

# Digitalizing IDD for DfMA Value Chain through Lean Principles

## Introduction

Design for Manufacturing and Assembly (DfMA) has enabled a shift in the industry from labour-intensive processes to prefabricated/manufactured production assembly setups that can ensure efficient project delivery in a controlled environment, driving safety, quality, and sustainability. To enable this, an IDD approach of connected systems can ensure information is communicated seamlessly between off-site and on-site stations, as well as between all the relevant stakeholders.

VisiLean, the Lean-BIM integrated construction management solution, designed as a central platform for production management and control, was implemented in a live project in Singapore. Following are the key features of VisiLean:

- **Location-based Planning driven by Last Planner® System:** With a clear focus on Location-based Planning through a bottom-up Last Planner® approach, teams can review the work to be done at each stage of pre-fabrication, through each factory all the way to site for installation.
- **Real-time Updates:** With fabricators at each stage updating the status of production real-time using the Mobile App and flagging and issues that may come up, the entire network of stakeholders is aware of the flow of units at any point of time. This ensures the fabricators and suppliers can remain prepared at each stage for production and delivery as per the project site's requirements.
- **Integrated BIM Visualisation:** With the added advantage of BIM visualisation, the linking of fabrication elements to the production plan allows for fabricators across each factory to visualise the status of each element in real-time in a live 4D environment, thereby making communication seamless and accurate across the supply chain.

## Project Overview

The benefits of VisiLean were realized in a live project constructed by Soil-Build (Pte.) Ltd., one of the Singapore-based top main contractor firms. The project, Verticus, is a high-end residential freehold condo in the city fringe. Located in the heart of Balestier, the project is ideally stationed with excellent last-mile connectivity.



Figure 1: Verticus – Project Render (<https://soilbuild.verticus.net/>)

With a total of 28 levels, including 3 levels of multi-storey carpark and 2 levels of facilities deck, Verticus hosts a series of 1, 2, 2+1, and 3-bedroom apartments, as well as 3(+) bedroom Penthouse options. Verticus offers outstanding benefits in terms of sports facilities, parking lot for every unit, as well as leisure facilities like dining, pool, and sky gardens.

## Implementation of Lean Principles to facilitate IDD for DfMA Workflows

While VisiLean’s production management engine is designed for managing an integrated delivery approach, the workflow was customised on the tool to suit the project team’s requirements accurately for the project. The BIM Model was linked with the tasks (extracted from main contractor’s master project schedule) at each stage, in some cases with multiple elements linked to the same task to ensure the visualisation is accurate for the project stakeholders.

Furthermore, two features were crucial to ensure the success of the implementation which were exclusively developed by VisiLean for the project.

- Documenting **Multiple Baselines** to track the progress at various plan stages
- Introducing a **Mobile App-only access** for precast/PBU fabricators and the site teams

Both these requirements stemmed from a Planning and Control approach; having baselines at each stage helped in tracking the collaborative planning against the master schedule to review any variances. Further, the Mobile App-only access ensured a level of control in terms of giving the flexibility for fabricators to participate in, but not directly impact the schedule. Furthermore, the following use cases were established for efficient project delivery for IDD for DfMA:

Table 1. Lean Principles proposes a transformed approach in DfMA workflows through IDD

Conventional Approach	Transformed Approach
<p><i>Planning &amp; Tracking: Master schedule created by the Project Planner would constantly remain inaccurate due to latency in the tracking of site updates.</i></p>	<p>Integrated Planning: The master schedule prepared by the Project Manager was imported into VisiLean. The subcontractors (including fabricators and suppliers) were then able to visualise the work to be carried out at their end, and breakdown the high-level targets into their detailed work tasks to be executed.</p>
<p><i>Weekly meetings would be conducted between the main contractors and subcontractors and fabricators to discuss the progress, but there was no central platform or tool to keep record of these updates.</i></p>	<p>Weekly meetings were conducted between the project manager and the sub-contractors with VisiLean as a central platform to review the progress updates and monitor the tasks completion and delays.</p>
<p><i>Information Communication: WhatsApp / SMS was used as the main communication tool between the office and the site teams for both progress updates, as well as issues, which made it difficult to manage the information received from the various suppliers and fabricators, further adding to latency and inaccuracy in the data shared.</i></p>	<p>Real-time Progress Tracking: Using a central system, the tasks were assigned to the sub-contractors and fabricators to give live updates in a digital manner.</p>
<p><i>Manual project updates: The project team would spend immense amount of time tracking progress updates and manually record the information in a spreadsheet. These updates would have to be recreated in the schedule, thereby isolating the tracking from the planning.</i></p>	<p>Digital project updates: Engineers from site and factory were able to provide live updates on the tasks, with attached photos, notes, and assigned pre-defined constraints in case of issues with the help of the VisiLean Mobile App.</p>
<p><i>Isolated BIM Implementation: While the project did have 3D BIM models created, but they remained isolated from the production planning and monitoring. The Digital Engineer of the project would update the project status on the 3D models manually to create 4D simulations in a 4D scheduling separate software. The result of this was generally an outdated 4D simulation which would show inaccurate site status. Hence, while the 4D BIM tool would provide a planned vs actual simulation, it was not in real-time.</i></p>	<p>Linking BIM with Lean: The project teams were able to review the live progress from the site on the BIM models linked to the schedule. The BIM module on the platform helped to integrate the planning with production and execution monitoring, as well as status review of any issues on site. 4D BIM, through VisiLean, was also reviewed in real-time for proactive planning decisions.</p>

## Benefits observed and key success factors

- **Linking schedule to 3D BIM Models:** The 3D BIM models no longer remain isolated from the project schedule. The detailed models developed were linked to the schedule which helped in establishing clear visual communication.
- **Real-time 4D BIM:** The ability to visualise the real-time status of work on-site directly on the BIM model played a critical role in monitoring the Percent Planned Complete (PPC) on a regular basis.
- **Live Updates from Site:** The VisiLean Mobile App – *LiveSite*, helped enable participation from teams in terms of giving regular and accurate updates at the click-of-a-button. Any issues faced were communicated instantly with the help of dedicated constraints, with owners responsible for resolving them. All these updates were reflected directly on the BIM model in a Live 4D-BIM format, thereby connecting the site information with the model elements for complete clarity.
- **Comparing the Progress Live:** The planned vs actual progress review was done in the BIM model with the latest live updates from the site by the all the suppliers and fabricators.

## Key Performance Indicators

The following KPIs were observed for all project stakeholders during implementation of VisiLean

- The project team became aware of the exact work to be done and by whom. There is increased clarity of works to be performed.
- VisiLean enabled digital tasks assignment and real-time status updates by the project stakeholders upon completion of tasks. Teams are notified when any tasks are left unchecked or undelivered. Issues are recorded, updated, and tracked with the constraints logged in VisiLean to provide an up-to-date audit trail of records.
- Linking of Lean principles with BIM helped in accurate project planning and monitoring through Live 4D sequencing and scheduling. This was used for comparing the planned vs actual progress as well through 4D BIM for performance improvement through continuous review of variance & issues.
- The project team observed improvements in Percent Planned Complete (PPC) from 38% to 63%, within the first week of adopting VisiLean. 6 months into the implementation of VisiLean, this PPC has been raised to about 86% through regular reviews. Such high PPC has facilitated the main contractors, fabricators, suppliers, and sub-contractors to be more collaborative for their production and tasks delivery.

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