

CHAPTER 4

EXISTING PROJECT EXECUTION MODELS

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4.1 OVERVIEW:-

The chapter covers the main components of the project execution model and the present execution models are being used in the construction sector. The main components of a project execution model, organisational structure, management information system, project management system and risk management system are briefed here.

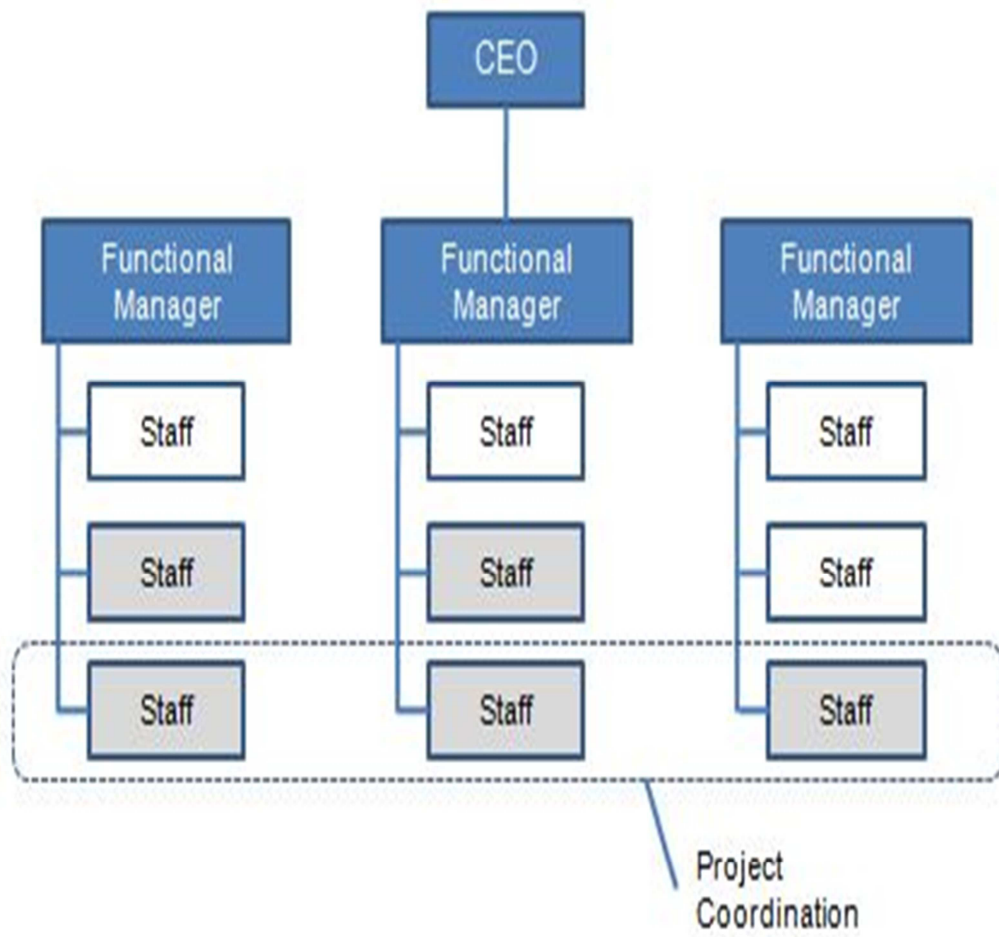
Present contract like Engineering Procurement & Construction (EPC), Engineering Procurement Construction Management (EPCM)etc strategies/ models are being practiced in infrastructure and energy sectors are discussed here. The mathematical equation and graphical presentation of models are also described.

4.2 COMPONENTS OF MODEL:-

Organizational structure, management information system, project management system and risk management are the major components of the project execution model.

4.2.1 ORGANISATIONAL STRUCTURE: - Every organization needs a suitable organisational structure in order to operate systematically. A customised or general proven organizational structure can be used by any organization if the structure fits into the nature of the organization. Matrix Structure is used in large project organization. A typical matrix structure is shown in Figure No.-4.1.

Figure No.-4.1 :- Matrix Structure



The matrix structure is a proven and the best in project organisations. In this type of organizational structure, the company uses teams to complete tasks. The teams are formed based on the functions they belong to (ex: design engineers) and product they involved in (ex: Project A).

Matrix structure, proven organisational scheme is applicable in Government of India institutions also.

4.2.2 MANAGEMENT INFORMATION SYSTEM: - The Management Information System (MIS) is a multi-disciplinary approach of a business management. It should be kept under a constant review and modification to meet the organisation needs of the information. The MIS is a not a static concept but dynamic process subject to change with time and again, with a change in the business management process. MIS interacts continuously with the internal and external environment & agencies of the projects. It also provides a corrective mechanism in the system.

The role of the MIS in an organization can be compared to the role of heart in the body. The information is compared as the blood and MIS is compared as the heart. The heart plays the role of supplying pure blood to all part of the body including the brain. On supply of more blood when needed, the heart works faster and faster. Heart not only regulates and controls the incoming impure blood but also processes it and sends it to the desired destination in the quantity needed. It fulfils all needs of blood supply in normal course and also in crisis. The MIS precisely plays exactly the same role in the organization. The MIS ensures that an appropriate data are collected from the various sources, processed, and sent further to the destinations. The MIS fulfils the information needs of an individual, a group of individuals, the management functionaries and the top management. The MIS interfaces with & satisfies the diverse needs Query Systems, Analysis Systems, Modelling Systems and Decision Support Systems. The MIS

also helps in Strategic Planning, Operational Control, Management Control and Transaction Processing. The MIS plays the vital role of information identification & generation, communication, problem identification and helps in the process of decision making. The MIS, therefore, plays a vital role in the management, administration and operations of an organization.

Translating the real concept of the MIS into reality is technically, an infeasible proposition unless computers are used. The MIS relies heavily on the hardware and software capacity of the computer and its ability to process, retrieve communicate with no serious limitations.

4.2.3 PROJECT MANAGEMENT SYSTEM:- Monitoring in the project organisation is a contentious process of collecting, storing, analysing and reporting project information used to make decisions for project management. Monitoring provides project management and project stakeholders the information needed to evaluate the progress of the project, identify trends, patterns or deviations, keep project schedule and measure progress towards the expected goals. The right information at the right time and to the right people supports the decisions, like changes in the implementation strategies, that can help the project reduce costs and increase its outputs. Project monitoring provides invaluable information to managers and other project stakeholders on the progress of the project.

Quantitative and qualitative information are the critical components of an evaluation process of project. Without it, it is almost impossible to identify how project interventions are contributing/or not contributing to the project goals.

Many software like MS Projects, PRMIVERA etc. equipped with latest project management techniques like CPM/PERT etc. are available. These tools have facility to integrate with MIS.

4.2.4 RISK MANAGEMENT: - Risk management is an important and an integral part of the project. The risk has direct relationship with the schedule and cost of the project.

There are three basic parts in project risk management:

1. Schedule:- Will the project go over schedule?
2. Cost:- Will the project overrun its budget?
3. Performance:- Will the output satisfy the goal(s) of the project?

At the start and up until the end of a project, the answers to each of these questions are unknown. Any yes answer to any or all of the questions is taken to be an undesirable consequence. And hence each and every of these elements should be subjected to a risk analysis preferably quantitative. This will help project managers to decide whether the project is not meeting its commitments and whether or not to take action to mitigate the risk.

Schedule Risk: - The first such quantitative technique of modern project management in the area of schedule risk analysis was the Gantt chart.

The Programme Evaluation & review Technique (PERT) is also used. In PERT the detailed diagram of all anticipated tasks in a project, are organized into a network.

The Critical Path Method (CPM) also used for risk analyses. In CPM the systematic exploration of alternative resource allocations are allowed to reduce the time.

Monte Carlo simulation is nowadays used in the computer era but Stochastic CPM is now the preferred methodology for assessing schedule risk in project management.

Cost Risk: - The technique used for cost risk analysis of projects is based on the Work Breakdown Structure (WBS). The WBS breaks a project down into its components, services, facilities etc., with each succeeding level going to a finer level of detail. WBS cost estimation is based on attaching a cost to each element and summing to a total.

Project planning, experts in relevant field are asked to specify a probability distribution for each part of the WBS for quantitative risk analysis. Then Monte Carlo simulation is used to estimate a probability distribution for the total project cost.

Performance Risk: - Unlike schedule and cost risk analysis, the performance risk analysis tends to be much more tightly tied to subject area. Quantification of the relationships between different aspects of performance may be much more difficult. However, current practice a mix of quantitative methods and models are used. When a project is in the stages of initial planning, cost estimating relationships is used to get a rough estimate of costs based on hypothesized characteristics of the new project and subsequently use a subjective judgment approach is used to estimate an aggregate risk for performance risk.

4.3 PROJECT EXECUTION MODELS :-

Many other resources are also involved in the execution of project in addition to the huge amount of money invested. Different people from different stake holders/organizations/systems/ departments are grouped together to form the project team who coordinate all the activities to execute the project successfully. They include:

- i.** Owner or project authority
- ii.** Contractors/Subcontractors
- iii.** Suppliers/Vendors
- iv.** Banks and financial institutions.
- v.** Many other supporting organizations

Forming the project team is not easy task since an organizational change is required to maintain the cooperative relationship between the participants which are coming from different organizations with different conflicting interests.

A well written contract should define clearly the legal, financial and technical aspects of the project to avoid the conflicts between the stake holders. The top management should regard the project contract documents with greater concern.

The projects are progressed in consecutive phases. For projects there are two main phases:

The Development Phase- the output is the Basic Engineering of the project. And

The Implementation Phase- includes Detailed Engineering, Procurement and Construction.

In project management, in addition to two main phase of the project, there are feasibility study phase which comes before development and the start-up which comes after the implementation.

Projects execution are explained & analysed as contract strategies by economist and project execution strategies/models by engineers/managers.

4.3.1 CONTRACT STRATEGY:- Selection of type of contract is an important decision for both the owner and contractor. Based on the pricing method, the contracts can be classified as :

- a. Fixed Price:** - The owner/ project authority and contractor agree on specific cost when signing the contract. This cost is fixed and will normally not changing (except in some situations) during the execution of the project. The contractor has to pay the additional cost in the case when the actual cost of the project goes above the agreed cost. The contractors add high contingency amount in project costing to avoid this risk. Therefore, the cost in this type of contract is high.
- b. Cost Reimbursable (Cost-Plus):-** The owner and contractor agree on target cost during finalisation of the contract. This target cost has two parts:

- i. The cost of material, equipment, labour, subcontract or overhead costs, contingency and profit.
- ii. The risk fee which could be fixed or variable.

If the contractor is able to build the project within the target cost, he will get both parts of the cost. Otherwise he will get only part “a” with or without profit. Trust between the two parties is important in this type of contract.

- c. **Unit Rate:** - The cost cannot be known until the completion of the project. The project activities are known but the exact quantities are not known. Therefore, it is important to measure carefully the amount of completed work on regular basis. (Almohawis & Salem, 2011).

4.3.2 PROJECT EXECUTION MODELS IN PRACTICE: - There are generally three type of contract considered in project execution model.

a). The owner/project authority calls for a competitive bidding form the probable bidders for the development phase of the project. The main scope of the bidder/contractor is to deliver a basic design package containing drawings, technical specifications & tender specifications & documents. The owner/ project authority calls for another competitive bidding on the completion of the basic design package for the implementation subsequent phases, Detailed Engineering, Procurement and Construction.

b). The owner/ project authority contact simultaneously with two most technical & financial capable bidders/contractors for the development phase. On the completion of basic design phase, the owner/ project authority calls competitive bidding from only two bidders/contractors. One of them is winner of the bid.

c). This contract is similar to the first one except that the same contractor will do the two phases. On the completion of the basic design package, the owner and contractor negotiate the contracting approach for the implementation of subsequent phases. On the failure

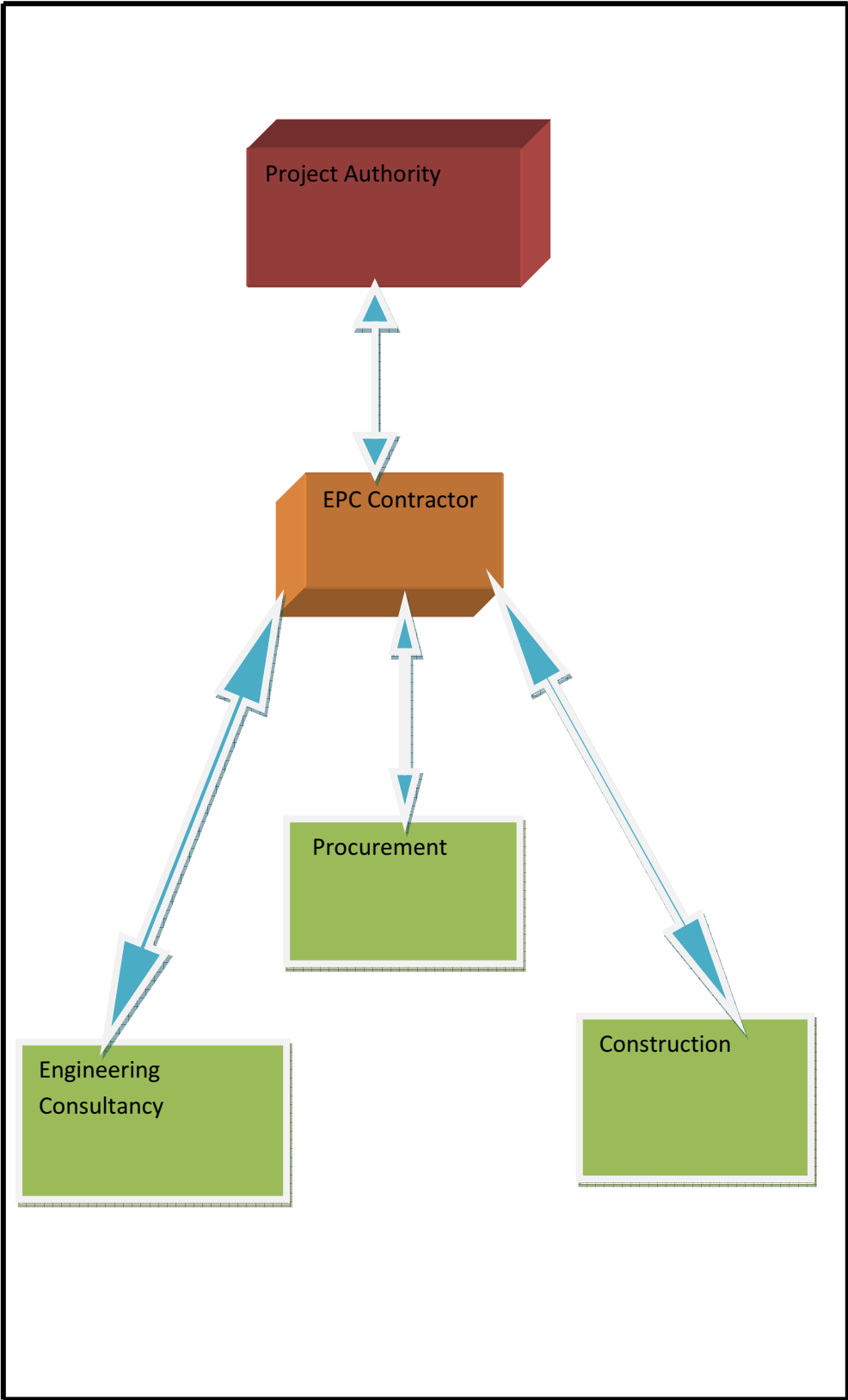
of agreement, the owner can switch to the first strategy and call for competitive bidding for implementing the project based on the basic design package. (Almohawis & Salem, 2011).

Based on the contracts the following project execution models being in practice in construction sector can be derived;

A. EPC: Engineering Procurement Construction (EPC) is fixed priced lump sum contract. In EPC mode, contractor is fully responsible for constructing & commissioning the project according to the design package prepared & agreed during the development & engineering stages. The equipment and materials are required to be purchased during the procurement stage by the contractor. EPC contract is basically “single point of responsibility” contract. The EPC contractor is responsible for designing the total facility/systems/ equipment, building the structures, buying/ fabrication & installing the equipment, performing all construction activities, testing & commissioning, training the operators and handing over the complete project along with the drawings and operations manuals to the owner/project. The EPC contractor is a main contractor who performs the work directly by his own staff or indirectly by vendors and subcontractors. He is the only single point of responsibility for the project authority. The owner has little authority to intervene during the construction. The contractor claims additional cost and time in the event of owner intervenes. The allocation of most of the risk is to the contractor. The contractor will put higher contingency to account for these risks, therefore the cost of EPC is usually higher. (Almohawis & Salem, 2011).

The EPC contact strategy concentrates the project objective, time and cost only. Since there is no incentive for betterment, he ignores the technical parameters like quality, safety etc. The EPC project execution strategy can be modelled as block diagram in Figure No. 4.2:

Figure No.-4.2:- Engineering Procurement Construction



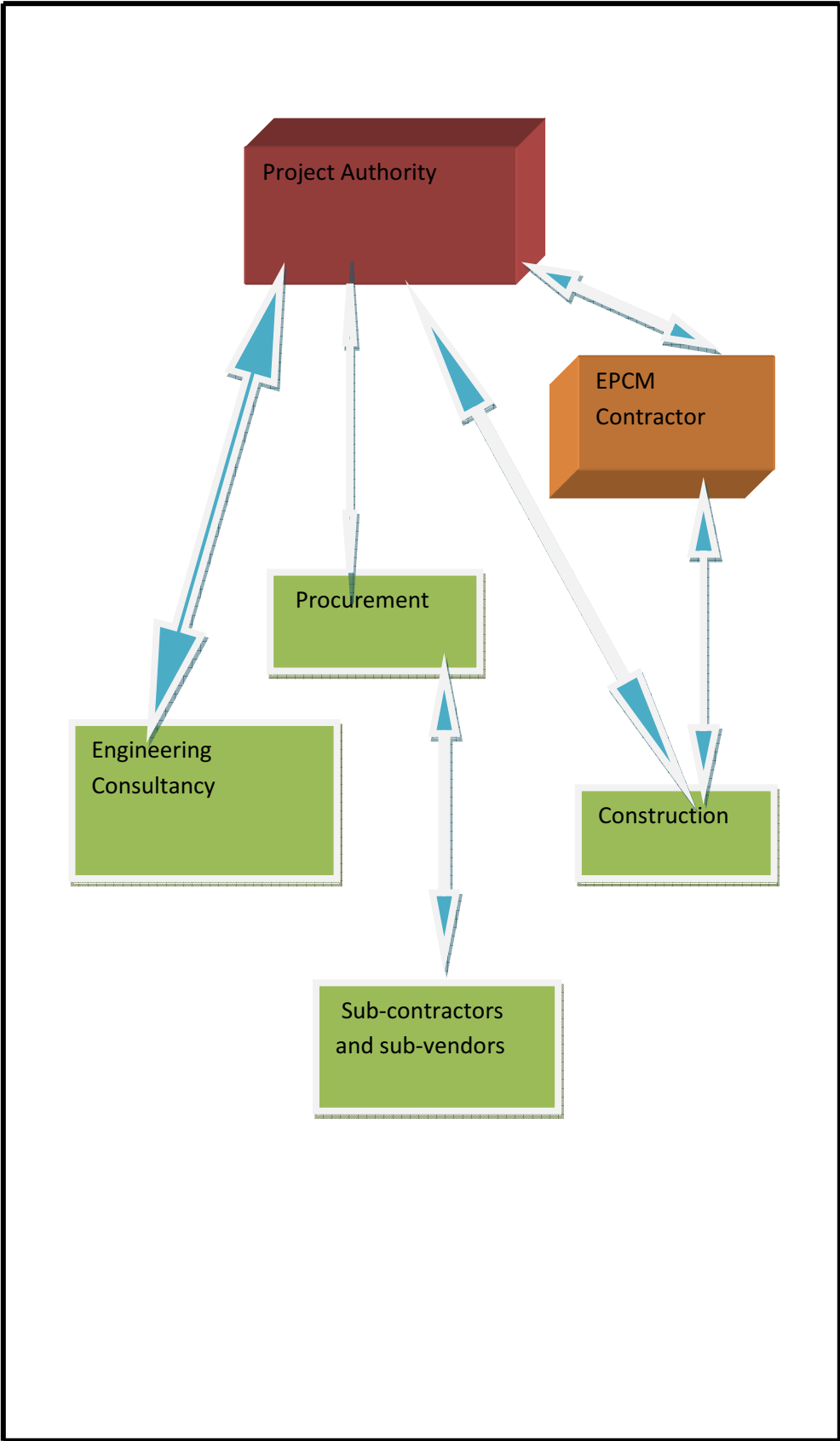
B. EPCEM:

In Engineering Procurement Construction Management (EPCM) contractor is not responsible for constructing the project. EPCM contractor manages the construction which done by other parties. He acts as the owner representative and creates on behalf of the project authority (owner) a direct contractual relationship between the project authority and construction contractors, subcontractors and suppliers. The project authority is only responsible for construction. The owner pays the fixed amount to EPCM contractors for his service and make the payment to the trade and construction contractors directly or reimburse the actual though EPCM contractor. EPCM in fact is a professional services contract unlike the EPC contract which is considered as construction contract.

EPCM contract is more flexible. EPCM is selected when the owner wants greater role in procuring the equipment and selecting the construction contractors. Therefore, the owner has more control on the project. The EPCM contractor manages and administrates the construction contracts during construction. The owner should have a large and experienced in-house team to assist the EPCM contractor. EPCM contractor does not take full responsibility to complete the project on time and within budget. (Phil & Nick , 2006).

The EPCM project execution strategies can be modelled as block diagram in Figure No. 4.3:

Figure No.-4.3:- Engineering procurement Construction Management



The main difference between the EPC and EPCM is risk distribution between the owner and the contractor. The owner in EPCM assumes most of the risks as he is responsible for the approval and review of the engineering, procurement and construction processes. The project authority actually who derives the project. Risk sharing has a direct impact on both the cost and schedule of the project. The cost in EPC is higher than in EPCM, but the time is shorter. Therefore, project management has to decide between these two modes. (Almohawis & Salem, 2011).

C. HYBRID CONTRACT MODEL:- The economist defined EPC contract as Firm Fixed Price (FFP) and EPCM as Cost Plus Fixed Fee (CPFF).

The hybrid version of EPC (LSFP) and EPCM (CPFF) was proposed by researchers known as Cost Plus Incentive Fee (CPIF) contract. The Engineering Contractor (EC) got a specified contract sum for the entire scope of work. The cost risk is born by the EC. In EPC (LSFP), other than agreed cost there is no financial performance incentive for the EC.

At the other end reimbursable type contracts such as EPCM (CPFF) contracts has the cost risk allocation. In a EPCM (CPFF) contract the owner reimburses the Engineering Contractor for all purchase orders, sub-contracts and other costs associated with the project scope as actual or agreed upon. The cost risk is totally born by the owner. The owner pays the EC a fixed amount for EPCM services in addition to this.

In CPFF contract no risk premium has to be paid to the EC and this is an important advantage for the owner. The main disadvantage is the lack of a financial performance incentive for the EC regarding project cost. At the result in CPFF, extensive owner involvement is required.

In LSFP and CPFF contracts the cost risk are attached with entirely with one party.

In the incentive contracts sharing of the cost risk between owner and EC are introduced.

The simplest form of incentive contracts is the Fixed Price Incentive (FPI) contract. A target cost and a target profit are calculated & established in this type of contract.

In other form of incentive contracts is Cost Plus Incentive Fee (CPIF). In this contract, the owner and EC also share the difference between the actual cost and the target cost/budgeted cost in a band around the target profit. The incentive fee is based on performance against specified criteria. For under run project, the engineering contractor shares the profit subject to a ceiling value. The owner bears all the cost risk in the event of actual project cost exceeds a certain level for cost overrun project. There is no loss sharing in case of overrun project. This model is also considered as the advanced or extended EPCM contract. (Berends , 2000).

4.4 MATHEMATICAL EQUATION FOR MODEL:

SC ward and CM Chapman has evaluated the EPC and EPCM as FPP and CPFF economical model respectively. He has analysed the incentive contract as linear equation .(Ward& Chapman, 1995).

$$Cp = Tp + \phi(Tc - Ac)$$

Where

Cp = Contract Profit

Tp = Target profit

Tc = Target Cost

Ac = Actual Cost

\emptyset =Risks haring proportion

In case EPC : $\emptyset = 1$

In case of EPCM; $\emptyset = 0$

In case of CPIF: $0 < \emptyset < 1$

4.5 GRAPHICAL ANALYSIS OF MODEL :

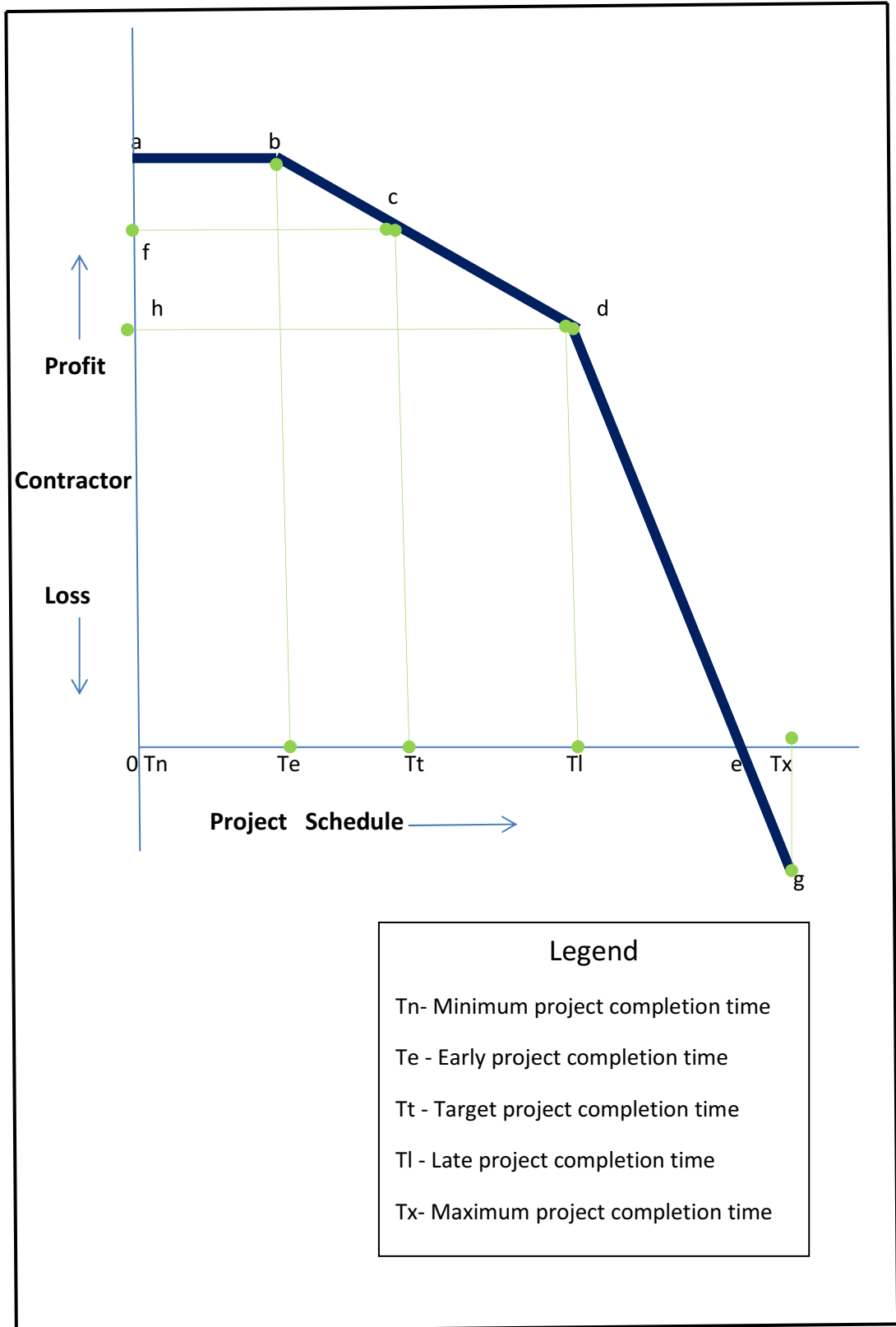
The economist has analysed the contract models in contractor profit & project cost prospective. SC Ward and CB Chapman have drawn the graph, contractor profit vs. project schedule/cost for FFP and CPFF model. But the project owner interest is not considered. (Berends , 2000).

In this model target profit and maximum profit are defined. The target profit is the cost on which both parties do agree and work to meet this. The maximum project profit is also considered in the model.

Desirable times, early project completion time and target project completion time are shown in the graph. Late project completion and maximum completion time are also defined in the graph.

The contractor profit/ loss with respect to project schedule are shown in Figure No. -4.4:

Figure No.-4.4: - Contractor Profit/Loss vs Project Schedule



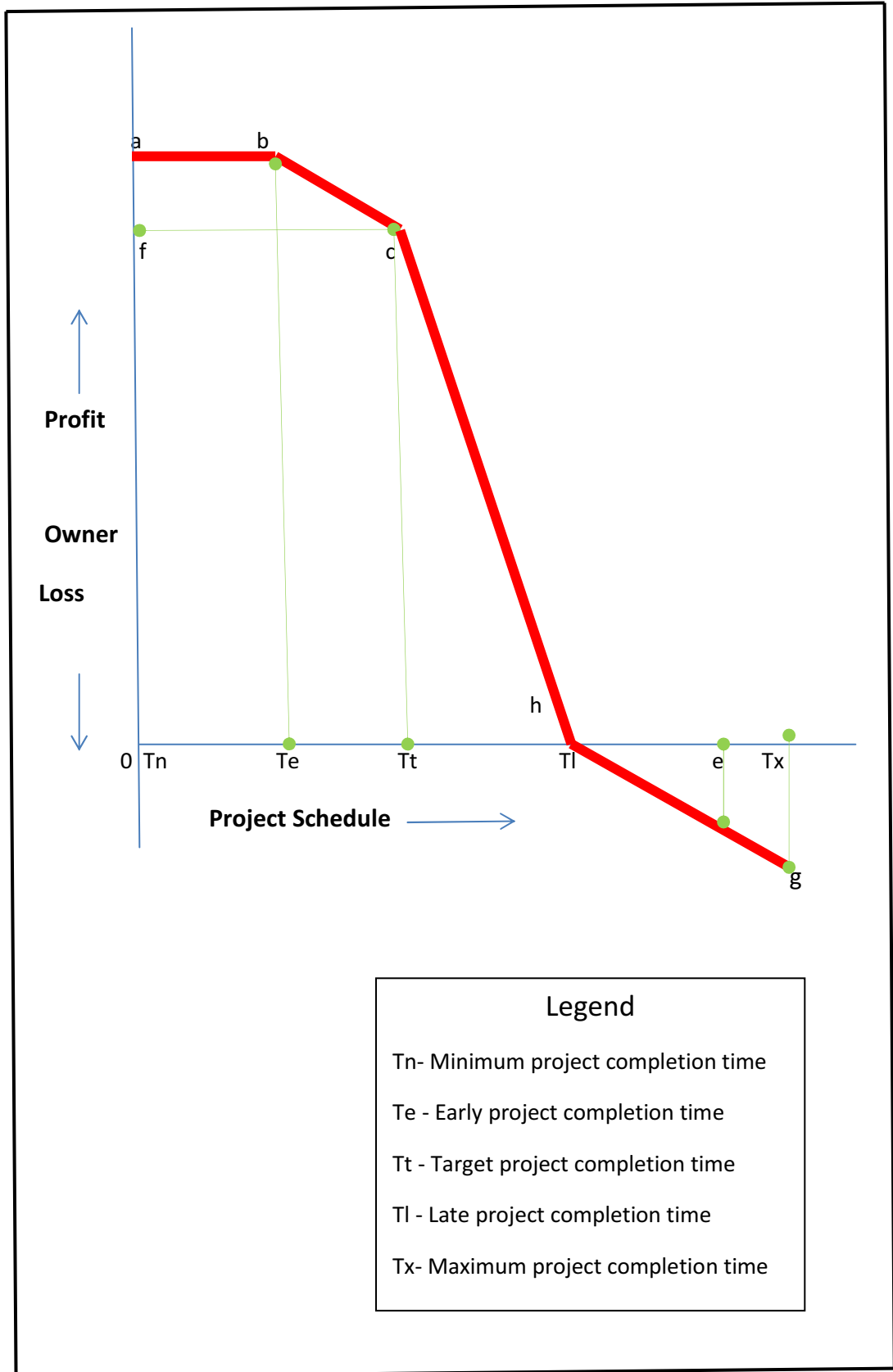
Contractor has maximum profit “oa”, if he is able to complete the project much before target schedule, “Te” “Tt”. Afterwards the profit decline as time elapses. The decline in profit upto point “c”, which is the target profit, there is no worry to contractor. The corresponding time, point “Tt” , is the target schedule. The contractor does the calculation of profit on the basis of target schedule.

The contractor keeps some margin in the profit calculation to absorb some delay upto “Tl”, late project completion time. Beyond the point “d”, the profit declined sharply. Because contractor has not anticipated this delay and also not considered in the calculation. Additional labour & material cost, interest on borrowed capital etc. reduces the profit. If situation is not controlled, the profit becomes zero at point “e” and further continues to point “Tx”, which is maximum loss.

Owner gain vs project schedule are the important factor to evaluate the contract strategy. This is missed in the above model. The owner profit/ loss vs project schedule can be drawn for EPC and EPCM model considering the SC Ward linear model. Early project completion time, target project completion time and late project completion and maximum completion times are taken as it is.

The owner gains in terms of target profit and maximum profit are also shown on “Y” axis in Figure No. -4.5 :

Figure No.-4.5:- Owner Profit/Loss vs Project Schedule

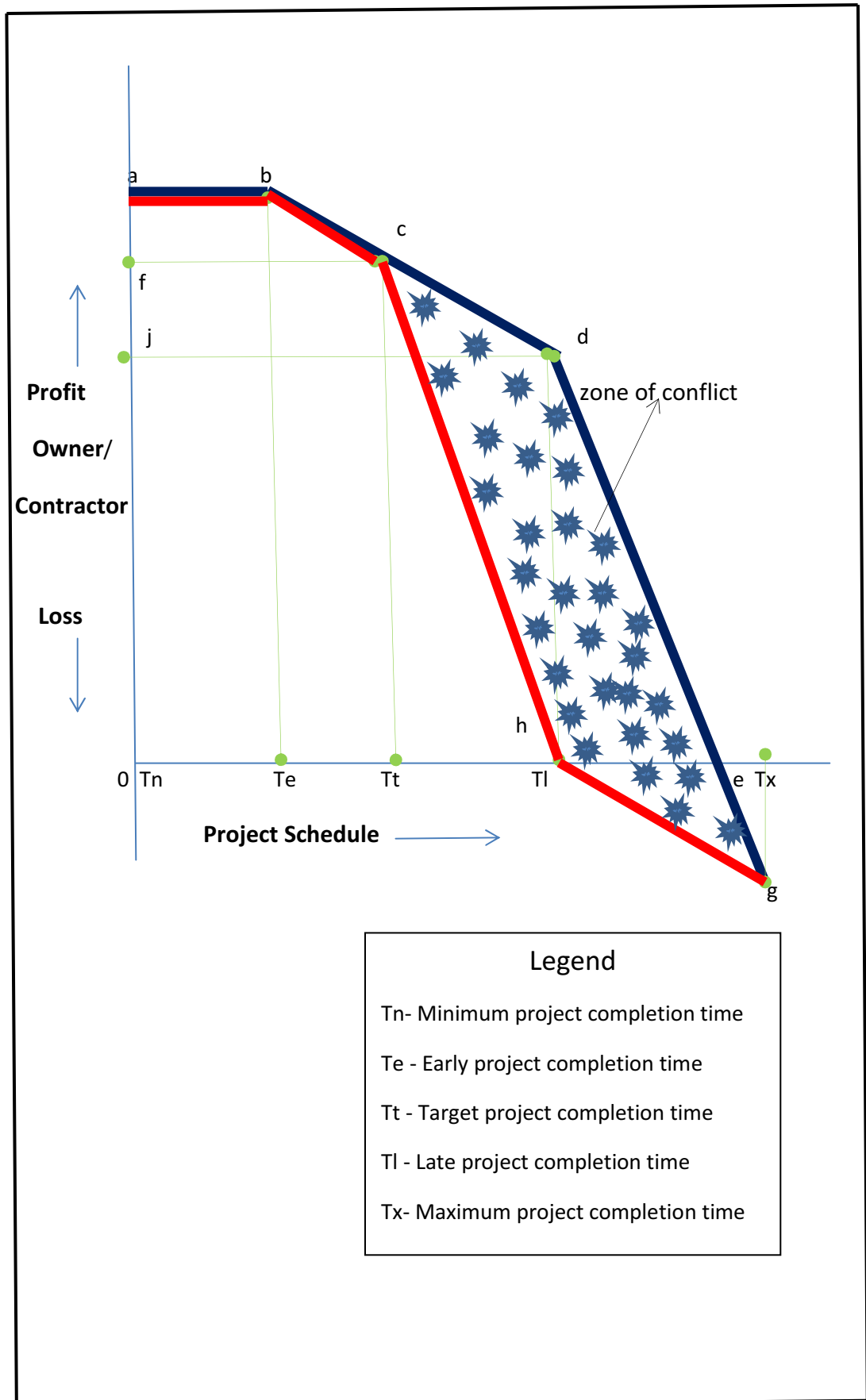


The owner gain is maximum upto the point ‘b’ where project is completed before the target time. It follows the same pattern as followed by contractor profit. This is desirable situation in project execution but practically it is very rare to see such situation. So, neither contractor nor project owner concentrates upto point ‘b’. Both parties put their attention in the segment ‘bc’ which is target schedule & target profit/gain.

The owner gain reduces sharply as the time passes because the owner plans post commissioning activities of project according to target schedule. At point ‘h’, the owner gain becomes zero. Further delay, beyond point ‘h’, may cause the owner’s gain to slide sharply.

To find out the gap/ deviation in the interest of contractor & owner, the two graphs are overlapped and are shown in Figure No.-4.6.

Figure No.-4.6 :- Zone of Conflicts



On overlapping of above two graphs of the owner and contractor, shows the zone of conflict “c d e g h”. Owner of the project do the post commissioning planning for operation/ production, launching, marketing, distribution etc. along with the planning & scheduling of the project. He plans the post commissioning activities considering the project completion schedule, ideally “Tt” (target time) but not surely before “Te” (early project completion time). Owner is not gaining much in very early project completion.

The point “b” is the breakeven point where both contractor and owner are interested. But very small numbers of project are completed in time worldwide.

The zone “c d e g h” shows wide gap between the contractor and owner interests. The owner profit reduces very sharply because he has invested & planed post commissioning activities as per the schedule. He has to bear not only project overrun cost but also production losses & interest on borrowed capital. Contractor can bear his loss up to “e” but at this point owner profit become negative. The point “e” is considered as crucial in project life cycle. But it is very sensitive also. Lot of conflicts & disputes are arisen here. These conflicts may further delay the project or may cause complete closure the project.