Study of Risk Management in EPC Contracts in Highway Constructions: A Case Study of Kollam and Alappuzha Bypass

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ABSTRACT

An efficient project delivery method is the key factor for any venture. For rapidly growing constructions, an effective mode of contracting is needed. When compared with other modes of contracts, EPC (Engineering, Procurement, Construction) contracts have better risk allocation, fixed cost and fixed time. Governments also prefer contracting modes with less risks to them, and EPC is one among them. From review of literature, it has been found that EPC contracts are being extensively used in highway constructions. In Kerala, two prestigious projects, Kollam and Alappuzha bypass, have been done in the EPC mode. For the two bypass projects, risk identification, analysis, assessment and treatment strategies adopted are studied. Direct interviews and questionnaire surveys were conducted on the project personnel. The impact of the risks on the project objectives of cost, schedule, quality and scope of work are found. For Kollam bypass, the highest impact was due to the Material Availability and for Alappuzha bypass, delay in permits, approvals and change of scope order were crucial. The projects had mitigated the risks to a certain extent, but better response strategies can also be explored.

Keywords: EPC, Highway constructions, Risk management, Qualitative analysis.

1 Introduction

Large investments from public as well as the private sector will be needed in various infrastructure sectors to meet the growing needs of the Indian economy. The purpose of an EPC contract is to allocate risks to the contractor for the main elements leading to completion of a facility for use by an employer. EPC contracts in National Highways are developed based on the guidelines and specifications laid down by the Ministry of Road Transport and Highways (MoRTH) and the National Highway Authority of India (NHAI). The highway construction projects based on EPC makes more sense and concludes as an alternative for other contracting methods. For EPC, the government takes care of clearances, acquisition of land etc. The risks should be identified and analyzed very carefully and the impact of these risks should be studied before execution (Aitwar et al. (2016)). Risk assessment is needed for the EPC contracts in highway constructions, since, by identifying the risks earlier, prioritizing and taking effective measures can reduce the impact of these risks on achieving the project objectives (Hui An and Qin Shuai (2011)).

The EPC contracts have different objectives on different infrastructure projects. In Kerala, two important projects, the Kollam and Alappuzha bypasses, have been implemented in the EPC mode. Hence the detailed study on EPC Contracts is done on these two projects. These projects had immense scope of risk management. This paper deals with the nuances of EPC versus routine contracts in highway construction projects based on cost, time, scope and quality. A detailed study on qualitative risk analysis is also carried out on Kollam Bypass and Alappuzha Bypass projects.

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The objectives of the study include:

1. Critical review of EPC contracts in highway constructions.
   - Comparing EPC with other contracting methods.
2. Study of Kollam Bypass and Alappuzha Bypass.
   - Study of risk management in Kollam and Alappuzha bypass.

2 Methodology

The methodology of the work as a flow chart is given in the figure 1.

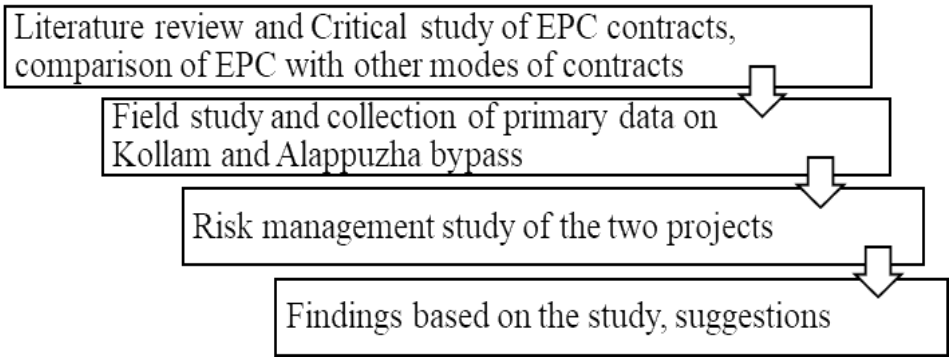

Figure 1. Methodology Flow Chart

3 Critical Review

EPC stands for Engineering, Procurement and Construction. The technical parameters explained below is from the detailed review of the model agreement on EPC contract of Civil Works. A High-Powered Working Group (HPWG) constituted by Construction Industry Development Council (CIDC) during the year 2017 formulated the agreement.

3.1 Technical Parameters

The technical parameters of the EPC contract are explained below.

3.1.1 Contract Price

It covers contractor's obligations for the works and all things necessary for the construction and for the rectification of any defects in the project.

3.1.2 Contract Period

If delay occurs in handing over the site within 90 days, any reason other than Force Majeure, the authority shall pay an amount. If there is no achievement in any of the project milestones or no reasonable progress in the work, the Contractor, with reasons for the delay, should submit the request for extension within 15 days. The authority should give the payments as mentioned in the agreement and the payments should be made within 30 days of receiving a demand from the contractor. In case of any payment delay from authority, the interests are to be paid as calculated at a rate of 3% of original payments.

3.1.3 Risk Allocation

The Contractor bears all the risk related to construction of works, materials, goods and equipment. The contract price or scheduled date will not be adjusted in case of unforeseeable difficulties.

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3.1.4 Design and Construction

The Contractor appoints a design director, a proof check consultant. The authority appoints an engineer within 15 days. Within 30 days, the contractor should submit the methodology for the construction of the works, wherein Part 1 consists of the contractor 's organisation for the project, Part 2 includes the schedule of the project and project milestones of the works and Part 3 gives monthly cash flow forecast for the project. Contractor should construct the project as specified in the agreement.

3.1.5 Force Majeure

The occurrence of any of non-political event, indirect political event and/or political event are considered as force majeure. The Contractor should notify about the event and request for extension and is liable for any relief amount.

3.1.6 Termination

Termination of the contract may be due to the contractor not achieving the project milestone, work continuing to be in default for 45 days, stopping the works for 30 days without notifying the authority's engineer etc. or due to the authority failing to provide the environmental clearances and forest clearances within the period of 180 days, the authority's Engineer failing to issue the relevant Interim Payment Certificate within 60 days after receiving a statement and supporting documents from the contractor etc.

3.1.7 Monitoring and Supervision

The authority or any representative, inspects, reviews the progress, quality of the construction of works and issues appropriate directions to the authority's engineer and the Contractor. They appoint an external technical auditor to conduct an audit of the quality of work.

3.1.8 Payments

The Payment for the contractor is based on the stages of work completed. The Stage payment statement will be submitted by the contractor less than 30 days from the date of the applicable Project Milestone or the Scheduled Completion Date.

3.1.9 Defects Liability

The Contractor should repair or rectify all the defects during the Defects Liability Period within a period of 15 days from the date of notice issued and if contractor fails, an amount equal to 20% of cost as damages are recoverable by the authority.

3.2 Comparison of EPC with Other Modes of Contracts

The comparison of EPC contracts with other mode of contracts for highways like lump sum turnkey contracts, item rate contracts and PPP contracts are done and is given in Table 1.

4 Field Study and Data Collection

A study of the Detailed Project Report (DPR) is done to assess the project history, description, contract details etc. The DPR studied is that of Four laning of Cherthalai to Thiruvananthapuram section of NH-47 (new NH-66) under NHDP phase III in the State of Kerala, where Alappuzha and Kollam Bypass are added to the project. Kollam Bypass, conceived in 1972, was fully completed and opened from 15 January 2019. Alappuzha bypass was proposed in 1980. Both the projects are 50-50 in funding from State and Central government. The

Construction of Kollam bypass is of 13.200 km (Kurian S. M. and Surendran A., (2017)) and Alappuzha bypass is of 6.70 km.

Table 1. The comparison of EPC with other mode of contracts

Features	EPC	Other Contracts
Investment	Public investment	• Private and public investment for PPP. • For item rate contracts, payment based on the cost of measurements of items.
Maintenance	Only 4 years maintenance	• For PPP, 25-30 years. • Maintenance as per contract given for the item rate contracts.
Design	Design freedom	• Design freedom is comparatively less for both PPP and item rate contracts.
Time	Fixed cost and time	• Cost and time can be varied as per requests and extra amount for the works shall be given as per the authority's requests for both PPP and item rate contracts.
Change of scope	Scope is fixed	• Scope can be varied by the authority for PPP and item rate contracts.
Extension of time	Time extension is not easy	• Applicable as per requests.
Risks	More risks to the contractor	• Risk is shared for PPP. • Lower risks to the contractor for item rate contracts.

The major delays found for Kollam bypass were 23% from MoRTH and 77%from GoK (Government of Kerala) for the delay for permits and approvals and a 95-days delay in material availability. Change of scope order was put forward by Ministry for highway street lighting and culverts. For Alappuzha bypass, the major delays were 50% from MoRTH, 80% from GoK and 59.4 % from Railways for delay in permits and approvals. A 96-days delay for adverse weather conditions. And 433- days delay due to change of scope order for slip road and elevated highway lighting work.

5 Risk Management Study

A risk management study is conducted for both the projects including risk context, identification, analysis, assessment and treatment.

5.1 Risk Context

From the literature review, 25 risk factors such as availability of materials, delay for permits and approvals, unstable political situation in the host country, inflation, safety, availability and shortage of equipment, delay in payments to clients, inadequate or incorrect design, exchange rate fluctuations, corruption among government authorities, poor financial conditions of the contractor, labour availability, design changes and interventions, adverse weather conditions, changes in laws and regulations, acts of God, delayed payment on contract, technology issues, legal disputes, poor co-ordination, improper construction methods and quality control, change of scope order, contractual risks, installation of mechanical and electrical machines and purchase and procurement affecting EPC contracts in highway constructions have been identified.

Out of the 25 risks factors, from direct interview with project personnel, only 10 have been found to exist in these projects. Hence only those 10 have been taken for detailed analysis. The risks are material availability, delay for permits and approvals, inflation, delay for client payments, labour availability, adverse weather

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conditions, changes in laws and regulations, acts of God, delayed payment on contract and change of scope order.

From these, only those risks which affect the project objectives are considered for analysis. This information was collected by a questionnaire survey conducted on project personnel from both the projects. The stage of the project in which the risk factor has influenced the Kollam and Alappuzha bypass projects are studied.

5.2 Risk Analysis and Assessment

Risk Analysis summarizes what is known about the risks and risk evaluation shows how important these risks are to the project. The required details have been collected through a questionnaire survey. It was conducted on the project personnel to find out the impact of the risks in the project objectives such as cost, schedule, scope and quality. The respondents were the officials from the project management team.

5.3 Risk Probability of Case Studies

From the responses collected, values are assigned to the probability of occurrence. The values are denoted as rarely (0.1), sometimes (0.3), frequently (0.5), very frequently (0.7), mostly (0.9) (Al Sharaf and Abdel Wahab (2015)). The risks selected for study and the corresponding values of probability are given in table 2.

Table 2. Probability of Risks for Kollam and Alappuzha Bypass Projects

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

5.4 Impact of Risks in the Project Objectives

The impact of the risks in each project objective like cost, schedule, scope and quality for Kollam and Alappuzha bypass respectively were studied. The summary of impacts gives the numerical or gradient value for the maximum responses for the impact of each risk on project objectives, based on PMBOK (Project Management Body of Knowledge). The summary of impact of risk for Kollam bypass is given in table 3 and the summary of impact of risk for Alappuzha bypass is given in table 4.

Table 3. Summary of Impact of Risks for Kollam Bypass

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

Table 4. Summary of Impact of Risks for Alappuzha Bypass

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

5.5 Risk Scores in Kollam Bypass

Table 5 gives the risk scoring of Kollam bypass obtained by multiplying probability and impact of the corresponding risks given in table 4. The high scored risks are given in red colour, moderate scored risks as orange colour and low scored risks as yellow colour. The moderate and low scored risks are to be included in the risk register. Table 5 gives the risk scores for Kollam bypass where the high scored risks are scope and quality due to unavailability of materials. Table 6 gives the risk scores for Alappuzha bypass.

Table 5. Risk scoring for Kollam Bypass

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

Table 6. Risk scoring for Alappuzha Bypass

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

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5.6 Risk Mitigation Measures for Kollam Bypass and Alappuzha Bypass

An investigation into the mitigation measures adopted by the project personnel in Kollam and Alappuzha bypass was done. This is presented in Table 7, along with mitigation measures suggested for the risks.

Table 7. Mitigation Measures Adopted for the Risks

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

6 Conclusion

Though scope of the work is different for both Kollam and Alappuzha bypass, the risks they faced are similar. The severity of risks on the project objectives obtained is different for both the bypass projects. The EPC contracting method is of fixed cost and time. The fixed cost causes more risks in contract price for the contractor. The highly scored risk that affected most of the project objectives of Kollam bypass was material availability. The highly scored risks that affected the project objectives of Alappuzha bypass were delay in permits and approvals and change of scope order. The projects had mitigated the risks to a certain extent, but better response strategies have to be devised. Mitigation measures, appropriate to the situation, are suggested through the study. Moderate risks and low risks are considered for the risk register. Strategies such as reduction, transfer, acceptance etc. are some of the strategies possible in the current scenario. Considering the risks in EPC contracts, HAM (Hybrid Annuity Model), a combination model of EPC and BOT, is found to be better. Maintenance of EPC is 4 years, but for HAM it is 30 to 35 years. This provides less risks for the government.

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References

Aitwar V., Kaustubh S., Kartik P., and Salunkhe A. (2016). *"Risk Planning in Construction of Highway Project: Case Study."* International Journal of Latest Research in Engineering and Technology (IJLRET), 2(3), 57-63.

A Guide to the Project Management Body of Knowledge (PMBOK Guide) -5th edition (2013), ISBN 978-1-935589-67-9.

Hui An and Qin Shuai (2011). *"Analysis of Risk in EPC Project and the Countermeasures"*. IEEE paper.

Kurian S. M. and Surendran A., (2017). *"Performance evaluation of Kollam Bypass road construction Kavanadu to Kallumthazham stretch"*. International Journal of Enginerring Reasearch and Technology, 6(10), 207-209.

Langhe A. and Minde P. (2018). "Comparitive Analysis of Three Major Type of Contracts with Case Study". *International Research Journal of Engineering and Technology (IRJET)*, 5(10), 237-240.

Preparation of Detailed Project Report (DPR) study for 4 laning of Chertalai – Thiruvananthapuram Section of NH-47 (New NH-66) (from KM 379/100 to KM 551/900) [Package –III] under NHDP Phase III in the State of Kerala.

The model EPC document on Construction sector prepared by erstwhile Planning Commission which was deliberate upon by a High-Powered Working Group (HPWG) constituted by Construction Industry Development Council (CIDC) (2017).