



MODULARISATION AND PRE-ASSEMBLY PAPER #6 OFFSHORE FABRICATION AND ASSEMBLY COST DEVELOPMENT

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INTRODUCTION AND OVERVIEW

This paper has been compiled to provide an insight into how the basic economics are developed for offshore fabrication and assembly as applied to a modular or pre-assembly delivered project. This paper is a supporting supplement to the paper by the author, Modularization And Pre-Assembly Paper #1 - Underpinning Parameters And Considerations. It also compliments and builds on the concepts from the authors paper, Modularization And Pre-Assembly Paper #5 -Development Of Economic Model Costs.

From the perspective of the project owner, the establishment of this key component of overall project economics is critical to the decision making process related to a modular or pre-assembly delivery model over a traditional site erect, stick build project delivery model.

This paper will introduce the high level concepts and considerations of general applicability. They can be applied to specific projects on an individual basis by the reader. The following areas of central importance will be discussed to a level of detail that will enable the reader to appreciate the underpinning methodologies and considerations. The topics selected for more detailed discussion are as follows;

1. Project scope packaging;
2. Facility requirements for economic data;
3. Application of economic data;
4. Concluding discussion.

This paper will concentrate on the initial development of the offshore fabrication and assembly economics as a fundamental element that should be developed early in a projects formative phases with specific applicability to the pre-feasibility study phase. The subsequent progression of the economic validation process as applicable to the feasibility phase are not discussed in any detail in this paper but are a progression and refinement of the processes outlined for the pre-feasibility phase. This paper will be as generically applicable as possible, however the authors reference

benchmarks are generally related to South East Asian facility locations with project locations in Australia. However, the concepts and considerations outlined are equally applicable to project locations in any international location and other fabrication and assembly facilities in low cost high productivity international regions.

PROJECT SCOPE PACKAGING

Given that initial economic model development and data collection is critically linked to the pre-feasibility phase of project development, the reader may rightly be asking on what basis of engineering scope and detail is it possible to approach the market, and what meaningful data can be established? By way of general description of the process, the following points summarize the key steps and relevant core information

1. Establish a commodity list applicable for the Total Project Scope, this is not total project quantities just the construction total commodities description;
2. Develop a representative set of Modules or Pre-Assemblies collectively containing all project construction commodities and assigned specific quantities to the representative Module or Pre-Assembly set;
3. Establish target fabrication & assembly facilities on a country and regional basis;
4. Develop fully inclusive costs per commodity at each facility;

"The major benefit of this method is the economic basis at a commodities level can be established for fabrication, assembly, trial assembly and load out in the offshore facility and directly extrapolated at a commodity level to the extended project quantities as they are defined."

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5. Compile collective data based on commodity costs on a facility basis or country or regionally averaged basis;
6. Extrapolate economic cost data to overall project scope quantities as engineering definition is developed.

This robust and flexible approach uses the minimal definition of final scope available at pre-feasibility development stages. It substitutes the engineering and quantities definition for the encompassing description of commodities on a unit of measure basis to accurately capture the base fundamentals. From this position, the accurate population of an economic model with data at base unit of measure level is possible. Modules or pre-assemblies do not have to be absolutely defined. Reasonable representation of dimensional scale and complexity is adequate to cost assembly and load out on a module or pre-assembly commodity level. Mass variables can also be accounted for by categorizing the modules and pre-assemblies into commodities based on dimensional and mass ranges. However, some estimation as to the complexity of structural joint geometry and fixing, (bolted or welded), must be provided to the facilities.

The major benefit of this method is the economic basis at a commodities level can be established for fabrication, assembly, trial assembly and load out in the offshore facility that can be directly extrapolated on a commodity level to the extended project quantities as they are latter defined. This approach also allows the concurrent development of valid economic data while engineering definition is being developed for modules and pre-assemblies without the risk of engineering developments relating to scope invalidating economic data or model development.

Base Project Information

Generally, the pre-feasibility phase of project development is by nature undefined, but, is the optimum period to cement the module or pre-assembly development approach if the economics prove positive. At this juncture, many readers will undoubtedly be thinking that without definition in engineering and associated quantities, this will be

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difficult, if not an impossible expectation.

Although the engineering scope and quantities detail may be limited, projects at this stage of development will have the following key areas defined to a reasonable degree.

1. General estimation of overall project quantities;
2. General estimation of overall project schedule;
3. A project Work Breakdown Structure;
4. A Project Materials Commodity Code list;
5. A Basic Equipment list;
6. A general layout plan for project scope.

With these base project elements established and available, it is possible to build a fully representative project scope package based on the work breakdown structure, associated commodities and equipment lists with which to approach the offshore fabrication and assembly market.

At this early phase of project development, the project owners and developers will also have a reasonable feel for overall project quantities. This basis of quantities may be established from previous similar projects, or from historical experience coupled with current levels of project definition. This is not to say an accuracy level is available from which detail can be drawn, rather, it is more than reasonable to expect that a project will understand basic total tonnage ranges and in a similar manner, the schedule for project delivery should be bracketed to a point where total tonnage can be linked to delivery time frames which can subsequently be used to target facility capacity ranges. This information is adequate to convey the expected scale of a project to prospective facilities targeted for offshore fabrication and assembly services. This information will provide the facility with an overall project scale and time frame from which they can establish their level of interest and ability to service the production requirements. A facility is now in a position to receive a more specific cost related enquiry.

The Structure of the Package to the Facility

The key to developing a basis of strength in an economic sense, is to ground the economic model by the project work breakdown structure using base units of measure at a commodity level. The associated project construction commodities list is of fundamental importance and the first item that

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needs to be established for the offshore cost data collection purpose.

The construction commodities list and associated set of codes is a fundamental tool used by all engineering and project delivery providers. It is a cornerstone and foundation basis for project controls management. Construction commodities lists and codes changes little from project to project with the exception of exotic materials, piping categories etc. Otherwise, these lists of base construction materials is reasonably standard. The list of construction commodities is relatively easy to establish even at a pre-feasibility level of engineering definition. The greater challenge is to develop a set of representative modules or pre-assemblies from which the facilities can base their cost and productivity development. A strong point of note, is that while cost data is a primary objective for the economic model, productivity information on a commodities basis is also very useful reference information that can be used to validate construction schedules and facility capacities based on facility resource strength.

“The actual configuration of a module or pre-assembly is not the key issue, dimensions, mass and the extent of the composite commodities of construction are the only essential elements in the development of cost data.”

To establish a set of representative modules or pre-assemblies without full engineering definition, the project may use preliminary designs and develop dummy Material Take Off's (MTO's). Alternatively, a project can use concepts from other projects that will be utilized in the current project. The detailed configuration of a module or pre-assembly is not the key issue, dimension, mass and composite commodities of construction are the only essential elements in the development of cost data. Mass is predominantly of interest for the load out services and will be linked to a module or pre-assembly commodity group. There are a number of key questions a fabricator and assembler should be asking and to which their prime interest should be focussed.

1. What are the commodities of construction?
2. What is the quantity of each commodity of construction?
3. What is the elevation at which the commodity of construction is required?

As a point of note, the elevation at which a commodity is installed affects the productivity of in-

ACQUIRING ECONOMIC DATA FROM OFFSHORE FACILITIES

Careful consideration to the psychology of acquiring the economic data is required to ensure the optimum outcome is achieved. The development of the economics should not be interpreted by the facility as a bid process. The closest commercial link to the cost development should be pre-qualification validation of safety, quality, technical and management maturity, cost and schedule performance. The psychology of a bid scenario and an economic enquiry yield differing behaviors and motivations from the recipient facilities. Each facility should at a minimum be informed as to the other countries from which the economic data will be derived. This knowledge should be adequate to set the depth of competitive focus without manifesting a full bid based costing environment which is not the basis for solid economics.

Whenever possible, the facilities should be reimbursed for the time and effort of their estimating resources and production managers that contribute to the development of the cost data. The costs associated with this are minimal and generate a focus and commitment from the facility to complete the required work in a timely manner. To further ensure that the overall economic development is founded on a common base of parity, representatives from the project should sit with the facilities in their offices while the data is being developed. This allows maximum efficiency of the facility resources through direct and immediate access to the project representative.

The facility estimating and production management will generally be conditioned to having a full and final scope of work to price jobs. They require strong support and communication to cement the concept of how the cost data will be used, and, to the level of accuracy required. Facility personnel are not generally familiar with the approach or application of economic costing information.

stallation and the cost of associated equipment. Consequently, this is important to a facility estimator and production manager.

The key items supplied by the project to a facility for the generation of the required cost and productivity data can be generalized as follows.

1. Concept drawings for Module or Pre-Assembly with mass and dimensional

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envelopes, limited internal detail;

2. Materials Take Off by commodity for each Module or Pre-Assembly;
3. A set of base assumption and inclusions for the purpose of cost development on an all inclusive commodity unit of measure basis;
4. Assistance from the Project Team to interpret and develop the cost related information on a common basis of parity with other facilities.

These key items are simple in concept and are practically achievable with a small focused project team. Some attention to the definition of engineering detail and general standards is required, and will be requested by the facility for costing purposes. For instance, a general understanding of the complexity of welded or bolted structural connection and surface preparation and coating standards will be required. In general, most project delivery organisations and some project owners will have typical standards for these areas that can be quickly obtained and used to great advantage for the economic costing purposes. A representation of a typical set of applicable standard engineering detail, (even from past representative projects), including joint detail will help frame the complexity factors for the facility and add to the strength of the underlying cost data obtained. If a project does have special conditions such as seismic, extreme weather requirements etc, it is possible to over stipulate requirements for the purposes of the economic development as long as it is done on a constant basis of parity. Subsequent relaxations in technical specification during more advanced project development will not adversely affect the overall balance of the economic model.

The final consideration when presenting the scope package to the facility is the allocation of the total project quantities. The facility managers will need to frame the total project scope. It is essential that the estimations of the overall project quantities is reflected in a sensible ratio allocation of total numbers of modules and pre-assemblies and site erected quantities. The package presented must reflect the objective of the effort which is to develop data on the full spectrum of commodities of construction based cost data that is valid for direct extrapolation to project quantities with greater refinement in scope and engineering detail.

FACILITY REQUIREMENTS

The facilities must be able to interpret the representative package on a basis of clear understanding of the purpose of the data, underpinning assumptions and the required inclusions in the price information such as management, equipment, etc. The project must ensure this basis of cost data collection from multiple facilities in many different country and regional locations is comprehensively established on a basis of equivalence and parity. To ensure this parity, it is not unreasonable to expect that there will be a requirement from the project to place representatives within the facilities during the development of the cost data. This will facilitate a smoother more accurate approach to the task by facility estimating and production management.

The primary areas of economic interest provided by the facilities are as follows, noting that modules and pre-assemblies are also categorized on a commodity basis by size and mass range at a Unit Of Measure (UOM) commodity base level.

1. Materials Costs by Commodity UOM;
2. Detail Shop Drawing by Commodity Group;
3. Fabrication Cost by Commodity UOM;
4. Assembly Cost by Commodity UOM;
5. Trial Assembly Cost by Commodity UOM;
6. Load Out Cost by Commodity UOM.

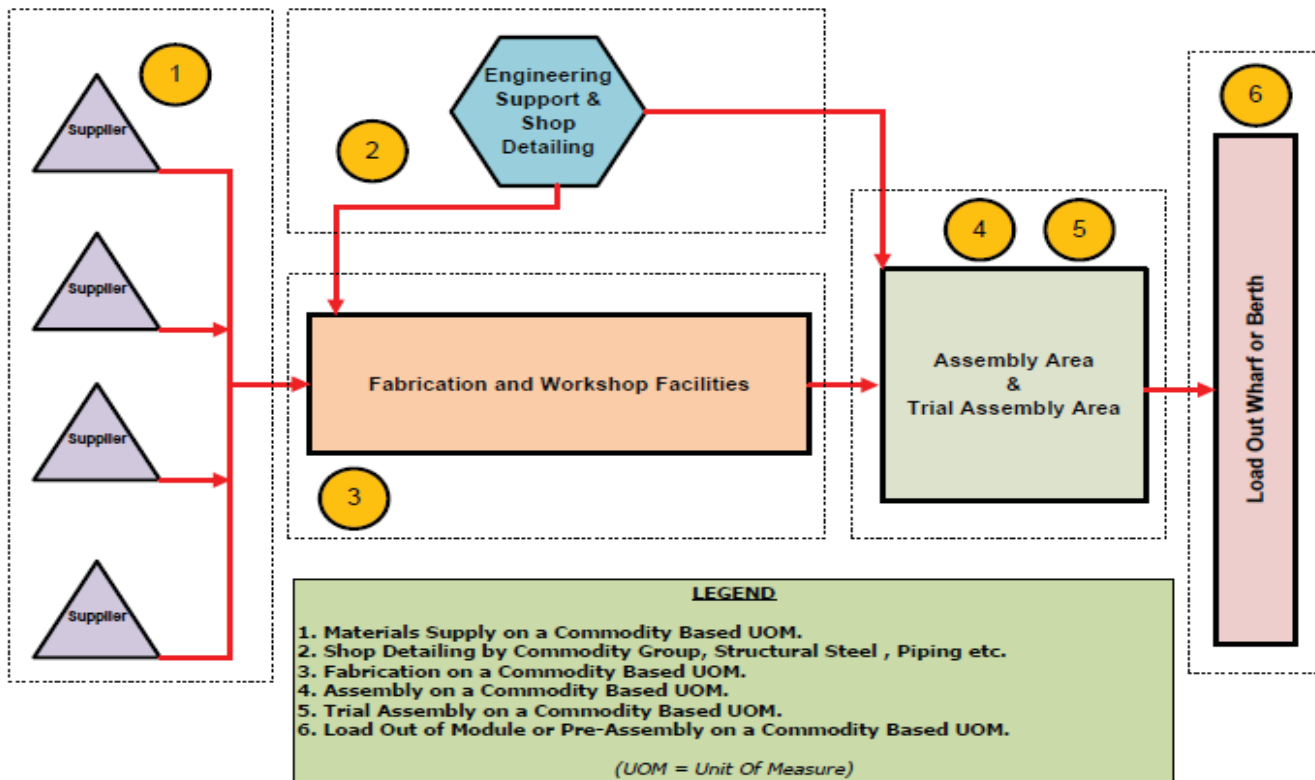
SHIPPING STEEL

It should be noted that additional steel for a modular or pre-assembly delivered project is not a special commodity. All bracing, grillage, support or transport related steel will be covered by an existing project construction material commodity codes. The **ESSENTIAL** point of note, is that the associated quantities related to the additional shipping and transport steel for a modular or pre-assembly delivery must be included in the allocated quantities for the economic model and, **most importantly**, in the overall project quantities.

All costs must be developed on a commodities basis, at a UOM level as per the categories above. The key areas are further illustrated in the diagram on the following page. The only variation

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Commodity Based Economic Cost Development Package Division of Pricing Areas in Recipient Facilities



being detailed shop drawing which suits commodity grouping such as structural or piping isometrics rather than individual commodity based costing. Modules and pre-assemblies are also categorized on a commodity basis by UOM in bracketed categories reflecting dimension and mass ranges.

It is also important to understand that cost development at the fundamental unit of measure level in offshore facilities must include all corporate overhead, management, facility plant and equipment and third party costs associated with the level of value adding steps identified above. This concept of all inclusive costing on a commodities basis must be carefully and fully defined and explained to the facilities to ensure that a solid and valid cost basis for extended extrapolation into total project quantities is established. The economic costing inquiry document should always include a comprehensive checklist of requirements, allowances, inclusion etc for each of the key cost

“The method of averaging economic cost data at a country and regional basis provides a project with a strong economic analysis platform without surrendering commercial impartiality.”

categories to ensure all inclusive costs are developed.

The selection of facilities for early project economics development should generally be restricted to higher tier fabrication and assembly facilities with dedicated load out facilities and a high level of corporate and operational maturity. This approach ensures that robust, even conservative economic platforms are established. It is beneficial and prudent to base project economic decisions on some level of confidence that safety, quality and the facilities operational systems and equipment will meet project expectations and standards. It is possible in latter project development to seek the maximum value via costs derived from less mature and operationally advanced facilities in low cost high productivity offshore country and regional locations. It should be noted that it is unusual that lower tier fabrication and assembly facilities will have in house facilities for load out requirements such as berths, wharves or transport and handling equipment. The fact that these lower tier facilities are less operationally mature will require considerable assistance and validation by the project team to ensure solid economic foundations are established.

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A point of note, if a facility does not have direct unobstructed access to a load out berth or wharf, the associated risks of using the facility is increased as a direct result of the requirement for the external interface outside the direct control of the project.

APPLICATION OF ECONOMIC DATA

Economic cost data can be collected from multiple country locations and multiple fabrication and assembly facilities from within a country. The cost and productivity data can be used in a variety of ways as follows;

1. Individual facility based economic models;
2. Country averaged economic models;
3. Regionally averaged economic models,

Each of the modeling methods identified will have differing applicability on a project specific basis to the overall economic model of a specific project. Careful consideration of the applicable model is important to ensure the overall project economic model is robust enough to satisfy due diligence in the decision making process for the selection of project delivery method.

The method of averaging economic cost data at a country and regional basis provides a project with a strong and conservatively robust economic analysis platform, without surrendering commercial impartiality or pre-supposing commercial strategies. This is a very desirable characteristic with respect to due diligence of establishing the economic basis of a project. This is exceptionally important in the early development phases of a project when it is essential to develop the value of an overall modular or pre-assembly delivery methodology without prematurely linking an evaluation model to a particular location which subsequently locks the project to specific facilities and strategies and limits execution options.

As the project develops and crystallizes procurement, logistics and commercial strategies, the refinement of the regional and country locations for fabrication and assembly can be undertaken. To ensure that the project establishes an execution strategy with the most value, the regional, country and specific facilities can be "cherry picked" to provide an execution solution with a balanced cost and risk profile that encompasses procurement and logistics considerations.

When the economic models related to modular

and pre-assembly viability forecast a positive value for the delivery method, commercial enquiries and discussions can be initiated with specific facilities to refine and develop complete overall cost estimates for the defined scope and quantities established in latter phases of project development. Given the initial economic cost information is developed on a unit of measure commodity basis, it is not unreasonable or ill advised to pursue this basis as the central model for commercial execution strategies. This approach has great flexibility for quantity scope changes during project execution. Specific cost data built and validated from formal commercial bid enquiries, not economic models, should be used to establish final project cost estimates that will be used for project control purposes during project execution.

CONCLUDING COMMENTS

The selection of a modular or pre-assembly delivery strategy is a major decision and needs to be underpinned by due diligence related to the economic and risk factors associated with the delivery. The economic platform for offshore fabrication and assembly is a central component of the overall modular or pre-assembly delivery economics. However, it is only one component of the overall economic validation process. Further discussion on the complete modular or pre-assembly delivery economic model cost development is discussed in the paper by the author, Modularization And Pre-Assembly Paper #5 -Development Of Economic Model Costs.

The cost information established for the offshore fabrication and assembly must be consistently represented and derived in a currency that is uniformly applied throughout the project economic development. Fluctuations in the exchange markets will always have an impact on the final estimate of total installed cost but there are methods to minimise their impact on a project. As such, the economic model must be a snapshot for the purposes of establishing project execution viability on a cost basis with a validity period that does not stretch in general more than a half a year without review and confirmed re-validation. If the base currency of the economic model is chosen wisely, the core cost balances should survive general currency fluctuation impacts if the momentum in project development is sustained without extended delay between development phases.

The final project total installed cost estimate should always be based on formal commercial bid response data and the commercial strategy should

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always reflect the project delivery strategy.

As a final concluding note, the importance of the decision on a project strategy of modular, pre-assembly or traditional site erection methods is significant for any project. A position of sensible conservatism is a strong platform for the underpinning economic decision making tools and models in the early phases of project development. Shareholder and corporate value is fundamentally at stake and the basis of a project decision of this magnitude should be founded on robust assumptions absent from blue sky forecast or speculation. The results of robust economic analysis should provide project owners and developers with strong confidences to adopt modular or pre-assembly delivery strategies. After this key decision is finalized, there should be no further reflection on alternative execution delivery strategies. 