transferred the risk to the authority	Reduce risk by adopting transparency in dealings, coordination with authority
Labour availability	No serious measures taken, causing time overrun for Kollam bypass. For Alappuzha bypass, risk transferred to the authority due to COVID'19 Pandemic situation	For Kollam bypass: Reduce risk with reliable subcontractors, having labourers on roll For Alappuzha bypass: Risk has to be accepted
Material availability	Contractor transferred to Authority, causing time overrun	Reduce risk by negotiating with reliable vendors
Change of scope order	Contractor transferred the risks to the authority	Reduce scope changes
Adverse weather conditions	Acceptance of the risk	Risks have to be accepted
Acts of God	Acceptance of the risks by the parties	Risks have to be accepted

Fig 3.6 Mitigation strategies

3.2.8 CONCLUSION

The author suggested fixed cost caused time and cost overrun as the projects progressed . Hybrid annuity model was proposed by the author were EPC works along with BOT model of delivery .

3.3 NEW AIPORT , PAKYONG , SIKKIM

3.3.1 INTRODUCTION

Pilot project in the state of Sikkim , is a greenfield project that was initiated covering 400 acres which was initially planned to be set within 2 years of commencement of construction .

1st revision: 5 Years (By the main contractor) .

Additional delays due to internal and external factors.

2nd revision: Additional 7 years.

3rd revision: 2 Years

3.3.2 PROJECT OVERVIEW

- Planned start date : 14 Jan 2009
- Revised start date :29 Jan 2009
- Project duration :24 months
- Project type : Greenfield
- EPC contractor : Punjj Lloyd Ltd.,

- Planned completion : 14 Jan 2011
- 1st revision :31 Mar 2018
- Operation Date : 23 Jan 2020
- Initial cost : Rs 309.46 crore
- Revised : 553.53 crore
- Final cost: 603 crore
- Cost overrun: 293.54 crore
- % cost overrun- 94.85%

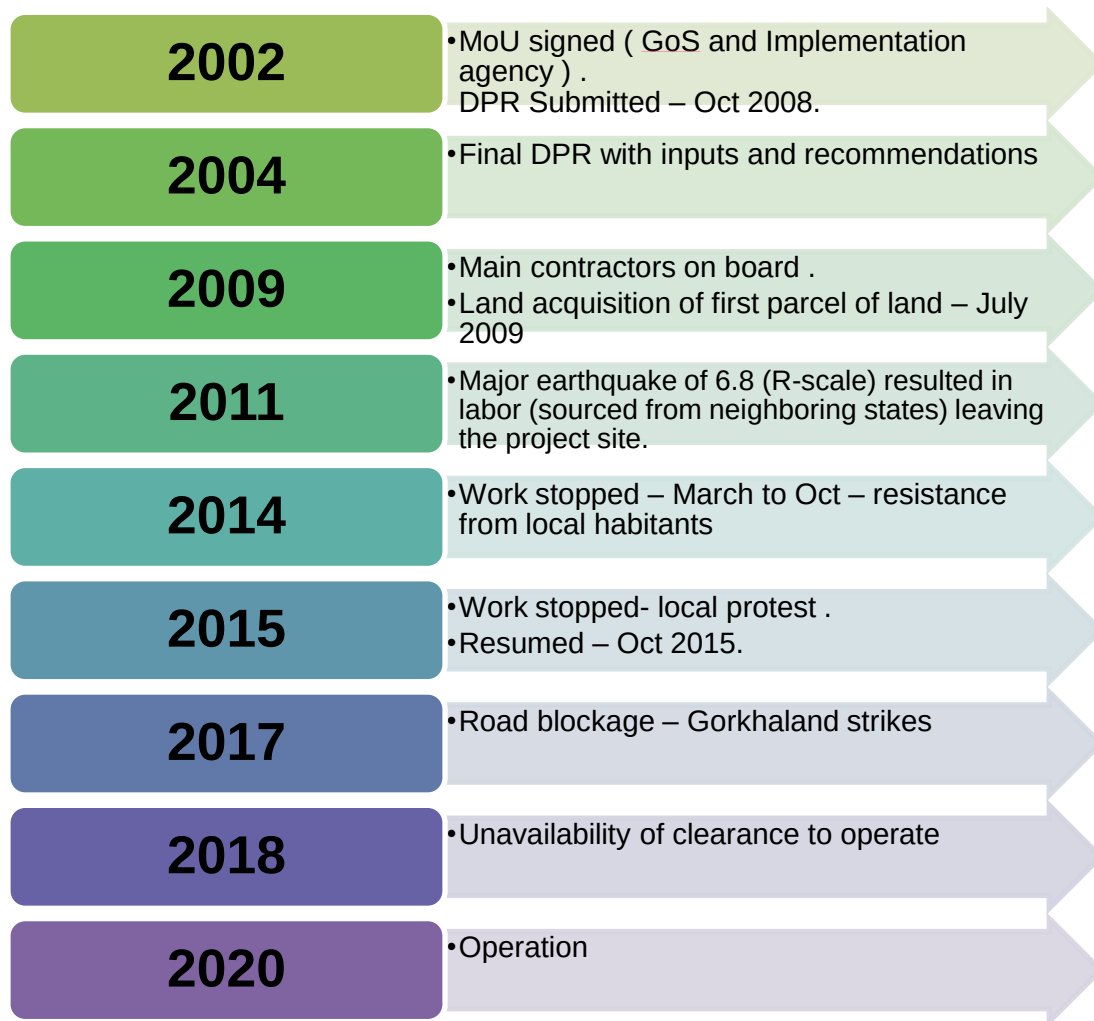


Fig 3.7 New Airport – Project timeline

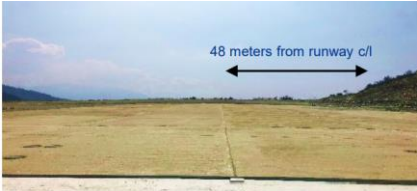
3.3.3 SCOPE OF WORK

1. Cutbacks to form the airfield platform
2. 1.7 km long North-South runway will only operate in one direction due to adjacent high hills in the flight path.
3. Apron with space for two planes
4. Near vertical face reinforcement wall. (Maximum height - 74 meters)
5. Terminal building (floating population - 100, staff - 50)
6. Air Traffic Controller (ATC) tower
7. Isolation Bay for emergency
8. DVOR - ground based radio navigational aid.



Fig 3.8 New Airport – Scope of work

3.3.4 RISK FACTOR ANALYSIS

RISK FACTOR	CAUSES	IMPACT
LOCAL PROTEST	Local protest – Demanding compensation for acquired land (result of soil filling on which the airport was constructed) .	Engineering
MATERIAL AND MANAGEMENT	Remote location caused problems for sourcing of materials and labours . Lack of local resources. Poor material management of diesel , geogrid and geotextile by the contractor caused delays .	Procurement and construction
PRE – PLANNING AND EXECUTION 	Inadequate soil testing – Pavement work saw failure - Distress in the already executed pavement . Cracks in the pavements resulted in immediate actions causing cost over-run. DPR requirement for clearance was stated as 75m on either side from the centreline . While executing it was only 48m at one point on the length of runway. .	Construction
LAND ACQUISITION	The biggest challenge was to displace and relocate 147 households . Initial delay of 8 months because of land clearance .	Engineering (pre- development)
SHORT WORKING WINDOW	Rainy season – April to October (7 months). This	Construction

	provides less time to execute the milestones.	
WEATHER CONDITIONS	Unseasonal rains were very common and increased the risk .	Construction
SCOPE CHANGE / ADDITION 	Retaining wall construction using a new technology called MSE or RE wall technology . The filling was carried out in layers causing increase in time (Each layer should settle and consolidate) . Soil nailing was done on the hillside – this was introduced as a corrective measure . Initially was not included in the scope .	Engineering and construction
COMPENSATION	Compensation for habitants was a cost increase because of the extensive damage to the existing properties of the project site .	Pre- development
GORKHALAND BANDH	The bandh created shortage of diesel and materials required for construction for almost 21 months because of the intermittent closure of NH31A . (Main route for supply of materials) .	Construction

Table 3.2. New Airport – Risks analysis

3.3.5 TIME AND COST OVERRUN

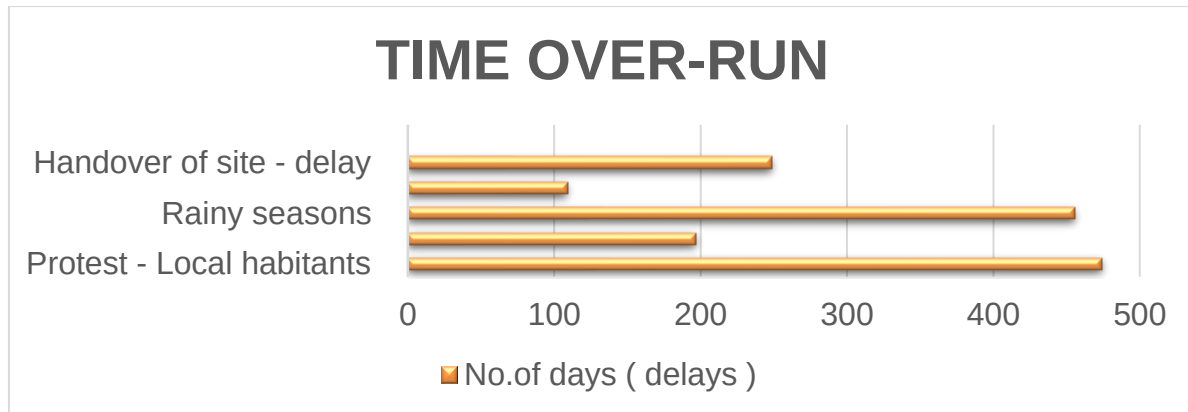


Fig 3.9 New Airport – Time over-run

On an average only 40 % of time duration was available to the contractor to execute the work

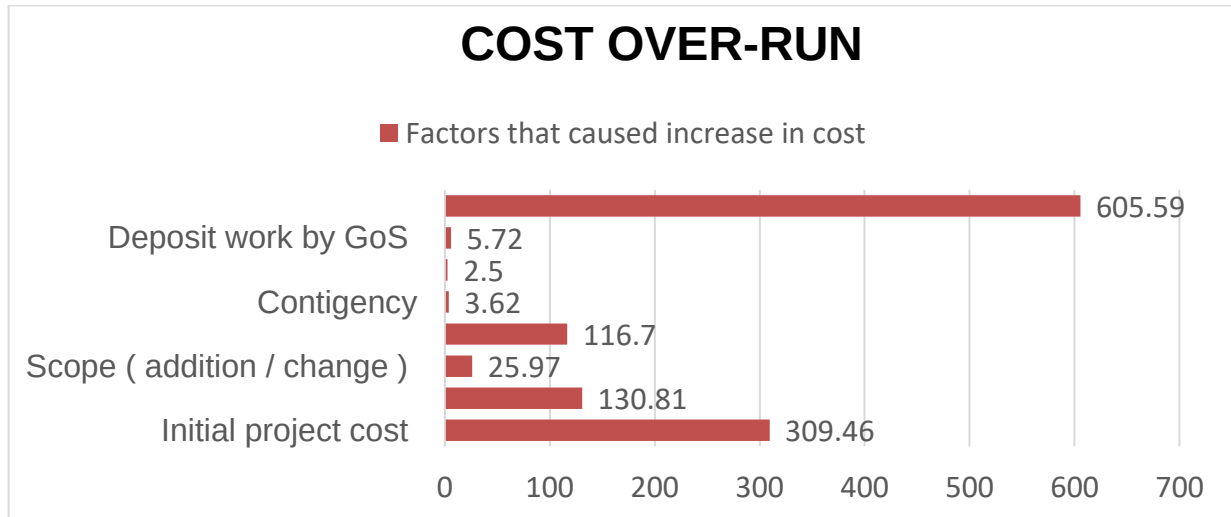


Fig 3.10 New Airport –Cost over-run

3.3.6 CONCLUSION

FACTORS	AFTERMATH
Local protest	Time and cost
Material and management	Time and cost
Pre – planning and execution	Time and cost
Land acquisition	Time
Short working window	Time
Weather conditions	Time and cost
Gorkhaland bandh	Time
Scope change / addition	Cost
Compensation	Cost

Table 3.3. New Airport – Conclusion

3.4 BARH STAGE 1 , PATNA

3.4.1 INTRODUCTION

The thermal power station was initiated by the National Thermal Power corporation. The plant is said to be supercritical and was planned to be staged in 2011 , January .

- Contractor : Doosan power systems
- Start date : 14 Mar 2005
- Project duration : 70 months
- Planned completion : Jan 2011
- Actual completion : April 2021
- Time over-run : 123 months
- Initial cost : Rs 8,693 crore
- Revised : 15,096 crore
- Cost overrun :Rs 6,403 crore
- % over-run : 73.6%
- Boiler contract: Technoproexpert .
- Rest of the plant : Doosan Power Systems .

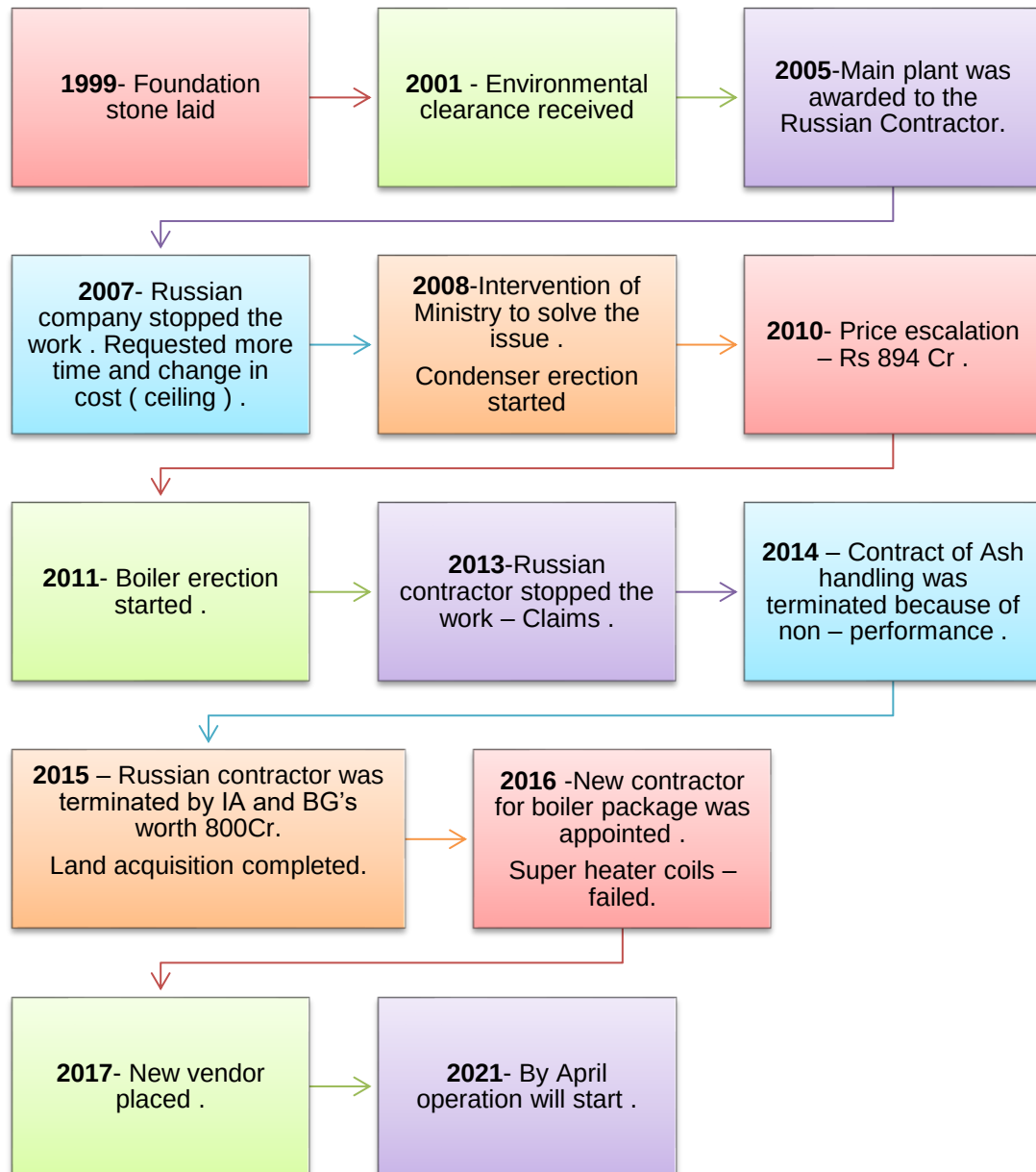


Fig 3.11 Barh stage 1 – Timeline

3.4.2 ANALYSIS OF RISK FACTORS

NON – PERFROMANCE (STEAM AND TURBINE GENRATOR)	Contractor delays due to request for changes – contract terms . There were delays in engineering and supplies of Steam generator package , other packages were also affected. The contract was terminated on Jan ‘15 – accounted for non – performance . 93 months – time delay Rs 2,131 Cr. – Cost over-run	Engineering procurement and construction .
RE-AWARD OF CONTRACTOR (BOILER PACKAGE)	1 year delay	Engineering
MATERIALS	Boiler – Hydro test – Leakage after installation .(2017) New contract – 18 months delay .	Procurement and construction
LAND ACQUISITION	50% - Contract award 95% - 29 months from start . 100%- 2015	Pre-development
GST	The project was awarded under MEGA PROJECTS by Ministry of power . The excise and customs duty were “nil” . But , GST implementation made the procurement of supplies very slow . As vendors were not ready to bear the taxes. (2017).The contractor borne the taxes and a extension of time was provided to all the vendors .	Procurement and construction .

CLAIMS	Several claims caused a great deal of delay. I. Reimbursement of servicing or repair - erected ii. Reimbursement of servicing or repair of equipment - erected - not made operational. iii. Reimbursement of BG and insurance charges iv. idling charges	Construction
INSTALLATION (FUEL GAS DESULPHURIZER)	Ministry of Environment , Forest and clearance in 2015 made it a mandatory for all the coal based plant to have Gas de-sulphurizer before the operation . This was not in the initial scope	Construction
RUSSIAN VENDORS	Sanctions were announce by the US government on the Russian vendors (TG). The unit was almost ready except for few electrical equipment.2018-2019 Proposal for resolution .	Construction
WARRANTY	The equipment / machineries are subjected to 12 months of warranty . Due to delay in the project , vendors have raised issue for not extending the warranty .	Procurement and construction
ZERO DISCHARGE	ETP (EFFULENT TREATMENT PLANT) AND STP were added . Cost increase . (to comply with zero discharge norms) .	Engineering and construction



Fig 3.12 Barh stage 1

3.4.3 COST AND TIME OVER-RUN

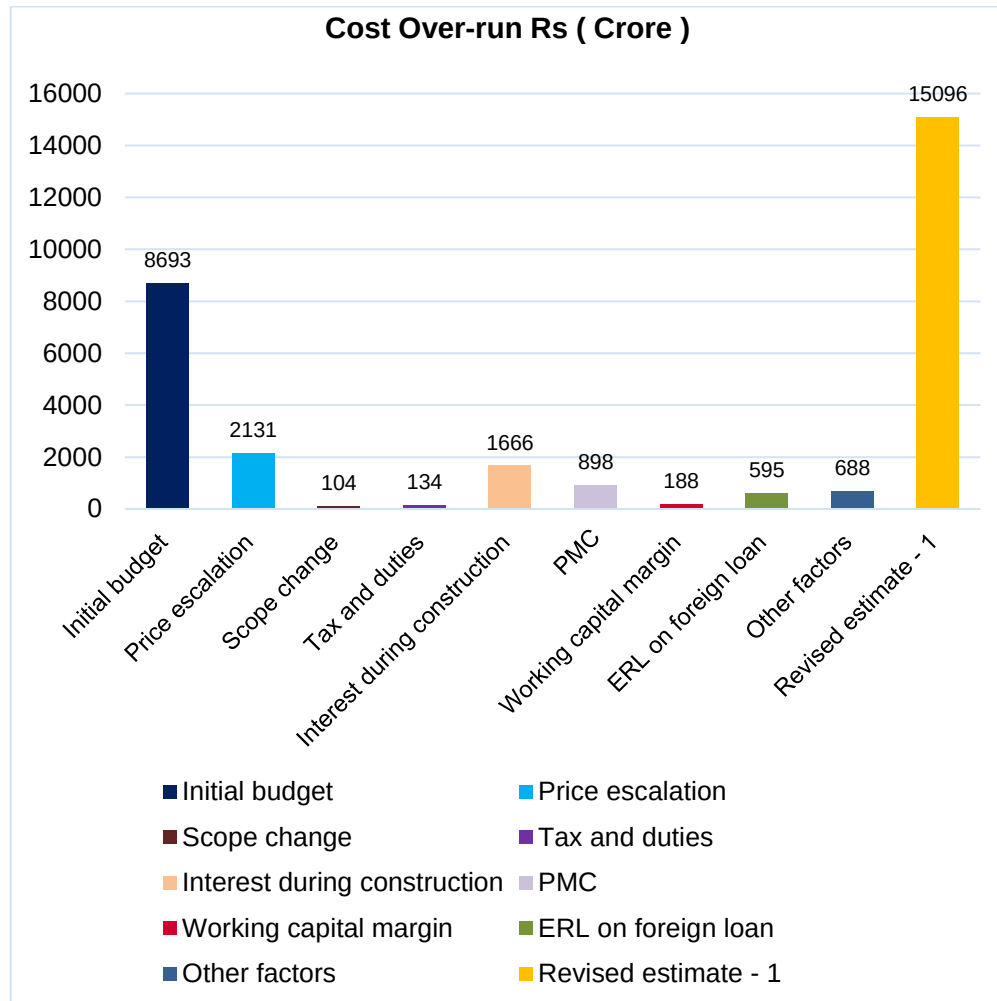


Fig 3.13 Barh stage 1 –Cost overrun

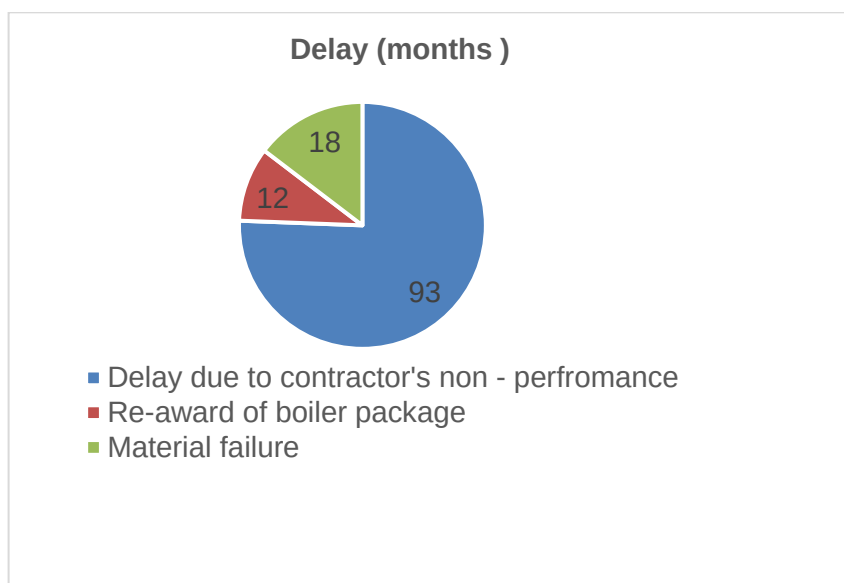


Fig 3.14 Barh stage 1 – Time overrun

3.4.4 CONCLUSION

FACTORS	AFTERMATH
Non – performance (steam and turbine generator)	Time and cost
Re-award of contractor	Time
Materials	Time and cost
Land acquisition	Time
GST	Time and cost
Claims	Cost
Installation (fuel gas desulphurizer)	Cost
Russian vendors	Time
Warranty	Cost
Zero discharge	Cost

Table 3.5. Barh stage 1 – Conclusion

3.5 ASSAM RENEWAL PROJECT

3.5.1 PROJECT OVERVIEW

The project briefly includes revamping of onshore surface facilities. It includes modernisation of onshore oil and natural gas exploration, storage and transport . This has resulted in the crude oil production from 1.5MTPA to 2.5 MTPA.

Contractor : MEIL

Start : 17 Mar 2009

End date : 16 Mar 2013.

Actual completion : 2019

Operation : 2020

Project duration :48 months

Time over run: 57 months

Cost : Rs 2,378 .85 Cr

Actual cost : 2,400 Cr



Fig 3.16 Assam renewal project

3.5.2 DELAY FACTORS

SCHEDULE	Recovery schedule was missing form the EPC contractor . No frequent meetings were done . Involvement of Assam Asset team during the execution phase was limited . No proper communication (approvals got delayed) .
MONITORING	Inadequate monitoring of critical activities . Delay record were not maintained . ERP was limited to PMC . No linkage between labour numbers and schedule . No proper report .

Table 3.6. Assam renewal project – delay factors

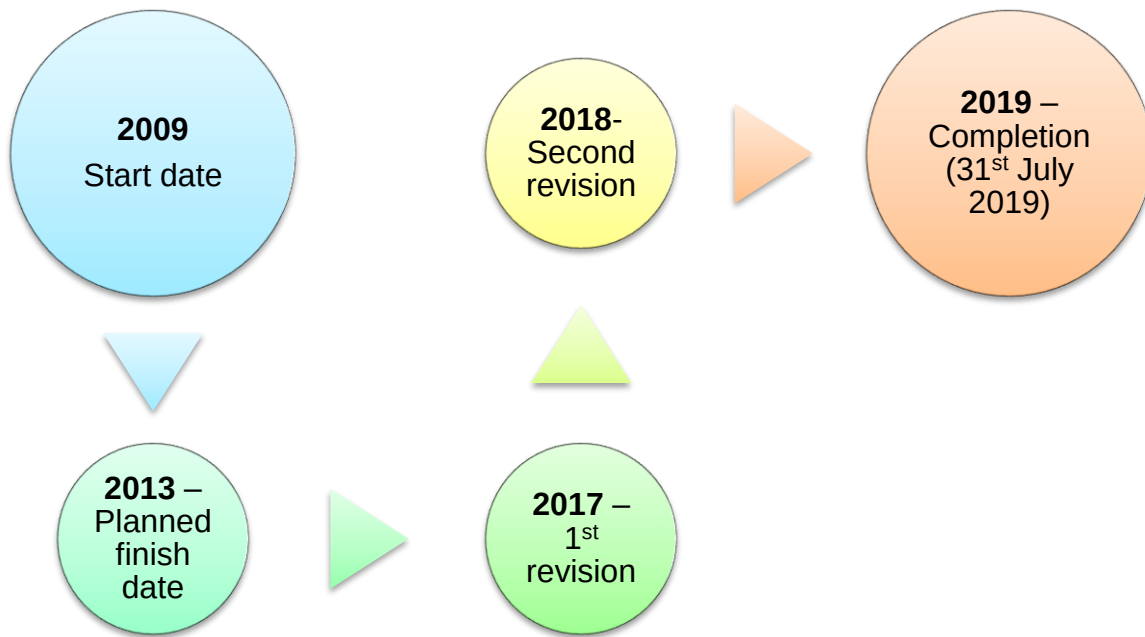


Fig 3.16 Assam renewal project – timeline

3.5.3 RISK ANALYSIS

Engineering management	Involvement of design consultant was delayed in this project. (epc company has its own lean team). Drawings were not available from which schedule was to be designed. No proper structuring of schedule was prepared. Additional revision were done . Insufficient data collection and incomplete survey . New vendors were introduced other than suggested . Vendor selection took time (unplanned time).	Engineering , procurement and construction
------------------------	--	--

Risk management	No proper risk management system. No proper mechanism for mitigation, monitoring .	Engineering , procurement and construction
Resource deployment	Limited work front	Construction
Bandh	Various bandh resulted in the restricted movement of materials. No documentation of time lost.	Procurement and construction

Table 3.7. Assam renewal project – Risk analysis

3.5.4 CONCLUSION

Schedule	Time
Monitoring	Time
Engineering management	Time
Risk management	Time
Resource deployment	Time
Bandh	Time

Table 3.8. Assam renewal project – Conclusion

CHAPTER 4 LIVE CASE STUDY

4.1 MADURAI – KANYAKUMARI SECTION – NH44

IMPLEMENTING AGENCY: National Highways Authority of India .

CONTRACTOR: KMC Associates , Theni .

SCOPE:

- Eliminate 2no.s black spots
 - 6 lane vehicular underpass
 - 2 lane service road on both sides at 173 +400 Km .
 - Half subway with 2lane service road on both sides at km 149+200.
- CURRENT STATUS: Poonakudi , Thirunelveli .

Destinations: Hosur - Krishnagiri - Dharmapuri - Salem - Namakkal - Karur - Dindigul - Madurai - Virudhunagar-Kovilpatti-Tirunelveli - Kanyakumari



Fig 4.1 Madurai – Kanyakumari section

4.1.1 PROJECT OVERVIEW

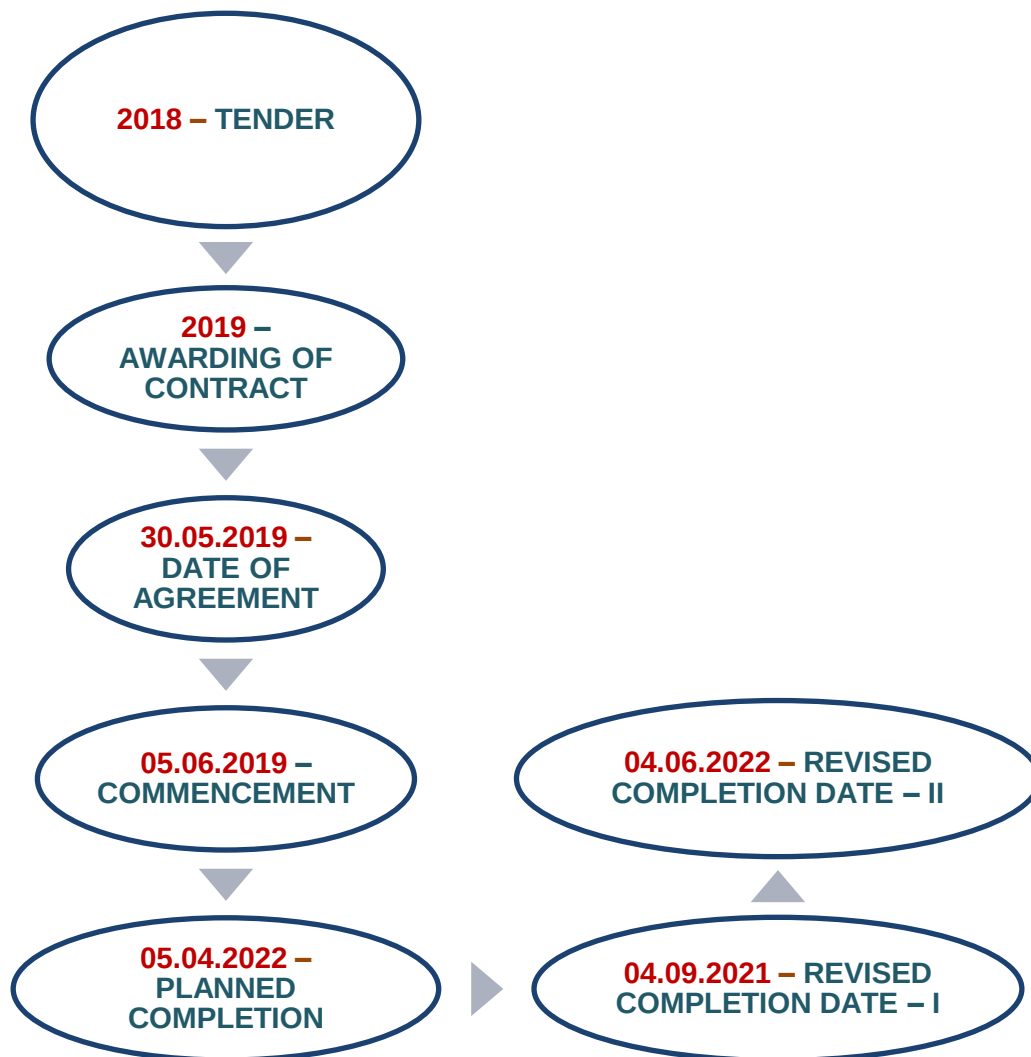


Fig 4.2 Madurai – Kanyakumari section – Project overview

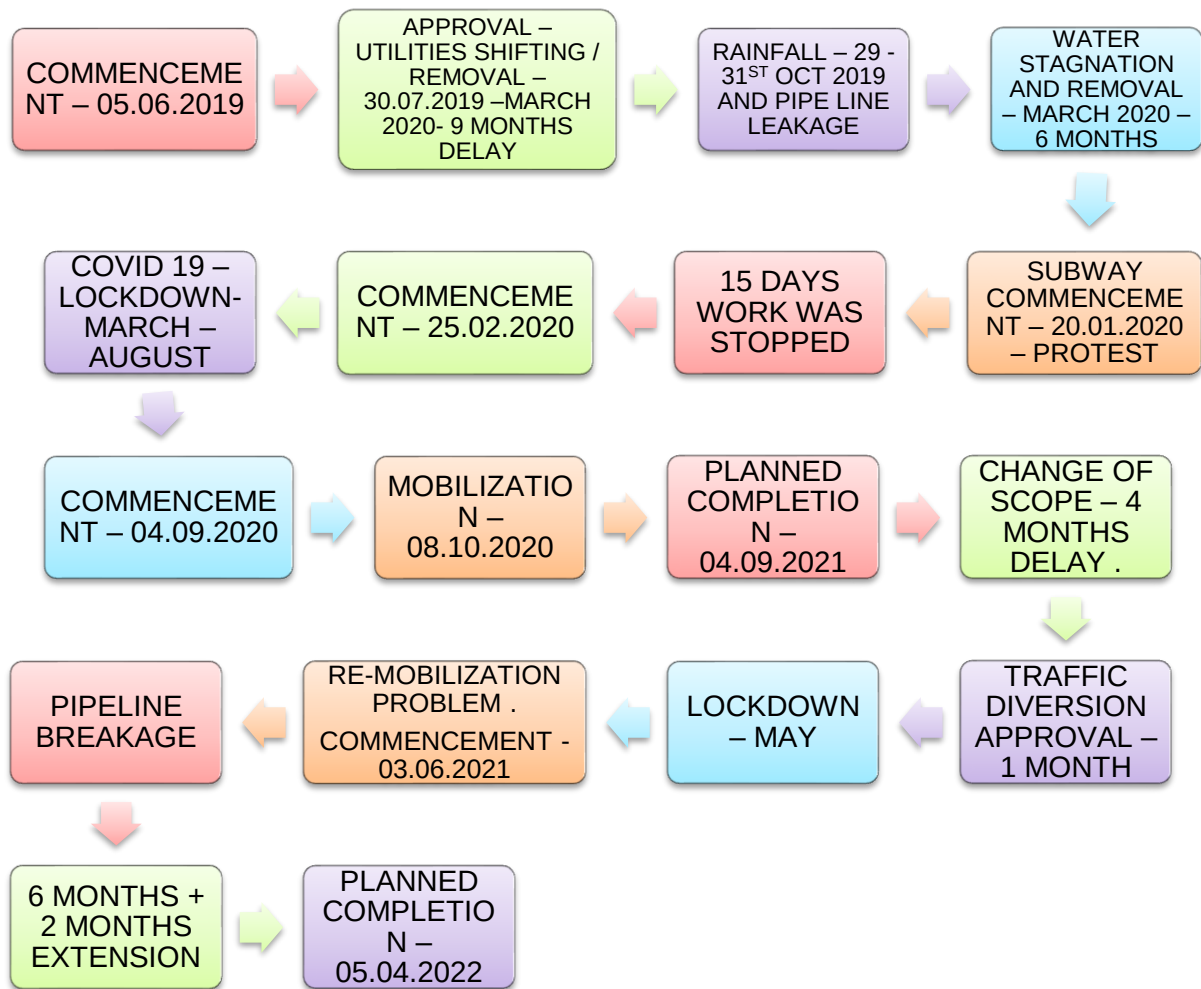


Fig 4.3 Madurai – Kanyakumari section – Timeline

4.1.2 RISK FACTORS AND THEIR IMPACT

FAILURE MODE	EFFECT	ANALYSIS
PRE-CONSTRUCTION	Removal of existing utilities were delayed by the IA.	Engineering and construction
SCOPE	There were structures that were to be removed before the commencement .These structures were later included in the scope with no additional time removal of black spots was added later to the scope .	Construction
APPROVAL		
	IA's approval for additional items were delayed .	Construction
	Traffic diversion approval was late .	Construction
	Approvals from authorities to remove / shifting of the utilities were issued late . Delay in the start or resume of work because encroachment on their services.	Construction
EOT AND CLAIMS	Approval for EOT and claims were delayed - average of 2 months .	Construction and procurement
PUBLIC UNREST 	The project faced protest from residents and politicians in demand to construct a flyover instead of half subway or shifting the location of half subway (Thalayuth).	Construction and procurement
IA / TWAD IMPLEMENTATION INADEQUENCIES	Hindrance in works due to staged water occurred by the existing broken water supply line and there is no action taken by TWAD. Interfered the progress in both the sides of service roads.	Construction

WEATHER	Seasonal and unseasonal rainfall have affected the work	Construction
COVID 19	Lockdown I and II have impacted the work in a larger scale .	Construction
	Idle time - cost - manpower , material and machineries	Procurement
	Re-mobilization of all the resource was very difficult . Change in cost of materials	Procurement

Table 4.1 Madurai – Kanyakumari section – Analysis of risk factors

4.1.3 RISK FACTORS CAUSING COST AND TIME OVERUN

The below table provides an overview of the significant cost and time overrun factors . The project saw a major leap in terms of time and monetary basis because of the below stated delay factors.

Commencement	05.06.2019	₹ 31,13,97,855.00
Utilities shifting	9 months delay	
Rainfall - pipe line leakage	3 days	
Water stagnation	6 months	
Covid 19 - i phase	6 months	₹ 32,10,57,279.00
Local agitation	15 days	
Commencement	04.09.2020	₹ 40,34,17,597.00
Mobilization	08.10.2020	
Scope change	4 months	
Lockdown	May	
Re-mobilization problems		
Pipeline breakage		₹ 45,02,29,418.00
6 months extension		

Table 4.2 Madurai–Kanyakumari section – overview of cost and time overrun

Planned cost	₹ 31,13,97,855.00
I revision	₹ 32,10,57,279.00
II revision	₹ 40,34,17,597.00
Final cost	₹ 45,02,29,418.00

Table 4.3 Madurai–Kanyakumari section – Cost revision

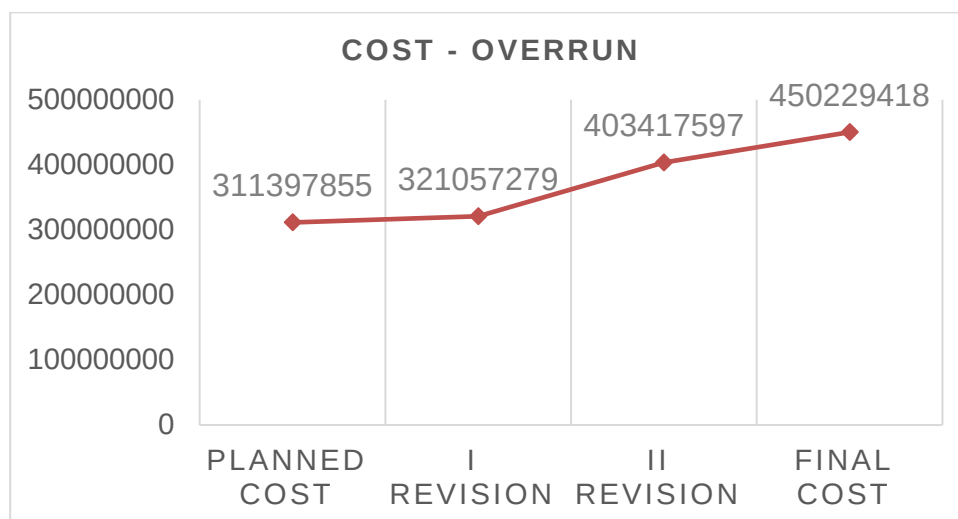


Fig 4.4 Madurai – Kanyakumari section – Cost overrun

Commencement date	05.06.2019
Planned completion	05.09.2020
Revision I	04.09.2021
Revision II	06.02.2022
Revision III	05.04.2022

Table 4.4 Madurai–Kanyakumari section – overview of time overrun

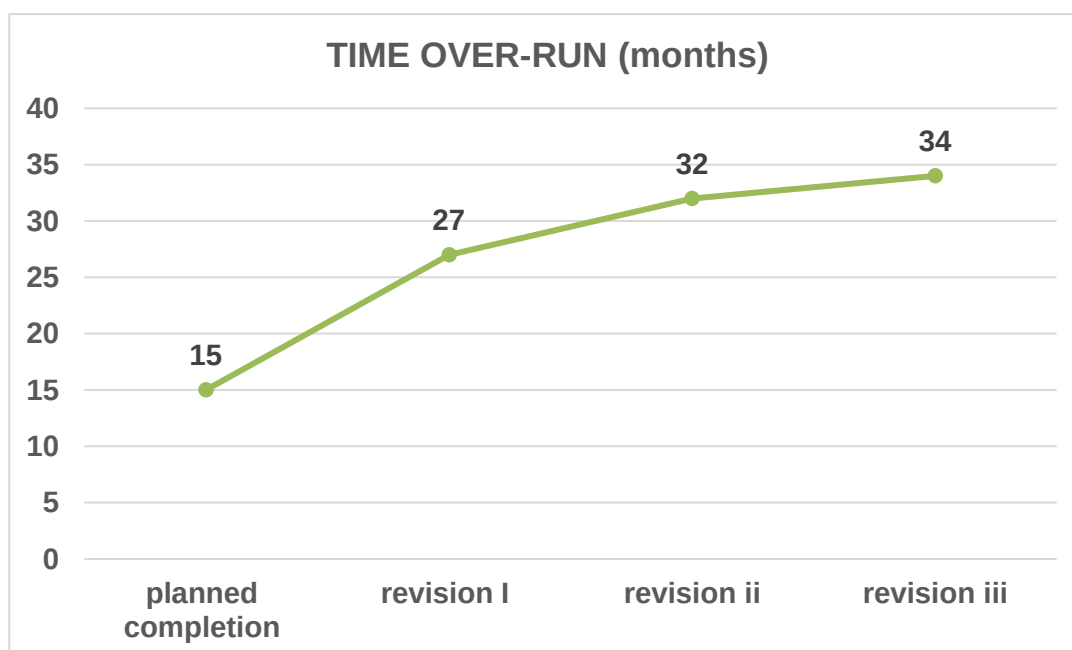


Fig 4.5 Madurai – Kanyakumari section - Time overrun

The risk factors were ranked by direct survey and interviews . This provided a great perspective of how these factors involve and evolve as the project progresses .

- **No.of . Respondents – 15**
- Engineer – 3
- PMC – 5
- Govt –in charge - 2
- Contractor – 2
- Procurement – 3

S.No	Failure effect	Mean	Ranking
1	Approvals	5	1
2	Scope change	4.30	2
3	EoT and claims	3.70	3
4	Public unrest	3.50	4
5	Implementation agency inadequacies	4.30	2
6	Weather	3.40	5
7	Covid - 19	5	1

Table 4.5 Madurai–Kanyakumari section – Risk factors ranking

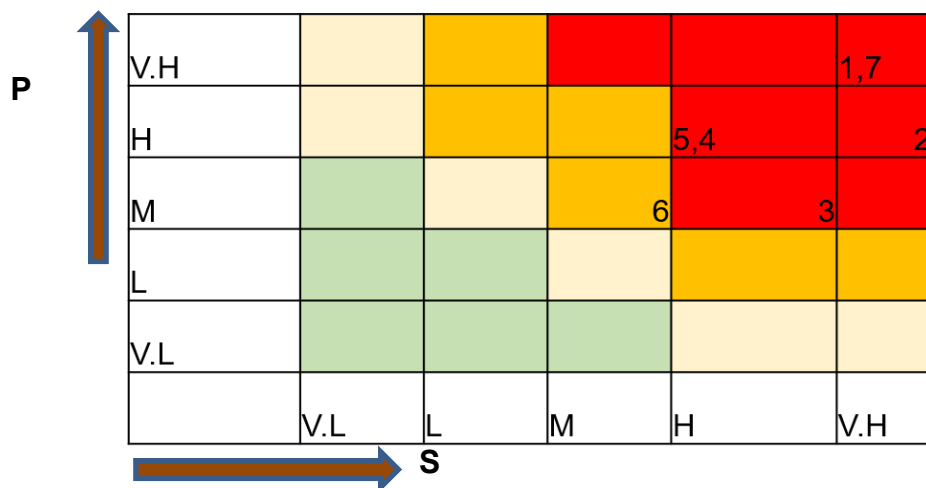


Fig 4.6 Madurai – Kanyakumari section – Risk matrix

The factors were then mapped against the risk matrix for better understanding about the severity of the factors that can jeopardize the upsurge of the project .

4.1.4 RISK MANAGEMENT

The company was able to fit in their IN – HOUSE PMC for this project . The had a very proper , structured hierarchy for communication , reporting and decision making .

The tools and techniques they used would include ,

- Expert's techniques
- Risk register – lesson learnt
- Risk response strategies
- Continuous meetings, workshops

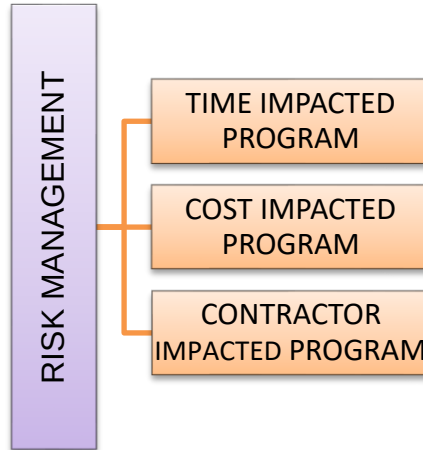


Fig 4.7 Madurai – Kanyakumari section – Risk management

The EPC contracting company was able to mitigate the barriers for implementation through their 3-tier management categorization.

4.1.3 INFERENCE

FACTORS	INFLUENCE	TIME	COST	SCOPE
Utilities	E& C	✓		
Scope change	C		✓	✓
Approval delays	C	✓	✓	
EoT and claims	C& P	✓	✓	
Public unrest	C & P	✓		
IA / TWAD Implementation inadequacies	C	✓	✓	
Weather	C	✓		
Covid 19 - lockdown	C	✓	✓	✓
Remobilization	P & C	✓	✓	

Table 4.6 Madurai–Kanyakumari section – Inference

4.2 STP AND WTP – 10 MLD , PERUGUDI

4.2.1 PROJECT OVERVIEW

I.A :CMWSSB – Chennai Metropolitan Water Supply And Sewerage Board

CONTRACTOR : BGR Energies , Chennai

COMMENCEMENT : 17.12.2019

PLANNED COMPLETION : 30.09.2020



Fig 4.8 Perungudi STP & WTP

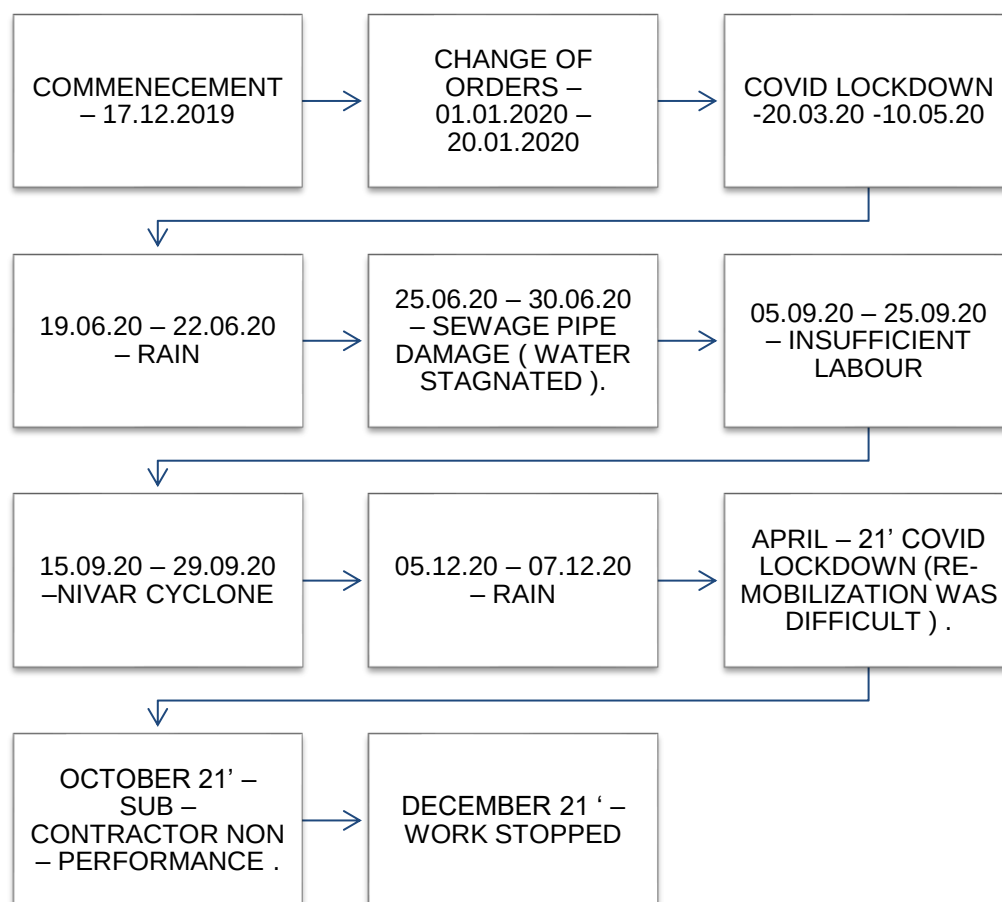


Fig 4.9 Perungudi STP & WTP – Project overview



Fig 4.10 Perungudi WTP

4.2.2 PROJECT TIMELINE

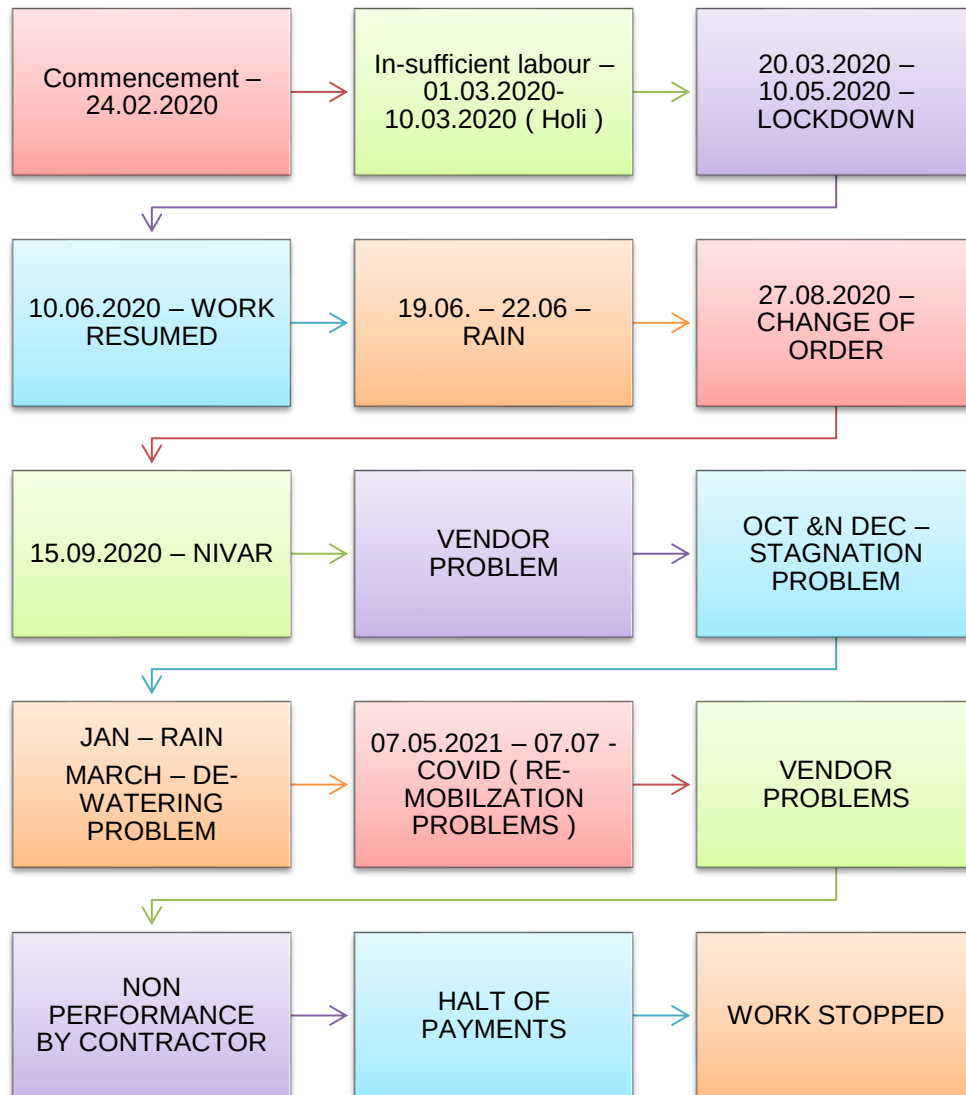


Fig 4.11 Perungudi STP & WTP – Project timeline

4.2.3 RISK FACTORS AND THEIR IMPACT

RISK FACTORS	CAUSES	IMPACT
Poor labour and material management	Sourcing of labour and material was difficult because of the COVID -19 lockdown . The absence of sub-contractor also led to in-sufficient labours . The project faced intermittent delays due to poor material management . No proper division of work front for STP AND WTP .	Procurement And Construction
Pre-planning inadequacies and change in orders	No adequate site study which led to change in orders -Twice .	Engineering , Construction And Procurement
Weather	Continuous rainfall and flood caused delays for a shorter working window .	Construction
Procurement	Disputes with sub - vendors resulted in delay of materials and work progress	Procurement And Construction
Approval delays	Approval from CMWSSB in concern with material check and implementation of work during covid was a major drawback for the progress.	Construction And Procurement
Procurement coordination	Coordination issues between the team at site and vendors .	Procurement And Construction
Change in scope	Caused material wastage and re-work causing schedule break .	Construction And Procurement
Re-award of SBR	After termination of the SBR contract , the re-award was very difficult to implement .	Construction
Material vendor	24 MONTHS WARRANTY FOR B from the date of commercial commencement . But , due to extension of time vendors raised concern for not extending the warranty .	Procurement And Construction

Monetary issues	Circulation of money that was allocated to the sub- contractor was divided for the other projects resulting in shortage of funds .	Construction And Procurement
Monitoring inadequacies	During the implementation, the sewage pipe was broken because of improper monitoring .	Construction
Financial constraints	Due to the financial constrains caused by the sub - contractor the progress is affected .	Construction
Governance	Pressure from the governing political party	Construction

Table 4.7 Perungudi STP & WTP – Analysis of risk factors

4.2.4 RISK FEATURES – SUBSTANTIAL COST AND TIME OVERRUN

Commencement	24.02.2020	38 Crores
Insufficient labour	10 days	
Lockdown	6 Months	
Rain and nivar	17 days	
Change of scope		40 crores
Water stangnation	2 months	
Re-mobilization	2 months	42 crores
Non-performance by contractor		
Halt of payments		

Table 4.8 Perungudi STP & WTP – overview of cost and time overrun

When we look at the management side of the project , the company did not host any project management personnel . They did not develop any risk management strategies ahead .

4.2.5 RANKING OF ELEMENTS OF DELAY

Ranking of the causative factors were done with “n” being 15 , consisting of engineers – EPC COMPANY , procurement team , EPC contractor, and government engineers .

Risk factors	Ranking
Approval	5
IA inadequacies	1
Pre- planning / construction	6
Scope change	
Change orders	3
EoT and claims	7
Poor material management	5
Procurement and coordination	4
Planning and control	2
Financial constrains	1
Coordination with vendors / sub - contractors	3
Re-awarding of contract	1
Governance	6
Weather	3
Covid - 19	1

Table 4.8 Perungudi STP & WTP – Ranking of risk factors

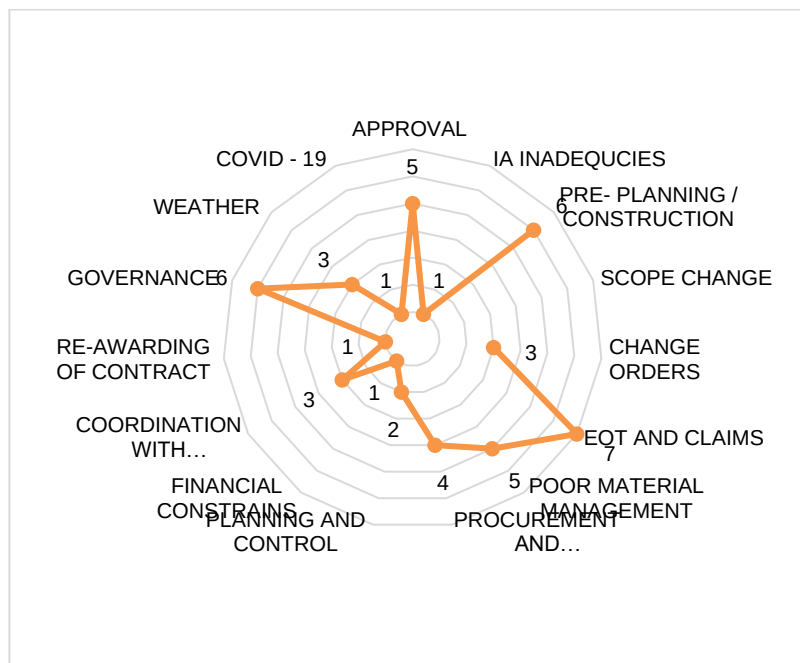


Fig 4.12 Perungudi STP & WTP – Ranking of risk factors

4.2.6 INFERENCE

The inference from the case study was outlined using function deployment matrix . The matrix address what , how and delineate the ranking along with comparison. This also serves as a relationship matrix .

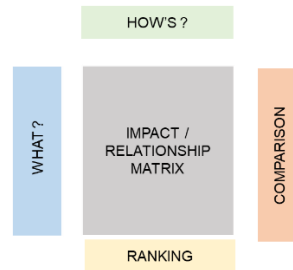


Fig 4.13 Functional deployment matrix

FACTORS	TIME	COST	SCOPE	MEAN
APPROVAL	✓	✓		4
IA INADEQUNCIES			✓	5
PRE- PLANNING / CONSTRUCTION	✓		✓	3.666667
SCOPE CHANGE	✓	✓	✓	2.333333
CHANGE ORDERS	✓	✓		4.5
EOT AND CLAIMS		✓		3.5
POOR MATERIAL MANAGEMENT	✓	✓		4
PROCUREMENT AND COORDINATION	✓	✓		4.166667
PLANNING AND CONTROL	✓	✓		4.666667
FINANCIAL CONSTRAINS	✓	✓		5
COORDINATION WITH VENDORS / SUB - CONTRACTORS	✓	✓		4.5
RE-AWARDING OF CONTRACT	✓			5
GOVERNANCE	✓			3.666667
WEATHER	✓			4.5
COVID - 19	✓	✓		5
RANKING	1	2	3	

Table 4.9 Perungudi STP & WTP – Inference

4.3 LIVE CASE STUDY - INFERENCE

A project planning technique , RAIDAR is used to conclude the inference for the case studies. Through which Risks , Assumptions , Issues , Dependencies are identified . Actions and Repairs (mitigation) can be fostered carefully .

RISK	ACTUALS / ASSUMPTIONS	ISSUES	DEPENDENCIES	ACTION	REPAIRS
Approvals	Delay	Shifting of utilities Traffic diversion	Service road construction got delays	I.A	Mitigate
Scope	Change	Removal of blackspots	Underpass work got delayed	I.A	Mitigate
EoT and claims	Delay	Lack of claim admin and management	Whole project is lagging	S	Mitigate
Public unrest	Occurred	No progress in work	Work was stopped for 15 days	I.A	Transfer
IA inadequacies	Lack	Scope change , change of orders ,lack of pre-planning	Re-work	I.A	Accept and mitigate
Weather	Unforeseen	Work was stopped	Schedule lag	S	Accept and mitigate
Covid - 19	Unforeseen	Work was stopped	Schedule lag	S	Accept and mitigate
Material management	Less work front	No proper allocation of labours	Schedule lag	C	Mitigate
Change of orders	Twice	No proper site study , no proper documentation	Schedule lag	S	Accept and mitigate
Procurement	Delay	No proper planning	STP workflow	C	Mitigate
Coordination	Lack	No proper communication and coordination	Non - performance by vendors	C	Mitigate
Re-award	Contractor left halfway through the project	Non - performance of contractor	Work is stopped	C	Mitigate
Governance	Change of government	Cope up with schedule lag	Schedule lag	S	Transfer
Monitoring and control	Lack	No proper workflow and financial constraints occurred	Not able to cope up with the planned schedule and cost planning	C	Mitigate

Table 4.10 Live case studies – Inference

CHAPTER 5 ANALYSIS AND INFERENCE

5.1 CONTROLLABLE AND UNCONTROLLABLE FACTORS

Risk factors from literature and live case studies are broken down into controllable and uncontrollable factors . This segregation will give more insights in terms of mitigation plan . With the outcome one can know about factors that must be planned upfront or can be sorted immediately .

Controllable	Uncontrollable
NEW AIRPORT - PAKYONG	
Local agitation - execution	Land acquisition and local agitation - project initiation
Weak labour management	Shorter working window
Material management	Gorkhaland bandh
Pre - planning inadequacies	
BARH STAGE I , PATNA	
No performance by contractor	Implementation of goods and service tax
Re-award of boiler package	Sanctions on Russian vendors
Material failure - boiler	
Land acquisition	
ASSAM RENEWAL PROJECT	
Lack of schedule management	Bandhs - shorter working window
Engineering management	
Inadequate risk management	
Inadequate resource management	
Delay - work front	

LALITPUR - KHAJURAHO NEW BG RAIL LINE PROJECT	
INADEQUATE ALLOCATION OF FUNDS	Land acquisition
ESCALATION	
CHANGE IN SCOPE	
MADURAI - KANYAKUMARI SECTION NH44	
RAINFALL	Shifting of utilities
EOT AND CLAIMS	Covid lockdown
MOBILIZATION	Change of scope
	Local unrest
	Approval delay
STP AND WTP , PERUNGUDI	
WORKFRONT DEPLOYMENT	Covid lockdown
CONTRACTOR NON - PERFROMANCE	Cyclone
VENDOR PROBLEMS	Rain
	Approval delay
	IA inadequacies

Table 5.1 Controllable and uncontrollable factors

5.2 UNDERSTANDING AND DEFINING THE RISK PARAMETERS

The risk parameters are systemized used Japanese A3 – Design thinking method. The understanding technique has been applied to apprehend the root cause for all the risk factors. The risk indicators are also defined into various categories .

RISK - DEFINITION	PROBLEMS / CHALLENGES	UNDERSTANDING
PRE – DEVELOPMENT / DEVELOPMENT (APPROVALS , PRE – TENDERING , TENDERING STAGE NEW INITIATIVES)	Local protest – Land demand . Inadequate soil testing . Re-location of 147 households . Re-awarding . Land acquisition . Installation of Gas de- sulphurizer (after awarding of contract) .	No proper study of the basic requirements . No proper understanding of the local needs. Misunderstanding of internal political situations. Not able to accommodate with new

	Land compensation rates. Tax borne by contractor and vendors . Removal of utilities Approval delays	rules . No mitigation plan . No proper background study. Identification of utilities
STAKEHOLDERS MANAGEMENT	Contractor delays due to request for changes – contract terms . Selection of vendors . Tax borne by contractor and vendors . Warranty issue for machineries. Involvement of Asset team (ASSAM). ERP was limited . Involvement of design team (lean) . Contract cancel – nonperformance . Russian contract – cancel . Subcontractor underperformance	No proper study of the basic requirements . No proper understanding of the local needs. Misunderstanding of internal political situations. Not able to accommodate with new rules . No mitigation plan . Misunderstanding of contracts . No proper assessment of delivery team .
MONITORING AND CONTROL	DPR – 75m clearance . 48m was only given . Boiler failure . Failure of pavements . Lack of work front . Cancel of tender. Incomplete survey . Weather and rainy season Insufficient data collection . Inadequate allocation of funds.	There is no common platform of communication. Lack of information transmittals. No proper understanding of the scope. No co-ordination . No proper WBS . No performance measurement . Lack of inspection . No proper schedule to release / raise for funds. No proper auditing .

SCOPE DEFINITION	Re-awarding of contract . ETP and STP were added later . No recovery plan . Additional revisions were done . Land cost . Increase in work . No .of. Stations were added. Removal of dark spots .	Unrealistic definition of work breakdown. Improper understanding of site conditions and requirements . No risk management plan. Scope creep . Insufficient study and team skills. Misunderstanding of contracts . Lack of response . Lack of planning and poor definition of scope .
MONITORING AND CONTROL	DPR – 75m clearance . 48m was only given . Boiler failure . Failure of pavements . Lack of work front . Cancel of tender. Incomplete survey . Weather and rainy season Insufficient data collection . Inadequate allocation of funds.	There is no common platform of communication. Lack of information transmittals. No proper understanding of the scope. No co-ordination . No proper WBS . No performance measurement . Lack of inspection . No proper schedule to release / raise for funds. No proper auditing .

SCOPE DEFINITION	Re-awarding of contract . ETP and STP were added later . No recovery plan . Additional revisions were done . Land cost . Increase in work . No .of. Stations were added. Removal of dark spots .	Unrealistic definition of work breakdown. Improper understanding of site conditions and requirements . No risk management plan. Scope creep . Insufficient study and team skills. Misunderstanding of contracts . Lack of response . Lack of planning and poor definition of scope .
COMMUNICATION	Contractor delay – Change orders . Claims . No meetings . Material procurement was not proper . Russian contractor - issue. Re-awarding of contract . Introduction of new vendors . Approvals got delayed .	Lack of monitoring and coordination . No proper information sharing . Misunderstanding of design . Delay in information sharing . Miscommunication – conflict . Lack of stakeholder management .
PROCUREMENT	Remote- location . Lack of local resource . Poor material management . Bandh created more reckless procurement of materials. (21 months delay) . There were delays in engineering and supplies of Steam generator package , other packages were also affected. Leakage after operation . Limited Workfront . Idle charges . Failure of boilers .	Lack of awareness about procurement places . No clarity about requirements . No proper uncertainty response . Lack of knowledge on work methodology . No proper planning of material usage . No clear idea about optimised usage of equipment . No proper testing .

	Remobilization of materials and labours after covid .	No proper quality check . No proper resource planning .
CONSTRUCTION	Pavement failure . 48m clearance instead of 75m Installation of gas- sulphurizer Reimbursement of servicing or repair of equipment already supplied but not erected Reimbursement of servicing or repair of equipment erected but not made operational. Retaining wall – new technology . Soil nailing was added later . Boiler failure . Warranty for machines (more than 12 months – vendor issue) . Re-award	No proper understanding of the scope. Lack of quality audit . Lack of site awareness . No effective stakeholders management . Ineffective contractual terms . Lack of knowledge about the project and it's needs . No proper sub-contractor assessment .
REPORTING AND DOCUMENTATION	Delay record was not maintained . No linkage between labour numbers and schedule . no proper report . Additional revision were done . insufficient data collection and incomplete survey . No documentation of time lost .	Lack of format . Missing data . No effective recording of documents and drawings . No flow of activity and lack of coordination . Difficulty in understanding previous contractor's work . No proper documentation of old records. No standard protocols

		to maintain to coagulate all the submittals, drawings and other medium of data.
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Table 5.2 Define and Understanding of risk factors

5.3 CATEGORIZATION OF RISK PARAMETERS IN EPC PROJECTS

By defining and analyzing the underlying cause of the risk factors , categorization has been done under 12 different categories . The categories would include,

- Pre-planning / development.
- Contract / scope management.
- Stakeholders' management.
- Engineering and construction.
- Reporting and documentation
- Project monitoring / control.
- Communication management
- Resource management
- Environmental
- Local conditions
- Governance
- Financial management

RISK CATEGORY	RISK FACTORS
PRE - DEVELOPMENT / PLANNING	
	In-efficient feasibility study
	No proper survey
	No proper geotechnical assessment
	Pre-commissioning requirements not fulfilled.
	Resettlement and rehabilitation risk
	Land acquisition delay

	Lack of site study
	Identifying utilities
CONTRACT / SCOPE MANAGEMENT	
	Inadequate specifications and details
	No clear contractual terms
	No proper terms for litigation and claims
	Suboptimal scope
	No proper feasibility study
	Payment conditions
	Insufficient data collection
	No proper contractor / vendor assessment
	Poor claim administration and management
	Scoop creep
STAKEHOLDERS MANAGEMENT	
	Insufficient stakeholder management
	Non - performance of contractor / vendors
	Dispute
	Reputation loss
ENGINEERING AND CONSTRUCTION	
	Poor design
	Incomplete design
	Design failures
	Design errors and change orders
	Schedule delay
	Rework
	Poor quality of work
	Impractical technology
	Project complexity/ uniqueness
	HSE management
	Installation risks
	Identifying and shifting of utilities

	No proper usage of technology
REPORTING AND DOCUMENTATION	
	Inadequate documentation
	Availability of previous work orders
	No proper reporting format / process
PROJECT MONITROING / CONTROL	
	Poor project planning
	Poor estimation and scheduling
	Improper work methodology
	Inadequate QA/QC
	No proper risk management
	Contractor - bankrupt
COMMUNICATION MANAGEMENT	
	Poor decision making / holding key decisions
	Lack of coordination and communication
RESOURCE MANAGEMENT	
	Import of materials
	Lack of resources/work front
	Long - lead delivery
	Poor quality material
	Inefficient equip / mat
	Equipment breakdown
	Human resource training
	Mobilization , transportation and logistics
	Unskilled labour
	Ineffective labour / material utilization
ENVIRONMENTAL	
	Unforeseen weather
	Force majeure
	Disaster prone - areas

	Harsh environmental conditions
	Unforeseen conditions
	Social acceptability risk
	Geological surprise
LOCAL CONDITION	
	Local population resistance
	Bad local order
	Disorderly vicious competition
GOVERNANCE	
	New law
	Bureaucratic problems
	Delayed approvals
FINANCIAL MANAGEMENT	
	Exchange rate fluctuations
	Inflation risk
	Fluctuation in the economy
	Limited funding
	Delay in payments
	Large change in interest
	Delayed opening Ic
	Budget released in trenches
	Land acquisition cost

Table 5.3 Categorization of risk factors

A sector wise division of all the risk parameters were derived. The average cost and time overrun was also derived using pervious EoT claims , newspaper articles , government reports for the period of 2018-2022.

Ranking using RII method was done for the listed risk parameters involving stakeholders from the live case studies.

$$RII = \sum W / A \times N$$

W – Weightage given to each factor

A – Highest weightage
N- No.of respondents

In the study the number of participants involved were 10 .

PRE - DEVELOPMENT / PLANNING	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
In-efficient feasibility study				28	15	43	0.86	3
No proper survey				40		40	0.8	4
No proper geotechnical assessment				40		40	0.8	4
Pre commissioning requirements not fulfilled.					50	50	1	1
Resettlement and rehabilitation risk				16	30	46	0.92	2
Land acquisition delay			18	16		34	0.68	6
Lack of site study			15	20		35	0.7	5
CONTRACT / SCOPE MANAGEMENT	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Inadequate specifications and details				12	35	47	0.94	3
No clear contractual terms					50	50	1	1
No proper terms for litigation and claims			12	24		36	0.72	7
Suboptimal scope				8	40	48	0.96	2
No proper feasibility study				32	10	42	0.84	5
Payment conditions			6	32		38	0.76	6
Insufficient data collection			12	24		36	0.72	7
No proper contractor / vendor assessment				8	40	48	0.96	2
Poor claim administration and management				12	35	47	0.94	3
Scoop creep				20	25	45	0.9	4
STAKEHOLDERS MANAGEMENT	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Insufficient stakeholder management				8	40	48	0.96	2
Non - performance of contractor / vendors					50	50	1	1
Dispute				12	35	47	0.94	3
Reputation loss				16	30	46	0.92	4

PROJECT MONITROING / CONTROL	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Poor project planning				8	40	48	0.96	2
Poor estimation and scheduling				16	30	46	0.92	4
Improper work methodology			9	28		37	0.74	5
Inadequate QA/QC				12	35	47	0.94	3
No proper risk management					50	50	1	1
COMMUNICATION MANAGEMENT	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Poor decision making / holding key decisions				12	35	47	0.94	2
Lack of coordination and communication					50	50	1	1
RESOURCE MANAGEMENT	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Import of materials				40		40	0.8	4
Lack of resources/work front				28	15	43	0.86	3
Long - lead delivery			3	36		39	0.78	5
Poor quality material				40		40	0.8	4
Inefficient equip / mat			12	28		40	0.8	4
Equipment breakdown			18	16		34	0.68	7
Human resource training			15	20		35	0.7	6
Mobilization , transportation and logistics				8	40	48	0.96	2
Unskilled labour					50	50	1	1
Ineffective labour / material utilization					50	50	1	1
ENGINEERING AND CONSTRUCTION	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Poor design				12	35	47	0.94	3
Incomplete design				28	15	43	0.86	5
Design failures				12	35	47	0.94	3
Design errors and change orders					50	50	1	1
Schedule delay					50	50	1	2
Rework				8	40	48	0.96	2
Poor quality of work				16	30	46	0.92	4
Impractical technology			15	16	5	36	0.72	8
Project complexity/ uniqueness					50	50	1	1

HSE management			6	28	5	39	0.78	6
Installation risks			9	24	5	38	0.76	7
No proper usage of technology			12	24		36	0.72	8
REPORTING AND DOCUMENTATION	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Inadequate documentation				24	20	44	0.88	2
Availability of previous work orders					50	50	1	1
No proper reporting format / process				32	10	42	0.84	3
ENVIRONMENTAL	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Unforeseen weather			9	28		37	0.74	6
Force majeure					50	50	1	1
Disaster prone - areas				4	45	49	0.98	2
Harsh environmental conditions				12	35	47	0.94	3
Unforeseen conditions				28	15	43	0.86	5
Social acceptability risk				20	25	45	0.9	4
Geological surprise					50	50	1	1
LOCAL MARKET	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Local population resistance					50	50	1	1
Bad local order				16	30	46	0.92	2
Disorderly vicious competition			15	20		35	0.7	3
GOVERNANCE	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
New law				8	40	48	0.96	3
Bureaucratic problems				4	45	49	0.98	2
Delayed approvals					50	50	1	1
FINANCIAL MANAGEMENT	VERY LOW	LOW	MEDIUM	AGREE	STRONGLY AGREE	TOTAL	RII	RANKING
Exchange rate fluctuations			15	20		35	0.7	5
Inflation risk			15	20		35	0.7	5
Fluctuation in the economy			12	24		36	0.72	4
Limited funding				12	35	47	0.94	2
Delay in payments					50	50	1	1
Large change in interest			12	24		36	0.72	4
Delayed opening Ic			15	20		35	0.7	5

Budget released in trenches				28	15	43	0.86	3
Land acquisition cost					50	50	1	1

Table 5.4 Ranking of risk factors

5.4 RISK FACTORS IMPACTING STAKEHOLDERS

Direct interviews were conducted with contributors from IA , EPC contracting office. The outcome establishes the stakeholder's perspective of delay causing constraints .

CONTRACTING AGENCIES: KMC Associates, Sindhu Contractor, L&T, BGR energies.

IMPLEMENTING AGENCIES: CMWSSB, CMRL (BANGALORE).

5.4.1 RISK FACTORS IMPACTING IA

PRE – PLANNING /IMPLEMENTATION

(APPROVALS , TENDERING , FEASABILITY STUDY , LAND ACQUISITION , ETC) .

- Suboptimal DPR .
- Inadequate soil investigation , site study .
- Acquiring approval for pre- investments.
- Signing MoA with respective state government and allotment of the project.
- Utility shifting .
- Site handover
- Public unrest .
- Compensation and claims – government rates vs quoted rates.
- Land acquisition

ENGINEERING

- Less time for planning .
- Availability of survey reports .
- Local market based costing .
- Quality of contractor , PM and other participants .
- No proper base line planning .
- Approval delay .
- No proper scheduling and identification of critical path.
- Delay in statutory clearances

PROCUREMENT

- Improper selection of contractor .
- Delay in award and re-awards of contract .
- Less time window for placing orders .
- Vendor's delivery on time .
- Fluctuations in the cost

CONSTRUCTION

- Weather conditions .
- Short working window.
- Public unrest .
- Non – performance of contractor / vendor .
- Change in policies and law
- Change in scope
- Change of orders
- No proper skilled labours
- Lack of communication
- Idle time / breakdown
- Interest increase during implementation.
- Claims and disputes administration and management
- Mobilization of equipment's.
- No proper documentation of technical reports
- Delay in acquiring approvals for operations
- Contractual disputes

5.4.2 RISK FACTORS IMPACTING EPC CONTRACTING AGENCY

PRE – IMPLEMENTATION

- DPR and tendering date difference
- Unrealistic working window and obligations
- Suitable locations for establishments
- Approvals

ENGINEERING

- No clear understanding of scope, finance and schedule limits of the project .
- Change orders
- Design quality adhering to site conditions .
- No proper cost benefit analysis .

PROCUREMENT

- Unavailability of materials mentioned in the DPR .
- Legal issues .
- Unworkable quoted rates
- No proper approvals
- Material management

CONSTRUCTION

- No proper coordination within IA , contractors and vendors .
- Unresolved claims and issues .
- Delay in payments .
- Approvals form removal and shifting of utilities.
- Funding in trenches during execution .
- Lack of manpower .
- Poor quality control .
- Schedule and cost lag .
- Land acquisition issues

5.5 RISK ALLOCATION

Risk allocation was based upon white paper research and case examples . The table will provide a great view of final allocation of each risk impacts . Certain cases the aftermath can be shared by both the IA and Contractor . There are times when only one participant is liable. The allocation will help use in developing a mitigation strategy ahead of the project.

KEY:

S- SHARE

I.A – IMPLEMENTING AGENCY

C- CONTRACTOR

	RISK ALLOCATION	
PRE - DEVELOPMENT / PLANNING		FINAL ALLOCATION
	Feasibility study	I.A
	Survey	I.A
	Geotechnical assessment	I.A
	Pre-commissioning requirements	I.A
	Resettlement and rehabilitation risk	I.A
	Land acquisition delay	I.A
CONTRACT / SCOPE MANAGEMENT		
	Specifications and details	I.A
	Clear contractual terms	S
	Terms for litigation and claims	S
	Scope	I.A
	Payment conditions	I.S
	Proper contractor / vendor assessment	S
	Scoop creep	I.A
ENGINEERING AND CONSTRUCTION		
	Poor design	C
	Incomplete design	C
	Design failures	S
	Design errors and change orders	D
	Schedule delay	C
	Rework	S
	Poor quality of work	C
	Impractical technology	C
	HSE management	C
	Installation risks	C
	Identifying and shifting of utilities	I.A

	Proper usage of technology	C
REPORTING AND DOCUMENTATION		
	Documentation	C
	Availability of previous work orders	I.A
	Proper reporting format / process	S
PROJECT MONITROING / CONTROL		
	Project planning	I.A
	Estimation and scheduling	C
	Improper work methodology	C
	Inadequate QA/QC	I.A
	Contractor - bankrupt	C
COMMUNICATION MANAGEMENT		
	Decision making / holding key decisions	S
	Coordination and communication	S
RESOURCE MANAGEMENT		
	Import of materials	C
	Lack of resources/work front	C
	Long - lead delivery	C
	Poor quality material	C
	Inefficient equip / mat	C
	Equipment breakdown	C
	Human resource training	C
	Mobilization , transportation and logistics	C
	Ineffective labour / material utilization	C
ENVIRONMENTAL		
	Unforeseen weather	S
	Force majeure	S
	disaster prone - areas	S
	Harsh environmental conditions	S
	Geological surprise	S
LOCAL CONDITION		
	Local population resistance	S

	Bad local order	S
	Disorderly vicious competition	C
GOVERNANCE		
	New law	I.A
	Bureaucratic problems	I.A
	Delayed approvals	I.A
FINANCIAL MANAGEMENT		
	Exchange rate fluctuations	S
	Inflation risk	S
	Fluctuation in the economy	S
	Limited funding	I.A
	Delay in payments	I.A
	Large change in interest	S
	Delayed opening Ic	I.A
	Budget released in trenches	I.A
	Land acquisition cost	I.A

Table 5.5 Risk allocation

5.6 RACI MATRIX

RACI matrix helps to have better understanding of the responsibilities each stakeholder are responsible for . They also tell individual participant's contribution to a specific activity.

KEY :

- R-RESPONSIBLE
- A-ACCOUNTABLE
- C-CONSULT
- I-INFORM

	I.A	CONTRACTOR	DESIGN/ ENGINEERING CONSULTANT	PROJECT MANAGER	LEGAL TEAM	FINANCE TEAM	PROCUREMENT TEAM	SUPPLIERS, VENDORS,
PRE - DEVELOPMENT / PLANNING								
FEASIBILITY STUDY	R/A	R		I				
SURVEY	R/A	R/A	A/I					
GEOTECHNICAL ASSESSMENT	A	R	A/I	I				
PRE COMMISSIONING REQUIREMENTS	R	I						
RESETTLEMENT AND REHABILITATION RISK	R /A	C/I						
LAND ACQUISITION	R /A	C/I						

SITE STUDY	R /A	C/I	I	I				
CONTRACT / SCOPE MANAGEMENT								
SPECIFICATIONS AND DETAILS	R	A/I/C	I/C	I/C			I/C	I
CONTRACTUAL TERMS	R	R/A		C		C		
LITIGATION AND CLAIMS	A	R/A		I/C	R/C			
SCOPE	R/A	I	I	I		I	I	I
PAYMENT CONDITIONS	R/A	I/A				I/C/A		
CONTRACTOR / VENDOR ASSESSMENT	R/A	R/A	C	A/I/C				I
CLAIM ADMINISTRATION AND MANAGEMENT	I	R/A			R/C			
SCOOP CREEP	R/A	A/I	I	C	C	I	I	I
STAKEHOLDERS MANAGEMENT								
STAKEHOLDER MANAGEMENT	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I
NON - PERFORMANCE OF CONTRACTOR / VENDORS	I/C	R/A		I/C	I/C	I/C	I	R/A
DISPUTE	R/A/C/I	R/A/C/I	R/C/I	R/A/C/I	R/C/I	R/C/I	R/C/I	R/C/I
PROJECT MONITROING / CONTROL								
PROJECT PLANNING	I/C	R/A/C/I	C/I	R/A/C/I			I/C	
ESTIMATION AND SCHEDULING	A/C/I	R/A/C/I	C/I	R/A/I/C		R/C	I/C	I/C
WORK METHODLOGY	A/C/I	R/A/C/I	R/C/I	R/A/C/I			I	I
QA/QC	A/C/I	R/A/C/I		R/A/C/I				R/I
RISK MANAGEMENT	A/C/I	R/A/C/I	I/C	R/A/C/I	I/C	I/C	I/C	I/C
COMMUNICATION MANAGEMENT								
DECISION MAKING / HOLDING KEY DECISIONS	R/A/C/I	R/A/C/I	I	I/C/R	I/C	I	I	I
COORDINATION AND COMMUNICATION	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I	R/A/C/I
RESOURCE MANAGEMENT								
RESOURCES/WORK FRONT	C/I	R/A/C/I		R/I/C			R/I/C	R/I/C
DELIVERY OF MATERIALS	I	R/A/C/I		R/I/C			R/C/I	R/C/I
QUALITY MATERIAL	I/C	R/A/C/I		R/A/C/I			R/A/C/I	R/A/C/I
EFFICIENT EQUIP / MAT CHOICE		R/A/C/I		R/A/C/I			R/A/C/I	I/C

HUMAN RESOURCE TRAINING		R/A/C/I		R/A/C/I				
MOBILIZATION , TRANSPORTATION AND LOGISTICS		R/A/C/I		R/A/C/I			R/C/I	
SKILLED LABOUR		R/A/C/I		R/A/C/I			C/I	R/C/I
LABOUR / MATERIAL UTILIZATION		R/A/C/I		R/A/C/I				R/C/I
ENGINEERING AND CONSTRUCTION								
EFFICIENT DESIGN	R/I/C	R/A/C/I	R/I/C	R/I/C				
DESIGN ERRORS AND CHANGE ORDERS	I/C	R/A/C/I	R/A/C/I	R/I/C		I	I	I
SCHEDULE DELAY	I/C	R/A/C/I		R/A/C				A/I/C
REWORK		R/A/C/I					I/C/A	I/C/R
POOR QUALITY OF WORK	I	R/A/C/I		R/A/C/I				R/I
HSE MANAGEMENT	I/C	R/A/C/I		R/A/C/I				R/I/C
INADEQUATE DOCUMENTATION	R/A	R/A/C/I	A	R/A/C/I	A	A	A	A
ENVIRONMENTAL								
ENVIRONMENTAL CONDITIONS	I/C	I/C		I/C	I/C/A		I	I/C
LOCAL MARKET								
LOCAL POPULATION RESISTANCE	I/C/A/R	I/A/C	I	I/A/C	I/C	I	I	I
BAD LOCAL ORDER								
GOVERNANCE								
NEW LAW	I/C/A/R	I/A/C	I	I/A/C	I/C	I	I	I
BUREAUCRATIC PROBLEMS								
DELAYED APPROVALS								
FINANCIAL MANAGEMENT								
EXCHANGE RATE FLUCTUATIONS	I/C/A/R	I/A/C	I	I/A/C	I/C	I	I	I
INFLATION RISK								
FLUCTUATION IN THE ECONOMY								
LIMITED FUNDING	R/A/C/I	R/A/C/I		R/A/C/I	C	R/A/C/I	I/C	I/C
DELAY IN PAYMENTS	R/A/I	R/A/C/I		R/A/C/I		C/I	I/C	I
BUDGET RELEASED IN TRENCHES	R/A/C/I	R/A/C/I		R/A/C/I	C	R/A/C/I	I/C	I
LAND ACQUISITION COST	R/A/C/I	R/A/C/I		R/A/C/I	C	R/A/C/I		I

Table 5.6 RACI Matrix

5.7 SWIM LANES

Swimlane diagrams are used as process flow diagrams which can give put visual outcome of job sharing and responsibilities in a process. Swimlane for different phases are developed to have deep understanding of how the process works . Thorough which mitigation and management plan can be visioned.

5.7.1 PROJECT INITIATION

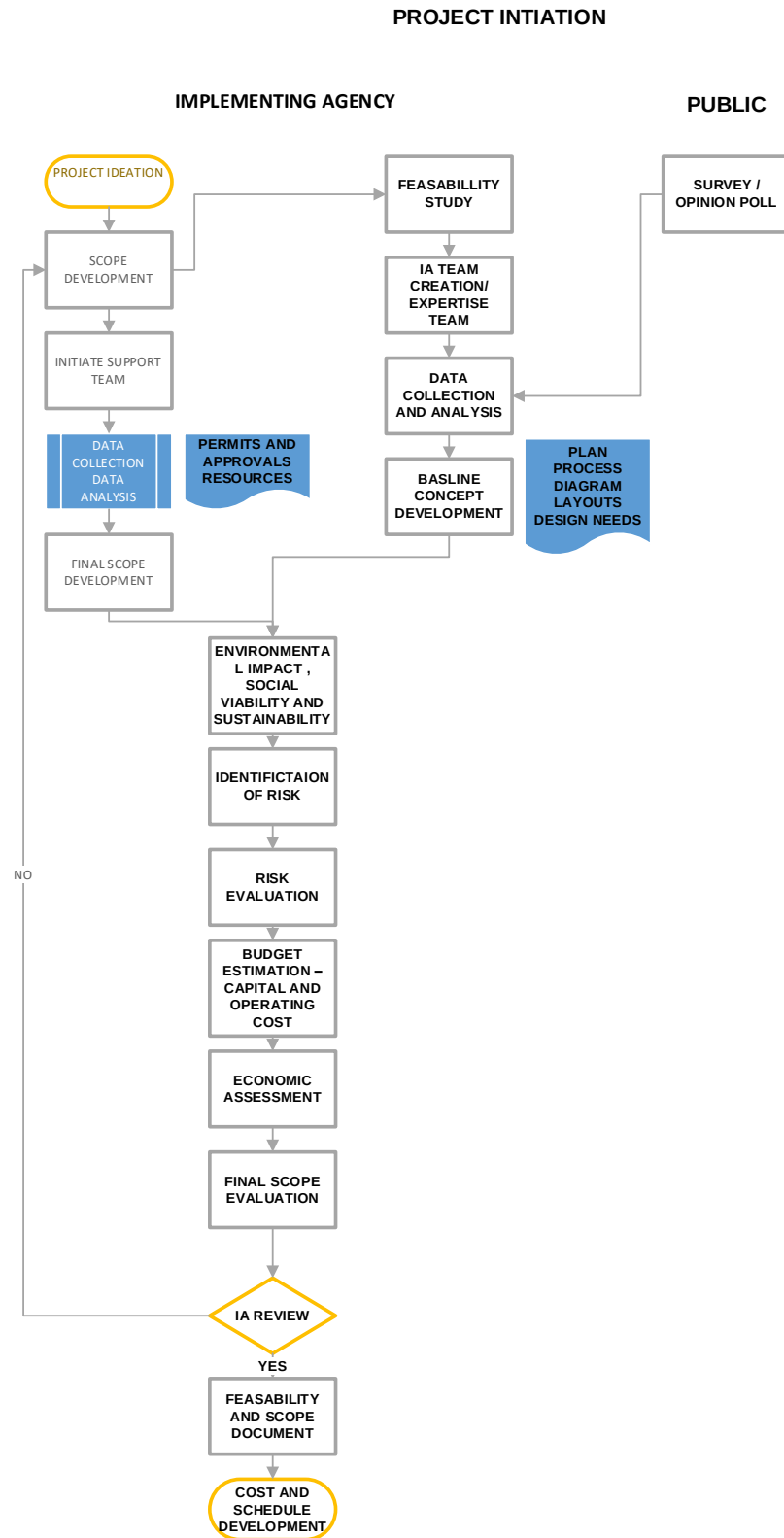


Fig 5.1 Swimlane – Project initiation

5.7.2 . BUDGETARY APPROVAL

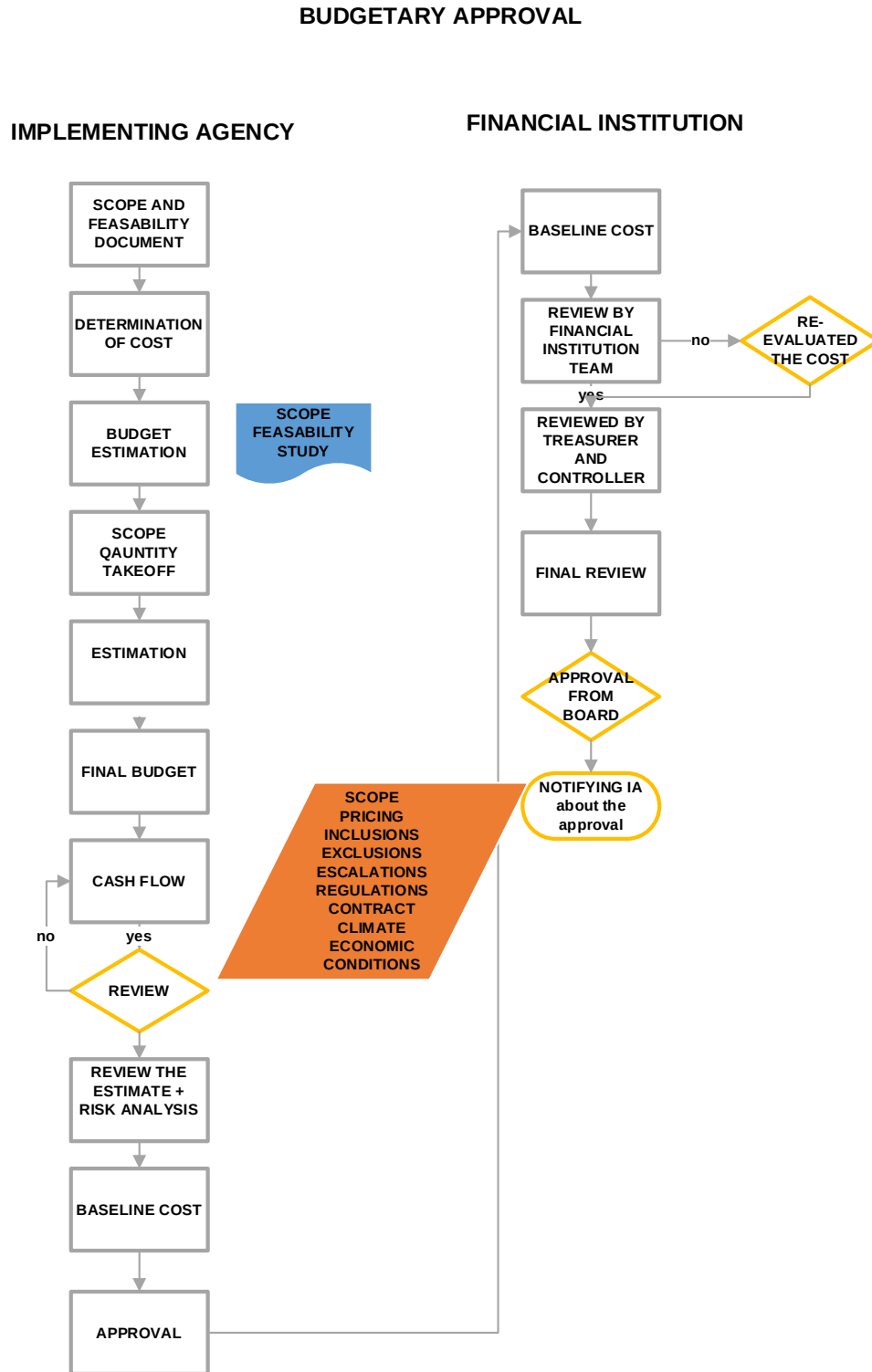


Fig 5.2 Swimlane – Budgetary approval

5.7.3 SCHEDULE APPROVAL

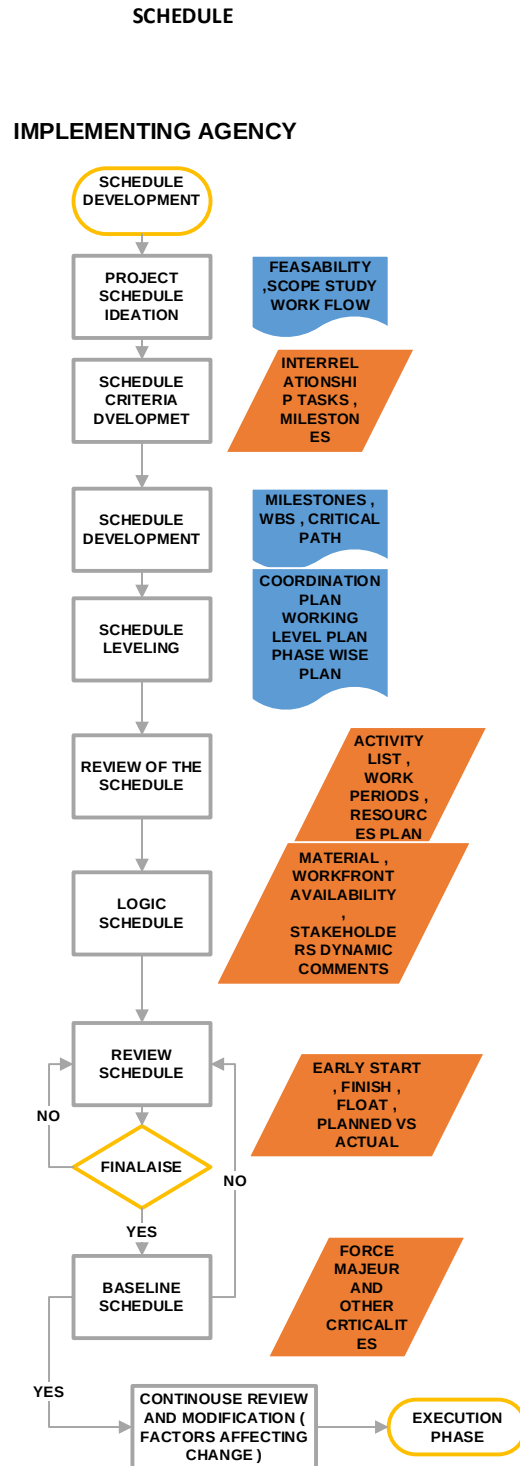


Fig 5.3 Swimlane- Schedule approval

5.7.4 PROJECT KICKOFF

PROJECT - KICKOFF

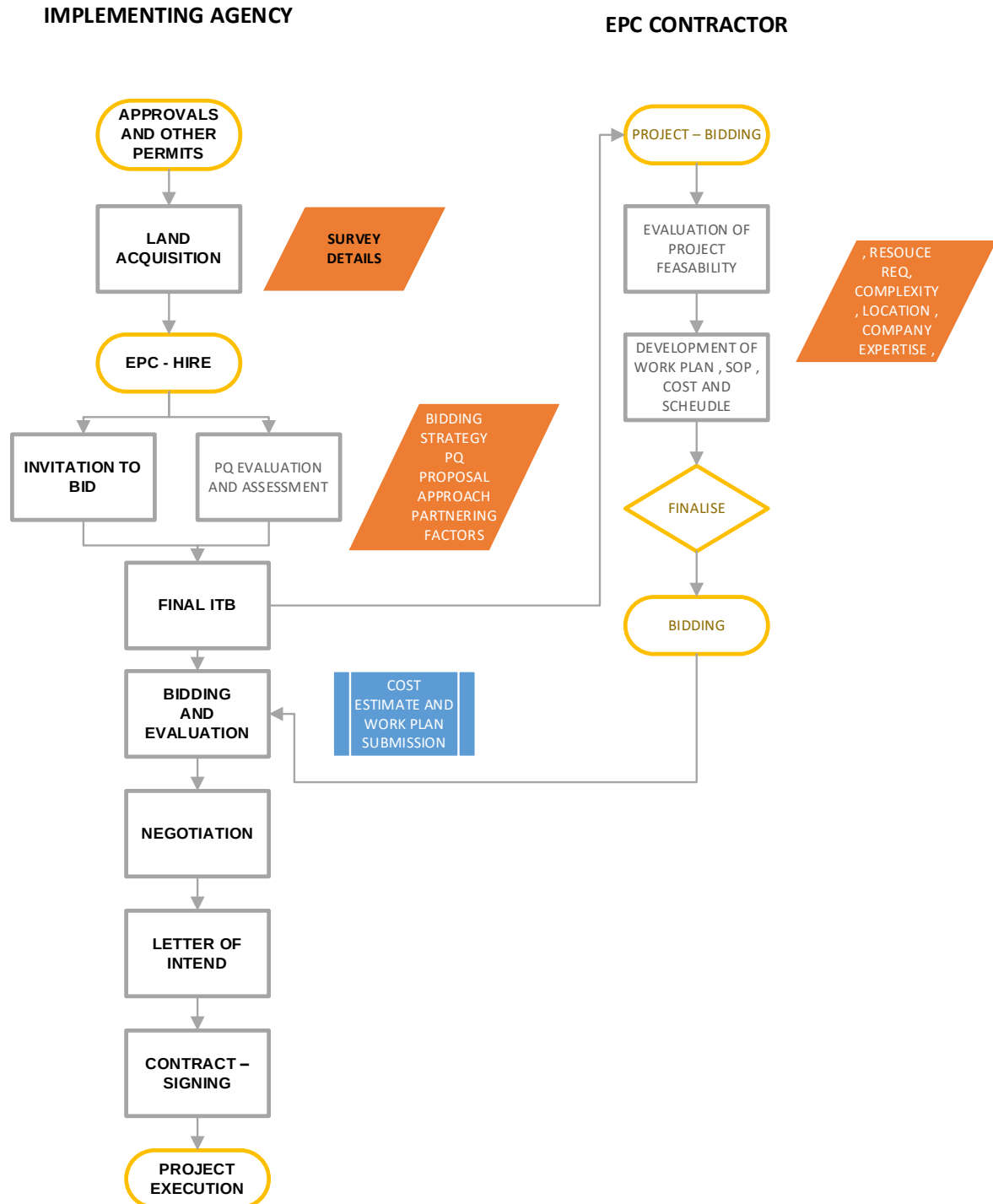


Fig 5.4 Swimlane – Project kick-off

5.7.5 PROJECT EXECUTION

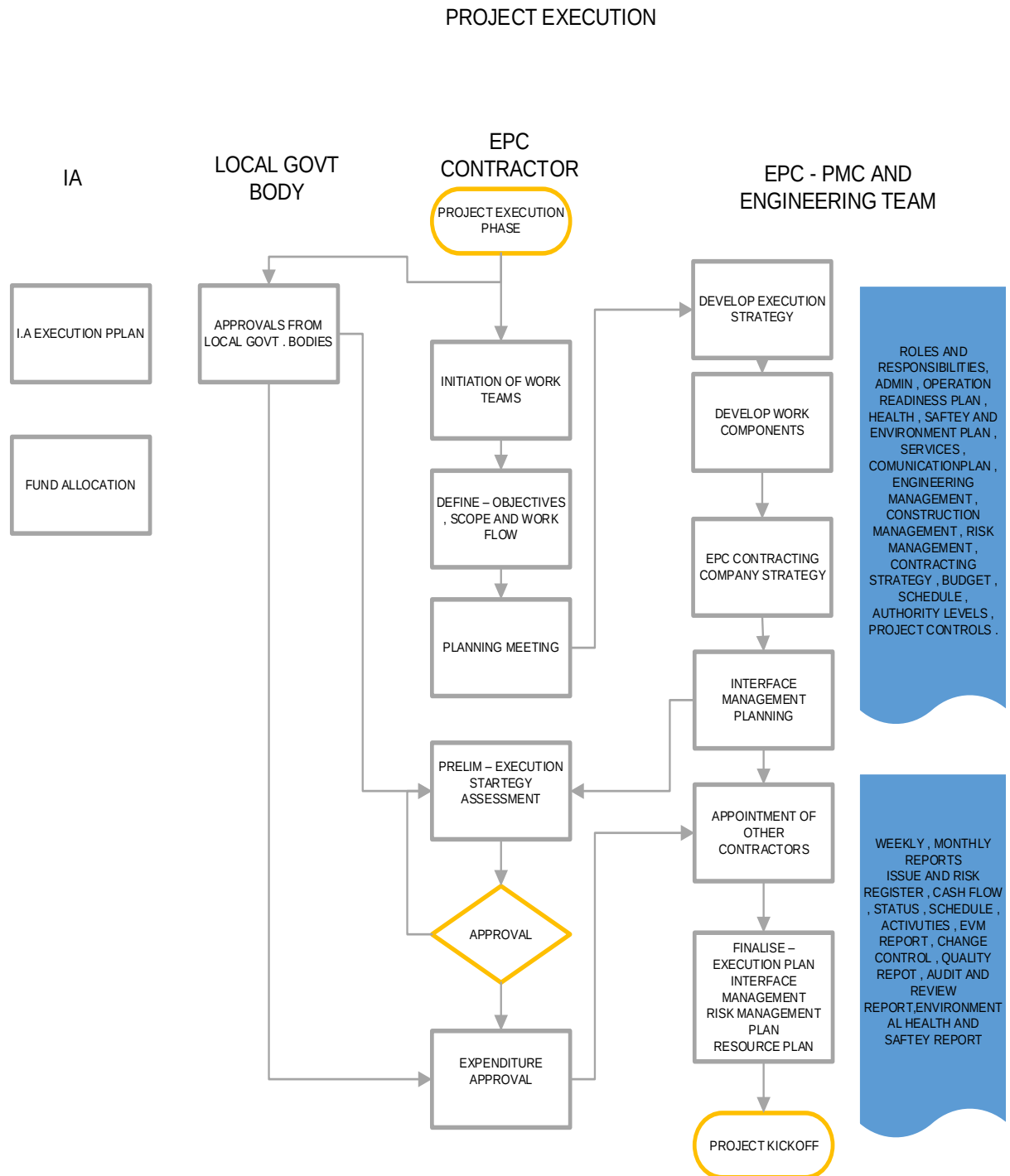


Fig 5.5 Swimlane – Project execution

5.7.6 . ENGINEERING AND PROCUREMENT

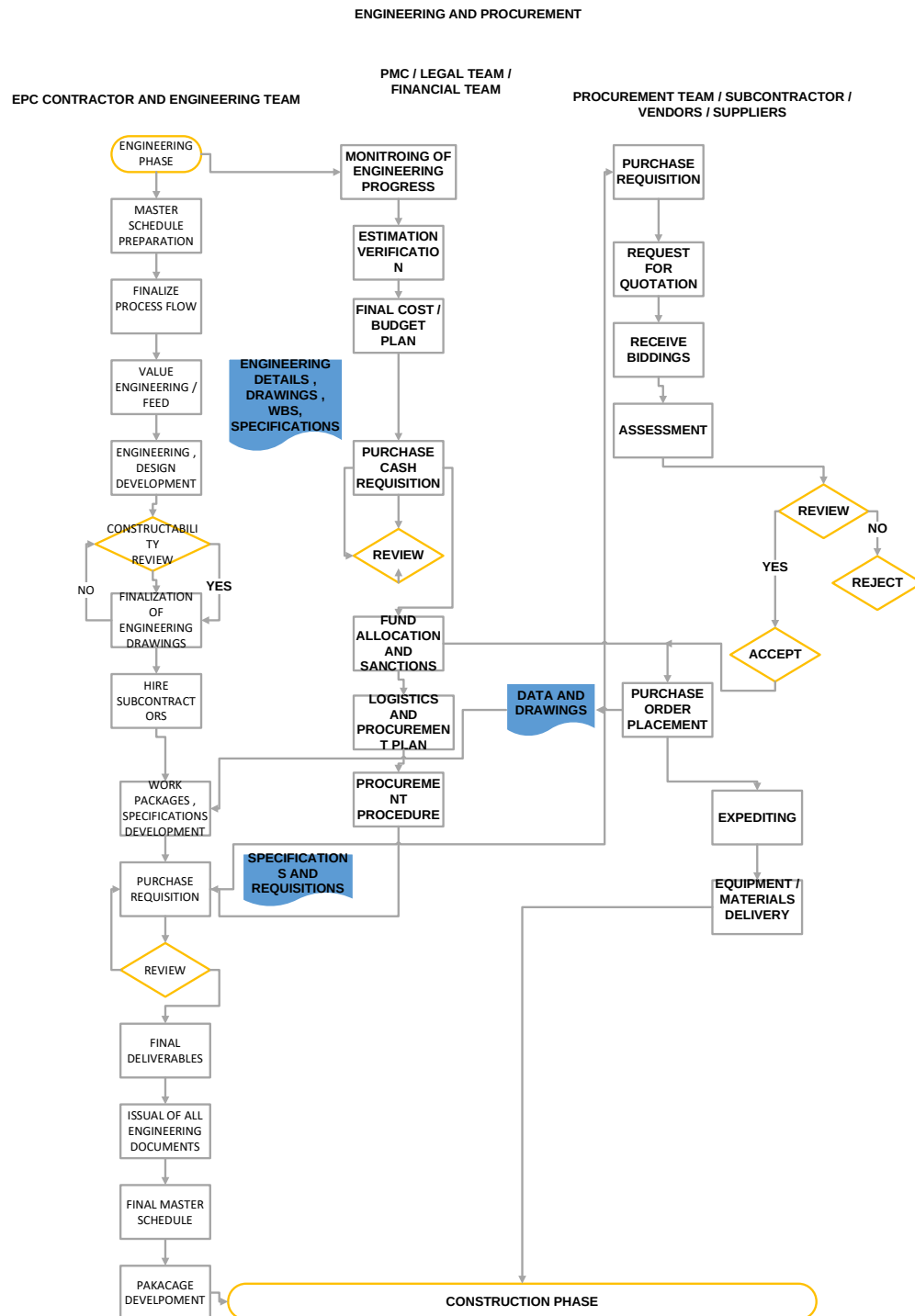


Fig 5.6 Swimlane – Engineering and procurement

5.7.7 CONSTRUCTION PHASE

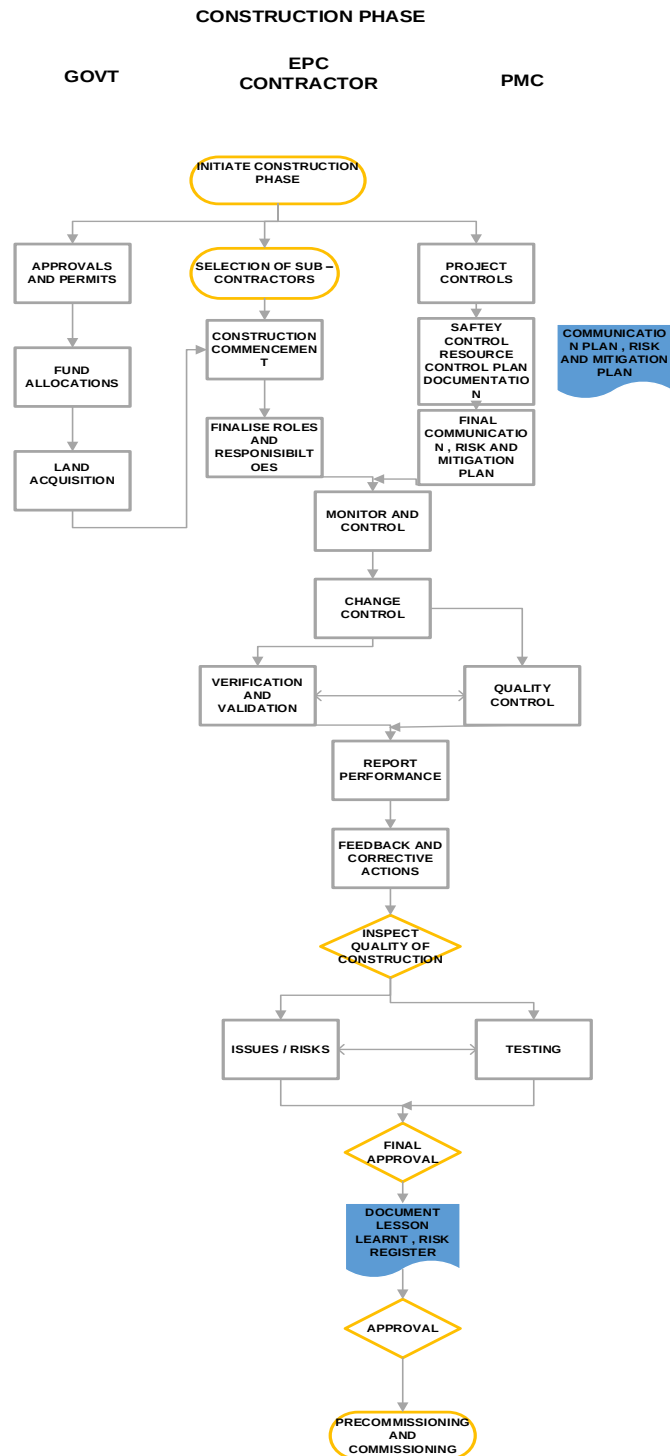


Fig 5.7 Swimlane – Project execution

5.8 SECTOR WISE STUDY

A detailed time and cost overrun for projects dating back from 2018 till 2021 was carried out. The average monetary and time delays were studied along with their impact factors.

5.8.1 TIME OVERRUN

SECTOR	FACTORS	AVERAGE DELAY
RAILWAYS		
	Schedule management	60 -80 months
	Cash flow in tranches	
	Contractual disputes	
	Claims	
	Co-ordination of IA and PM team	
POWER , OIL AND GAS		50 months
	No proper base line planning	
	Land handover	
	No skilled labours	
	Local protest	
	Approval delay	
	Claims and disputes	
ROADWAYS AND HIGHWAYS		30 months
	Approval delays	
	Claims and dispute	
	Suboptimal DPR	
CIVIL AVIATION		
	No proper base line planning	50 months
	Local agitation	
	No proper contractor assessment	
	Geological surprise	

Table 5.7 Sector wise – Time overrun

5.8.2 COST OVERRUN

SECTORS	FACTORS	PRICE ESCALATION (Cr)
RAILWAYS		
	Land acquisition , labour cost	2 L
	Material price increase during execution	
	No proper risk management	
POWER , OIL AND GAS		70 ,000
	Land acquisition	
	No proper risk management	
	Contract and claim management	
	Change orders	
	Scope creep	
	Lack of skilled labours	
ROADS AND HIGHWAYS		5,000
	Land acquisition	
	Contract and claim management	
	Suboptimal DPR	
CIVIL AVIATION		200
	Poor DPR	
	Material price escalation beyond workable	
	Poor framing of documents	
	Contractual disputes	

Table 5.8 Sector wise – Cost overrun

5.8.3 TIME IMPACT ASSESSMENT

S.no	Criteria	Impact %
1	Change of scope	5.2
2	Inadequate lack of planning	5.2
3	Shifting of local utilities	2
4	Local agitation	2.1
5	Land acquisition	6
6	delay in decision making	3.1
7	Inadequate admin in claims and disputes	4
8	Delays in approvals	7.7
9	No proper procurement planning	4.7
10	No adequate risk management	6.6
11	Shortage of fund allocation	3.4
12	No proper contract conditions	4.6
13	Ineffective usage of resources	4.5
14	Lack of skilled resources	4.5
15	Improper contractor assessment	4.1
16	Geological surprises	2.8
17	Handling of multiple projects	2.5
18	Unavailability experienced contractors	2.7
19	Law and order problems	3.7
20	Lack of technological usage	3.7
21	Communication and coordination problems	3.6
22	Pre- commissioning activities	3.5
23	Overall project management	3.2
24	Delayed funds	3.8
25	Unfavourable geological conditions	2.8

Table 5.9 Time impact assessment

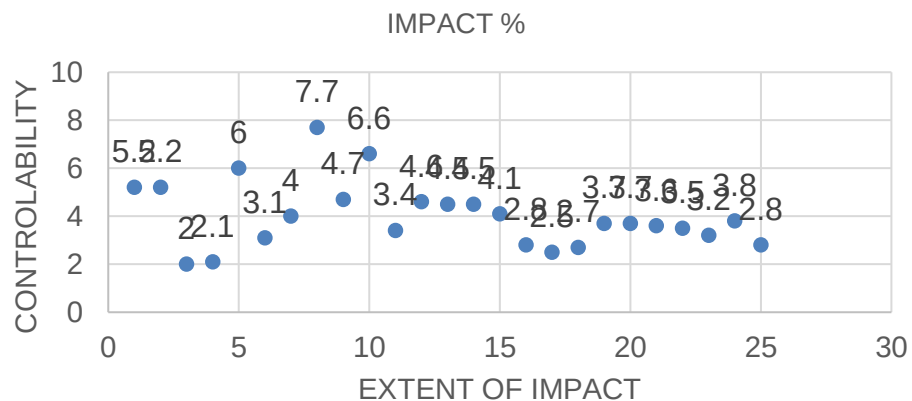


Fig 5.8 Time impact

5.8.4 COST IMPACT ASSESSMENT

1	Suboptimal DPR and scope	6.6
2	Scope creep	6.4
3	Location and transportation connection	4
4	Material price escalation	6.2
5	Selection of sub contractor and vendors	6
6	Lack of base planning	6.9
7	Land acquisition cost	6.6
8	Change orders	6.8
9	Labour cost variation	5.6
10	Poor utilization of labours	5.8
11	Availability of skilled labours	5.4
12	Poor claim and contract management	5.6
13	Improper procurement planning	5.1
14	Inadequate contract framing and disputes	4.8
15	Lack of detailed estimation	4.6
16	Rehabilitation and resettlement measurements	5.4
17	Financial risks	4.2
18	Technological choice	4

Table 5.10 Cost impact assessment

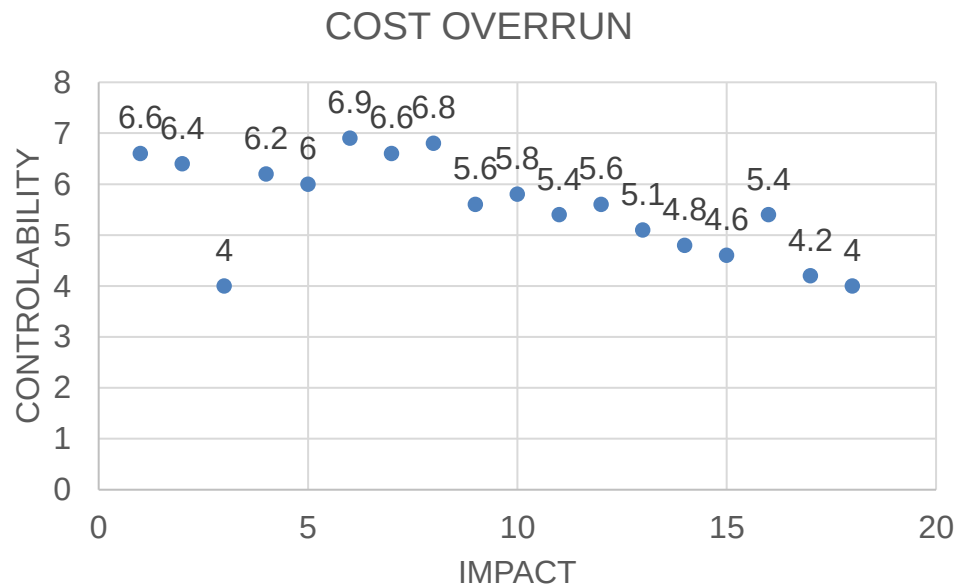


Fig 5.9 Cost impact

CHAPTER 6

SUMMARY AND RECOMMENDATIONS

6.1 MITIGATION MATRIX

	Threat			Opportunity			
	SITUATION	IMPACT	LIKLIHOOD	SITUATION	IMPACT	LIKLIHOOD	
MITIGATE	ADAPT	REDUCE	DISABLE	IMPROVE	AUGMENT	ENABLE	ENHANCE
AVOID	REFOCUS	COUNTERACT	ELIMINATE	REFOCUS	CAPTURE	ENSURE	EXPLOIT
TRANSFER	REASSIGN	SHIFT	OUTSOURCE	REASSIGN	PARTNER	OUTSOURCE	SHARE

Table 6.1 Model mitigation matrix

Mitigation in general includes transfer , mitigate , avoid, and accept process. Selection of the above strategies can limit the impact. An extensive matrix was developed to mitigate the influence of the parameters in a comprehensive and thorough method.

PRE - DEVELOPMENT / PLANNING		STRATEGY	SITUATION	IMPACT	LIKELIHOOD	STRATEGY	SITUATION	IMPACT	LIKELIHOOD
	INEFFICIENT FEASIBILITY STUDY	TRANSFER AND MITIGATE	REFOCUS	SHIFT	DISABLE AND OUTSOURCE	ENHANCE	REFOCUS	AUGMENT	ENSURE
	NO PROPER SURVEY	AVOID AND TRANSFER	REASSIGN	COUNTERACT	OUTSOURCE	ENHANCE	IMPROVE	PARTNER	ENSURE
	NO PROPER GEOTECHNICAL ASSESSMENT	MITIGATE	REFOCUS	SHIFT	ELIMINATE	ENHANCE	IMPROVE	PARTNER	ENSURE
	PRE-COMMISSIONING REQUIREMENTS NOT FULFILLED.	MITIGATE	ADAPT	SHIFT	ELIMINATE	SHARE	IMPROVE	PARTNER	ENSURE
	RESETTLEMENT AND REHABILITATION RISK	AVOID	ADAPT	REDUCE AND COUNTERACT	OUTSOURCE / SHARE	SHARE		PARTNER AND CAPTURE	ENABLE
	LAND ACQUISITION DELAY	ACCEPT AND MITIGATE	ADAPT	COUNTERACT	ELIMINATE	ENHANCE	REASSIGN	CAPTURE	ENSURE
CONTRACT / SCOPE MANAGEMENT									
	INADEQUATE SPECIFICATIONS AND DETAILS	TRANSFER	REASSIGN AND ADAPT	SHIFT	SHARE	SHARE AND ENHANCE	REFOCUS	CAPTURE AND PARTNER	ENSURE
	NO CLEAR CONTRACTUAL TERMS	MITIGATE	REFOCUS	COUNTERACT	OUTSOURCE AND DIASBLE	SHARE AND ENHANCE	REFOCUS	CAPTURE AND PARTNER	ENSURE
	NO PROPER TERMS FOR LITIGATION AND CLAIMS	MITIGATE	ADAPT AND REFOCUS	REDUCE AND COUNTERACT	ELIMINATE	SHARE	REASSIGN	PARTNER	ENSURE
	SUBOPTIMAL SCOPE	MITIGATE	AND ADAPT	REDUCE	OUTSOURCE	EXPLOIT	IMPROVE	AUGMENT	ENABLE
	NO PROPER FEASIBILITY STUDY	MITIGATE	REASSIGN AND ADAPT	REDUCE AND SHIFT	OUTSOURCE AND ELIMINATE	EXPLOIT	IMPROVE	AUGMENT	ENABLE
	INSUFFICIENT DATA COLLECTION	MITIGATE	REASSIGN AND ADAPT	REDUCE AND SHIFT	OUTSOURCE AND ELIMINATE	EXPLOIT	IMPROVE	AUGMENT	ENABLE
	NO PROPER CONTRACTOR / VENDOR ASSESSMENT	MITIGATE	REASSIGN AND ADAPT	REDUCE AND SHIFT	OUTSOURCE AND ELIMINATE	EXPLOIT	IMPROVE	CAPTURE	ENABLE
	POOR CLAIM ADMINISTRATION AND MANAGEMENT	MITIGATE	REASSIGN AND ADAPT	REDUCE AND SHIFT	OUTSOURCE AND ELIMINATE	EXPLOIT	IMPROVE	AUGMENT	ENABLE
	SCOOP CREEP	MITIGATE	REASSIGN AND ADAPT	REDUCE AND SHIFT	OUTSOURCE AND ELIMINATE	ENHANCE	REASSIGN	PARTNER	OUTSOURCE
STAKEHOLDERS MANAGEMENT									
	INSUFFICIENT STAKEHOLDER MANAGEMENT	MITIGATE	REFOCUS	COUNTERACT	OUTSOURCE	EXPLOIT	IMPROVE	AUGMENTT	ENABLE
	NON - PERFORMANCE OF CONTRACTOR / VENDORS	MITIGATE	ADAPT AND REASSIGN	SHIFT AND COUNTERACT	ELIMINATE	ENHANCE	REASSIGN	CAPTURE	ENSURE
	DISPUTE	MITIGATE AND TRANSFER	REASSIGN	REDUCE	ELIMINATE	SHARE	IMPROVE	PARTNER	OUTSOURCE

ENGINEERING AND CONSTRUCTION									
	POOR DESIGN	MITIGATE	ADAPT	REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	INCOMPLETE DESIGN	MITIGATE	ADAPT	REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	DESIGN FAILURES	MITIGATE	ADAPT	REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	DESIGN ERRORS AND CHANGE ORDERS	MITIGATE	ADAPT	COUNTERACT AND REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	SCHEDULE DELAY	MITIGATE	ADAPT	REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	REWORK	ACCEPT AND MITIGATE	ADAPT	REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	POOR QUALITY OF WORK	MITIGATE	ADAPT	REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	IMPRACTICAL TECHNOLOGY	MITIGATE	ADAPT	REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	PROJECT COMPLEXITY/ UNIQUENESS	MITIGATE	ADAPT	COUNTERACT AND REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	HSE MANAGEMENT	MITIGATE	ADAPT	REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	INSTALLATION RISKS	MITIGATE	ADAPT	REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	IDENTIFYING AND SHIFTING OF UTILITIES	MITIGATE	ADAPT	COUNTERACT AND REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
	NO PROPER USAGE OF TECHNOLOGY	MITIGATE	ADAPT	COUNTERACT AND REDUCE	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	
REPORTING AND DOCUMENTATION									
	INADEQUATE DOCUMENTATION	MITIGATE	REFOCUS	COUNTERACT	DISABLE	ENHANCE	IMPROVE	CAPTURE	ENABLE
	AVAILABILITY OF PREVIOUS WORK ORDERS	MITIGATE	REASSIGN AND ADAPT	REDUCE AND COUNTERACT	DIABLE	ENHANCE	IMPROVE	CAPTURE	ENABLE
	NO PROPER REPORTING FORMAT / PROCESS	MITIGATE	REASSIGN AND ADAPT	COUNTERACT	ELIMINATE	EXPLOIT	IMPROVE	AUGUMENT	ENABLE
PROJECT MONITROING / CONTROL									
	POOR PROJECT PLANNING	MITIGATE	AND ADAPT	COUNTERACT	ELIMINATE	ENHANCE	IMPROVE	PARTNER	ENHANCE
	POOR ESTIMATION AND SCHEDULING	MITIGATE	REASSIGN AND ADAPT	REDUCE AND COUNTERACT	ELIMINATE	ENHANCE	IMPROVE	CAPTURE	ENHANCE
	IMPROPER WORK METHODOLOGY	MITIGATE	AND ADAPT	COUNTERACT	ELIMINATE	ENHANCE	IMPROVE	CAPTURE	ENHANCE
	INADEQUATE QA/QC	MITIGATE	AND ADAPT	COUNTERACT	ELIMINATE	ENHANCE	IMPROVE	PARTNER	OUTSOURCE
	NO PROPER RISK MANAGEMENT	MITIGATE	AND ADAPT	COUNTERACT	ELIMINATE	ENHANCE	IMPROVE	CAPTURE	OUTSOURCE
	CONTRACTOR - BACKRUPT	MITIGATE	REASSIGN	REDUCE AND SHIFT	ELIMINATE	ENHANCE	IMPROVE	PARTNET	OUSOURCE
RESOURCE MANAGEMENT									
	IMPORT OF MATERIALS	MITIGATE AND TRANSFER	ADAPT	COUNTERACT	OUTSOURCE	ENHANCE	IMPROVE	CAPTURE	ENSURE
	LACK OF RESOURCES/WORK FRONT	MITIGATE	ADAPT	COUNTERACT	OUTSOURCE	ENHANCE	IMPROVE	CAPTURE	ENSURE
	LONG - LEAD DELIVERY	MITIGATE	ADAPT	COUNTERACT	DISABLE	ENHANCE	IMPROVE	CAPTURE	ENSURE
	POOR QUALITY MATERIAL	MITIGATE	ADAPT	COUNTERACT	DISABLE	ENHANCE	IMPROVE	CAPTURE	ENSURE
	INEFFICIENT EQUIP / MAT	MITIGATE	ADAPT	COUNTERACT	DISABLE	ENHANCE	IMPROVE	CAPTURE	ENSURE
	EQUIPMENT BREAKDOWN	MITIGATE	ADAPT	COUNTERACT	OUTSOURCE	ENHANCE	IMPROVE	CAPTURE	ENSURE
	MOBILIZATION , TRANSPORTATION AND LOGISTICS	MITIGATE	ADAPT	COUNTERACT	DISABLE	ENHANCE	IMPROVE	CAPTURE	ENSURE
	UNSKILLED LABOUR	MITIGATE	ADAPT	COUNTERACT	DISABLE	ENHANCE	IMPROVE	CAPTURE	ENSURE
	INEFFECTIVE LABOUR / MATERIAL UTILIZATION	MITIGATE	REASSIGN AND ADAPT	COUNTERACT	DISABLE	ENHANCE	IMPROVE	CAPTURE	ENSURE
ENVIRONMENTAL									
	UNFORSEEN WEATHER	ACCEPT AND MITIGATE	ADAPT	SHIFT	OUTSOURCE	SHARE	REFOCUS	PARTNER	ENSURE
	FORCE MAJEURE	ACCEPT AND MITIGATE	ADAPT	SHIFT	OUTSOURCE	SHARE	REFOCUS	PARTNER	ENSURE
	DIASER PRONE - AREAS	ACCEPT AND MITIGATE	ADAPT	SHIFT	OUTSOURCE	SHARE	REFOCUS	PARTNER	ENSURE
	HARSH ENVIRONMENTAL CONDITIONS	ACCEPT AND MITIGATE	ADAPT	SHIFT	OUTSOURCE	SHARE	REFOCUS	PARTNER	ENSURE
	UNFORSEEN CONDITIONS	ACCEPT AND MITIGATE	ADAPT	SHIFT	OUTSOURCE	SHARE	REFOCUS	PARTNER	ENSURE
	SOCIAL ACCEPTABILITY RISK	ACCEPT AND MITIGATE	ADAPT	SHIFT	OUTSOURCE	SHARE	REFOCUS	PARTNER	ENSURE
	GEOLOGICAL SURPRISE	ACCEPT AND MITIGATE	/REFOCUS	SHIFT	OUTSOURCE	SHARE	REFOCUS	PARTNER	ENSURE
LOCAL CONDITION									
	LOCAL POPULATION RESISTANCE	MITIGATE	ADAPT	REDUCE	DIASBLE	SHARE	IMPROVE	CAPTURE	ENSURE
	BAD LOCAL ORDER	MITIGATE	ADAPT	COUNTERACT	DISABLE	SHARE	IMPROVE	CAPTURE	ENSURE
	DISORDERLY VICIOUS COMPETITION	TRANSFER	ADAPT	SHIFT	ELIMINATE	SHARE	REASSIGN	CAPTURE	ENSURE
GOVERNANCE									
	NEW LAW	TRANSFER AND MITIGATE	ADAPT	COUNTERACT	DISABLE	ENHANCE	IMPROVE	CAPTURE	ENABLE
	BUREAUCRATIC PROBLEMS	TRANSFER AND MITIGATE	REFOCUS	REDUCE	OUTSOURCE	SHARE	IMPROVE	CAPTURE	ENABLE
	DELAYED APPROVALS	TRANSFER AND MITIGATE	REFOCUS	COUNTERACT	DISABLE	SHARE	REASSIGN AND REFOCUS	PARTNER	ENABLE
FINANCIAL MANAGEMENT									
	EXCHANGE RATE FLUCTUATIONS	MITIGATE	ADAPT AND REFOCUS	REDUCE AND COUNTERACT	DISABLE AND ELIMINATE	ENHANCE AND SHARE	ELIMINATE	PARTNER	ENSURE
	INFALTION RISK	MITIGATE AND TRANSFER	ADAPT AND REFOCUS	REDUCE AND COUNTERACT	DISABLE AND ELIMINATE	ENHANCE AND SHARE	ELIMINATE	PARTNER	ENSURE
	FLUCTUATION IN THE ECONOMY	MITIGATE AND TRANSFER	ADAPT AND REFOCUS	REDUCE AND COUNTERACT	DISABLE AND ELIMINATE	ENHANCE AND SHARE	ELIMINATE	PARTNER	ENSURE
	LIMITED FUNDING	TRANSFER	ADAPT AND REFOCUS	REDUCE AND COUNTERACT	DISABLE AND ELIMINATE	ENHANCE AND SHARE	ELIMINATE	PARTNER	ENSURE
	DELAY IN PAYMENTS	MITIGAT E	ADAPT AND REFOCUS	REDUCE AND COUNTERACT	DISABLE AND ELIMINATE	ENHANCE AND SHARE	ELIMINATE	REFOCUS	ENSURE
	LARGE CHANGE IN INTEREST	TRANSFER	ADAPT AND REFOCUS	REDUCE AND COUNTERACT	DISABLE AND ELIMINATE	ENHANCE AND SHARE	ELIMINATE	PARTNER	ENSURE
	BUDGET RELEASED IN TRENCHES	MITIGATE	ADAPT AND REFOCUS	REDUCE AND COUNTERACT	DISABLE AND ELIMINATE	ENHANCE AND SHARE	ELIMINATE	REFOCUS	ENSURE
	LAND ACQUISITION COST	MITIGATE AND AVOID	ADAPT AND REFOCUS	REDUCE AND COUNTERACT	DISABLE AND ELIMINATE	ENHANCE AND SHARE	ELIMINATE	PARTNER	ENSURE

Table 6.2 Mitigation matrix

6.2 MITIGATION STRATEGIES

6.2.1 PRE DEVELOPMENT /PLANNING STAGE

- High investment for pre planning and development stage .
- Phase wise action plan .
- PM should ensure the completion of stage wise of all the framework before starting the next phase .
- Realistic buffer for approvals .
- Socio – economic benefits can be explained- Local protest .

TECHNOLOGIES :

- Usage of technologies can be used for extensive site study .
- Ex : Mobile mapping
- Best available technology (BAT) should be employed.

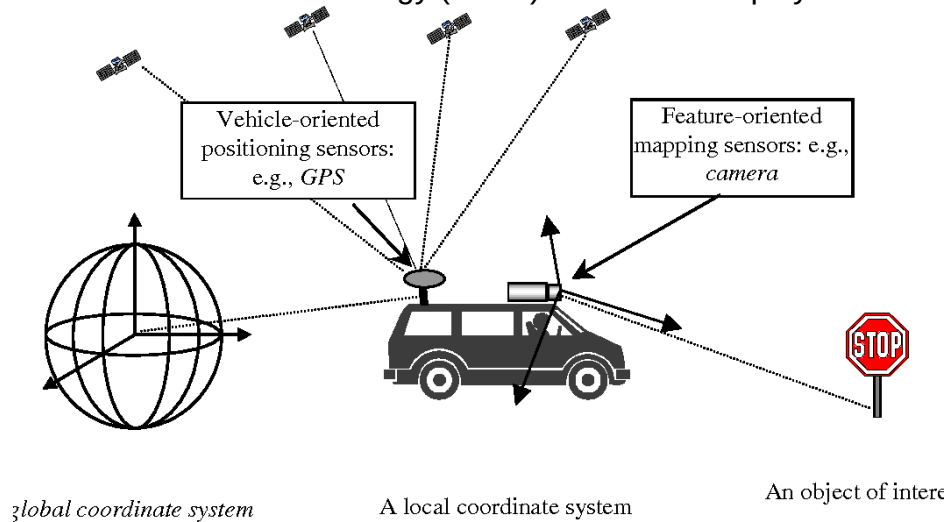


Fig 6.1 Mobile mapping

BENCHMARKING

- IA should develop benchmarking to measure the provided details .
- The benchmarking can be setup according to the past projects .
- Internal benchmarking (EPC company) will help them to evolve proper pre development details .

DESIGN REVIEW :

- The detailed drawings can be reviewed by PMC .
- This will provide a clear understanding of the necessary components and to study the criticality .
- Buffer time for review should be included within the schedule .

REVALIDATION OF DPR

- If there is a lag between development of DPR and tendering stage , re-evaluate the DPR .

PROJECT SANCTIONS ALIGNING WITH APPROVALS

- Delays in approvals can cause inaccurate base line cost and schedule , idle

time etc.

- Governing bodies can create a framework where implications of time and cost required for land acquisition and resettlement is considered after which budget can be approved .

SCBA

- The results obtained from SCBA can be made public to increase the awareness regarding out come of the projects
- Can help from local protest.

DIGITIZATION

- Record of land and other documents can be digitized .
- Technology of geo – references can be used .
- Non editable formats can be used for documentation .
- Easy record maintenance and transactions .

Farmers have “voluntarily offered” about 90 per cent of the 38,581 acre land required for Andhra Pradesh's new capital at Amravati under the pooling system, a state government official said. The central government think tank NITI Aayog has lauded the ‘land pooling’ method as a “model to the nation” in land acquisition. “Farmers have voluntarily offered 32,637.48 acre (89 per cent) of the targeted 38,581.15 acres of land for the new capital. The work is in full swing,” T Srinivasa Rao, OSD to CM (Media Advisor) told PTL.

Rao said the Land Pooling Scheme (LPS), evolved by the state, is the assembling of small land parcels under different ownerships voluntarily into a large land parcel. Andhra Pradesh Capital Region Development Authority (APCRDA), formulated for planning, co-ordination, execution and promoting and securing the planned development of the capital region, ensures return of reconstituted land and payment of benefits to the land owners per every acre voluntarily handed over, he said.

Fig 6.2 Amaravati pooling system

6.2.2 ENGINEERING AND CONSTRUCTION PHASE

COLLABORATIVE PLANNING

- With collective involvement project baseline and cost can be very realistic .
- This will also ensure optimized design and construction process .
- Involving stakeholders across various level will help to develop standardized engineering and construction action of plan .

EXTENSIVE MEETING SESSIONS

- Periodic reporting and meetings will help to work effective.

“COST OF DELAY “ AND “OPPORTUNITY LOSS”

- They should included in the schedule and cost plan and control . Resulting in well approached execution decisions and plans.

COLLABORATIVE PROJECT MANAGEMENT PLAN

- A management plan involving all the stakeholders should be initiated .
- Baseline schedule.
- Master schedule .
- Cost estimate and cash flow.
- Accountability and role
- Execution plan
- Engineering plan
- Risk management plan
- Recovery plan

TECHNOLOGICAL USAGE TO BE MADE CONTRACTUAL

- Implementation of various BIM based for engineering , schedule analytics – primavera and MSP , stakeholders interface and other application tools should be rationalized in the contracts.

LEAN MANAGEMENT TOOLS

- Last planner
- Work sampling
- Percentage of Planned commitments
- Removal of waste during operations – IoT can be implemented.
- Work sampling – time motion study

Few achieved benefits:

- | | |
|----------------------------------|--|
| • Slab Cycle time reduced by 25% | • Batching Plant output increased by 27% |
| • Labour Efficiency up by 72% | • Crane utilization up by 20 % |
| • Crew Utilization up by 95% | |

Fig 6.3 KPMG Lean outcomes

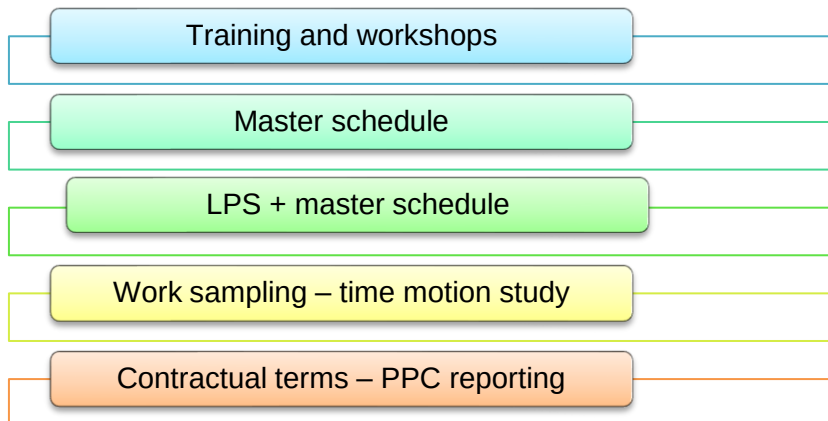


Fig 6.4 Lean tools

6.2.3 PROCUREMENT PHASE

WATERFALL APPROACH

- Implementation of waterfall approach will help us to check the viability for distinct stages.

VENDOR SCORE CARDS

- Performance can be measured using scorecards in terms of their quality, service, cost and delivery time.
- Efficient communication between procurement team and vendors.

IA STRATEGY

- Not all companies have the experience or capital investment to handle procurement.
- Policy making bodies (NITI Aayog) can support by developing procurement strategy with necessary contract documents.

BIDDING METHODS

- Low bidding price method sometimes can be unrealistic.
- Two stage bidding methods can be implemented.
- Optimized strategy
- Competitive proposal
- Good track
- Technical qualifications



Fig 6.5 Bidding methods

6.2.4 STAKEHOLDERS MANAGEMENT

CLEAR RESPONSIBILITY CHART

- Ensure effective decision making.
- Balance between different levels of decision making (centralised and de-centralised).

TECHNOLOGY

- IoT, Interface management, dash boards, collaborative platforms
- E-file mechanism



Fig 6.6 Invest India web portal

REVIEW – LEGAL POLICIES

- Delayed decisions because of ambiguous policies that can cause challenges .
- Periodic reviews – conducted to make them relevant for current scenario .

REVOKING RESOURCE MANAGEMENT

- Transparent compensation to performance appraisal system can increase performance and productivity -(Merit based)

Mechanisms across the world		Other mechanisms	
European Union	Individual Performance Appraisal system	Funding	Reduce or restrict agency funding.
	Performance related pay		Eliminate agency funding.
South Korea	Performance Appraisal system & Pay for performance	Flexibility	Return all funding to the centre.
	Lateral hiring from private sector		Restrict ability to transfer funds.
Brazil	60% of compensation is linked to performance and 40% is fixed	Public recognition	Publicly recognise the agency's achievements.
			Publicly criticise the agency's performance.
Singapore	Selects & trains the best students on a renewable contract basis		Order a management audit of the agency.

Source: Paper on "Improving Public Sector Efficiency: Challenges and Opportunities" by Teresa Currissine, Zsuzsanna Lonti and Isabelle Jourard

Fig 6.7 Resource management

IMPLEMENTATION OF DEPARTMENT OF PUBLIC ENTERPRISE

- a) Alignment of HR strategy with business
- b) Rewards and recognition
- c) Promotion and career management
- d) Employee engagement
- e) Training and development
- f) Leadership development

Fig 6.8 Public enterprise

6.2.5 PROJECT MONITORING AND CONTROL

CENTRAL CONTROL CELL:

- India Investment grid or creation of a new platforms.
- Help track / monitor execution status
- Helps to take key decisions on vital activities.
- Periodic review of all investment decisions.
- BROADENED ROLE OF MosPI
- They provide periodic data on performance of various infra projects.

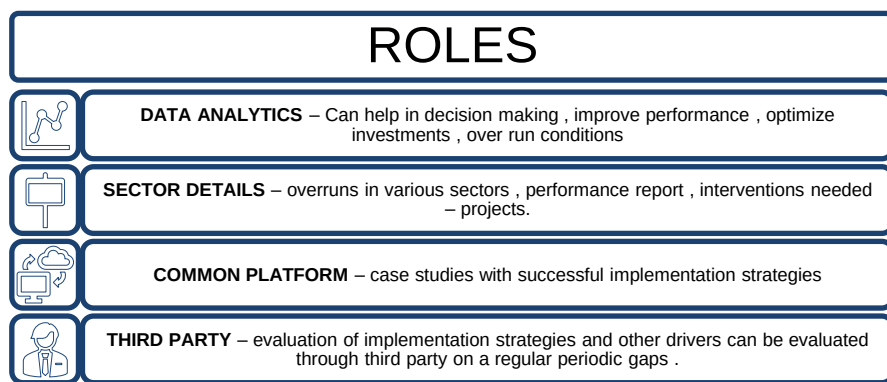


Fig 6.9 Broadened role of MosPI

The Oil and Natural Gas Corporation (ONGC) Limited has implemented a structured Stage-gate framework as a project delivery mechanism, comprising of project stages and gates in between. The incorporation of gates ensures that the project moves across the stages only after completion of all the deliverable/check-points for the respective gate.

Other Implementation Agencies should leverage this framework or develop a customized end-to-end Stage-gate project delivery framework for executing projects. Few of the expected benefits for Implementation Agencies include but not limited to:

- ✓ A transparent process known and understood by all key stakeholders; internal and external,
- ✓ Improved diligence in pre-planning (such as DPR, geological investigation studies etc.) and planning activities,
- ✓ Better confidence in the accuracy of budget and schedule baselines during project approval,
- ✓ A disciplined and consistent approach to project execution, and
- ✓ Built in cross-department/government inputs at all gates as check points such as land acquisition, regulatory approvals etc.

Fig 6.10 ONGC limited Stage gate framework

6.3 PROJECT MANAGEMENT MATURITY ASSESSMENT

Major Projects Advisor tool or MPA tool for conducting the survey. The tool is globally used to understand the project control assessment and benchmarking against the leading practices.

	COST MANAGEMENT	PROCUREMENT MANAGEMENT	ORGANISATION AND ADMIN	RISK MANAGEMENT	SCHEDULE MANAGEMENT
POWER	1.9	1.85	1.56	1.94	1.2
ROAD AND HIGHWAYS	1.65	2.1	1.98	1.55	1.58
AVIATION	2.2	1.98	1.96	1.89	1.85
OIL AND GAS	2.3	1.78	1.85	1.73	1.8

Table 6.3 Maturity assessment

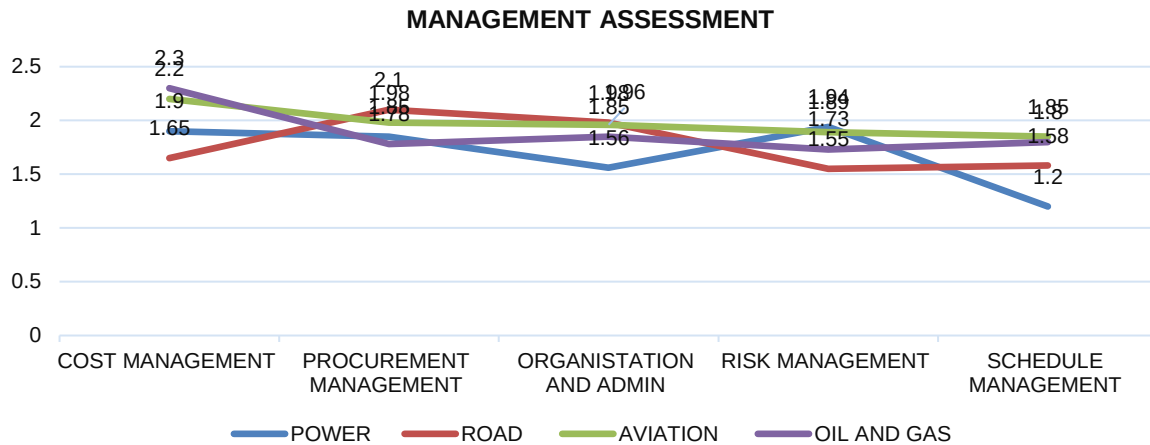


Fig 6.11 Maturity assessment

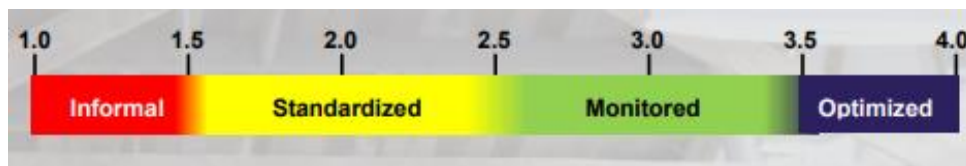


Fig 6.12 Major project advisory tool

6.4 INTERFACE MANAGEMENT

Interface Management System is defined as a Systematic approach to effectively identify and handle interfaces through whole project lifecycle with the objective of facilitating the alignment process between stakeholders by defining the interface characteristics, responsibilities of involved parties and the need time of deliverables.

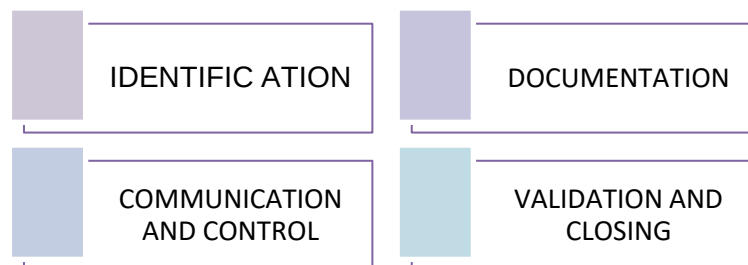


Fig 6.12 Interface Management phase

6.4.1 SCHEDULE AND COST PERFORMANCE

	E.S.P	P.S.P	C.S.P
IA - C	1	0.86	0.92
C-S.C	0.9	0.94	0.96
C-V	0.88	0.94	0.92
S.C - V	0.7	0.84	0.82
C- D	0.9	0.86	0.84
C - F.I	0.92	0.94	0.98
C - E	0.94	0.94	0.96
C - P	0.92	0.94	0.98
C- L.G	0.9	0.9	0.92

Table 6.4 Schedule performance

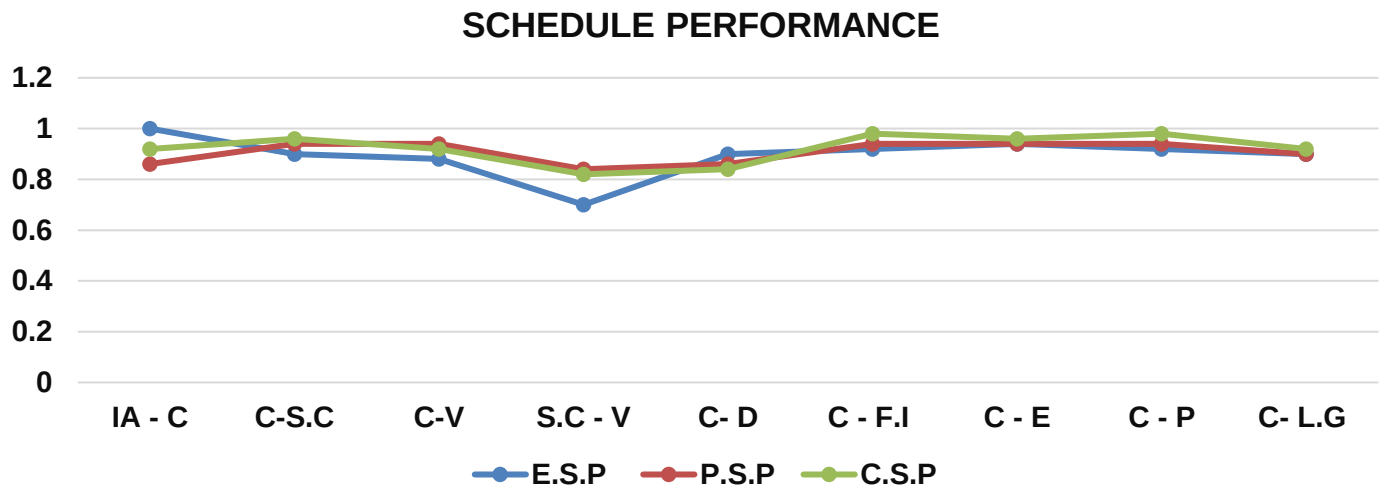


Fig 6.13 Schedule performance

	E.C.P	P.C.P	C.C.P
IA - C	0.94	0.96	1
C-S.C	0.92	0.96	1

C-V	0.88	0.98	0.94
S.C - V	0.68	0.88	0.86
C- D	0.88	0.86	0.86
C - F.I	0.86	0.9	1
C - E	0.96	0.94	0.98
C - P	0.88	0.92	0.98
C- L.G	0.94	0.92	0.96

Table 6.5 Cost performance

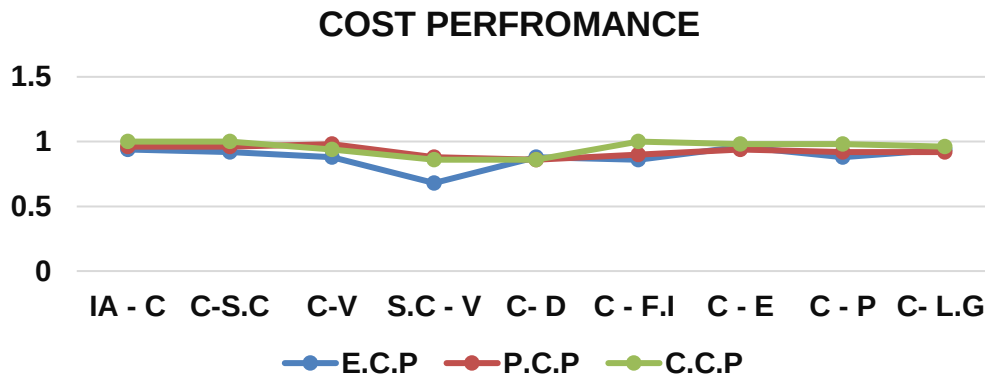


Fig 6.14 Cost performance

KEY :

IA – IMPLEMENTING AGENCY

C- CONTRACTOR

S.C – SUBCONTRACTOR

V – VENDORS

D- DESIGN TEAM

FI- FINANCIAL INSTITUTIONS

E – ENGINEERING

P – PROCURMENT

L – LOCAL GOVERNMENT

6.4.2 INTERFACE MANAGEMENT PROCESS

Interface management process was developed with four distinct phases. The process envisages to develop and create a harmonious communication and interface management. The process starts from the lower level of hierarchy reaching till the top level of management.

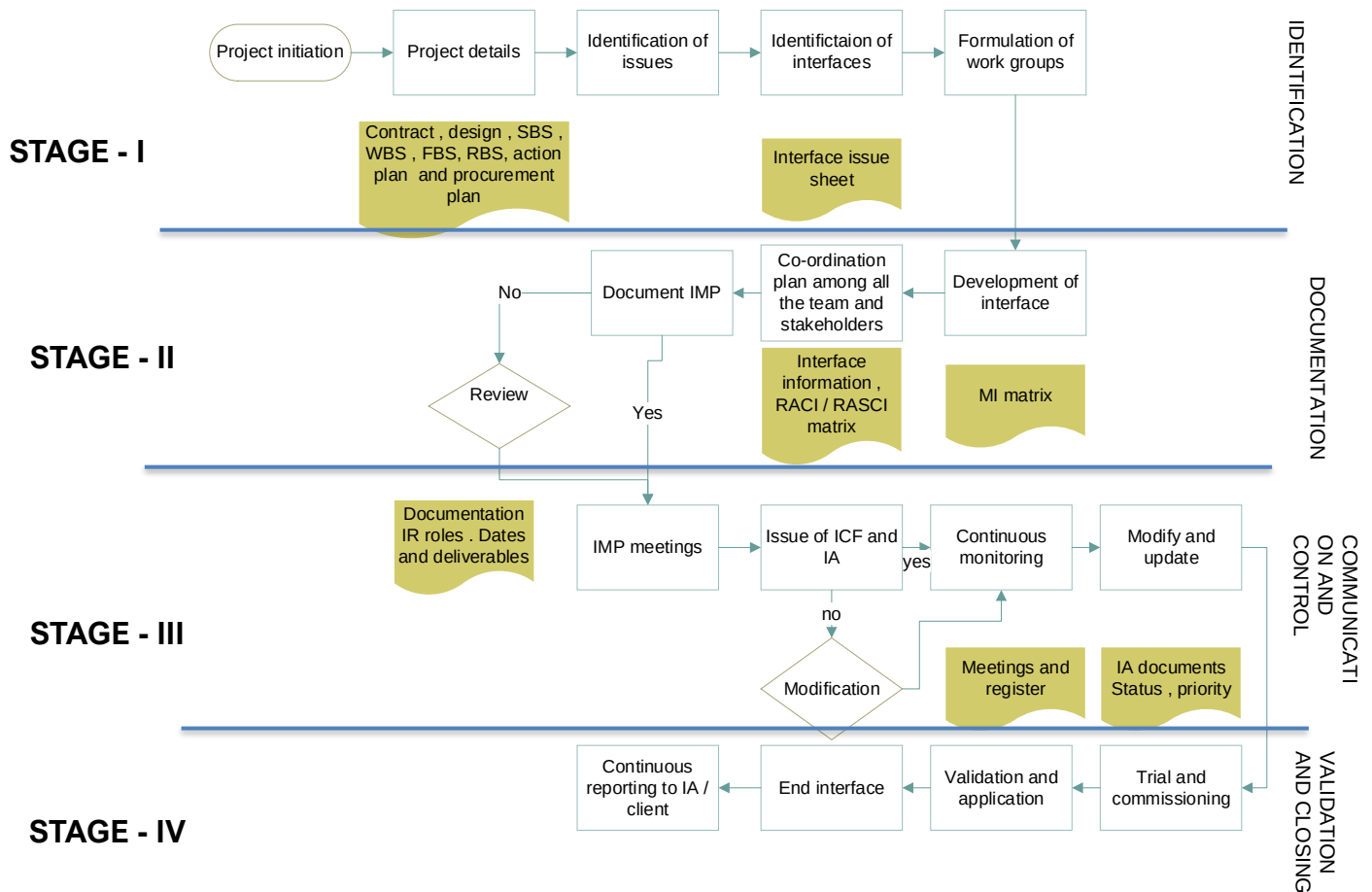


Fig 6.15 Interface management plan

6.4.3 IDENTIFICATION AND RESPONSE

A3 design sheet technique is used to create a template for identification of issues and response register in interface management. This technique makes the process of identification and sorting of risk factors and impacts at ease.

PROJECT		I.A	EPC CONTRACTOR	DATE
ACTIVITY		ACTIVITY ID	CONTRIBUTOR	
SCOPE / WORK ITEM				
EXPECTED ACTIVITY COMPLETION DATE			IDENTIFIED ISSUE	
INTERFACE				
INTERNAL	EXTERNAL			
ACTIVITY		ACTIVITY ID	EXPECTED DATE OF COMPLETION	
SCOPE			ISSUES IDENTIFIED	
INTERFACE	INTERNAL	EXTERNAL		
REMARKS / NOTE			SIGNATURE	

Fig 6.16 Identification sheet

PROJECT TITLE			EPC CONTRACTOR	DATE
WORK ITEM			SCOPE	STATUS
STAKEHOLDERS / PARTICIPANTS	INTERNAL	EXTERNAL	ISSUES	DOCUMENTS
	INTERFACE ID	INTERFACE ID		
RESPONSE			RESPONSIBILITY	STRATEGIES AND BENEFITS
RESULTS			NOTE / REMARKS	SIGNATURE

Fig 6.17 Response sheet

The interface management can be tracked using Excel tool for beginners. We can customize list down options for certain criteria.

ACTIVITY ID	SCOPE OF WORK	REQUESTING TEAM / PERSON	DATE -ISSUE RAISED	DESCRIPTION	RESPONSIBLE TEAM /PERSON	DATE - ISSUE TO BE SOLVED	CLOSING DATE	STATUS	RESPONSE	DOCUMENTS	NOTES / REMARKS
001											

Table 6.6 Model excel sheet

ACTIVITY ID	SCOPE OF WORK	REQUESTING TEAM / PERSON	DATE -ISSUE RAISED	DESCRIPTION	RESPONSIBLE TEAM /PERSON	DATE - ISSUE TO BE SOLVED	CLOSING DATE	STATUS	RESPONSE	DOCUMENTS	NOTES / REMARKS
001	SITE CLEARANCE	CONTRACTOR	24.02.2020	Request for mobilization plan	PMC	25.02.2020	27.02.2020	COMPLETED	Revised plan was issued .		
002											
003											
004											
005											
006											
007											
008											

Fig 6.18 Drop down options

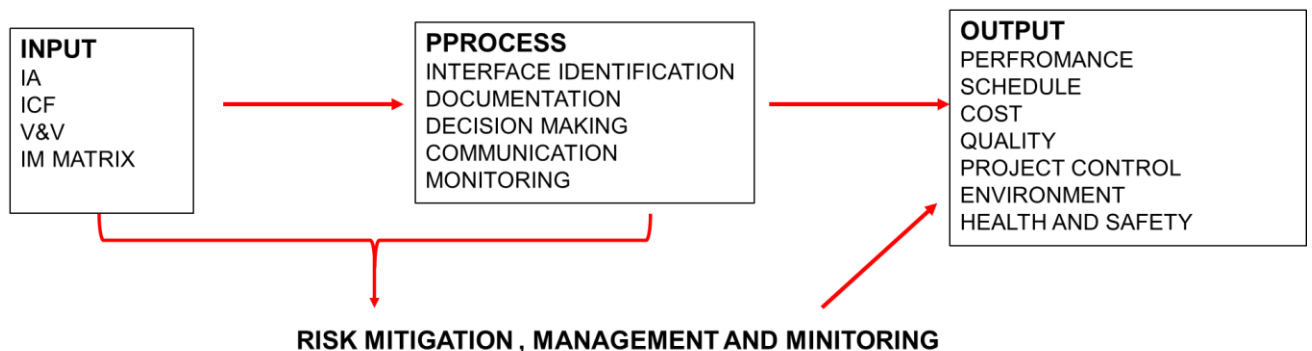


Fig 6.19 Framework – Interface management

6.4.4 SWIMLANE

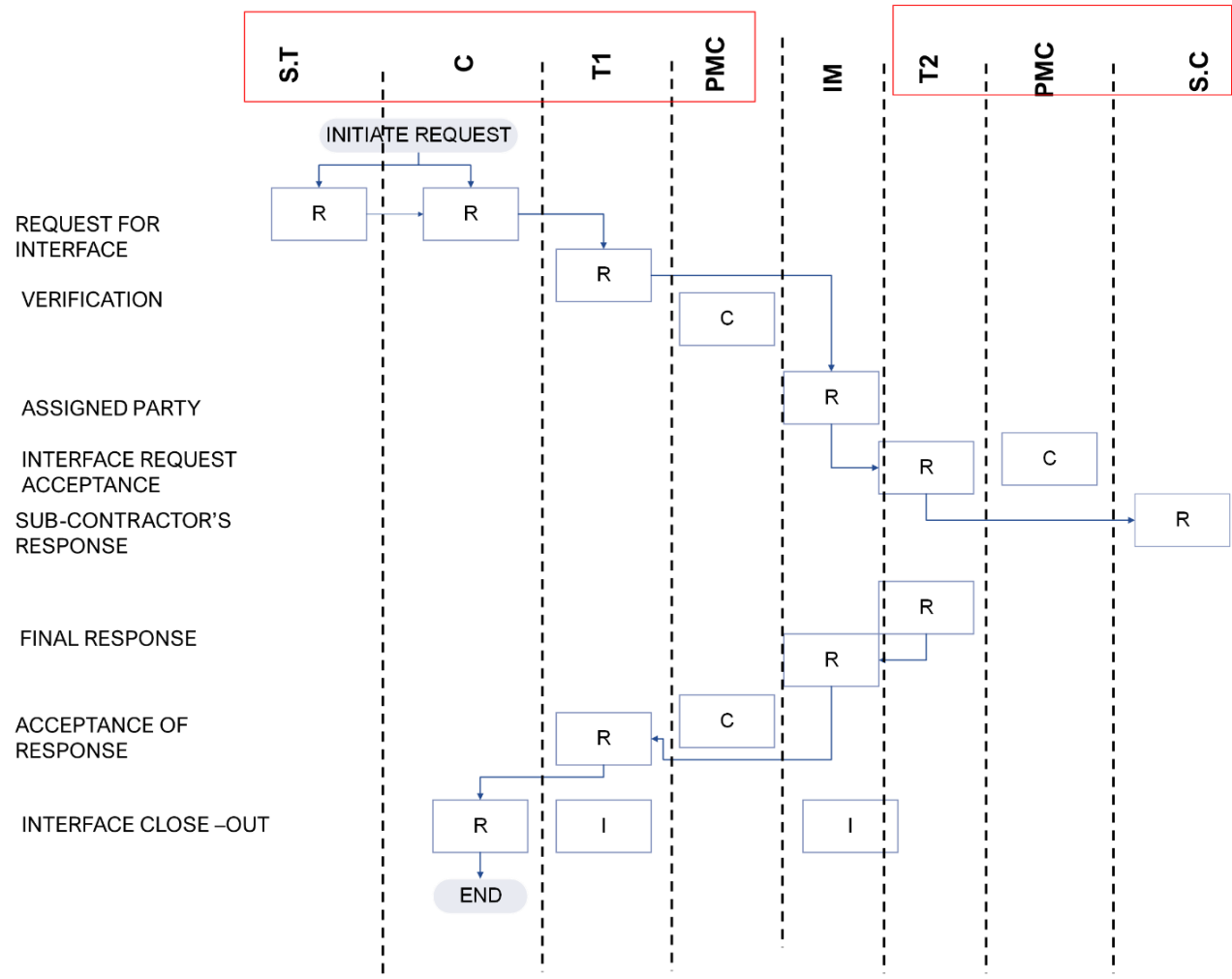


Fig 6.20 Swimlane – Interface management

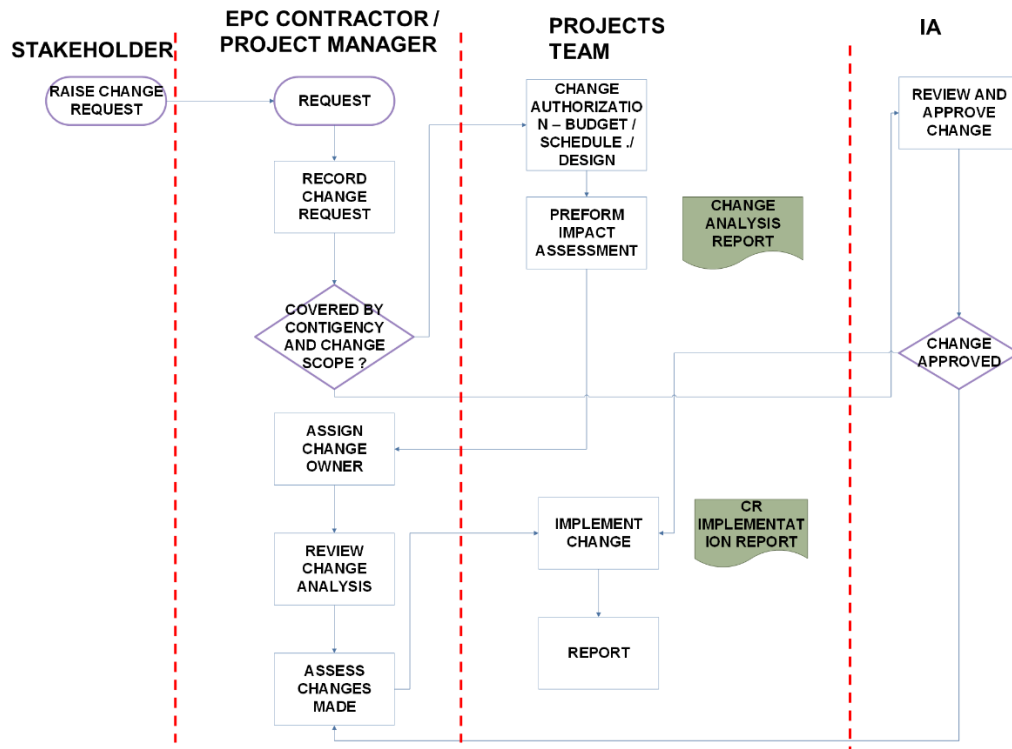


Fig 6.21 Swimlane – Change management

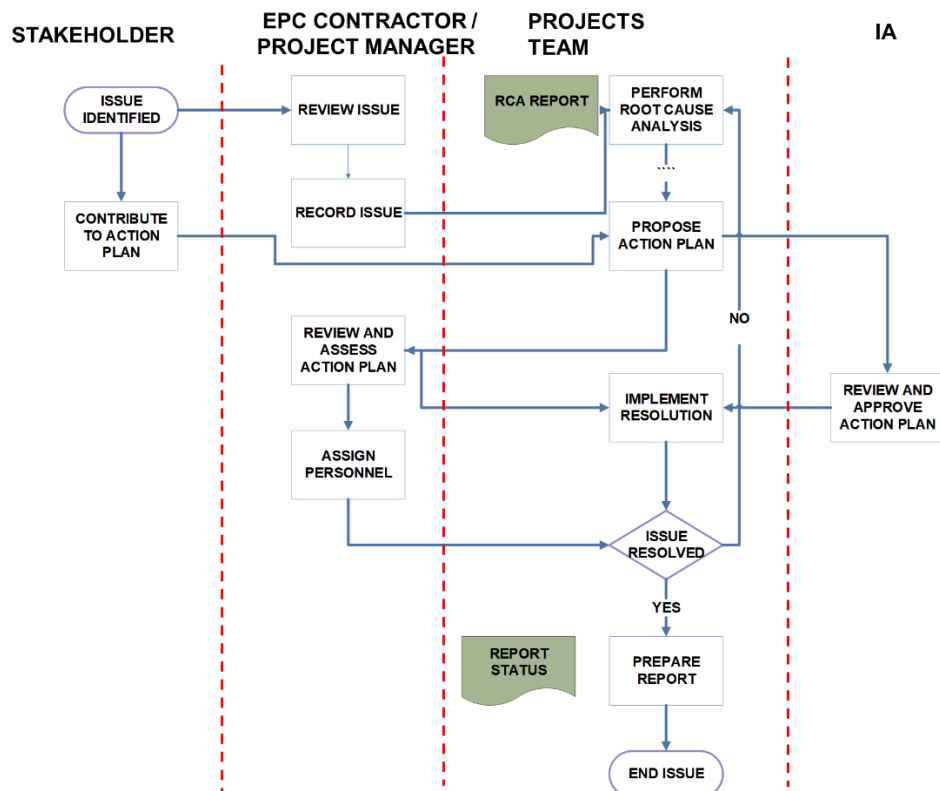


Fig 6.22 Swimlane – Issue management

6.5 RISK MANAGEMENT

Managing risk plays a significant part of the implementation process. A process flow was developed for the same. The plan consists of three stages involving every aspect of an EPC project.

6.5.1 RISK MANAGEMENT PLAN

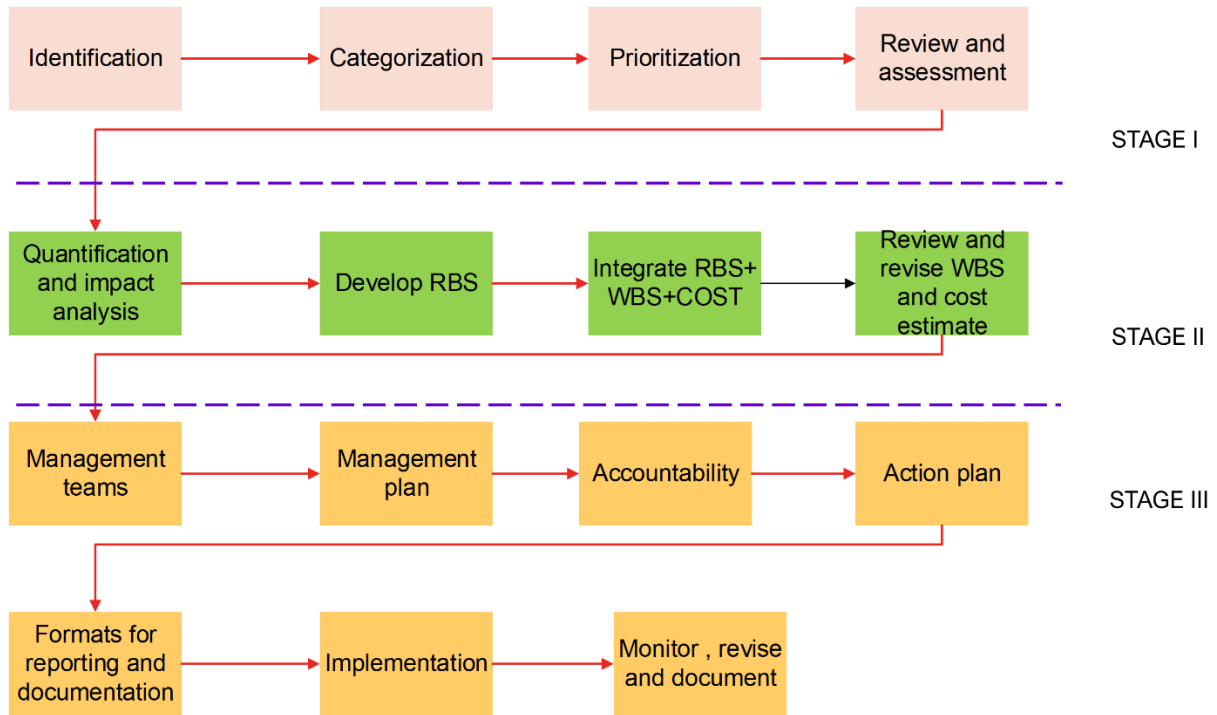


Fig 6.23 Risk management plan

ACTION	INPUT		OUTPUT
IDENTIFICATION AND CATEGORIZATION	Scope, feasibility study	Risk factors will be identified and categorized as per the project . techniques such as brainstorming , checklists , Delphi , expert methods can be used .	Categorization
PPRIORITIZATION , REVIEW AND ASSESSMENT	Categorization	Risk factors are arranged on the matter of prime concern and potential impact . Assessments are made on their outcomes	Assessment report

QUANTIFICATION AND ANALYSIS	Assessment report , basic analysis (project type)	Impact analysis on the outcomes is studied . quantification of the impact and severity will be pointed . Techniques : strategic meetings involving all stakeholders qualitative and quantitative personal analysis experts computer modeling	Impact analysis report
DEVELOP RBS AND INTEGRATION WBS AND COST	Impact analysis report	RBS is developed . their impact on schedule and cost is analyses . Through which there are revised . Proper leads and lags can be identified .	Detailed RBS
MANAGEMENT TEAM AND MANAGEMENT PLAN	Revised WBS , cost estimate , impact report and assessment documents , RBS	•Organizational teams such as , Scope management Budget management Quality management Human resource Engineering and construction Procurement Interface • A management plan is devised for the whole project . •Personnel are assigned . • Activity based action plans are schemed .	Detailed management plan
ACTION PLAN		Mitigation strategies are shelled out • Avoidance Alleviation Transfer Acceptance Management plan is aligned with strategies .	

MONITORING AND IMPLEMENTATION		Management plan is executed . Lesson learnt are documented . periodic documents , status reporting is noted . Risk management plan is revised if necessary . Key performance indicators are identified .	Risk register status report
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Table 6.7 Risk management process outline

A template accounting to the identification process was drawn up . The PESTLE technique of figuring out the root cause is inculcated .

PROJECT		IA		STAGE		AUTHOR		DATE	
STAKEHOLDERS	CATEGORISATION								
	P	E	S	T	L	E			
BUDGET	COST		IMPACT SCALE		RESPONSE PLAN				
ROLES AND RESPONSIBILITIES			TOOLS AND TECHNIQUES				DOCUMENTS		
NOTES / REVIEWS									

Fig 6.24 Risk identification

6.5.2 RISK MANAGEMENT PROCESS

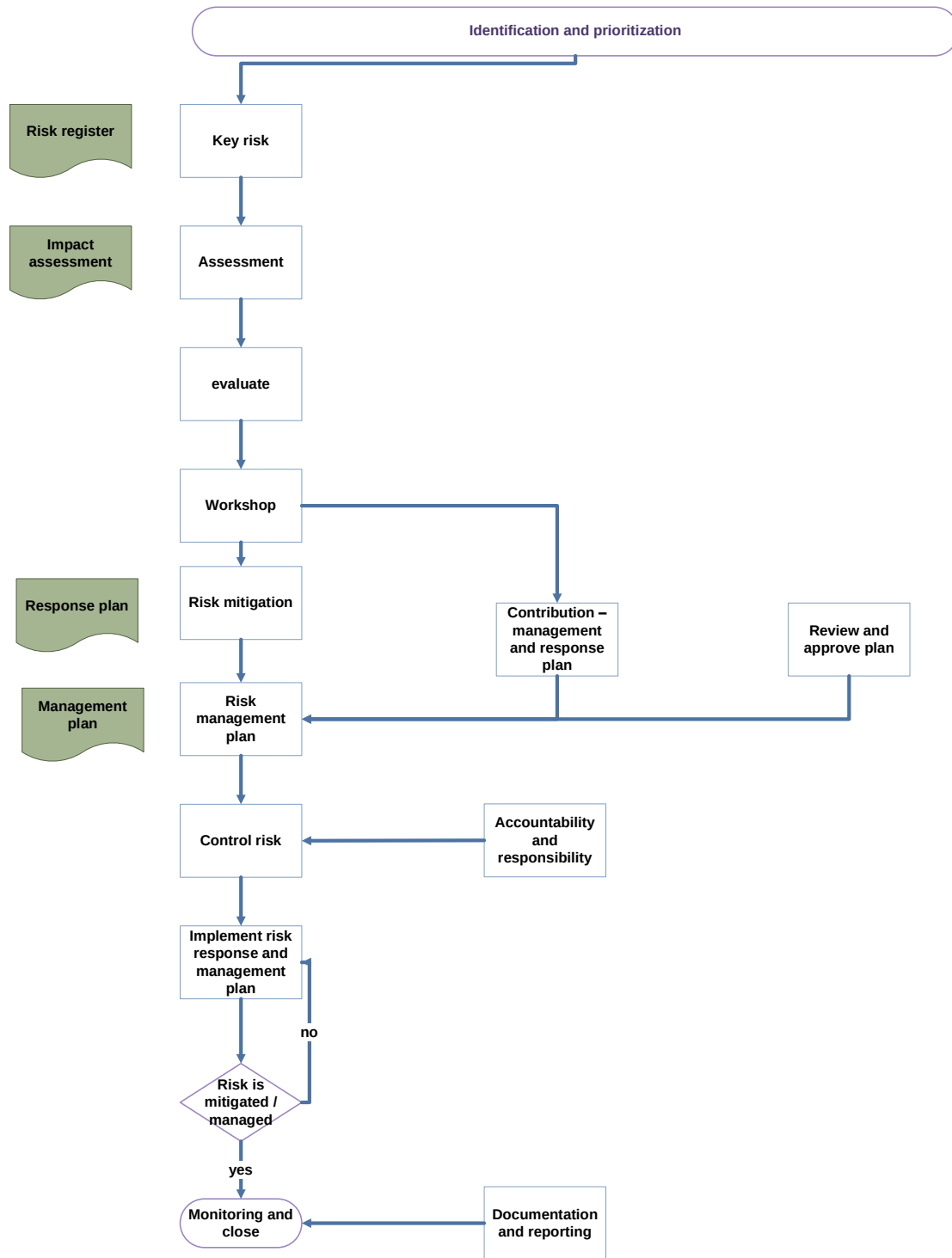


Fig 6.24 Risk management process

6.5 RISK MANAGEMENT MATRIX

A matrix emphasis management strategies from the initiation till operation and maintenance was formulated .

	PRE-DEVELOPMENT	PLANNING	E	P	C	TESTING , COMMISSIONING	OPERATION AND MAINTENANCE
EPC + IA	Formulate project SOP and management policies.	Sort approvals and funding schedule and source. Assessment of sub- contractors and vendors . Establish Interface management	Enable continuous meetings with all the stakeholders . Development of Design and ancillary documents .	Formulation of Procurement strategy and procurement plan	Construction strategy . Management plan . Technological application plan .	Approvals . Start up plan .	O&M plan.
SCOPE & CONTRACT	Scope and objective manifestation . Establish proper contracting strategy .	WBS, RBS , SBS , FBS - Formulation . Action plan	Work split along with in charge . RACI matrix .	Material requisition and approvals . Funding procedure - check and approve .	Appointment of sub - contractors . Endow sub-contracting plan + assessment .	Test packs + checking - plan	Scheduled maintenance. Maintenance procedure and plan . Responsibility - fixed .
DESIGN MANAGEMENT	Requirements and specifications	Design develop and monitoring team	HAZOP , HAZID studies	HAZID , HAZOP studies	Review and formulate constructability studies	Start up - plan	Maintenance plan of action
CHANGE ORDERS	Change plan , follow ups , mitigation strategies .	Initiate control team	Change control and management plan				

	PRE-DEVELOPMENT	PLANNING	E	P	C	TESTING, COMMISSIONING	OPERATION AND MAINTENANCE
SCHEDULE	Planning team - set up	Planning team + implementation team - Meetings . Implementation plan and management	Workout WBS along with RBS and financial structure.	Procurement plan of action	Construction plan of action	Commissioning plan of action	Maintenance plan of action
COST	Identify funding source and procedures	Cost control team and procedure - set up	Monitor design cost . Pre- plan construction cost and set up cost control plan .	Monitor Procurement cost	Monitor and establish cost control	Monitor start-up cost	Monitor O&M cost
QUALITY ASSURANCE	Analyse and evaluate specifications .	Map out QA-QC control team .	Devise project control plan of action. Procedure for inspection and testing. QAQC - management plan .	Monitor testing . FAT and SAT requirements to be determined.	Monitor and inspect QAQC management plan		
PROCUREMENT AND SUBCONTRACTORS / VENDORS	Frame strategies for maintenance and mitigation	Construct subcontractors and vendors - procurement plan and team.	Material requisition , quotations , BOQ , invite to bid. Evaluation and assessment of bids .	Requisition of quotations and approvals.	Develop construction windows along with delivery dates .	Testing and commissioning - seek technical service	Maintenance schedule . Spare parts and repair plan .

	PRE-DEVELOPMENT	PLANNING	E	P	C	TESTING , COMMISSIONING	OPERATION AND MAINTENANCE
LABOUR MANAGEMENT	Special team and procedures	Management plan			Supervision team + HR		
COMMUNICATION , REPORTING AND DOCUMENTATION	Procedure and plan	Control team	Communication platform + IT facilities	Revised and approved reporting and documentation method + format			
HSE	HSE routine and policy formulation	HSE + QAQC Team formulation	Develop KPI , performance assessment , monitoring plan and control systems .	Check and assess HSE documents and requirements - Vendors and materials		Monitor , assess , report and document	

Table 6.8 Risk management matrix

6.6 CHECKLISTS

To conclude the study , checklists were developed for each of the phases. These checklists will assist anyone opting for an EPC project. The checklist will act as a management tool to lessen the impact of any certain and uncertain forces that can cause risk and delay.

6.6.1 ENGINEERING CHECKLIST

S.NO	DESCRIPTION	STATUS		NOTES / REVIEW	DATE
		COMPLETED	YET TO COMPLETE		
A	GENERAL				
1	EPC contractor appointment				
2	Regulation of project scope				
3	Formulation of master schedule				
B	PRE-DEVELOPMENT PHASE				
1	Engineering works - completion				
2	Development of Engineering programme - IA				

3	Defined Surveys, measurements , topographical details				
4	Schedule for Engineering phase				
5	Productivity forecast				
6	Labour				
7	equipment				
8	Defined scope				
9	Revision of scope (IF)				
10	Approval - revised scope				
11	Impact assessment				
12	Risk assessment				
13	Engineering plan and course of action				
14	Policy and coordination plan				
15	I.A				
16	EPC contractor				
17	SUB CONTRACTOR				
18	VENDORS				
19	Reporting - Hierarchy plan				
20	Reporting and documentation format				
21	SITE STUDY				
22	Site information				
23	Topographic information				
24	Geological test and report				
25	DESIGN DEVELOPMENT				
26	Issual of conceptual scheme				
27	Estimation of cost				
28	Approval of drawings				
29	Functionality check				
30	Standards and codes to be implied				
31	Criteria - Design				
32	Process flow diagram				
33	Requirement of special components / equipment				
34	Components and system list - IA				
35	Availability of drawings				
36	Availability of calculations and specifications				
37	Verification of Compliance - Regulatory agencies				
38	Approval to develop - Detailed Drawings				
E	DETAILED DESIGN				
1	Authorized drawings				
2	Value engineering report				

3	Environmental impact study				
4	Permits and environmental clearance				
5	Social considerations report				
6	Vendor / sub contractor assessment				
7	Constructability review				
8	HAZOP analysis				
9	flow and flaw analysis				
10	IA - authorization of complete design				
F	DELIVERABLES				
1	Plot layout				
2	Design drawings				
3	Codes and standards				
4	Specifications				
5	Calculations (if any 0				
6	Equipment and component list				
7	Pipeline and layouts				
8	Other instrumentation scheme				
9	Cable and conduit scheme				
10	General arrangement drawings				
11	Detailed engineering drawings (REV - 0) - IFC				
12	Manuals and training procedures				
13	Testing procedures				
14	inspection plans				
15	Regulatory requirements				
16	Material purchase requisition - procurement team				
17	Material control and storage plan				
18	Filling - Records and documentation - Documentation team				
19	Master schedule				
20	Cost estimation				
G	BIDDING				
1	Packages, deliverables , cost and schedule - preparation				
2	Bid evaluations				
3	Review compliance				
4	Final assessment and evaluation of bids				
H	PRE CONSTRUCTION				
1	Design conformance				
2	Site testing and inspection - materials				
3	Review of shop drawings				
4	Approval of shop drawings				

5	Change order , issue control plan				
6	Manuals and drawings - Sub contractors and vendors				
7	Quality assurance plan and report - Documentation				

Table 6.9 Checklist – Engineering phase

6.6.2 PROCUREMENT CHECKLIST

S.NO	DESCRIPTION	STATUS		NOTES / REVIEW	DATE
		COMPLETED	YET TO COMPLETE		
A	GENERAL				
1	Purchasing team - appointment				
2	Purchasing management plan				
3	Procurement manager appointed				
B	STRATEGY				
1	Procurement - flow chart				
B.1	IDENTIFICATION OF MATERIAL AND EQUIPMENT				
1	Critical (high value and high impact)				
2	Non critical items				
3	Long lead items				
4	Market analysis to be conducted				
5	Supplier and vendor study (dynamics study)				
6	Specifications approval by IA				
7	Work package segmentation				
8	Global market study + Local market				
9	Organisation of procurement team + E& C				
10	Procurement responsibility chart				

11	Issue resolution procedure				
12	Collaboration of Engineering and procurement process - Study				
C	PROCUREMENT PLAN				
1	Procedure and action plan				
2	Establishment of S curve - progress study				
3	Expediting and schedule plan				
4	Labour and material requirement				
5	Labour and material - working hours forecast				
6	Scope change - monitored (PMC)				
7	Cash flow report				
8	Cost control plan and documentation				
9	DOCUMENTS - to be prepared				
10	Terms of procurement and purchase				
11	Specifications along with MRP AND MRQs.				
12	Equipment and material list				
13	Sourcing plan and policies				
14	Preferred vendors list				
15	Alliance				
16	Bidders lists				
17	Request for quotation				
18	Approved suppliers list				
19	Warranty requirements				
20	Guarantee requirements				
21	Repair and replacement policy formulation				
22	Vendor assessment				
23	Manuals				
24	Insurance requirements				
25	Insurance				
D	SOURCING				

1	Bid evaluations				
2	Selection				
3	Business flow				
4	Business terms and conditions				
5	Vendor drawings (set)				
6	Vendor deliverables				
E	EXPEDITING AND TESTING				
1	Process and schedule				
2	Expeditors appointment				
3	Shop drawings along with QAQC plan				
4	Testing procedures and manuals				
F	LOGISTICS				
1	Logistics plan				
2	Tracking system				
3	Bar coding system / RFID tracking system - Establish				
4	Material tracking IT program				
5	Inventory plan				
G	MATERIALS MANAGEMENT				
1	Storage yard and warehouse - Location				
2	Establish ERP Systems				
3	Material management plan - Establish				
4	Quality testing and conformance				
5	Documentation - Receipts, in - out logs , bills				
6	Purchase order - Register				
7	Vendor data log				

Table 6.10 Checklist – Procurement phase

6.6.3 CONSTRUCTION CHECKLIST

S.NO	DESCRIPTION	STATUS		NOTES / REVIEW	DATE
		COMPLETED	YET TO COMPLETE		
A	GENERAL				
1	Scope of work - work packages				
2	50 % of drawings issued for construction - OK				
3	Procurement plan - Meet construction schedule - OK				
4	Review work package - manageable packages				
5	Control management - Formulate				
6	Establish Contract administration				
7	Contractors appointed				
8	Insurance certificates - Contractors				
9	Pre construction and development meeting				
a	EPC contractor and IA				
b	EPC contractor and PMC				
c	PMC with other teams				
d	Within teams - Engineering				
e	Within teams - Procurement				
f	Within teams - Construction				
B	CONSTRUCTION PLAN				
1	Construction action plan - Finalise				
2	Subcontractor appointment				
3	Subcontractors management plan				
4	Work routine and regulations				
5	Code of conduct to be established				
6	Project objectives - understand				
7	Determine Workfront size				
8	Master schedule				
9	4 Level schedule development				
10	Short term goals - Plan				

11	Quality assurance plan - to be followed				
12	Identification of risks				
13	Risk management				
14	Preassembly - completion				
15	modularization and fabrication - plan				
16	Pre - construction site works				
17	Temporary facilities - set up				
18	Revised work fronts and management plan				
19	Other services and securities				
C	MONITROING , REPORTING				
1	Planned activities list				
2	Progress report				
3	Progress vs planned -EVM Curve				
4	Productivity monitoring				
5	Cost monitoring				
6	Schedule follow - up				
7	Change management				
8	Materials - Tracking				
9	Materials usage - monitored				
10	HSE procedure				
11	Permits obtained				
12	Environmental control established				
13	Sustainability plan				
14	Documents management				
15	Documents control				
16	O&M manuals				
17	Start-up procedure				
18	Interface management				
19	Mechanical certifications				
20	Contractual completion test				
21	Acceptance of certificate				

Table 6.11 Checklist –Construction phase

6.6.4 BIDDER SELECTION CHECKLIST

S.NO	DESCRIPTION	STATUS		NOTES / REVIEW	DATE
		COMPLETED	YET TO COMPLETE		
A	GENERAL				
1	Selection issue identified				
2	Determination of project complexity				
3	Sub contractor / vendor capacity identified				
4	Assessment of market				
5	Value additions				
B	SELECTION STRATEGY				
1	Experience (same field projects)				
2	Award process - defined				
3	Contractual terms - Established				
4	Evaluation of selection criteria				
5	Coordination plan between IA - C - Subcontractor				
C	SELECTION PROCEDURE				
1	Expression of interest				
2	Request for qualification				
3	PRE-QUALIFICATION				
4	Compatibility				
5	Financial fit				
6	Experience				
7	Availability				
8	Location				
9	Adjustability with contractual terms and issues				
D	REQUEST FOR PROPOSAL				
1	Bid instructions				
2	Scope and schedule				
3	specifications				
4	compensation and claim terms				
5	insurance requirements				
6	form of agreement				
E	ASSESSMENT				
1	Action plan				
2	Technical competency				

3	Contractor performance assessment				
F	AFTER SELECTION				
1	Negotiated contract				
2	Contract language - revised				
3	Incentives and penalties				
4	Final contract draft				
5	Project execution plan - finalised				
6	Permits and approvals - Follow up				

Table 6.12 Checklist –Bidder selection

6.6.5 BIDDER ASSESSMENT CHECKLIST

S.NO	DESCRIPTION	STATUS		NOTES / REVIEW	DATE
		COMPLETED	YET TO COMPLETE		
D	ENGINEERING QAQC				
1	Design review				
2	Engineering plan - reviews				
3	Operation and maintenance - review				
4	Constructability test				
E	PROCUREMENT				
1	Vendor - quality check				
2	Documentation - errors and lags				
3	Non - conformance inspections				
F	CONSTRUCTION				
1	Installation conformance				
2	Standards conformance				
3	Material check and testing				
4	Conformance with design				
5	Practice -align with standards				
G	REPORTING AND DOCUMENTATION				
1	QAQC reports				
2	Formats established				
3	lesson learnt report				

Table 6.13 Checklist –Bidder Assessment

6.6.7 RISK MANAGEMENT CHECKLIST

S.NO	DESCRIPTION	STATUS		NOTES / REVIEW	DATE
		COMPLETED	YET TO COMPLETE		
1	Defined objectives , scope and requirements				
2	Risk identification				
3	Criteria to be studied				
3.a	IA				
3.b	Cost				
3.c	Constructability				
3.d	Utilities				
3.e	Operations				
3.f	Labour				
3.g	Geographic				
3.h	Geological				
3.i	Technology				
3.j	Environmental impacts				
3.k	Social acceptance				
3.l	Foreign exchange				
3.m	Tax and business market				
3.n	Political status				
3.o	Execution plan				
3.p	Economic viability				
3.q	Capital access and fund				
4	Risk register - maintain				
5	Categorization and prioritization				
6	Workshop and training				
7	Quantification and assessment				
8	Matrix				
9	Accountability and roles				
10	Mitigation and management plan				
11	Action plan				
12	Implementation and monitoring				
13	KPI - identification				
14	Report formats and procedure				
15	Status updating				
16	Tolerance level - fix				

Table 6.14 Checklist –Risk management

CHAPTER 7

CONCLUSION

Although existing risk factors are self-evident when conducting EPC ventures in an unexplored advertise, most dangers may well be controlled and managed through risk management. The particulars of the thesis depicted as takes after:

- 1) It presents system for conveying EPC projects .
- 2) It presents strategies and strategies that give reference points for risk administration arranging of EPC projects.
- 3) It proposes a chain of command of hazard classifications in conjunction with the distinguished chance components in EPC projects .
- 4) It recommends countermeasures for the most potential chance factors. When orderly chance administration strategies are connected, chance can be diminished by utilizing built up thoughts, devices, and methods.

Risk administration and management prepared, in the event that created with the support of the extend group, empowers compelling administration of venture. Quick changing, unsteady, chance inclined situations cannot be halted, in any case stakeholders can get ready themselves for the coming about impacts of risks. This in turn decreases presentation to project's monetary , time and key performance.

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