Project Management Architecture (Model)

Contents

Introduction

During the 2001 to 2011 resources boom, many of the projects in the sector finished well over budget and behind schedule with poor safety records. With the large downturn in commodity prices in 2013, more cost effective, guaranteed outcome projects are required. This document highlights the importance of the project management architecture / structure employed in delivering successful project outcomes.

Project Management Models

EPC

One approach for a project is to adopt a fixed-price, turnkey approach known as an engineering, procurement and construction (EPC) contract, often referred to as a lump sum contract. In this model, a single contractor assumes responsibility for all elements of design, construction and procurement. In theory, this model can provide the Owner with a degree of certainty in cost and schedule required to undertake a project but in practice, this only occurs when a significant amount of design has already been completed. Under this model, Project risk is generally transferred to the Contractor. However, this can come with a substantial price "risk premium" since the Contractor bears the risk of performance across all subcontractor work packages and equipment supply. It is difficult to accurately price the construction work if the design has not been substantially completed.

One major drawback with the EPC model is that the responsibility for detailed design lies with the Contractor; hence the Owner needs to ensure that the functional and performance specifications are clearly specified to guarantee the delivered installation is of the required standard, quality and delivers a successful operation. On large complex process orientated projects this can be difficult to achieve up-front, as issues invariably arise as the engineering design progresses, that were not apparent at the start. This leaves the Owner open to cost overruns through contract variations where the Owner is locked in to negotiate with the one very large contractor. There is also a risk that the final delivered operating plant is not what the Owner requires to provide**,** a cost effective, efficient operation for the life of the resource / plant.

As an example, a power station project in Queensland, commissioned in 2001, was considered a successful project for being delivered on time and to budget, winning national recognition via a formal award. The specified capacity was for two 450MW generation units. Due to design limitations, these units were subsequently de-rated to 405MW, resulting in 90MW of lost power sales to the market for the life of the plant. This was a serious failing of that project when considering the long-term economic loss.

EPCM

During the recent resources boom, the engineering, procurement and construction management (EPCM) model was the norm for large design and construct projects. The EPCM project management model is a professional services contract, where a single contractor has responsibility for all aspects of design, procurement and construction management.

Of note is that all construction contracts and equipment purchases for the project are still between the Owner and the suppliers or construction contractors, with the EPCM contractor acting on behalf

of the Owner. Typically, the engineering, procurement and construction management services are conducted on a "schedule of rates" basis. Figure 1 shows a typical project organisational structure for an EPCM based project.

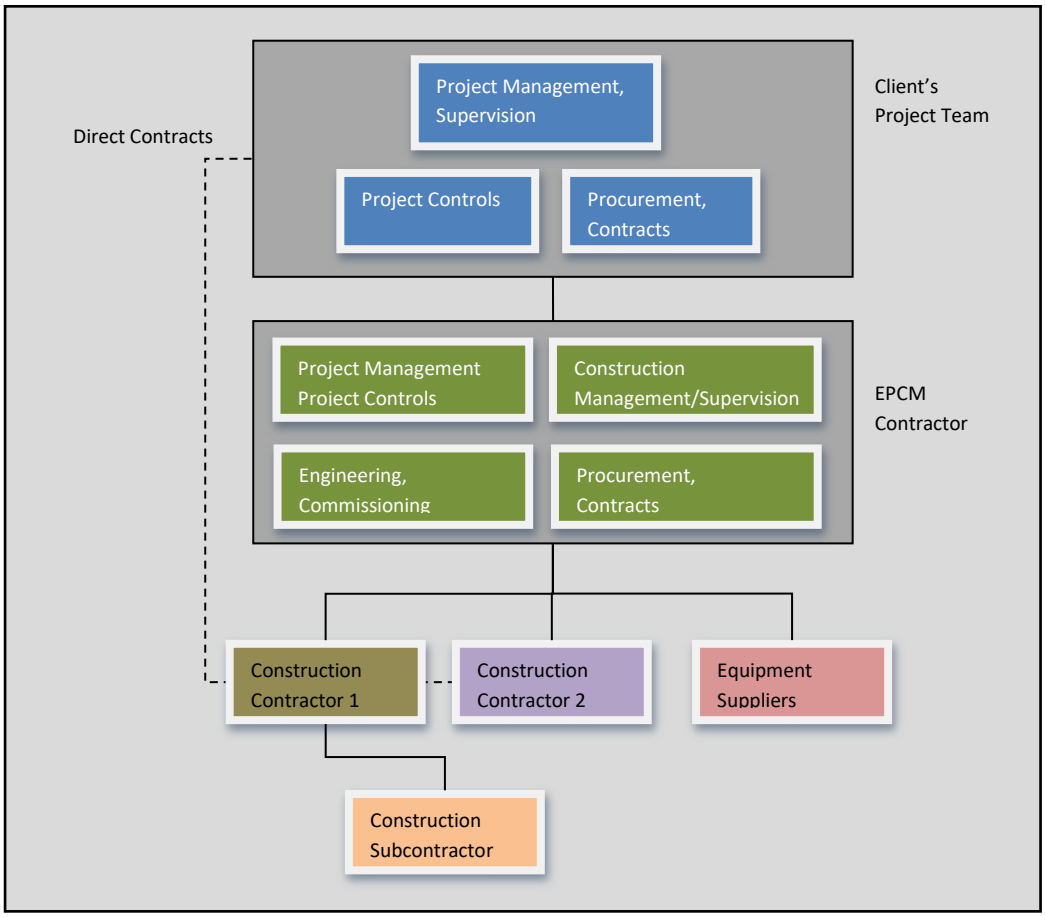

Figure 1: EPCM Project Management Model Organisation Structure

Loots & Henchie (2007) of Mayer Brown (an international law firm) argue that this industry wide change from EPC to EPCM style contracting was driven by market forces rather than by any actual or perceived benefit in the EPCM approach. They argue that traditional (EPC style) engineering companies prefer EPCM since the project risk is transferred back to Owners (and lenders) and reflects the stronger bargaining position of many engineering companies due to the high demand for their services at this time. The change in the economic climate however has seen this situation reversed, with the bargaining power now more favourable for Owners.

One distinct advantage of the EPCM model over EPC is that it allows the Owner's Team to have more input into the specifications and design of the new plant and to deal with changes more efficiently. Remembering the purpose of a project is to deliver a plant that provides a low cost, efficient operation for the life of the resource / operation, this is an advantage of the EPCM project model. This model also promotes the future operations team having ownership of the installation / design.

Limitations

EPCM projects were very lucrative for engineering companies, evident from the large increases in the market value of many engineering companies during the mining boom. For Owners however, there

are several limitations with the EPCM approach; the primary one being the lack of commercial incentive for EPCM contractors to deliver a project at the budget price and schedule. If the project overruns in schedule, the EPCM company often still make a profit based on the margins in their rates, or at worst, a reduced profit if there is a contractual mechanism to "share the pain" in the case of cost/schedule overruns. A few the failings inherent in the EPCM project management model from the Owner's perspective, can be summarized as follows:

- There is little or no commercial risk for the EPCM contractor for cost and schedule overruns.
- The final contract for the supply of equipment and construction services is between the vendors / contractors and the project Owner, not the EPCM contractor. This generally requires both the EPCM contractor and the Owner to have procurement / contract departments, systems and processes. This can easily result in considerable inefficiencies and duplication of effort in the project management team.
- The engineering companies typically do not assemble the commercial terms and conditions for the equipment and construction contracts. These are completed by the Owner thus restricting the ability of the EPCM contractor to put in place and negotiate, the commercial terms efficiently.
- Inaccuracies in the EPCM target cost and the project schedule. This is especially important in the case where the company who completed the feasibility study is retained by the Owner as the EPCM contractor to execute the project. The tendency is for the EPCM company to reduce the estimate to meet the hurdle rate as they do not take the risk on the project costs and are in the best position to execute the works on a EPCM schedule of rates basis.
- The EPCM model can result in at least three layers of management, Owner, EPCM contractor, and vendors / construction contractors. If subcontractors are included, this becomes four layers. This often results in a large, inefficient project management team with unclear lines of responsibility and high overhead costs.

Three examples of EPCM structured projects are:

- *A $2Billion Mine Extension* - a project to install a new mine adjacent to a current operational mine. This project was completed in 2013 well above the original budget and well behind schedule.
- *A Brisbane based service centre for a large Australian mining company* - an integrated office for planning, executing and optimizing multiple projects over an extended period. An EPCM project management model was used but has since been disbanded, despite having one of the world's largest and most experienced companies as the EPCM provider.
- *The 2.6Billion Wiggins Island Coal Export Terminal (WICET) expansion* – The EPCM contract was removed due to cost and schedule overruns and an Owners team put in place.

Alternate Project Model

Given the limitations and issues described above relating to the EPC and EPCM project models used by Owners, what alternatives can be used? When looking at examples of previous successful projects, going back before the resources boom the Moranbah North Coal (MNC) project (completed by Shell Coal in 1998) was delivered under budget ($488m against a budget of $500m in 1998 dollars), within schedule and with no Lost Time Injuries (LTI's) at the site. The project was a new underground coal mine and processing plant. This project is similar to the above mentioned $2billion mine extension

project. (A new underground coal mine project completed in 2013 which was reported to have a final cost of over 2billion with initial budget being 1.3billion).

Converting the MNC project budget to 2017 costs this equates to a budget of $750million which is well under the 2billion spent on the new underground mine completed in 2013. One marked difference was the number of people engaged on the two projects. Moranbah North Coal had less than 15 people as their core team (excluding procurement) whereas the PCM contractor for the 2013 project peaked at well over 120 personnel. Interestingly both project teams had very capable, experienced personnel but were structured very differently.

The MNC project management team consisted of a few Owner's personnel (Shell staff), augmented with experienced contract project personnel. The Owner's personnel focused on the quality of the installation, ensuring that it would provide a cost-effective operation for life of mine. The experienced project personnel focused on ensuring the project was delivered safely, to budget, and to schedule.

The Owner Team project model / structure was recently put into practise on a brownfield project at a copper processing plant in Laos.

Project Description

- Additional plant to treat a different ore type mix.
- Budget – 25 million USD.
- Delivery Schedule – 13 months.

Key outcomes

- Zero Harm – 9 months construction.
- Delivered to schedule – Apr 2016.
- Well under budget – Below U$18m.
- A Quality Installation.
- 98% of KPI paid for meeting targets.

This project structure and approach works as proven in the coal and hard rock mining industries.

Project Set-up

Based on the proven success of the Owner's project management team as described above, an "Owner's Team" would develop and implement a Project Execution Plan, based on the following recommendations and objectives:

1. A detailed procurement / contracting strategy for the project is required up front to provide clear direction to the project team. E.g. What equipment is to be purchased up front to provide vendor data to allow the design work to be completed efficiently? How are the

construction contracts set up? Separating engineering from construction is a favoured approach, i.e. engage a reputable design company and separate experienced proven construction companies.

2. An independent verification of the project costs and the schedule. A Study typically specifies the costs within a certain accepted range but this accuracy is often not present within the schedule. Schedule overruns result in considerable cost increases especially for schedule of rates (EPCM) based contracts. The approach taken with the Laos copper plant project in relation to the work completed in pre-feasibility study and the fact the design was based on existing equipment, contributed to a short engineering design period.

3. The design portion of the work is issued as a lump sum tender. This requires a more detailed work scope, but results in a more accurate cost estimate up front. It puts in place drivers for the engineering to be delivered on a competitively priced tender. This is not always practical especially for process orientated projects but needs to be considered in the overall project schedule and additional costs allowed if a schedule of rates model is adopted. An alternative to consider is the issue of a schedule of rates contract, which is then converted to a lump sum with the preferred bidder before award.

4. The shop detail drawings are included in the engineering companies scope, the design then rests with one company and there are savings in the overall project schedule.

5. Performance guarantees are contractually required from the engineering company, especially in processing plant designs. The scope for the engineering contractor should include working with the project management team to commission and handover a fully functioning operational plant that meet the specifications and design goals. This places responsibility on the engineering company to complete quality engineering to achieve the design specification / name plate capacity. A performance guarantee is difficult to implement but the exercise of developing the guarantee focuses the engineering and clients team on what had to be delivered for a successful Operation.

6. The breakdown of the work can include design and construct contracts when it makes sense to do so, i.e. where there are experienced suppliers in specific areas and where clear battery limits can be drawn between areas of design, for example, installation of stockpile handling plant.

7. Construction works should not be awarded to one overall contractor but separated into the general categories of Earthworks, Civil, Structural Mechanical & Piping (SMP), Electrical & Instrumentation. Separating the construction works allows the smaller, more cost-effective construction contractors to be engaged. To clarify this point, a detailed review of the construction contractors within the project area is required to determine the best break down of the construction scope which may vary this approach.

   If the larger construction contractors are engaged it is recommended some of the works is allocated to smaller (preferably local) contractors, with lower overheads. This ensures competition between contractors during the construction phase for any changes or additional work scopes. Experience of major contractors on a site is that they can be up to five times the price of a smaller local contractor for small variations.

8. Procurement and contracts is completed in house by the Owner's Team using the Owner's purchasing systems augmented with the applicable terms and conditions appropriate for the project, and experienced project procurement / contracts personnel. The engineering company (performing the design) is still responsible for completing the relevant data sheets and work scopes for the Owner's Team to issue to tender and will also assist with the technical evaluations of tenders.

9. Taking a lesson from the Power Industry the method of selecting a preferred bidder and finalising the scope, schedule and cost (often lump sum) before final award provides a good basis for the delivery of a successful project.

10. The work is broken down such that each contract has a "Contract Holder" responsible for managing and delivering the works associated with that contract. Contract Holders would typically be personnel experienced in the management of construction projects. This results in fewer but more experienced personnel with "runs on the board" that are involved from the start of the project design right through to hand over. i.e. Experienced project engineers.

11. Involving a construction manager in the design phase and the development of the procurement and contracting strategy as well as the award of the contracts provides continuity and ownership.

12. The Owner's Team is not set up to have discipline supervisors managing the construction contractor's supervisors, as is typically the case in EPCM projects. The experienced construction management team with nominated Contract Holders will be responsible for ensuring that the construction contractor delivers to the requirements of their lump sum contract and provide the appropriate level of experience and supervision especially with respect to safety. Quality inspectors are used to support Contract Holders in ensuring the plant is delivered to specifications if required.

13. The site accommodation requirements are clearly understood including a contingency should additional accommodation be required. Accommodation, site access and communications are to be well set up by the Owners team before the Construction contractors arrive at site.

14. Detailed inspections of the contractor's plant and equipment well before mobilising to site on the Laos Copper plant project, contributed to achieving "Zero Harm" in the 9 months of construction.

15. A key contract for most projects is the SMP contract. The recommended approach is the scope includes the supply, fabrication and erection of the structural steel including assembling the main sections of plant off site before delivering to site. This coupled with the approach of the engineering company completing the shop detail drawings results in reduced interface risks.

16. Involvement of the Owners team in the study phase to set up the architecture for the execution of the project and to take on Ownership for delivery.

Figure 2 shows the organisational structure of a project based upon the Owner's Team model. The Owner's Team model has fewer layers of management, clearer lines of responsibility and avoids duplication of roles.

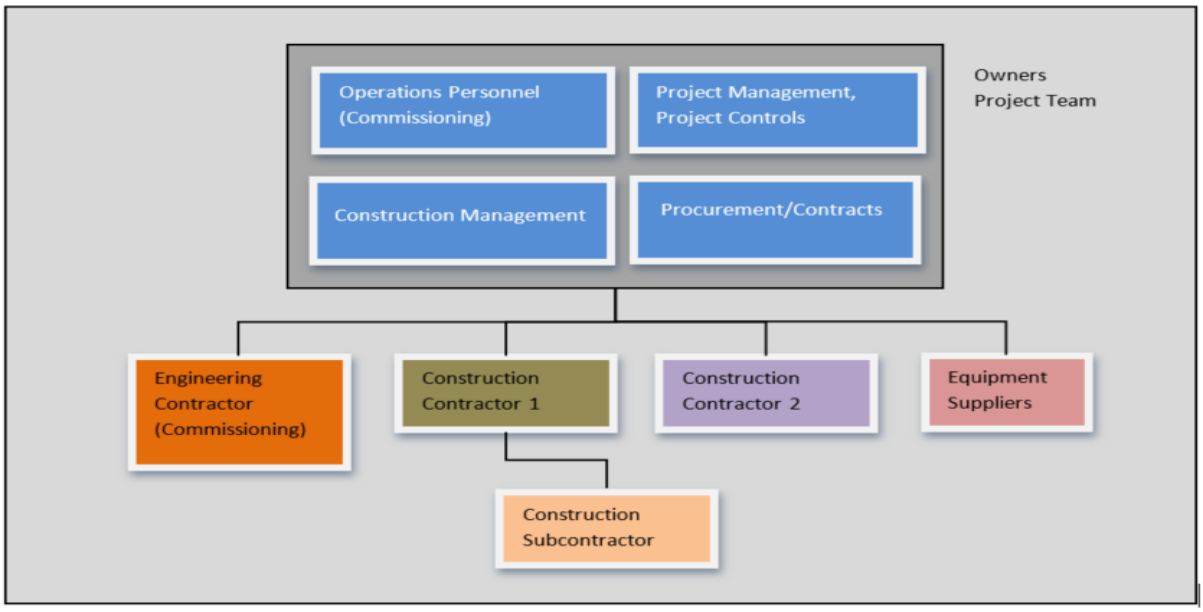

Figure 2: Owner's Team Project Management Model Organisation Structure

Works Scopes, Estimates and Brownfield Sites

Well Defined Work Scope

A well-defined, concise work scope is essential for delivering a successful project – **this is obvious** but not always achieved. To this end, the following approaches are recommended:

1. Once the various options have been defined in the feasibility studies, adequate time is to be allowed to establish a good design that incorporates ownership by the future operations personnel. Once construction starts, changes in design are extremely expensive.
2. The engineering design is completed to the "Issued for Construction" (IFC) stage including receipt of the "Approved Certified Vendor Data" before finalising and awarding lump sum construction contracts. This includes a review and sign off on the IFC drawings by the Owner's operational personnel.
3. Preferred equipment lists are developed at the start of the project to reduce procurement and engineering schedules / costs. This is particularly relevant for brownfield operations where the mine operations personnel need to take into consideration life cycle costs for spare parts and maintenance. E.g. standard pumps, electric motors, valves, PLC's etc. The typical EPCM approach of tendering all of the equipment supplies down to low-level miscellaneous equipment, and then waiting for the Certified Vendor Data results in a longer, more costly engineering / procurement phase.
4. A concise Project Execution Plan including the contract / procurement plan (strategy) is put in place (approved) before the detailed design phase is started.

5. A concise, prescriptive Health Safety and Environmental plan is put in place and issued with the construction tenders. A key to delivering the copper plant project with Zero Harm was the planning undertaken for the project.
6. The scope for the engineering company completing the design includes a provisional sum for the review and sign off on the construction installation and to take responsibility for commissioning including performance testing. This is especially important in areas such as process plants where performance targets must be met.
7. A procurement / contracting strategy is put in place to provide the correct drivers and leverage to successfully deliver the project. The procurement approach taken for a project is often not in line with the methods used for an operation, consequently this approach needs to be clarified up front.
8. A lump sum approach is taken with the tendering thus forcing both the Contractor and the Owner to focus on putting in place a detailed, accurate work scope up front for a more predictable cost and schedule with experienced reputable contractors.
9. Equipment supplier scopes are to include, the issue of approved certified vendor data, commissioning and operational spares, quality operation and maintenance manuals and an adequate allowance for onsite support during the commissioning phase.

Cost and Schedule Estimates

A realistic budget and schedule are fundamental to achieving a successful project. Projects with unrealistic budgets and schedules often result in a higher final cost than a project with a realistic budget and schedule estimate. This occurs because the project and management teams become preoccupied with justifying every overrun rather than focusing on delivering the project, which ultimately has the major impact on the final cost. In the case of EPCM based projects, the effort spent on the cost and schedule overruns is completed as a variation at the contractor's schedule of rates and is therefore borne by the Owner.

Confidence in a project estimate is required up front with the following points to be considered in relation to the project cost and schedule estimate:

- The company that provided the estimate usually has no commercial consequence for providing an inaccurate estimate. Further, if that company is expecting to perform the EPCM role on the project, there is an incentive to provide a low estimate to increase the likelihood that the project will be approved. Under the EPCM project management model the EPCM contractor typically do not take on any major commercial risk.
- Project Owners often try to reduce the estimate provided rather than ensuring that the work scope is accurate and that the costs are all inclusive. The driver for this is often to meet a specific hurdle rate to show that the project is economically viable. If the project is not viable then look to invest in a better project.
- The engineering company providing the estimate via the feasibility study, typically obtain quotes from equipment suppliers and construction contractors who provide indicative (low) prices to improve their chances of receiving a tender when the project is approved. These suppliers / contractors typically have no obligation to maintain their quoted prices at tender stage with increases of 20% over the quoted price not uncommon[1]. To reduce

[1]As an example, when the Front-End Engineering and Design (FEED) study was completed for an LNG project in NSW it was found the actual tender costs received were, on average, 20% higher than the original quotes

this risk, it is recommended full tenders are issued for the larger pieces of plant. This takes more time in the study phase but saves time if the project goes into execution.

- Project estimates are typically reviewed by comparison to other feasibility study estimates, rather than using actual project costs.
- Budgets are typically calculated within an accuracy range based on engineering industry standards. Schedule estimates however, do not normally have the same level of rigor or standardization applied. Given the impact of schedule blowouts on the final project cost, the project management team need to gain a high level of confidence in the schedule.
- The engineering company that provided the feasibility estimate is usually engaged on an EPCM basis by the Owner to deliver the project. This is problematic since there is no independent review of the project costs. As a result, overruns in cost and schedule are often not realized until after the construction contracts tenders have been received, which is difficult to rectify at this stage of the project. This also puts the EPCM project management team in a compromising position of defending the estimate as opposed to delivering the project.

Brown Field Sites

When developing a Project Execution Plan, the interface between the new and existing operations (or future operations) need to be considered in detail. Some of the key issues to consider:

1. The disruption to the existing operation is minimised where possible, even if this requires a new plant to be constructed as opposed to upgrading the existing plant.
2. The battery limits and responsibilities are clearly defined between each contractor and the operations team. Commissioning of the new plant is a critical area that needs to be considered and clearly understood by all parties at the start of the project.
3. The responsibility for Health & Safety is clearly defined. The preference is to augment the existing site operational safety system with the specific (new) project risks so that all personnel are following the one safety system on site during construction and commissioning.
4. Scheduling of work needs to be completed in close alignment with the operations team. Tie-ins, is one area that requires in depth planning with the construction team ready to take advantage of unplanned shut down opportunities if possible. Specific drawings with pictures, P&ID's (before and after), detailed material lists, bagged materials per tie and pre-erected scaffold as some of the items to be set up for a successful program.
5. The project team includes some key personnel from the future operation to assist with developing and managing the project and to help focus on delivering a cost effective and safe operation for the plant life. Being an integral part of the project Owner's Team will require the operations personnel to be committed to deliver to the project time frames and costs.

Conclusion

An independent Owner's Team significantly reduces overhead costs through reduced layers of management, better communication and clearer lines of responsibility. Utilising one set of systems and processes, the Owner's Team approach provides an efficient structure for managing project risks. This is particularly important for brownfield sites and outage projects.

received during the feasibility stage. Since the general terms and conditions of contract are typically not issued during a feasibility study, the likelihood of cost increases at the tender stage is high.

The Owner's Team is independent from the engineering, construction and supply contractors engaged on a project, the team is only focused on what is best for the project. This independence provides the leverage required to hold the contracted organisations to account, ensuring that the Owner's interests are always the priority.

The Owner's Team management model is flexible enough to be able to select the best practices from the alternate project management models and incorporate them into the Owner's Team project management plan. This results in a flexible and dynamic Owner's Team truly invested and focussed on the best outcome for the Owner.

The Owner's Team management model puts the correct structure in place to provide a safe work site with simple management and reporting structures, clear lines of responsibility and a common safety system throughout the site.

The Owners Team model has been well proven, within a variety of mining and processing industries.

The one independent Owner's Team, with the responsibility, accountability and authority to deliver a project provides an optimum project management model for success.

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