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ARCADIS INSIGHTS

DFMA FOR PREFABRICATED MECHANICAL, ELECTRICAL AND PLUMBING (MEP) SYSTEMS

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INTRODUCTION

In the effort to drive the industry towards improving construction productivity and quality, reducing reliance in labour intensive production, and promoting a safer and sustainable working environment, the concept of adopting Design for Manufacturing and Assembly (DfMA) technologies in projects is gaining popularity.

WHAT IS DFMA – MEP SYSTEM

DfMA refers to the practice of integrating factory-manufactured building components being delivered to site for assembly. DfMA provides a better quality, a time-managed solution and a safer construction site as more activities are carried out off-site. DfMA comes in many forms – the principal focus of this article is Prefabricated Mechanical Electrical and Plumbing (MEP) Systems.

Through the implementation of DfMA for Prefabricated MEP Systems, major MEP construction processes which are traditionally labour intensive will be carried out at off-site facilities. The respective prefabricated MEP modules which are complete, with two or more MEP services, will be transported to the construction site for final assembly, inspection, installation, testing and commissioning.

TYPES OF PREFABRICATED MEP SYSTEMS

There are various types of Prefabricated MEP modules available in the market including horizontal ceiling modules, vertical riser modules and plant modules. The potential areas of application are as follows:

	Residential	Commercial	Hotel	Office	Industrial	Healthcare	Institutional	Data Centre
Prefabricated Duct	✓	✓	✓	✓	✓	✓	✓	✓
Prefabricated Horizontal or Vertical MEP Module including Pipes, Cable Trays, Ducts	✓	✓	✓	✓	✓	✓		✓
Prefabricated Riser Module	✓	✓	✓	✓	✓	✓	✓	✓
Prefabricated Horizontal Module including ceiling board, duct, pipe, lightings, etc		✓				✓		✓
Prefabricated Plant Module including Pumps, Pipes, Valves, Pump Skid	✓	✓	✓	✓	✓	✓	✓	✓
Prefabricated MEP Module integrated with Work Platform/ Catwalk		✓	✓	✓	✓	✓	✓	✓

BCA'S GUIDELINES FOR DFMA FOR PREFABRICATED MEP SYSTEMS

Prefabricated MEP Good Industry Practices Guidebook

The Building and Construction Authority (BCA) of Singapore released a Prefabricated MEP GIP guidebook in April 2018 to help practitioners to have a better understanding on prefabricated MEP modules and its benefits. The guidebook draw references from overseas project experiences and sets out some good industry practices guidance (from upfront planning, procurement and maintenance) on how such systems could be incorporated prefabricated MEP systems in the development.

Code of Practice on Buildability 2017

The Buildable Design Appraisal (BDAS) framework was further enhanced in May 2017. To promote designs giving considerations on DfMA, and encourage wider adoption of MEP Systems with higher productivity gains, the Code of Practice on Buildability 2017 allocated additional points to the following new MEP modules with at least 65% coverage in the project.

	N Value	
	Percentage of Coverage	
	≥ 65% to < 80%	≥ 80%
Prefabricated MEP modules integrated with work platform/ catwalk+	3.00	5.00
Prefabricated MEP modules e.g. pipes, cable trays/trunking etc+	2.00	4.00
Prefabricated MEP plant modules e.g. pump, compressor etc+	2.00	4.00

+ denotes items newly introduced in COP on Buildability 2017
Source: BCA Code of Practice on Buildability – Table 3 Design for Manufacturing and Assembly technologies (DfMA) – N Value

Points for other MEP modules with relatively lower class of DfMA as compared to those stated above has been adjusted in COP 2017 to commensurate the potential manpower savings expected from their adoption.

	N Value under COP 2017		N Value under COP 2015	
	Percentage of Coverage		Percentage of Coverage	
	≥ 65% to < 80%	≥ 80%	≥ 65% to < 80%	≥ 80%
Prefabricated and pre-insulated duct for air-conditioning system (Mandatory for all projects)	0.5	1.00	2.0	4.00
Flexible sprinkler dropper	-	1.00	1.00	2.00
Flexible water pipes	-	1.00	0.50	1.00
Common M&E bracket (at least 3 M&E services)	-	1.00	1.00	2.00

ACCREDITATION

Building Innovation Panel (BIP)

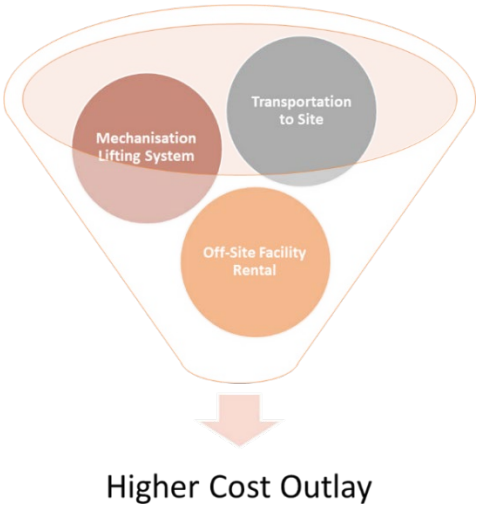
The Ministry of National Development (MND) and BCA has set up a Building Innovation Panel (BIP) comprising the various public agencies to facilitate the speedy clearance of innovative DfMA technologies that bring about a minimum 20% productivity gain. A Prefabricated MEP system that meets the authorities' regulatory requirements will be granted an In-Principle Acceptance (IPA) for use in Singapore. Generally, the process will take approximately two months to receive accreditation, however this may vary from project to project. A Prefabricated MEP system with IPA will receive a fast track status in subse- quent regulatory submissions involving the adoption of such modules.

Prefabricated MEP Manufacturer Accreditation Scheme

To further enhance the Prefabricated Mechanical, Electrical, and Plumbing (MEP) ecosystem in Singapore and ensure there are sufficient and competent suppliers in the market to meet the stepped up DfMA MEP demand, BCA jointly together with the Specialist Trade Alliance of Singapore (STAS) has recently launched a new Prefabricated MEP Manufacturer Accreditation Scheme (MAS) to ensure there is a minimum standard in the capability of the DfMA MEP suppliers.

This MAS accreditation scheme acknowledges prefabricators and/or installers that are able to demonstrate the ability to meet the minimum standard and deliver good quality prefabricated MEP modules. Further details on the scheme will be released at STAS website from 1 March 2019.

COST AND TIME IMPLICATIONS



The estimated cost premium of adopting DfMA for MEP systems can range from approximately 10% to 30% of the total MEP construction cost depending on the type of building and MEP system, mainly driven by the requirements for off-site prefabrication facility and mechanism lifting system.

When the utilisation rate of prefabrication components (including but not limited to MEP modules) increases, the above cost outlay will reduce as some of these costs can be shared with other prefabricated components.

In addition, such cost can be balanced off with savings in labour costs through more efficient use of labour in the factory or utilisation of regional factories with relatively lower wages.

CONSTRUCTION SCHEDULE

It is critical that the Employer, the Design Consultants and the Contractor's expectations are aligned on timeline and design. Design decisions must be finalised at an early stage to facilitate successful implementation of the Prefabricated MEP modules. This is to avoid abortive redesign, rework and additional time required for the construction processes which are costly and unproductive.

A Specialised team will also be required to lead the implementation of the DfMA MEP systems. Generally, the main building contractor will take on the leading role to co-ordinate logistic and work activities on and off-site.

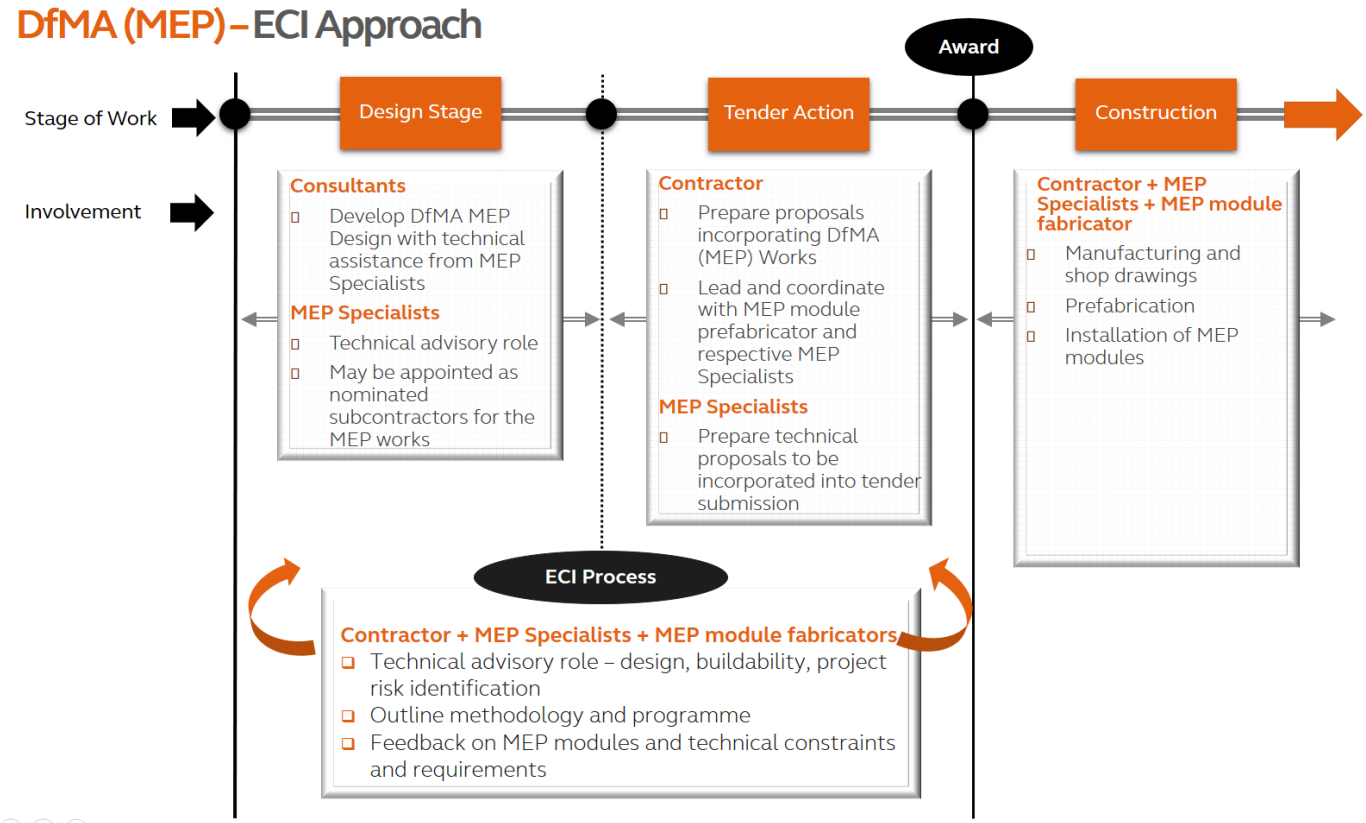
PROCUREMENT

Conventionally, procurement of the MEP contractors for any MEP trades are segregated from each other and that of the Main Building Contract. Each selected MEP contractors will eventually be appointed as a subcontractor of the Main Building Contractor. In some instances, the tender and/or award of the sub-contract packages may only occur during the construction period after the Main Building Contractor has been awarded.

DfMA MEP Systems requires a different approach to procurement, in which design decisions towards offsite factory construction must be made at the very onset of the project. The process requires early involvement of the MEP contractors to work together with the Main Building Contractor and the Consultants. Input from the MEP contractors can then be seamlessly incorporated into the design to attain a more effective and holistic technical solution. Thereby avoiding additional costs and time due to late induction and/or changes in detailing.

Adoption of Building Information Modelling (BIM) and Integrated Digital Design Delivery (IDD) also streamlines the DfMA work processes towards a more collaborative and integrated solution. BIM helps various project parties (example designers, engineers, contractors, manufacturers, suppliers etc.) to visualise detailed building designs in virtual 3D form before they are actually built, thereby minimising potential issues during construction. BIM and IDD capabilities is becoming an essential criterion for Clients to assess the firms' ability to deliver the project.

In moving towards the early involvement of the MEP contractors, it will include the early appointment of MEP contractors as Nominated/Designated Sub-Contractors or having main building contractor to team up with MEP contractors to tender for projects.



SITE INSPECTION

With a significant portion of the MEP works taken off site through the introduction of DfMA, it is important that the work processes incorporate measures to supervise, monitor and inspect the works-in-progress at the fabrication premises, upon delivery at site and upon final incorporation into the Works. The Employer will need to consider such additional requirements in determining resources for the site supervision team.

It is also prudent to request for a prototype MEP unit to be provided for inspection before the mass production of the components. This will help to ensure the MEP units comply with the drawings, specifications and any other contract requirements and allow the parties to address any issues with the MEP units early and avoid abortive costs.

During site inspection, BIM also plays an important role in ensuring quality control. The project team and contractor could use construction BIM information via mobile app to inspect site, progress and quality checks. The following checks example Visual Check, Interference Check, Standards Check, Element Validation can be considered. Each project team member should be responsible to ensure that the agreed quality processes are adhered to, and any updates or revisions to the BIM Model should be done regularly.

CONCLUSION

Many factors are leading the construction industry towards more productive ways to reduce reliance on low skilled labour, to build faster and improve quality. Many stakeholders are embracing changes and exploring ways to overcome the challenges faced when adopting various DfMA technologies such as Prefabricated MEP systems to realise the benefits which can be derived from these productivity initiatives.

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