



Modular Fabrication in the Resources Sector in Western Australia: Current Practices and Strategies for Improvement



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**Report for the Department of Commerce and the
Industry Capability Network**

**Report prepared by Dr. Martin West
November 2011**

Executive Summary

The resources industry in Western Australia (WA) is going through a significant boom period with an estimated \$180b of projects currently being undertaken or in the planning stages. These projects provide substantial opportunity for involvement of WA industries and services.

The Department of Commerce, together with the Industry Capability Network of Western Australia commissioned this study to identify the gaps in Western Australian industry to construct integrated modules and to develop strategies to improve the success rate of WA companies tendering for the fabrication of modules.

The project has been largely undertaken through face-to-face interviews with a range of senior representatives of various resource and fabrication companies in WA.

Advantages and Disadvantages of Modularisation

The respondents indicated that there are a number of advantages and disadvantages related to a modular construction approach

Advantages of modularisation include:

- Cost Reduction
- Schedule Improvement
- Improved Risk Management

The disadvantages associated with modularisation include:

- Higher costs in steel resulting from a module frame
- Increased cost of shipping
- Increased cost of engineering.
- Increased in complexity of management oversight and material tracking.
- Increased off site engineering supervision.
- Potential variability in quality depending on where the modules are manufactured.
- Increased cost of installation.

Success Factors for Modular Construction

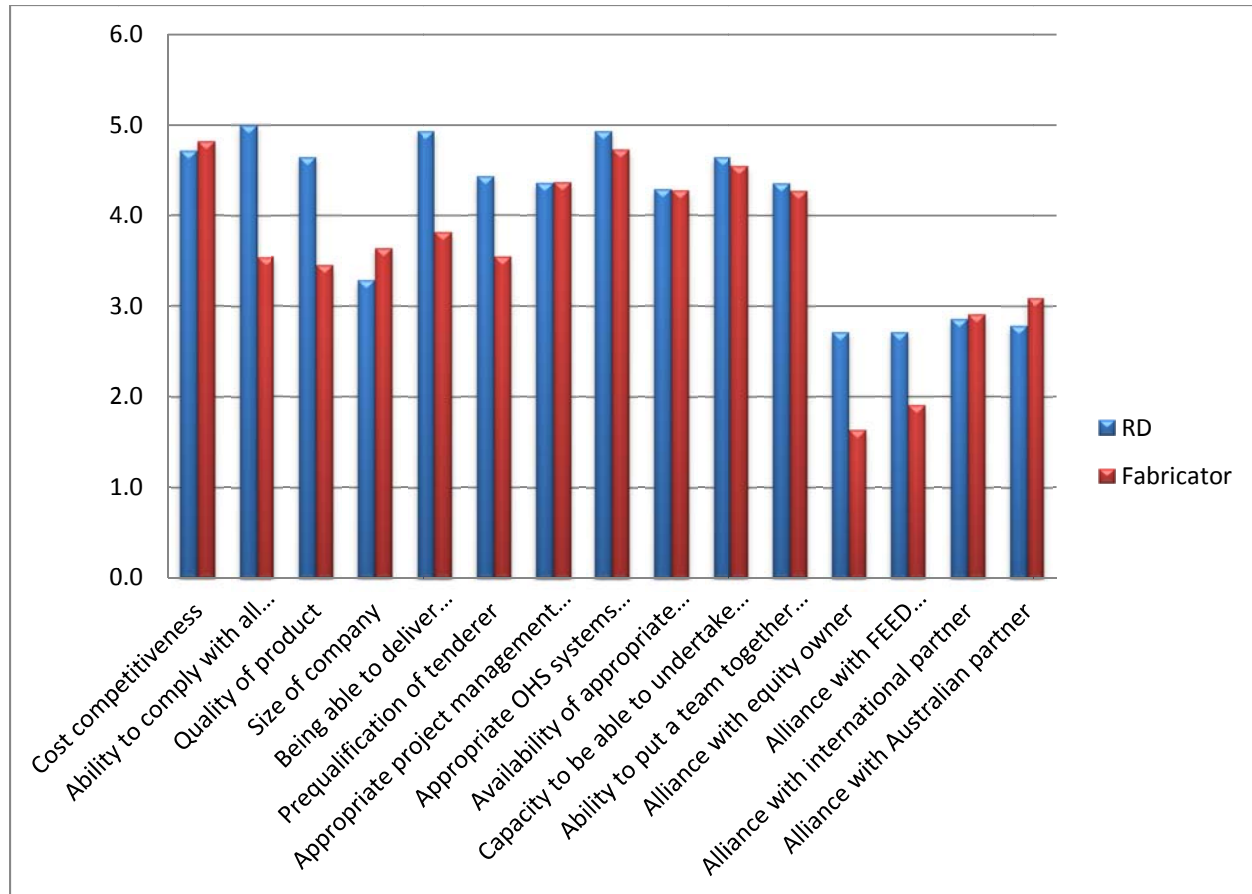
It is generally accepted that there are a range of factors affecting the success rate in tendering for fabrication of modules. An analysis of these factors has been undertaken through qualitative and quantitative questionnaires and interviews

The analysis differentiates between two categories of stakeholders, “resource developers” and “fabricators”. Resource developers include resource owners, EPC and EPCM companies and consultants (14 responses were included in this category). These are abbreviated as “RD’s”. “Fabricators” include all respondents who are involved in the fabrication industry (12 responses).

Respondents were asked to rate the factors in importance, ranging from 5 (very important) to 1 (not important).

The figure below shows the results. It differentiates between the responses of the resource developers and fabricators.

Success factors for Modular Construction.



The figure shows that although both RD's and fabricators are of the opinion that cost competitiveness is important for success, there are some significant differences in some of the important factors. The fabricators perceive the ability to comply with all technical specification, quality, and being able to deliver on time, as much less important as RD's view these factors. This is surprising, as apart from cost competitiveness, these factors are crucial for success in modular construction.

The factors impacting on success in tendering have also been discussed during the interviews. RD's have emphasised that the key drivers of all projects are cost, schedule, quality and HSE. Costs clearly determine the financial feasibility of a project; schedule impacts on the financial viability, as the longer the schedule the less viable and quality and HSE are vital for project execution.

Although alliance with an offshore equity partner is generally not seen as an important factor, some examples have been provided where an offshore equity partner directed the modular construction to be undertaken offshore. (particularly in the iron ore

industry). Although this is not common practice, where this happens, it impacts on the opportunity to compete by local industry.

Similarly, some reservations have been expressed concerning the offshore allocation of FEED as FEED engineers often tend to use suppliers or contractors for advice and basis for specifications which are near to them. In addition, an international FEED company may be less aware of the local vendor (WA) capabilities. It also makes it harder to engage with the FEED procurement group.

Other factors which impact on the success of tendering for modules are:

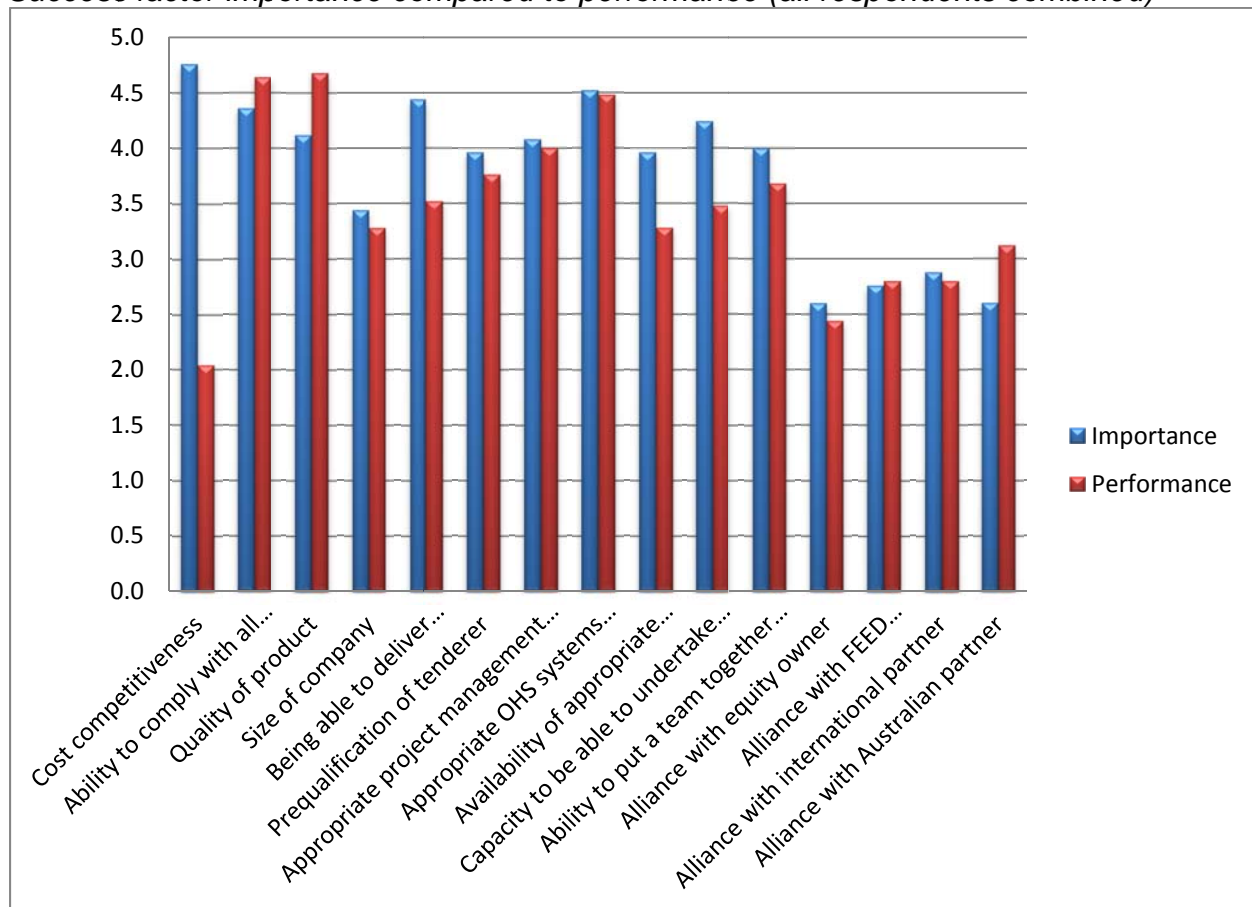
- Preferred supplier arrangements
- Vertical integration
- Government Policies
- Appropriate Infrastructure

Western Australia Performance

Following the identification of factors which are considered to be important for success in modular construction, the next step was to obtain an assessment of WA performance against the success criteria. The respondents were asked to rate WA performance on a scale of 1-5 against the fifteen criteria identified previously. The results are discussed below.

The figure below shows for all respondents (RD's and fabricators combined) a comparison of importance of success factors with perceived WA performance. There is a stark difference between importance of cost competitiveness and perceived performance; implying both RD's and fabricators are of the opinion that WA industry struggles to be cost competitive. There is also a significant difference between the importance related to the ability to deliver on time and perception of actual performance. Both of these factors are important drivers for success and on both WA is not doing very well. Given this assessment it is no surprise that a large proportion of modules are being fabricated offshore.

Success factor importance compared to performance (all respondents combined)



Success in Tendering

Experience during the past few years has shown that Australian fabricators have been somewhat reluctant to tender and when they did so they were not as successful as they would have wanted to be. Both these issues were explored using the questionnaires and during the interviews.

Some of the reasons given for not actively tendering included: lack of confidence, not being able to meet all the technical specifications, not being able to deliver within the required time frame, not large enough and realizing that they would not be cost competitive. These reasons correlate with the figures provided previously comparing actual performance with what is important for project success.

In exploring why Australian fabricators have not been successful, the most mentioned factor is cost competitiveness. It is clear that Australian labor rates are much higher compared with South East Asian Countries and even taking into consideration skill and productivity level differences the gap is still significant. Some respondents quoted trade labor rates in Thailand of \$40 per hour compared to \$180 per hour in remote locations in WA. Other respondents quoted welder rates offshore of \$200 per month compared with \$1800 per month in fabrication workshop and \$2500 per month on site.

Even highly skilled engineering rates are considered to be expensive. As one respondent put it:

“Over the last four years Australia has become the most expensive country to get engineering done with salaries and exchange rate too high. USA and Canada are now cheaper to do engineering.”

Not only are labour rates seen as high but other material input costs are also considered expensive. Some respondents quoted that steel in WA is around \$1300 per tonne while \$900 pt in Japan and substantially less in Korea and China. A number of respondents indicated that the costs to fabricate certain modules in Australia compared to other international countries could be 40-60% higher. Some respondents indicated:

“We wanted to do the module in WA but the costs were 40% cheaper overseas.”

“Our preference is to do modular construction in a stable first world country but labour and other costs are just too high.”

“We could get the module manufactured offshore for the same price as steel in WA.”

Industrial action, rigidity of the labor market and militancy of unions were also mentioned as an important factor in WA not being successful. Some RD's have specific strategies to move as much work offshore as possible so that they do not have to deal with unions. As one respondent put it:

“Current operator contract strategies minimize Australian participation where strong union involvement has historically delayed and increased project costs.”

International Comparison of WA Competitiveness

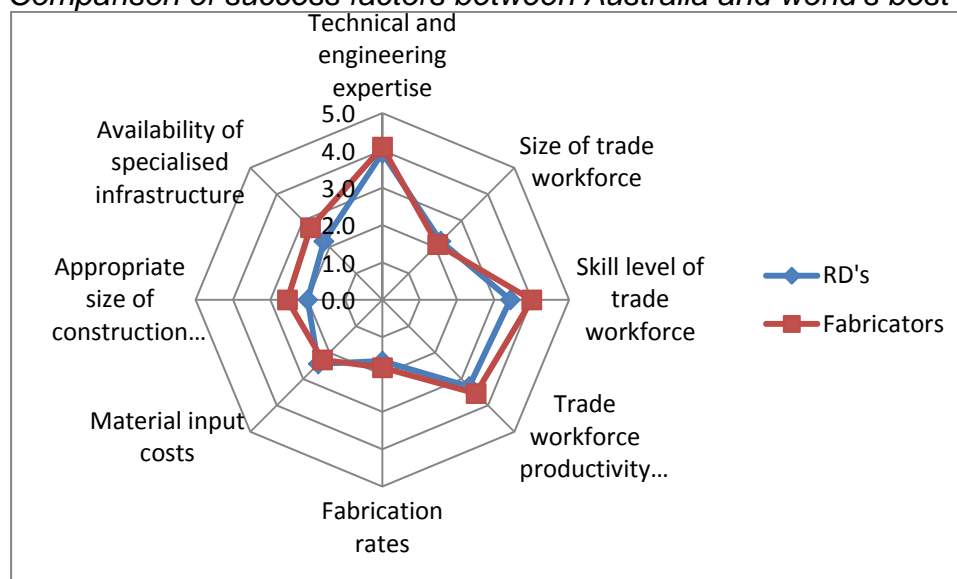
To gain a further understanding of the competitiveness of the WA industry, respondents were asked to compare Australia / WA with “world's best internationally.”

The respondents were requested to rate a number of key factors. These are:

- | | |
|---|---|
| • Technical and engineering expertise | • Size of trade workforce |
| • Skill level of trade workforce | • Trade workforce productivity (approximate manpower estimates) |
| • Fabrication rates | • Material input costs |
| • Appropriate size of construction facility | • Availability of specialised infrastructure |

Respondents were asked to rate each factor on a scale of 1 to 5, with 5 if Australia is equal to world's best and 1 if Australia is least comparable to international best practices. The results, differentiating between RD's and fabricators, are shown in the figure below.

Comparison of success factors between Australia and world's best



The figure shows that both RD's and fabricators believe that Australia compares reasonably favourably with world's best in technical and engineering expertise and skill level of trade workforce and to a lesser degree with trade workforce productivity. Australia compares less favourably in fabrication rates, material input costs, size of workforce, appropriate size of construction facilities and availability of specialised infrastructure.

Strategies for Improving Modular Construction Success

This section recommends strategies which could be considered to improve the success in modular construction for WA. It takes into consideration industry dynamics, realities of international, national and WA resources and infrastructure and differences in roles between the public and private sector.

The recommendations are summarised below.

RECOMMENDATION 1:

That government (both state and national) review the various policy settings which impact on modular construction. (This should include investigating the feasibility of a comprehensive industry strategy; assessment of the effectiveness and impact of the EPBS and AIP; special visas to work in zones for modular construction; feasibility of implementing vendor management programs; feasibility of government equity ownership in some resource projects).

RECOMMENDATION 2:

That government develops a mechanism for early intervention in the planning process before decisions are finalized regarding the location of module fabrication.

RECOMMENDATION 3:

That industry focuses on developing capabilities which would support the fabrication of smaller and higher value added and time sensitive modules.

RECOMMENDATION 4:

That government ensures the appropriate identification, reservation and development of key high wide load corridors.

RECOMMENDATION 5:

That the ICN extends its involvement in the resources sector by developing a database of all potential tender opportunities as well as capabilities of the local industry.

RECOMMENDATION 6:

That the Government investigates the feasibility of introducing a financial guarantee scheme for fabricators, similar to EFIC.

RECOMMENDATION 7:

That Industry and Government take the initiative in facilitating the development of effective alliances to support the resources industry.

RECOMMENDATION 8:

That industry and government considers appropriate industry development and communication programs which could improve communication and perceptions within the industry.

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Abbreviations

AIP	Australian Industry Participation Plan
EPBS	Enhanced Project By-Law Scheme
EPC	Engineering, procurement and Construction
EPCM	Engineering, procurement and construction management
FEED	Front end engineering and design
HSE	Health, safety and environment
HWLC	High wide load corridors
OHS	Occupational health and safety
PAR	Pre-assembled racks
PAU	Pre-assembled units
RD	Resource Developers
WA	Western Australia

1. Introduction

The resources industry in Western Australia (WA) is going through a significant boom period with an estimated \$180b of projects currently being undertaken or in the planning stages. These projects provide substantial opportunity for involvement of WA industries and services.

The use of modular offsite construction for resource projects is increasing in Western Australia. The contract size and construction complexity of some module packages has escalated to the point where potentially, no Australian/Western Australian module construction companies have expressed interest in undertaking these packages. In addition, the engineering design for these projects is being increasingly undertaken by overseas competitors, which is potentially leading to a loss in opportunities and skills for local organisations.

Given the increasing trend in complexity, the Department of Commerce, together with the Industry Capability Network of Western Australia commissioned this study to identify the gaps in Western Australian industry to construct integrated modules and to develop strategies to improve the success rate of WA companies tendering for the fabrication of modules.

Purpose

The main aim of the report is to identify the gaps in Western Australian industry to construct integrated modules. In particular this project focuses on Pre Assembled Racks (PAR) and Pre Assembled Units (PAU) (See section two for definitions).

The report covers the following components:–

- Examine why major Western Australian and Australian companies are declining to express their interest on major modular PAU and PAR packages;
- Identify barriers to entry in major global supply chains with particular reference to the major chemical, petroleum and mining projects;
- Identify the consequences of offshore engineering design and the ability of local companies to participate in major chemical and petroleum projects;
- Research and identify the gaps between Australian/Western Australian and offshore module construction facilities;
- Identify what can bring about potential consortia building between offshore and Australian/Western Australian module contractors to undertake some module construction in Australia including possible roles by Commonwealth and State governments;

Project Approach

The project has been largely undertaken through face-to-face interviews with a range of senior representatives of various resource and fabrication companies in WA.

These interviews were supplemented with formal structured questionnaires, which were finalised mostly during the interviews. Where it was not possible to undertake face-to-face interviews, these questionnaires were completed by telephone.

Different questionnaires were developed to focus on different issues related to resource owners, EPCM's, successful fabrication companies and unsuccessful fabrication companies and consultants. Copies of questionnaires are provided in Appendix A.

Representatives of the following companies have been interviewed or completed questionnaires:

Pacific Industries	Hertel Modern
BHP Billiton	Monadelphous Group
Rio Tinto	Leighton Contractors
AMC	Laing o Rourke
Chevron	John Holland
AGC	United Group Resources
Bossong Engineering	Park / Freemantle Steel
Woodside	SKM
Technip Oceania	Burrup Fertiliser
CBI	Fluor
Hatch	JP Kenny
Aibel	Apache Energy

Structure of Report

The structure of the report is as follows:

- Section one provides an introduction to the report.
- Section two provides background on modular construction.
- Section three identifies the factors which are considered to be important for success in modular construction.
- Section four is where the current WA performance is assessed
- Section five proposes some strategies to improve current performances.

2. Background on Modularisation

This section provides an overview of the various issues related to modular construction. It starts by defining terminology which is used in this report and is then followed by a discussion of the advantages and disadvantages associated with modular construction.

Definition of Terms

Conventional or stick build construction

“Stick build” is the conventional or traditional way of construction whereby the various components are transported to a site and then put together into a final product. Conventional or "stick built" construction strategies are time-honoured: the engineering, procurement and construction are done in a logical, consecutive fashion, with some parts completed in parallel and some consecutively. The goal being, to carry out the project as expediently and cost-effectively as possible.

Equipment and materials are procured from worldwide suppliers and are delivered to the site. At the site, roads are paved, foundations are poured, equipment is set, piping is erected and electrical wiring is completed. All of this is according to the drawings, specifications and standards developed during the detailed engineering phase of the project. (Tatum, 1987)

Modularisation

Modularisation refers to the pre-fabrication and pre-assembly of a complete system away from the job site which is then transported to the site.

Modularisation can be done in components as site-specific needs dictate. For example; prefabrication, preassemblies or packaged / skidded components all fall under the umbrella of modularisation. All of these can help a project owner overcome factors which may present technical or economic obstacles to traditional construction approaches.

There are generally various levels of modular construction. They can vary from stick build (no modularisation) to very large modules. The following provides a continuum of construction possibilities:

1. Conventional stick build construction
2. Pre assembly on site: pancake / small modules (< 10t)
3. Pre assembly at site: medium modules (10-50t)
4. Pre assembly at site: large modules (>50t)
5. Truckable - small to medium modules (<50t with road legal dimensions)
6. Truckable - medium modules (<50 with oversize dimensions)
7. Non truckable - modules (100-500t)
8. Non truckable - large module (500-1000t)
9. Non truckable - very large modules (1000-4000t)
10. Mega modules (>4000t)

Module

A module is a unit mounted on structural frame. This frame is often without full upper structural frame and can contain equipment, piping system, heat tracing, electrical and instrumentation systems, tubing, specialized coating, insulation, fire protection, ladders, or stairs and platforms etc.

Modules can be horizontal, vertical, single level or multi level. Different types of modules are referred to as Pre-assembled units (or modules) PAU (or PAM) or Pre-assembled racks (PAR). Images below provide examples of modules and PAU and PAR

Figure 1 - Example of a Pre-Assembled Rack (PAR)



Pre-Fabrication

Pre fabrication is generally a manufacturing process taking place at a specialised facility in which various materials are joined to form a component part of a larger item. Any component that is manufactured off site and is not a complete system can be considered to be pre fabricated.

Pre-Assembly

Pre assembly is a process where various materials, pre-fabricated components and equipment (such as pre-insulated devices, control stations, junction boxes and control panels) are joined together at a remote location for subsequent installation as a unit.

Pre assembly is generally completed at the job site which is in a location other than the final place of installation. Pre assembly can be a combination of pre fabrication and modularisation (Tatum, 1987)

Figure 2 - Example of a module



Figure 3 - Example of a mega module (Woodside train 5 module)



Figure 4 - Typical fabrication yard (Malaysia)



Advantages and Disadvantages of Modularisation

A modular approach to fabrication and construction is becoming increasingly popular. This is because there are a number of advantages using this approach. There are also disadvantages and both of these are discussed below.

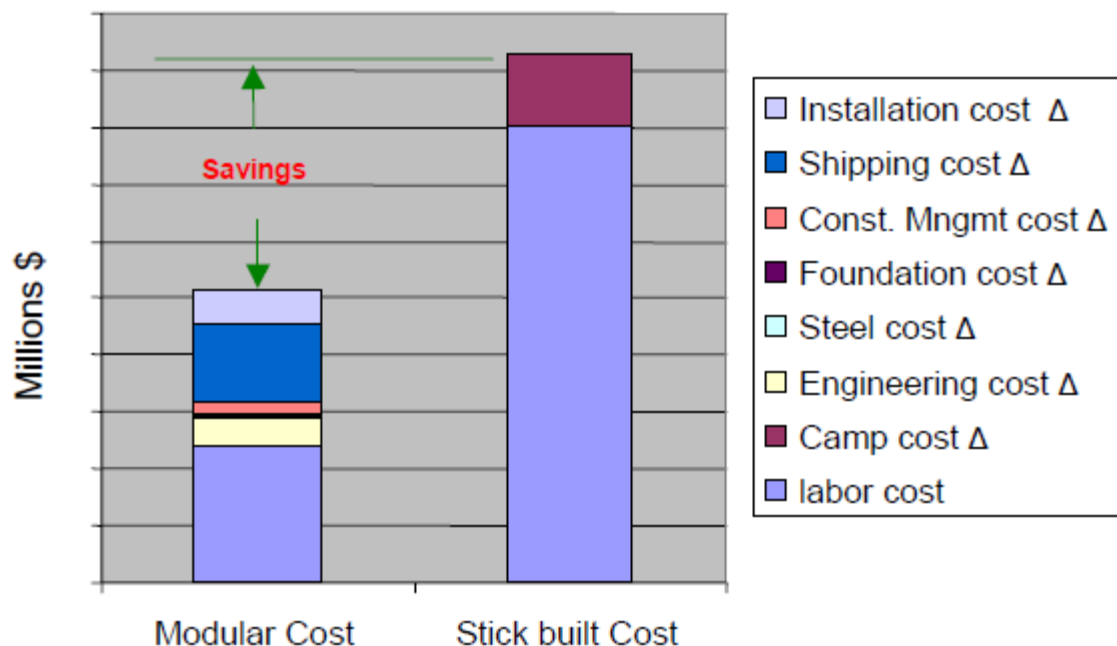
Advantages of Modularisation

Cost Reduction

Modularisation can potentially have a substantially positive impact on the economics and financial viability of a project. This is because it provides the opportunity to implement a range of cost saving measures. These measures include accessing a greater global pool of module construction yards, reduced on site labour leading to a reduction in indirect costs such as employee transportation costs, camp accommodation costs, consumables etc.

The figure below provides an indicative cost comparison between modular and stick building approaches. This is only indicative and will vary from project to project.

Figure 5 - Cost comparison between modular construction and stick build



An indicative labour economic comparison using stick build, modular construction within country and modular construction using international fabrication yards is provided below:

Table 1 - Indicative Economic Productivity Comparison

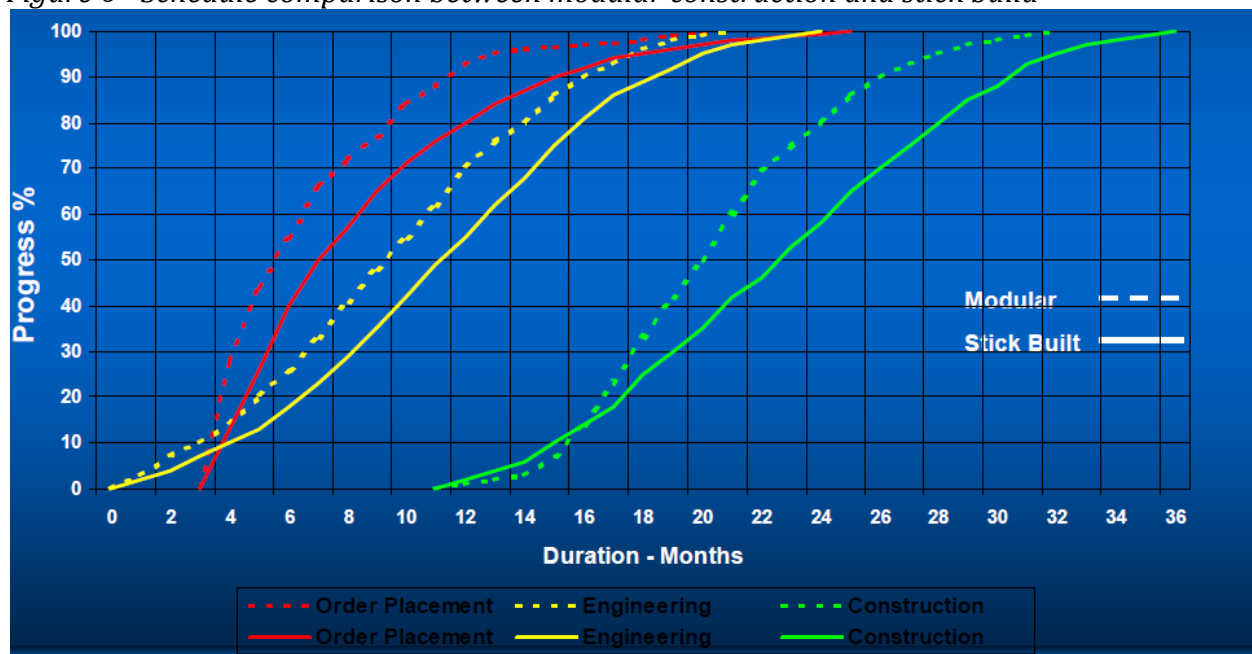
	On-site Stick Built	Modular in Country	Modular International
Labour Productivity	1.70	1.2	3.5
Composite Man-hour Cost	\$105	\$55	\$12.10
Relative Man-hour Costs	\$178.50	\$66.00	\$42.35
Economic Productivity Ratio	4.21	1.56	1

(Source: Foster Wheeler)

Schedule Improvement

One of the acknowledged advantages of modular construction is potential improvements in schedule due to a range of factors including: the ability to undertake concurrent fabrication of modules, ability to construct at a dedicated fabrication yard with associated infrastructure, removing of construction away from environmental and climate constraints such as poor weather conditions. An example of a comparison between modular and stick – build in terms of procurement, engineering and construction is provided below.

Figure 6 - Schedule comparison between modular construction and stick build



(Source: Foster Wheeler)

Risk Management

Modular construction provides various risk management opportunities. These include reduction in on-site man hours thereby reducing HSE risk and the reduction of environmental risk by reducing activities and foot print on sensitive sites. It also means minimising manufacturing risks by fabricating modules in a controlled workshop environment, it minimises potential impact of unavailability of skilled labour on site and reduces the potential of weather related delays and issues with construction window.

Disadvantages of Modularisation

The disadvantages associated with modularisation include:

- Higher costs in steel resulting from a module frame that is designed to contain the module and to protect during transportation (steel cost can be 5% more).
- Increased cost of shipping because modules are significantly larger than individual components and requires either a special ship or dedicated cargo areas.
- Increased cost of engineering due to additional engineering required to design modules which would not be required on stick built construction methods.
- Increased in complexity of management oversight and material tracking requiring additional manpower.
- Increased off site engineering supervision.
- Potential variability in quality depending on where the modules are manufactured.
- Increased cost of installation.

Modular Construction Decision Making Process

Deciding which construction method should be used is more often than not an involved and complicated process taking a range of factors into consideration. At times project dynamics dictate that one method is more desirable than another. For instance in areas where there are substantial environmental constraints (such as Barrow island) stick build is not appropriate. Where severe weather conditions exist, modular construction away from the constraints will be preferred. At other times where shipping and transportation options are limited, stick building can be advantageous.

At times where neither construction method has a clear cut advantage, it is prudent to undertake a careful analysis of the options before a final decision is made. The diagram in Appendix B provides an example of a decision analysis.

3. Success Factors for Modular Construction

It is generally accepted that there are a range of factors affecting the success rate in tendering for fabrication of modules. The focus of this section is to identify these factors and to assess which factors are more important than others. This has been undertaken through qualitative and quantitative analysis of questionnaires and interviews, where appropriate external data has also been used as part of the analysis.

To provide additional insights the analysis differentiates between two categories of stakeholders, “resource developers” and “fabricators”. Resource developers include resource owners, EPC and EPCM companies and consultants (14 responses were included in this category). These are abbreviated as “RD’s” in the remainder of the report. “Fabricators” include all respondents who are involved in the fabrication industry (12 responses).

The focus of the section is on identifying factors impacting on modular construction which can be influenced by industry or government. As such external factors such as exchange rates are not considered, even though they substantially impact on costs and financial viability of projects.

The initial literature review and discussions with stakeholders indicated a range of factors which influence the success rate of companies tendering for modular projects. These have been collated and reduced to fifteen different factors and included in the questionnaire. Respondents were asked to rate the factors in importance, ranging from 5 (very important) to 1 (not important). These factors are:

- Cost Competitiveness
- Quality of product
- Being able to deliver within specified time frames
- Appropriate project management and risk processes and expertise
- Availability of appropriate infrastructure
- Ability to put a team together to undertake all the work
- Alliance with FEED or EPCM contractor
- Alliance with Australian partner
- Ability to comply with all technical project specifications
- Size of company
- Prequalification of tenderer
- Appropriate OHS systems and processes
- Capacity to be able to undertake the required work
- Alliance with equity owner
- Alliance with international partner

Figure 7 shows the combined average rating of each of the 15 factors. It combines the responses of the RD's and fabricators.

Figure 7 - Success Factors for Modular Construction – Average for all Respondents

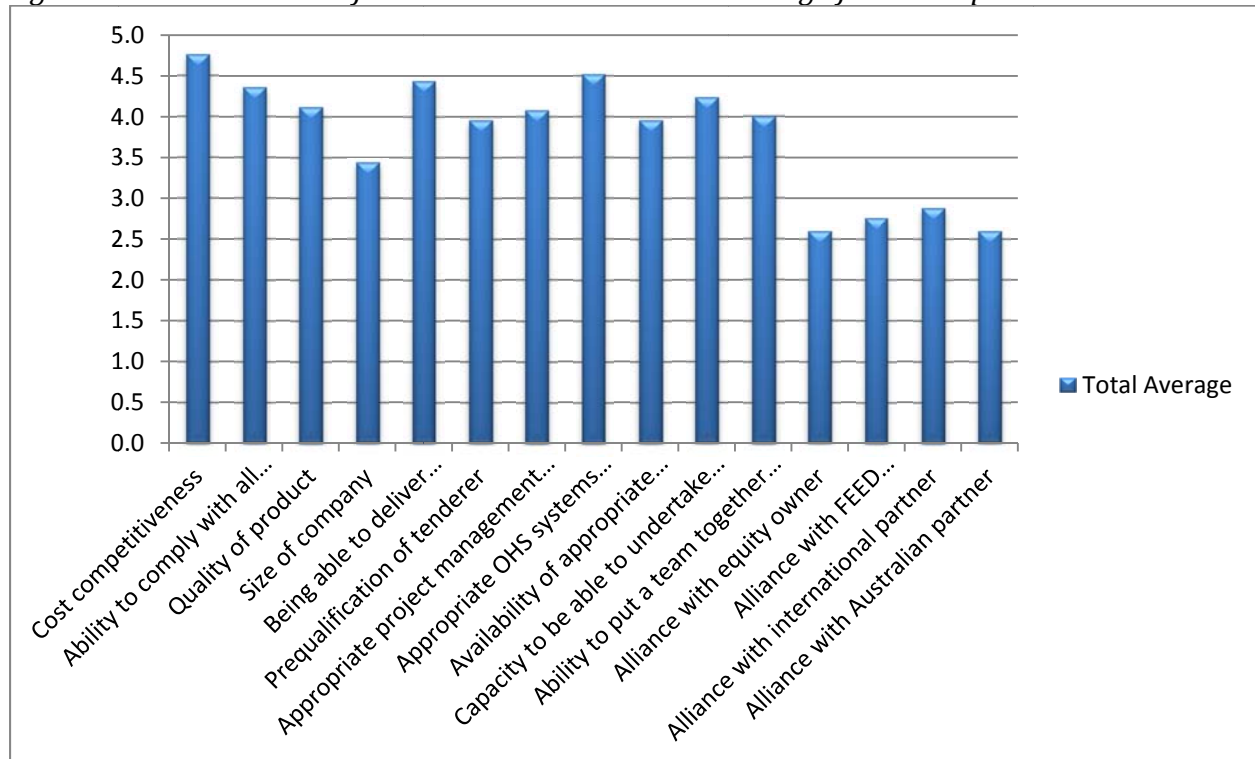
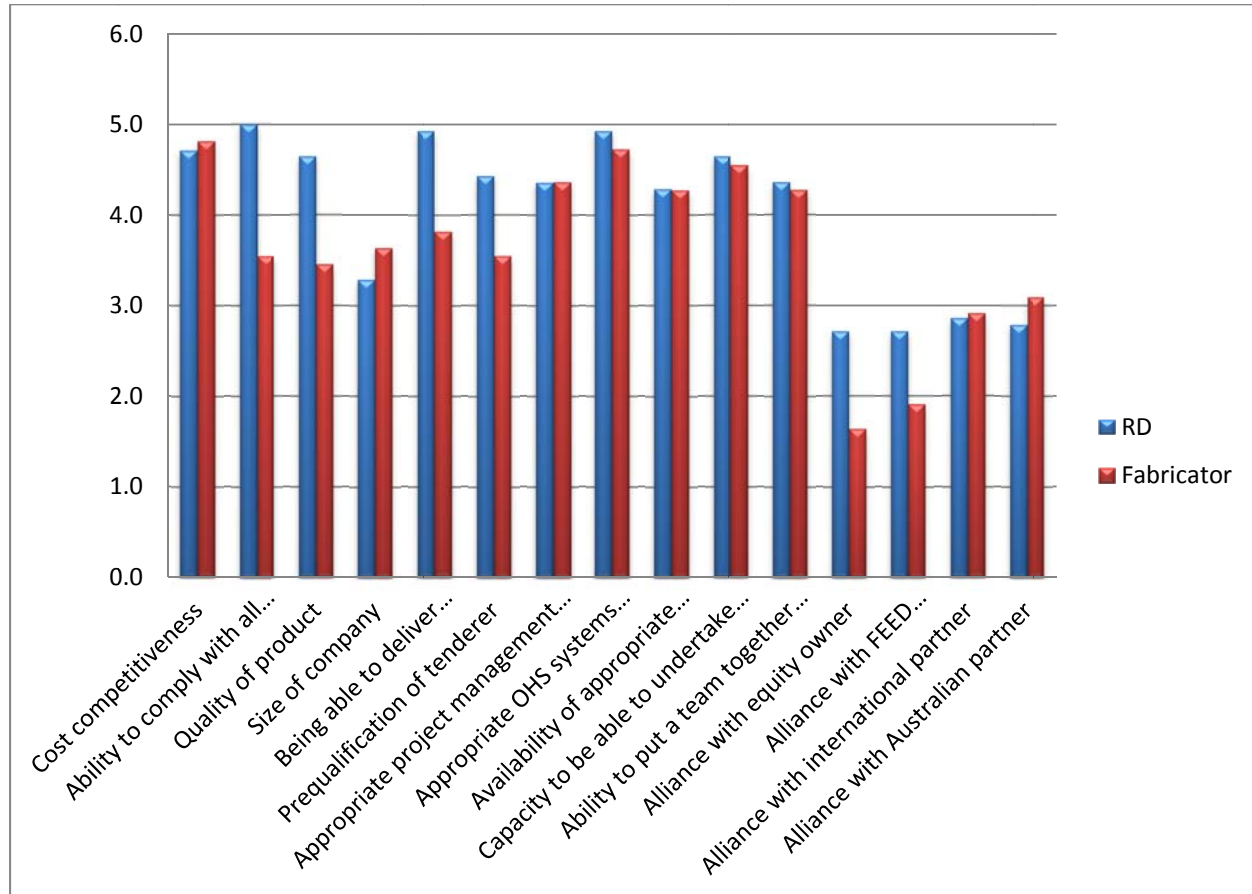


Figure 7 shows that the most important factors are cost competitiveness, ability to deliver within specified time frames, appropriate OHS systems and processes and ability to comply with all the technical requirements of the project. Least important factors are alliance with equity owner, alliance with FEED or EPCM contractor, alliance with international partner or alliance with Australian partner.

Figure 8 differentiates between the responses of the resource developers and fabricators.

Figure 8 - Comparison of average success factors between resource developers and fabricators.



The figure shows that although both RD's and fabricators are of the opinion that cost competitiveness is important for success, there are some significant differences in some of the important factors. The fabricators perceive the ability to comply with all technical specification, quality, and being able to deliver on time, as much less important as RD's view these factors. This is very surprising, as apart from cost competitiveness, these factors are crucial for success in modular construction.

The variability in answers within each of the respondent groups has also been explored and the results are presented in figures 9 and 10.

Figure 9 - Variability in responses by RD's

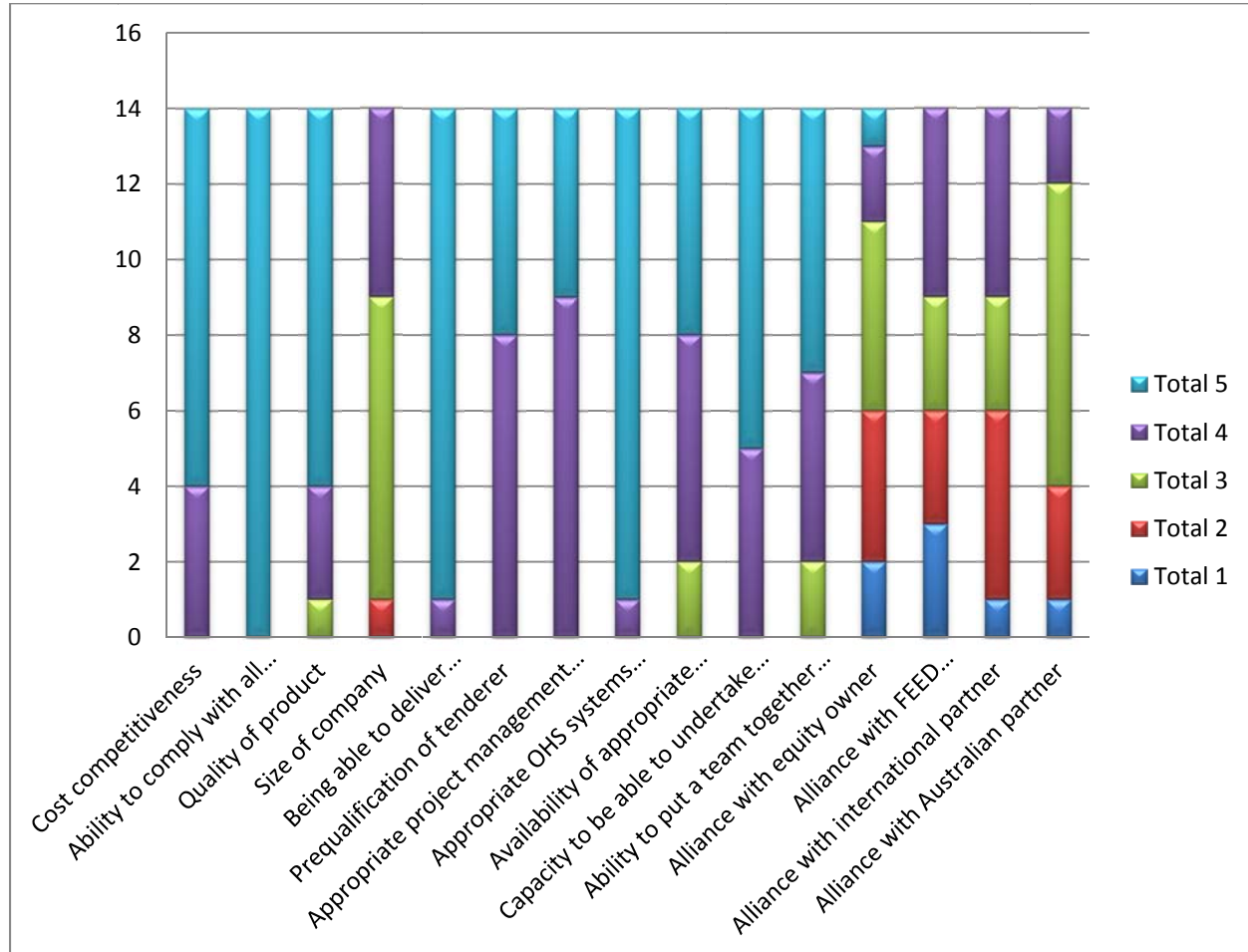
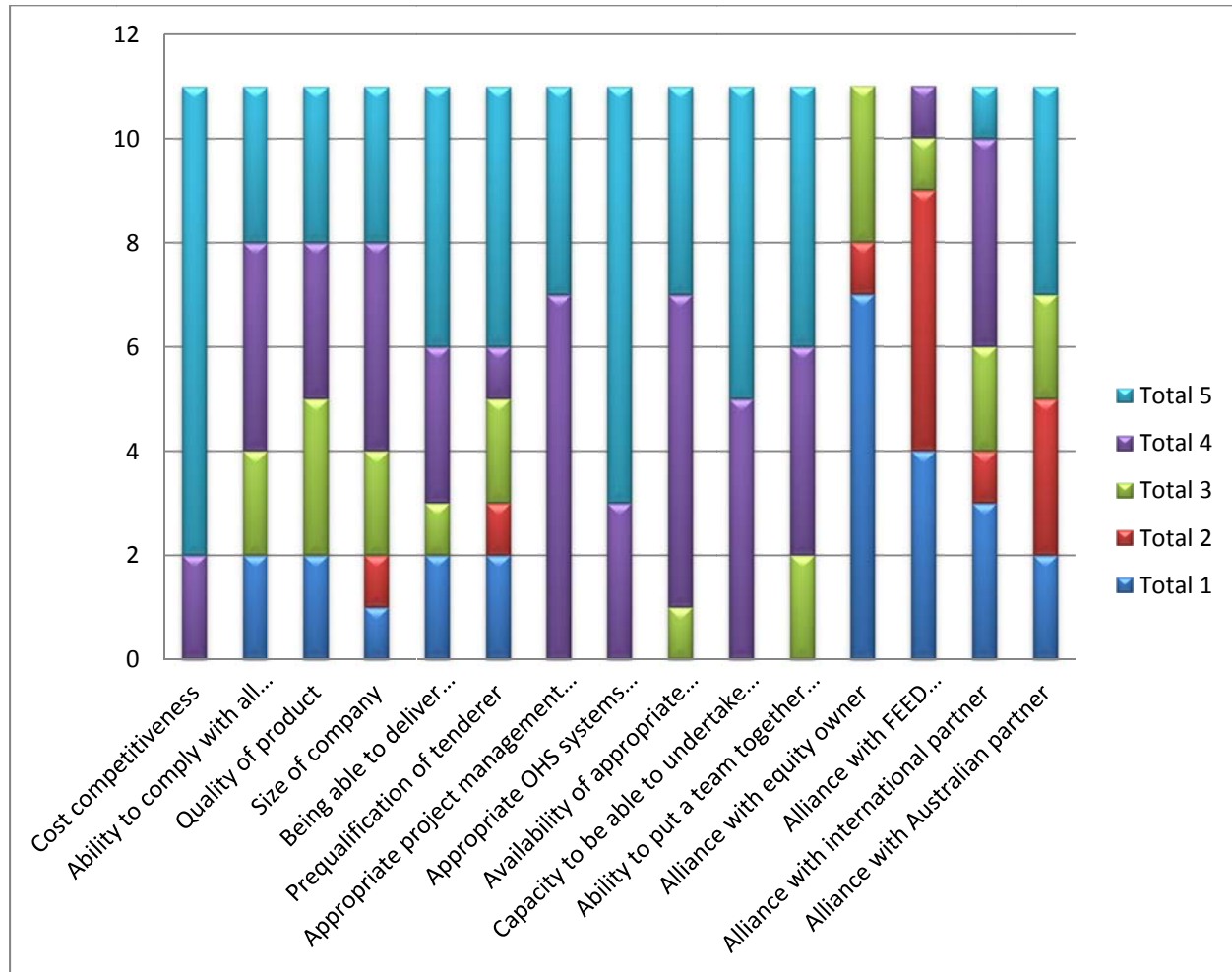


Figure 9 shows that there is not a substantial variability in responses between the various RD's. For instance all resource developers gave "cost competitiveness" either a four or a five and the RD's agree that the ability to comply with technical requirements is very important (5). This implies that there is general consensus amongst resource developers about a number of the issues that are important to succeed in modular construction.

There is a slight variability in some of the factors which are considered to be not so important for success. These include assessing the importance of alliances with equity owner, FEED contractor, international partner or Australian partner. Some RD's indicated that this is important while others implied that these factors are not relevant at all. This can probably be explained by a different focus in various sectors of the resources industry. For instance, in iron ore, alliance with equity owner is important for success in modular construction, whereas this is not as important in the oil and gas sector.

Figure 10 - Variability in responses by fabricators



The figures show substantial more variability with the responses of the fabricators compared to the RD's. Of particular interest is the variability in the quality of the product and ability to comply with all technical requirements. By comparison a number of fabricators indicated that this is not particularly important. Similarly, delivery on time is considered to be of importance by some and not so much by others. This is substantially different to the views of the RD's

The factors impacting on success in tendering have also been discussed during the interviews. RD's have emphasised that the key drivers of all projects are cost, schedule, quality and HSE. Costs clearly determine the financial feasibility of a project; schedule impacts on the financial viability, as the longer the schedule the less viable and quality and HSE is vital for project execution.

Although alliance with an offshore equity partner is generally not seen as an important factor, some examples have been provided where an offshore equity partner directed the modular construction to be undertaken offshore. (particularly in the iron ore industry). Although this is

not common practice, where this happens, it impacts on the opportunity to compete by local industry.

Similarly, some reservations have been expressed concerning the offshore allocation of FEED as FEED engineers often tend to use suppliers or contractors for advice and basis for specifications which are near to them. In addition an international FEED company may be less aware of the local vendor (WA) capabilities. It also makes it harder to engage with the FEED procurement group.

The interviews provided the opportunity to discuss a range of other factors which impact on successful tendering for modular construction. These are discussed below.

Preferred supplier arrangements

A number of RD's has preferred supplier arrangements. These can be somewhat informal to more formalised arrangements such as Frame Agreements¹. Frame agreements are standard contracts between customer (resource owner or EPC) and key suppliers. They provide a framework including specification of services and products at agreed prices, thereby reducing the need or desire to provide open and competitive tenders.

Vertical integration

Increasingly, the industry is becoming more vertically integrated with a number of international FEED / EPCM companies also having their own fabrication and associated capabilities. Industry is moving towards an EPFA model (engineering, procurement, fabrication and assembly). As some module construction and associated services are undertaken in-house, they reduce to packages and modules being available for competitive tendering. Where a FEED / EPCM company also undertakes fabrication and construction, some competitors are reluctant to tender as the FEED / EPCM company will obtain commercially sensitive information.

¹ The intent of a frame agreement is to increase collaboration between customers and suppliers. Such collaboration benefits all parties involved in several ways.

For the customer, frame agreements:

- Reduce life cycle costs through collaborative designs.
- Reduce delivery times through standardized processes.
- Facilitates standardization of products, documentation, processes, spare parts, services, etc.)
- Encourages technology development through risk and revenue sharing.
- Improves quality.
- Provides price certainty.

For suppliers, frame agreements:

- Reduce marketing & sales lead times; e.g. for quotation, negotiation, contracting, etc.
- Reduce costs associated with marketing & sales processes.
- Reduce expediting, documentation, and order handling costs.
- Standardizes working processes.

Module size

There is also some evidence that RD's prefer larger modules compared to smaller ones. Even though larger modules are generally more complex, they allow for economies of scale to be developed which reduces fabrication costs as the very large international fabrication yards become interested in tendering. Similarly, having less modules and therefore fewer contracts and fabricators to manage and oversee, reduces the interface and transaction costs. It was also mentioned that larger modules make it easier to demonstrate that Australian companies cannot undertake the work, reducing the requirement under the EPBS scheme (see below).

The benefits of large and mega modules can be summarised as follows:

Benefits of large versus small modules:

- Fewer process systems are split between modules.
- Fewer inter-module connections.
- Man hours/ton are less for fabrication and installation.
- Less engineering.
- Less plot area is used.
- Fewer instrument rooms.
- Hydro testing and PCO work is easier and more complete.
- Fewer foundations.
- More hours spent at fabrication site; therefore better quality.
- Larger or taller equipment is more easily accommodated.
- Reduction in schedule at installation site (faster start-up).

Benefits of Super Modules: (2000 + tons)

- Substantial reduction in site labor hours.
- Safer-less site exposure.
- Wider contractor pool for remaining work scope.
- A major saving on a construction site in using super modules is that the construction footprint area can be substantially reduced.
- Significant CAPEX savings.
- Site directs substantially reduced.
- Reduced camp requirements.

Government Policies

A key government policy which directly impacts on the ability and success of Australian companies to tender for modular construction is the Enhanced Project By-Law Scheme (EPBS) and the associated Australian Industry Participation Plan (AIP Plan).

The EPBS allows Australian industry to access tariff duty concessions (typically 5%) on eligible goods for significant projects in certain industries, under specific conditions. The scheme facilitates the importation of goods which are not made in Australia or that are technologically more advanced, more efficient or more productive than Australian made goods.

In applying for EPBS concessions, projects must satisfy a number of criteria including:

- fall within one of a number of eligible industries (includes mining and resource development);
- meet the capital goods expenditure threshold of \$A10 million or more;
- demonstrate eligible goods are not produced in Australia in the ordinary course of business or are technologically more advanced, more efficient or more productive than goods currently available from Australian production;
- develop and implement an Australian Industry Participation plan (AIP plan).

The AIP plan is an important element of the process. The AIP plan needs to be submitted to Federal Government and the objective of an AIP plan is to ensure that full, fair and reasonable opportunity is provided to Australian industry to supply goods and services to a project.

As part of the questionnaires and during the interviews, variable responses were received regarding the EPBS and AIP.

The EPBS scheme is generally only accessed by the resource owners. In some cases the EPBS does not apply as Free Trade Agreements make the scheme redundant – as in the case of Thailand. Some indicated that the EPBS is important whilst other resource owners indicated that they do not consider the EPBS scheme during their evaluation of projects.

Most fabricators are very skeptical about the scheme, indicating that it is very easy to circumvent the requirements by either requiring large modules which cannot be undertaken in Australia, or requiring specifications other than in Australian standards (e.g. steel in Japanese standards), thereby minimizing the ability for Australian industry to compete. Some fabricators also indicated that the scheme is counterproductive, as it allows for the duty free importation of components or modules which make Australian components or modules even less competitive.

The use of AIP is relatively widespread with eight of the RD's having specific AIP plans. No one however, has any specific targets. Respondents were also asked to rate their company's success in implementing AIP. Only two respondents rated their company's effort in implementing an AIP a 4 or a 5. Most indicated that the AIP is not very successful.

A specific question was asked as to whether any preference is given to Australian industry in the competitive process. No organization answered in the affirmative and they all indicated that Australian industries are only considered if they have the technical capability, the capacity to deliver and if they are cost competitive.

Infrastructure

Having access to appropriate infrastructure is seen as crucial to the success in modular construction. Infrastructure not only includes specialized fabrication facilities (such as the AMC) but also associated road infrastructure which would facilitate the movement of large modules over land. High wide load corridors (HWLC) are of particular importance.

The AMC is generally well regarded and has provided the opportunity to fabricate some modules which could then be transported by sea.

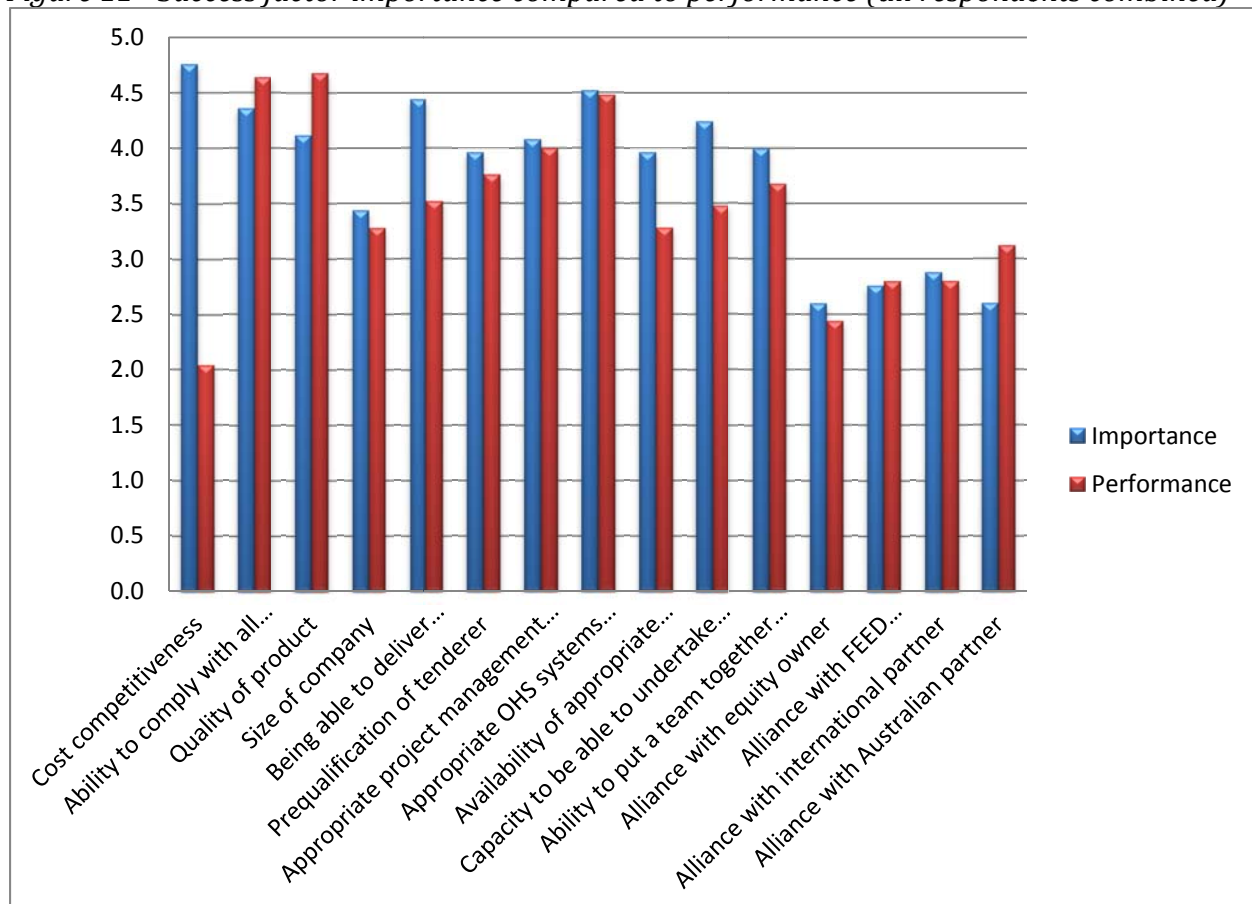
There has been some progress towards the establishment of HWLC but some respondents indicated that it seems that this initiative has stalled and insufficient progress has been made in reserving and developing these corridors.

4. Western Australia Performance

Following the identification of factors which are considered to be important for success in modular construction, the next step was to obtain an assessment of WA performance against the success criteria. The respondents were asked to rate WA performance on a scale of 1-5 against the fifteen criteria identified previously. The results are discussed below.

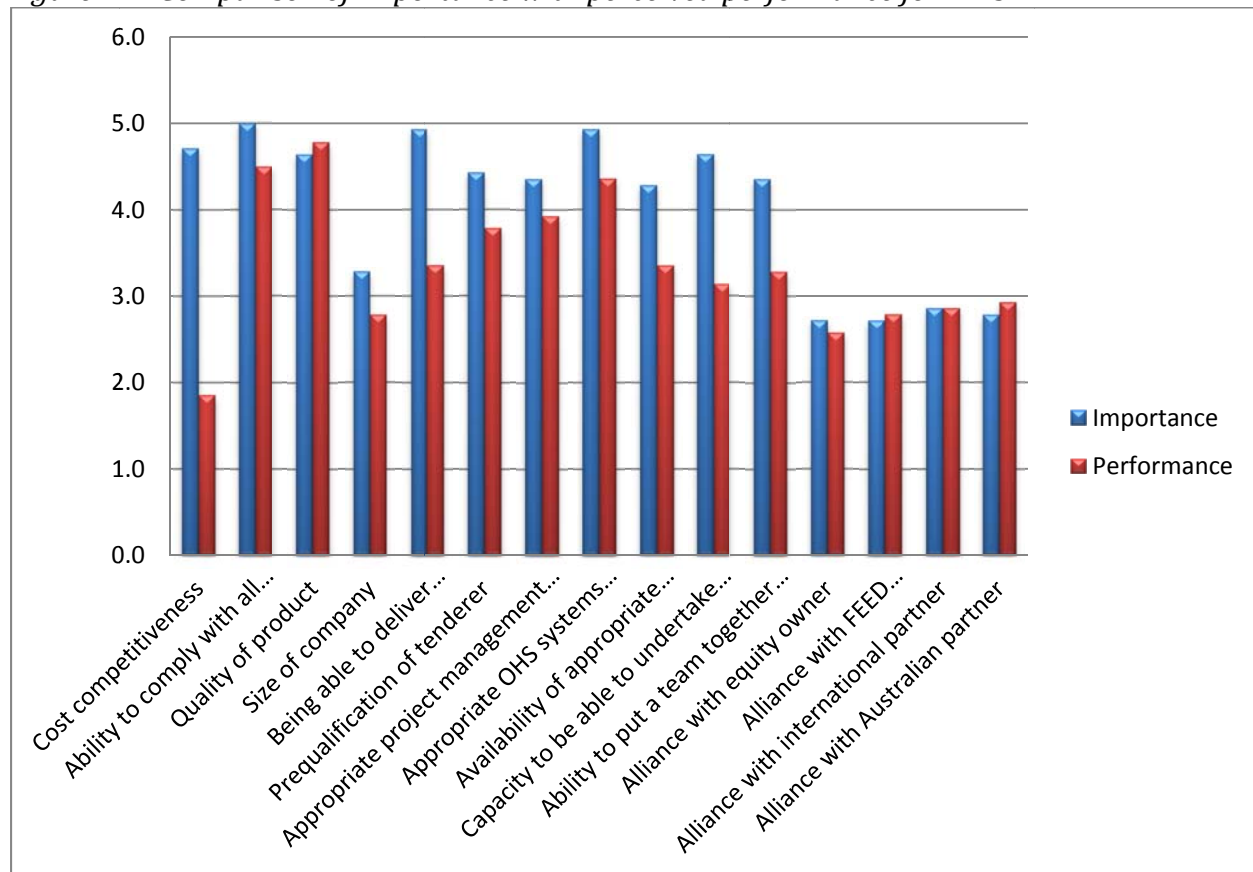
Figure 11 below shows for all respondents (RD's and fabricators combined) a comparison of importance of success factors with perceived WA performance. There is a stark difference between importance of cost competitiveness and perceived performance; implying both RD's and fabricators are of the opinion that WA industry struggles to be cost competitive. There is also a significant difference between the importance related to the ability to deliver on time and perception of actual performance. Both of these factors are important drivers for success and on both WA is not doing very well. Given this assessment it is no surprise that a large proportion of modules are being fabricated offshore.

Figure 11 - Success factor importance compared to performance (all respondents combined)



The comparison of perceived performance with importance has been further explored by analyzing the results for RD's and fabricators separately. The results are shown in figures 12 and 13.

Figure 12 - Comparison of Importance with perceived performance for RD's



According to the resource developers there is a significant gap between factors which they perceive to be important for success and actual performance. The biggest gaps are in terms of cost competitiveness, on time delivery, appropriate OHS systems, capacity to undertake the work and ability to put an appropriate team together. This clearly points to deficiencies in the current suppliers in WA.

Interestingly the fabricators have a different view on performance. Their responses are shown in figure 13.

Figure 13 - Comparison of Importance with perceived performance for fabricators

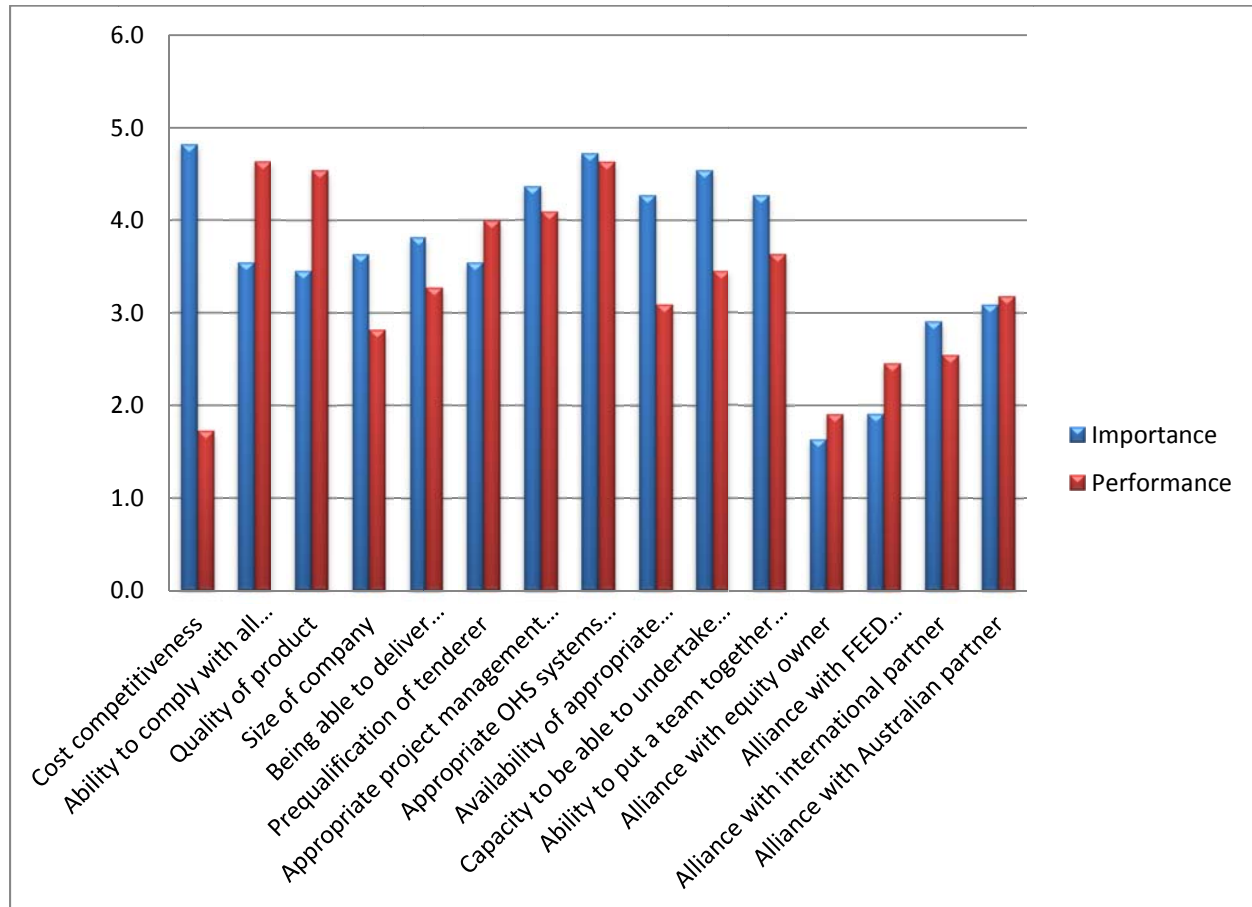


Figure 13 shows that the fabricators agree with the RD's, that WA performance on cost competitiveness is lacking. Interesting though, fabricators are of the opinion that they perform much better in certain factors than what the importance is of those factors. In particular fabricators believe the quality that they produce and the ability to comply with all technical specifications are much better than importance. This is in substantial contrast to the view of RD's. The fabricators also recognize that there is a gap between importance and performance related to delivering on time, capacity to do the work, size of the companies and available infrastructure.

Success in Tendering

Experience during the past few years has shown that Australian fabricators have been somewhat reluctant to tender and when they did so they were not as successful as they would have wanted to be. Both these issues were explored using the questionnaires and during the interviews.

Some of the reasons given for not actively tendering included: lack of confidence, not being able to meet all the technical specifications, not being able to deliver within the required time frame, not large enough and realizing that they would not be cost competitive. These reasons correlate with the figures provided previously comparing actual performance with what is important for project success.

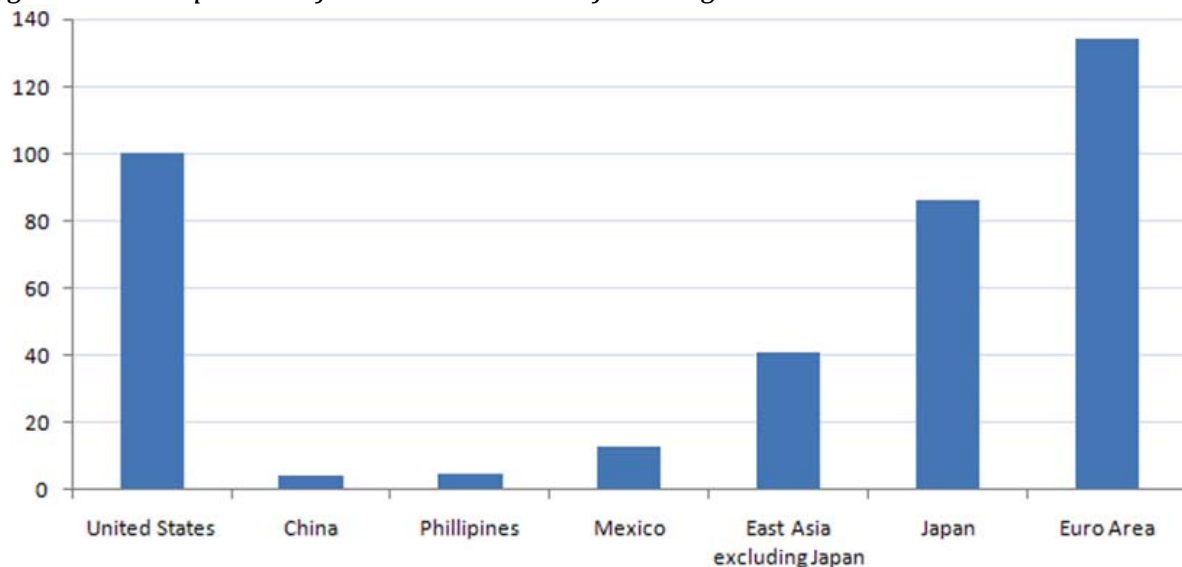
In exploring why Australian fabricators have not been successful, the most mentioned factor is cost competitiveness. It is clear that Australian labor rates are much higher compared with South East Asian Countries and even taking into consideration skill and productivity level differences the gap is still significant. Some respondents quoted trade labor rates in Thailand of \$40 per hour compared to \$180 per hour in remote locations in WA. Other respondents quoted welder rates offshore of \$200 per month compared with \$1800 per month in fabrication workshop and \$2500 per month on site.

Even highly skilled engineering rates are considered to be expensive. As one respondent put it:

“Over the last four years Australia has become the most expensive country to get engineering done with salaries and exchange rate too high. USA and Canada are now cheaper to do engineering.”

An independent comparison of manufacturing labour costs is shown in the figure below. The comparison does not focus on the resources sector but manufacturing in general but is still insightful. The comparison was undertaken by the USA Bureau of Labor Statistics and compares labour manufacturing cost in a range of countries for 2008. It shows China labour costs around 3% of USA costs and Korea and other East Asia countries around 40%. In 2008 Australia's manufacturing labour costs was similar to the USA. With current exchange rates Australia's manufacturing labour costs is most probably higher than the USA. It shows significant order of magnitude difference between advanced countries (USA, Europe, Australia) compared with south east Asian countries.

Figure 14 - Comparison of international manufacturing labour costs



(Source: USA Bureau of Labor Statistics)

Not only are labour rates seen as high but other material input costs are also considered expensive. Some respondents quoted that steel in WA is around \$1300 per tonne while \$900 pt in Japan and substantially less in Korea and China. A number of respondents indicated that the costs to fabricate certain modules in Australia compared to other international countries could be 40-60% higher. Some respondents indicated:

“We wanted to do the module in WA but the costs were 40% cheaper overseas.”

“Our preference is to do modular construction in a stable first world country but labour and other costs are just too high.”

“We could get the module manufactured offshore for the same price as steel in WA.”

Industrial action, rigidity of the labor market and militancy of unions were also mentioned as an important factor in WA not being successful. Some RD's have specific strategies to move as much work offshore as possible so that they do not have to deal with unions. As one respondent put it:

“Current operator contract strategies minimize Australian participation where strong union involvement has historically delayed and increased project costs.”

It is also clear that the lack of capacity inhibits the potential for success. The WA industry does not have the capacity to deliver large modules and cannot compete with the large international fabrication yards, in particular the tier one yards. As an example, Hyundai Heavy Industries in Korea has more than 24,000 workers with 2,800 design engineers, 600 ha of fabrication yards and sales of US\$10.7 billion in 2009. Similarly Daewoo shipbuilding has 15,000 skilled trade workers and 1,500 design and research and development staff. Similar yards, although not on

the same scale, exists in China and Thailand. In contrast 208 firms associated with the Australian Marine Complex in Henderson employ collectively just over 6,000 people.

In addition, most of the large fabrication yards provide integrated services. They often provide their own steel, finance, procurement support, heavy lift transport, blast and paint shops etc. This is often very attractive for RD's.

Other factors influencing the success rate for modular construction that were mentioned by a number of respondents include:

- Inability to deliver on schedule
- Quality concerns with local fabricators
- Schedule much quicker overseas, quick to get started
- Australia does not have the expertise in specialized modules
- AMC is expensive and there is no negotiation on price
- There is no incentive to use local fabrication
- Requirement to show financial viability by providing letter of credit

The financial requirement mentioned in the last dot point is often seen as a substantial impediment. Most RD's require some form of statement of financial viability by fabricators. Often this equates to a letter of credit of 10% of the contract price. This is often very onerous for fabricators and has been mentioned by one fabricator as a reason why the company was sold to a large international organization – to strengthen the financial ability.

International Comparison of Competitiveness

To gain a further understanding of the competitiveness of the WA industry, respondents were asked to compare Australia / WA with “world's best internationally.”

The respondents were requested to rate a number of key factors. These are:

- | | |
|---|---|
| • Technical and engineering expertise | • Size of trade workforce |
| • Skill level of trade workforce | • Trade workforce productivity (approximate manpower estimates) |
| • Fabrication rates | • Material input costs |
| • Appropriate size of construction facility | • Availability of specialised infrastructure |

Respondents were asked to rate each factor on a scale of 1 to 5, with 5 if Australia is equal to world's best and 1 if Australia is least comparable to international best practices. The results, differentiating between RD's and fabricators, are shown in figure 15.

Figure 15 - Comparison of success factors between Australia and world's best

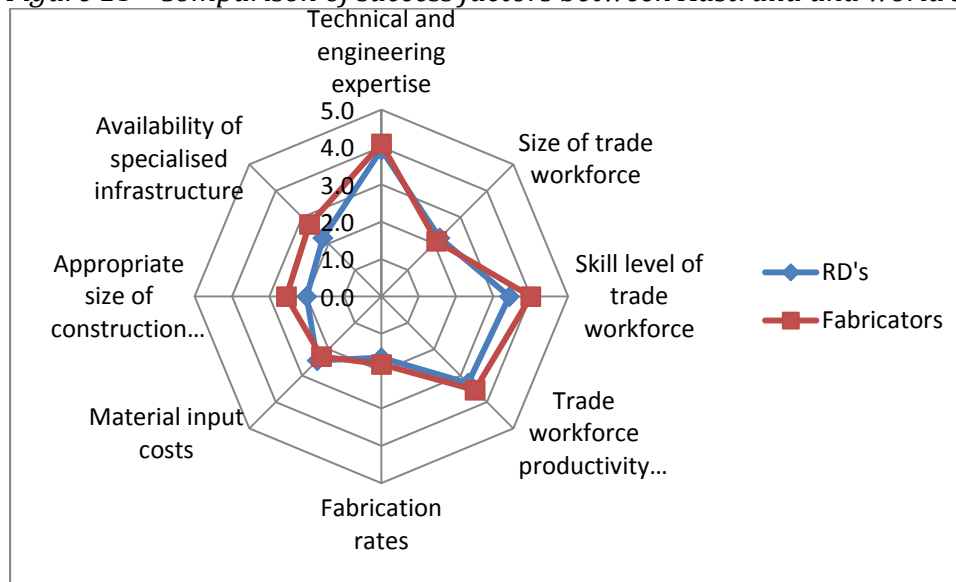


Figure 15 shows that both RD's and fabricators believe that Australia compares reasonably favourably with world's best in technical and engineering expertise and skill level of trade workforce and to a lesser degree with trade workforce productivity. Australia compares less favourably in fabrication rates, material input costs, size of workforce, appropriate size of construction facilities and availability of specialised infrastructure.

The figure also shows that there is somewhat different perspective between RD's and fabricators, with the RD's having a somewhat more pessimistic view than the fabricators with regards to skill level of trade workforce, productivity, availability and size of specialized infrastructure. There is consensus between the RD's and fabricators that fabrication rates and material inputs costs are not competitive and that technical and engineering expertise is close to international best practice.

5. Strategies for Improving Modular Construction Success

This section recommends strategies which could be considered to improve the success in modular construction for WA. It takes into consideration industry dynamics, realities of international, national and WA resources and infrastructure and different in roles between the public and private sector.

The previous analysis was able to identify a number of key issues impacting on the identification of appropriate strategies. These are summarized below:

- The modular method of construction will increasingly become the de facto standard for construction in the resources industry. It provides substantial benefits in the ability to access international best practices in technology, material input costs, labour skills, low cost fabrication yards and to capitalize on economies of scale. It provides the best method to be cost competitive within an optimum project schedule.
- Key factors for success in modular construction are cost competitiveness, schedule and appropriate HSE policies.
- WA is a high cost fabricator with both labour and other fabrication inputs such as steel considered to be much more expensive than low cost fabrication countries. Even with higher productivity in WA, increased project management requirements for offshore fabrication as well as potentially re work of parts of modules, WA still finds it difficult to compete with countries such as China, Thailand and Korea.
- Tier 1 fabrication yards in SE Asia has similar and sometimes superior technical and trade force skills and productivity than WA, but is substantially more cost and schedule competitive. Non Tier 1 yards are fabricating with variable quality.
- WA resource pool and capacity is relatively small and therefore does not have the capacity to undertake fabrication of large modules. The AMC is considered an excellent facility which has benefitted the industry.
- WA has recognized technical and engineering capability, together with high skill level of trade work force. Fabricators have a more optimistic view of Australian capability than the resource developers, who generally have a more international comparative outlook.
- Procurement practices by the resource developers are increasingly to fabricate offshore to limit exposure to potential industrial action and HSE requirements in WA and Australia.
- The AIP is not considered to be very effective, even after the recent changes. Most resource developers even view their own AIP as not very effective.
- The EPBS scheme is used by some resource developers but is mostly not a major consideration in the decision making process. FID is often driven by retention lease requirements while long term contracts drive schedule which in turn impact on fabrication method.

Appropriate Policy Settings

Both resource developers and fabricators emphasized during the interviews that policies settings by government essentially drives the extent of local fabrication. Whereas it is industry's role to maximize the return to its shareholders, it is government's role to maximize the return of

exploiting resources to the shareholders / citizens of the country. A number of examples have been provided where governments have implemented strategies and policies which led to substantial development of the local industry. These include Norway, Canada, Saudi Arabia, Indonesia and Malaysia.

Governments use a range of policy settings to accomplish economic and industrial development. One of the important roles of government is to “set the rules” in which the private sector have to operate. These rules substantially determine how the private sector operates within a specific country. For instance some countries have local content requirement for resource projects while others have industry development programs. Government also has other roles such as facilitating economic development, provision of infrastructure (often in partnership with the private sector), education and training and research and development and generally providing information.

Issues in relation to appropriate policy settings include the following:

- The current AIP plan is not effective in securing onshore modular fabrication (even after the recent changes). Even most resource owners are of the view that it is not very effective to secure local module fabrication.
- The EPBS scheme is useful in some cases but sometimes can work against local fabrication as imported modules are not subject to import duties.
- Internationally some governments have strong policies and strategies to develop their oil and gas sectors. This is possible even within international collaborative frameworks such as the WTO.
- Some governments (Canada) take equity ownership (5%) in projects which provide ability to influence key decisions.
- Some governments require a certain percentage of production to be undertaken within the country.
- Other governments use other reasons to increase local fabrication. An example was provided with Austal ships undertaking design of ships in Perth but is required to undertake production in the USA.
- Some countries have free trade zones or tax rebates to encourage local industry.
- Malaysia has a vendor development program which could potentially be duplicated in Australia
- Some governments have labour laws which allow the cheaper importation of labor under certain circumstances

RECOMMENDATION 1:

That government (both state and national) review the various policy settings which impact on modular construction. (This should include investigating the feasibility of a comprehensive industry strategy; assessment of the effectiveness and impact of the EPBS and AIP; special visas to work in zones for modular construction; feasibility of implementing vendor management programs; feasibility of government equity ownership in some resource projects).

Early Government Involvement

Many interviewees stressed that early intervention is required by government to have any real impact on the decision as to where modules are being manufactured. Examples have been provided where some countries require a “plan of development” which provides the opportunity to negotiate with the RD’s at a very early stage the level of fabrication that will be undertaken within the country. This should be scrutinized by experts in government with oil and gas expertise and experience to maximize local fabrication. This “plan of development” is required in Malaysia and Trinidad requires a “best endeavour” for fabrication to be undertaken locally with a detailed explanation when this is not possible.

RECOMMENDATION 2:

That government develops a mechanism for early intervention in the planning process before decisions are finalized regarding the location of module fabrication.

Appropriate Focus

It is recognized by industry that Australia (and WA) cannot compete with the very large fabrication yards in a number of SE Asian countries. It therefore requires an approach that focuses on smaller modules, higher value adding, time sensitive fabrication and in particular where offshore cost of fabrication and transport is less than onshore manufacturing.

RECOMMENDATION 3:

That industry focuses on developing capabilities which would support the fabrication of smaller and higher value added and time sensitive modules.

Appropriate Infrastructure

It is generally recognized by the interviewees that the AMC is an excellent facility which contributes substantially to the development of the industry. Some criticism has been expressed that the facility is expensive and that in some offshore fabrication yards it is possible to obtain access to facilities at a non commercial rate. This could not be substantiated.

Other infrastructure is also important to support modular construction. In particular high wide load corridors (HWLC) have been mentioned by a number of interviewees. HWLC are important as they allow some modules to be transported by land. Although some progress has been made in securing and developing HWLC it appears that progress has stalled.

RECOMMENDATION 4:

That government ensures the appropriate identification, reservation and development of key high wide load corridors.

Facilitation

Even though the WA resources sector is relatively small in terms of number of players, some resource developers indicated that they were not aware of which company provides which type of product or service. Similarly some fabricators indicated that they were not aware of some potential tender opportunities. The Industry Capability Network (ICN) has been active in providing a market place where RD's and fabricators and other providers can meet.

RECOMMENDATION 5:

That the ICN extends its involvement in the resources sector by developing a database of all potential tender opportunities as well as capabilities of the local industry.

Financial Guarantee

A number of interviewees indicated that the requirement by resource developers for a successful tenderer to have some form of financial guarantee such as letter of credit, to be very onerous.

RECOMMENDATION 6:

That the Government investigates the feasibility of introducing a financial guarantee scheme for fabricators, similar to EFIC.

Alliances

The analysis in the previous sections indicates a number of weaknesses in the industry:

- the inability of individual tenderers to comply with all technical project specification and being unable to deliver on time;
- insufficient economies of scale to tender for medium size modules; and
- insufficient capacity to undertake the required work.

These shortcomings can be overcome by forming effective alliances, not only with other fabricators and specialist providers within Australia, but also internationally. The recent WAMP alliance (WA Major Projects), although not having been successful, is a case in point.

RECOMMENDATION 7:

That Industry and Government take the initiative in facilitating the development of effective alliances to support the resources industry.

Industry Development and Training

The analysis in the previous sections indicated substantial differences between the RD's and fabricators with respect to their views on a range of key issues. For instance, fabricators are of the view that the quality of their product is much higher than what RD's perceive it to be. Similarly, fabricators don't believe that quality of the product, ability to comply with all technical specifications or delivery on time are as important as what RD's believe they are. There is a clear difference in opinion which requires improved communication and industry development to close the gap.

RECOMMENDATION 8:

That industry and government considers appropriate industry development and communication programs which could improve communication and perceptions within the industry.

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Appendix A - Example of Questionnaire

Modular Project Questionnaire for Resource Developers / EPC / EPCM

Name: _____

Organisation: _____

Title: _____

Contact No: _____

Date of interview: _____

Background: This project is undertaking an assessment of the critical success factors to improve involvement of the WA and Australian industry in modular construction projects in the oil and gas industry in WA (in particular PAU and PAR)

Policy Position

1. Does your company currently have a formal Australian Industry Participation Policy (AIP) or a corporate policy for ensuring Australian industry participation in large modular construction such as PAU or PAR.

Yes No

2. If so, what are the key objectives of the policy?

3. What are the major strategies for implementing the policy?

4. Does the policy include specific targets and what are they?

5. Are these policy positions re-stated to your prime contractors or procurement agents or their subcontractors?

Yes No

6. How would you rate the effectiveness of the strategies so far? (1= bad 5 = good) _____
7. Is there any preference given to Australian industries in the competitive tendering process for PAU and PAR? If so to what extent?

Success Factors

8. Please rate the following factors in terms of their importance for success for companies to be awarded modular construction projects by your organisation: (1= low importance 5= high)

a) Cost competitiveness	1	2	3	4	5
b) Ability to comply with all technical project specifications	1	2	3	4	5
c) Quality of product	1	2	3	4	5
d) Size of company	1	2	3	4	5
e) Being able to deliver within specified time frames	1	2	3	4	5
f) Prequalification of tenderer	1	2	3	4	5
g) Appropriate project management and risk processes and expertise	1	2	3	4	5
h) Appropriate OHS systems and processes	1	2	3	4	5
i) Availability of appropriate infrastructure (eg dry dock)	1	2	3	4	5
j) Capacity to be able to undertake the required work	1	2	3	4	5
k) Ability to put a team together to undertake all the work	1	2	3	4	5
l) Alliance with equity owner	1	2	3	4	5
m) Alliance with FEED or EPCM contractor	1	2	3	4	5
n) Alliance with international partner	1	2	3	4	5
o) Alliance with Australian partner	1	2	3	4	5

9. How do you rate Australian industry ability to undertake PAR or PAU in terms of the following:

a) Cost competitiveness	1	2	3	4	5
b) Ability to comply with all technical project specifications	1	2	3	4	5
c) Quality of product	1	2	3	4	5
d) Size of company	1	2	3	4	5
e) Being able to deliver within specified time frames	1	2	3	4	5
f) Prequalification of tenderer	1	2	3	4	5
g) Appropriate project management and risk processes and expertise	1	2	3	4	5
h) Appropriate OHS systems and processes	1	2	3	4	5

i) Availability of appropriate infrastructure (eg dry dock)	1	2	3	4	5
j) Capacity to be able to undertake the required work	1	2	3	4	5
k) Ability to put a team together to undertake all the work	1	2	3	4	5
l) Alliance with equity owner	1	2	3	4	5
m) Alliance with FEED or EPCM contractor	1	2	3	4	5
n) Alliance with international partner	1	2	3	4	5
o) Alliance with Australian partner	1	2	3	4	5

10. Australian companies have not been very active in tendering for PAU and PAR projects. In your view what are the major reasons for the limited tendering?

11. Very few Australian companies have been successful in tendering for PAU or PAR projects. In your view why would that be the case?

12. What can be done to make Australian companies more competitive in tendering for PAR or PAU projects?

13. How important is the EPBS scheme (concessions for importing capital goods duty free) to your organisation?

14. Does this EPBS scheme impact on your engaging Australian companies?

15. To what extent does offshore equity partners determine allocation of PAR / PAU projects?

16. What government policies (Federal or State) would be successful to improve the success rate of Australian industry in PAR / PAU projects?

17. How do procurement trends such as reduction in number of suppliers impact on success rate of Australian companies in PAR / PAU projects?

18. Does offshore allocation of FEED impact on the allocation of PAR / PAU projects? How?

19. How do you rate the following factors comparing Australia with worlds best internationally in relation to PAR / PAU projects? (1= Australia low 5= Australia high)

a. Technical and engineering expertise	1	2	3	4	5
b. Size of trade workforce	1	2	3	4	5
c. Skill level of trade workforce	1	2	3	4	5
d. Trade workforce productivity (approximate manpower estimates)	1	2	3	4	5
e. Fabrication rates	1	2	3	4	5
f. Material input costs	1	2	3	4	5
g. Appropriate size of construction facility	1	2	3	4	5
h. Availability of specialised infrastructure	1	2	3	4	5

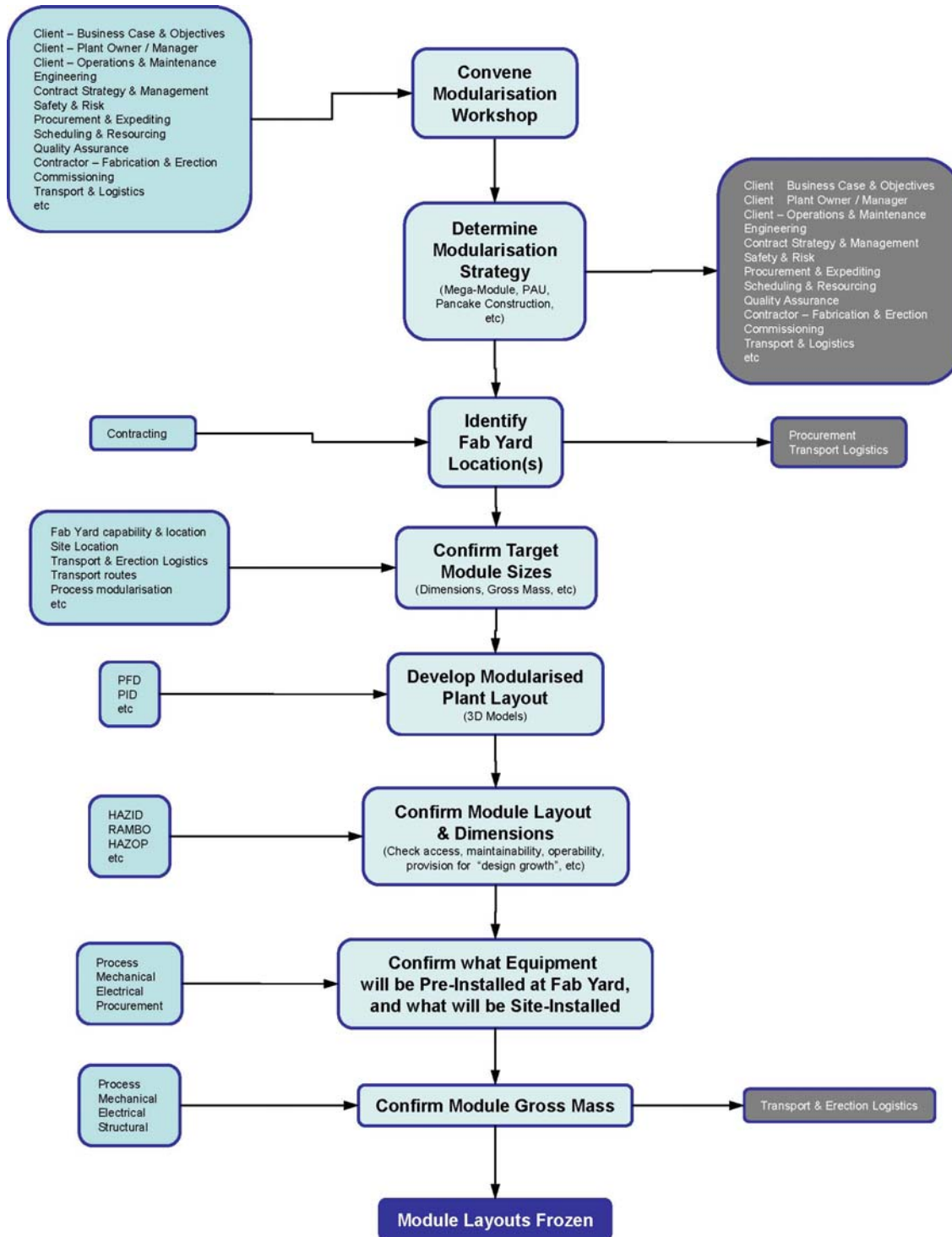
THANK YOU VERY MUCH FOR YOUR PARTICIPATION

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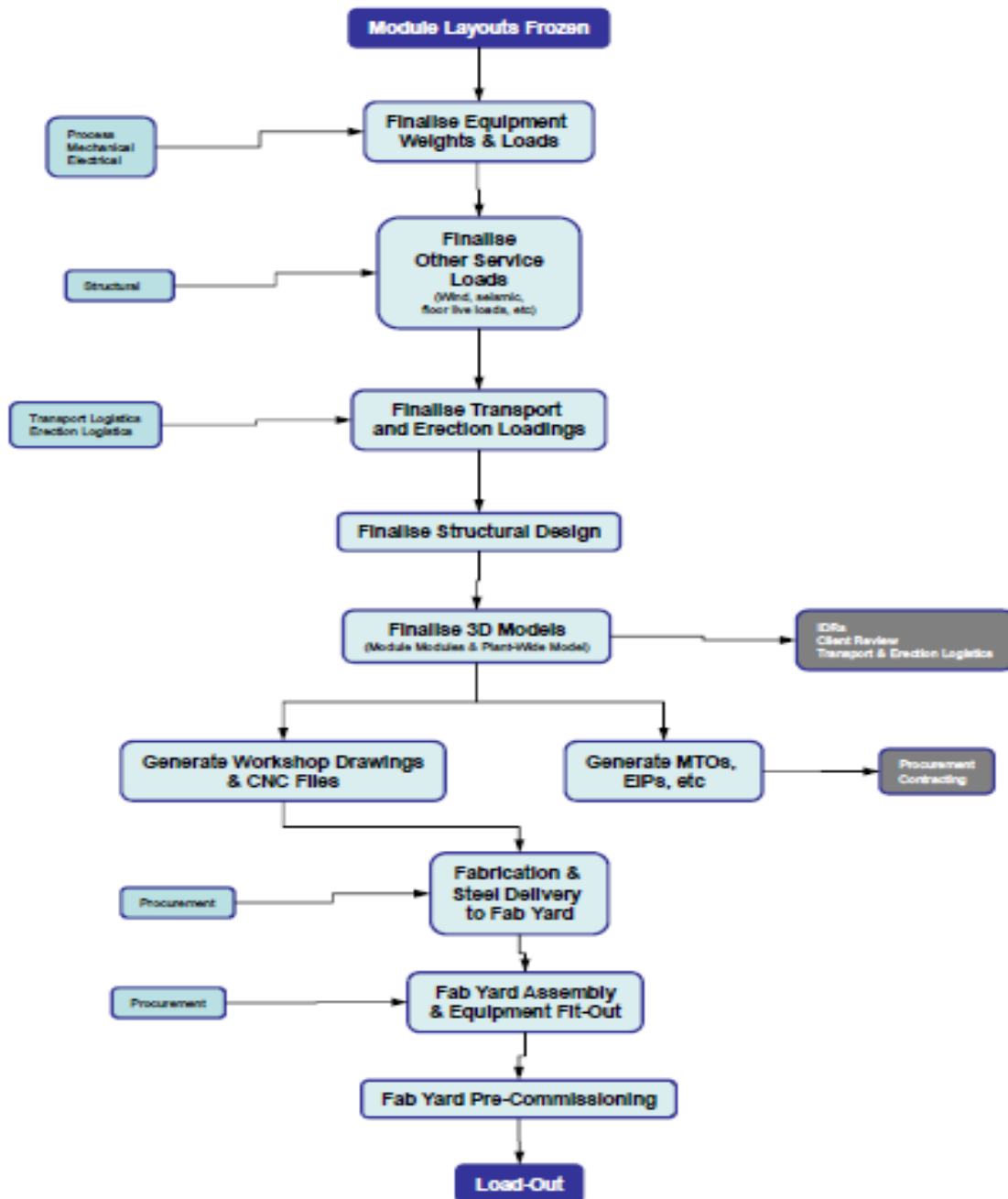
Martin West

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Appendix B - Modularisation Process Flowchart (source SKM)



Part 2 – From Frozen Module Layouts to Load-Out



Part 3 – From Load-Out to Hand-Over

