Integrated Collaborative Production Planning for DfMA

Introduction

Identifying Challenges in the DfMA Workflow – with physical dispersion of various construction activities from factory to yard and site in DfMA projects, using real time and reliable data to make decisions has always been a challenge. In view of the need to improve efficiency and coordination of various construction activities, digitalisation of the entire DfMA supply chain workflow was initiated by main contractor "Teambuild Construction & Engineering Pte Ltd" in close collaboration with solution provider "Capps Solutions Pte Ltd".

To establish the current pain points and issues, a value stream map of the entire DfMA process was mapped. The following issues were identified:

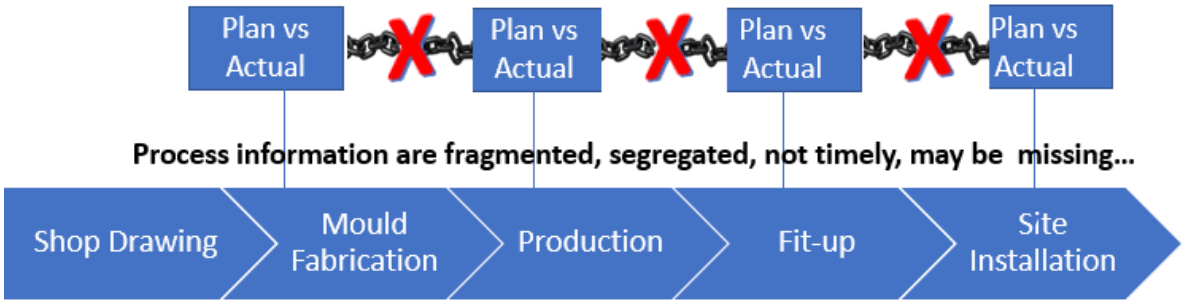

Figure 1. Fragmentation in the DfMA value chain

It was noted that there was disruption in terms of information flow across the supply chain from factory to yard and site, and at times, the information was incomplete and inaccurate.

As a result of a lack in reliable and real time data, the following issues faced by the project teams in planning, execution, tracking and control were observed.

- Planning
  1. Planning is manual and tedious.
  2. Plans relating to production, fit-up and installation are not aligned and synchronized.
  3. PPVC modules are not built-in sequence as per RC cycle (installation sequence).
- Execution
  1. Updates are done manually and are not consistent across each process and site.
  2. Coordination across factory, yard and site is not smooth.
- Tracking
  1. No visibility on the project progress as well as storage and transport movement of PPVC modules.
- Control
  1. Unwanted and excess inventory across Production Factory, Fit-up Yard and Installation Sites.
  2. Long waiting time from process to process and trade to trade.
  3. Resources and land space are not optimized.

Project Overview

Development of Digital Platform to enhance process workflow for DfMA

To address the observed challenges, a digital platform, CBOSS, was developed by Capps Solutions and a pilot project was conducted by Teambuild. With this digital platform, data can be collected in real time. Identification markers, such as QR codes were attached on each of the precast components to track its progress from factory to yard and site installation. The following capabilities were incorporated into the software to enhance the DfMA process workflow.

Capabilities	***Traditionally***	***Digital Platform - CBOSS***
Drawing status	In Excel format and not accessible by all	Online status - to ensure production team build the modules as per the latest drawing revision
Mould status	In Excel format and not accessible by all	Online status - to assist management to act on any delays in the mould's delivery and set up
Layout with status (production and yard) / storage map	Updated manually on white board - the information is not portable and a lot of unproductive hours were incurred to locate required components	Online - latest updated status provide real-time overview to production/yard engineers and to all process owners to improve coordination and reduce query time and improve coordination
Online PP09 for digital ordering of components	Paper-based and no audit trail of records (Purchase Orders (PO))	Online - allows site teams to place orders to factories and minimise confusion on the latest orders
Auto schedule computation	Manually tracked - not possible to have alignment	Online - allow cross-department collaboration on one agreed schedule. The schedule can be readily revised with all parties' alignment and agreement.
Real-time wall chart for all parties	In Excel format and updated separately by each party. With a time lag in between the updates by each party, the updates are not timely synchronised.	Real-time update across all parties - to spot issues proactively and ensure sufficient stock in the pipeline to support site installation, which will directly affect overall project schedule.
Resource planning for trades at fit-up yard	A lack of systematic resource planning always results in grossly estimated headcount	Resource planning - based on actual work content and projection at fit-up yard to establish a more accurate and realistic headcount deployment
Transport tracking	Updated via WhatsApp	Real time tracking and updates on logistics improve coordination and communication among all parties
Reinforced Concrete (RC) cycle tracking	Manually tracked - not reliable and consistent	Real time tracking ensures the project team meets overall project schedule
Productivity tracking	Manually tracked - not reliable and consistent	Real time tracking helps to identify inefficiencies and bottlenecks and allows for data-driven decisions to be made
QA/QC tracking	Paper-based	Real time tracking allows more immediate corrective actions. The data is centralised in the server and the client's customised report can be printed as needed.

How does the digital platform address challenges?

Broadly, all transactional data are collected digitally via mobile phones and real-time information are reviewed online to diagnose areas for immediate correction and process improvement. Specifically, the platform addresses the traditional processes and issues for DfMA in the following ways.

Traditional process/issues	*Solutions by TIPS*
Planning	
Planning is manual and tedious.	Auto schedule computation makes planning easy and simple based on the commitment of 3 parties.
Plans from Production, Fit-up and Installation Site are not aligned and synchronized.	Real time progress updates on wall chart to allow all parties to see the progress on one agreed schedule plan.
PPVC modules are not built timely in sequence as per RC cycle (Installation sequence).	Through data visualization, the yard and factory team can monitor to ensure PPVC modules are built as per installation schedule in real time.
Execution	
Updates are done manually and not consistent across each process and site.	Real-time updates via scanning of QR codes at each process across sites.
Coordination across factory, yard and site is not smooth.	One common schedule and real-time progress updates to improve coordination.
Tracking	
No visibility on the project progress, storage and transport movement of PPVC modules.	Online and real-time updates to monitor the status and transport movements.
Control	
Unwanted and excess inventory across Production, Fit-up yard and Installation Sites.	Factory knows what is needed to build based on real time wall chart and alignment on agreed schedule.
Long waiting time between trades/disciplines.	Real-time updates of the process status allow the specific trade/discipline to know the next steps to minimise waiting time.
Resources and land space are not optimized.	Real-time updates on storage map allows us to optimise the best use of available space.

Benefits observed and key success factors

As of the time of writing this case study, the implementation of the digital platform “CBOSS” is ongoing in a live project handled by Teambuild. The team is in the process of collecting sufficient data. However, the following improvement in various KPIs are expected upon completion of the pilot implementation. Broadly, the KPIs focus on on-time project schedule, capacity/space utilization, inventory and labour productivity to assess overall operations efficiency and coordination across factory, yard and installation site.

Sites/Areas	*KPI*	*Expected improvement*

Improve productivity at Factory	Productivity (m^3 per head)	To improve by 20%
	Rework (manhours)	To reduce 20%
Transport (from factory to yard)	Average turnaround time	Planning and coordination improved and waiting time for drivers reduced
Transport (from factory to site)	Average turnaround time	Planning and coordination improved and waiting time for drivers reduced
At fit-up yard	Cycle time by trade	Planning improved
	No. of modules received	Sufficient modules delivered to support site installation
	No. of modules delivered	Sufficient modules delivered to support site installation
	Storage utilization	Sufficient storage to take in all the modules delivered from factory
	Inventory aging	To assess area for improvement for PPVC that are staged at yard for too long
	Rework hours	Data can be used to assess the cost of rework and actions can be taken to reduce them
Transport (from yard to site)	Average turnaround time	Planning and coordination improved and waiting time for drivers reduced
At site installation	Cycle time of hoisting	Efficiency of the hoisting operations is tracked and utilisation of tower cranes can be improved by monitoring the idle time between multiple simultaneous installations
	No. of modules hoisted per day per block	Data can be used to measure productivity trend and actions can be taken where needed
	Reinforced Concrete (RC) cycle time	Data can be used to improve collaborative planning between the RMC supplier and fabricator
	Productivity (modules per head)	Data can be used to measure productivity trend and actions can be taken where needed
	Rework Hours	Data can be used to assess the cost of rework and actions can be taken to reduce them

Lessons learned

1. Well-defined requirements - It is important to have a well-defined scope and requirement. To achieve this, it is best to establish current process maps and gather feedback from experienced process owners prior to the start of the project.
2. Management support - It is also imperative that the project should involve management from the start. It is not just to gather inputs from the management's perspective but also to get their support.

3. Communication - Throughout the project, it is important to have regular updates to users and management. The communication helps to ensure alignment of the requirements across different departments.
4. Progressive implementation – For adoption of new digital platforms, it is a good practice to adopt a staggered implementation approach for multiple modules. With staggered implementation, progress can be closely monitored, and issues can be addressed in a more controlled manner.

Acknowledgements

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