Results of a Pilot Site Study Disrupters, Enablers and Variability Impacting Construction Productivity: Key Findings from VSSP

Abstract

This case study highlighted how proactive measures in planning can significantly mitigate common disrupters in design and construction projects while leveraging digital tools can enhance overall productivity outcomes effectively across various stages of development. Through continued diligence in these areas coupled with strategic approaches tailored specifically towards identified gaps/issues observed during the Construction Productivity Taskforce's pilot studies - construction industry stakeholders can be better equipped to tackle inherent challenges, disrupters and production variability head-on to drive tangible productivity improvements.

Overview

The Vehicle Storage Support Programme (VSSP) project at Ashchurch, Tewkesbury, represents a major public-sector development to deliver modern, sustainable, and effective storage and maintenance solutions for the British Army's land equipment fleet. The project involves regenerating the existing site with new infrastructure and new modern facilities. Awarded by the Ministry of Defence through the Defence Infrastructure Organisation (DIO), to Skanska, this £259 million project commenced in 2022 and is planned for completion by 2027.

This case study provides an analysis of the structural steel frame operations by William Haley Engineering Ltd and the delivery of the complex design solution using Adept Management Ltd "Flow" system of integrated design planning and control. A key aim of the study was to assess the efficiencies of these operations, gain insights into key productivity disrupters and enablers, and provide insights and solutions into how design and construction productivity can be improved.

The measurement and analysis of the collected data focuses on productivity metrics during the design and construction of the project from May 2023 to June 2024, using the framework established by the Construction Productivity Taskforce Measuring Construction Site Productivity: A Seven-Step Framework for Success (2022).

Figure 1 View of structural steelwork within a typical stores building

Background

The study examines the factors contributing to design and construction productivity on the project.

From a construction perspective the study examines the factors impacting on the delivery of the structural steel frame construction. The delivery team's strategies included conducting early-stage productivity and buildability reviews and establishing a measurement framework to record and monitor key data such as piececount (number of pieces installed per day) and labour productivity (pieces per worker per hour). The data was reviewed on a weekly basis to assess performance and identify productivity enhancing solutions.

From a design perspective the study examines factors impacting on design delivery and control, using digital technologies to improve design planning, reporting, productivity and delivery certainty. To achieve this, Skanska reached out to Adept Management Ltd, an expert in integrated design planning, ahead of the contract award to assist the project in establishing an integrated design programme and associated project control tools using their “Flow” digital design management platform. This enabled greater visibility on design progress and issues disrupting design, enhanced collaboration across all design disciplines and improved design productivity.

Figure 2 An overview of the 4 key stages of the Flow system of integrated design planning (Adept Management Ltd)

Key Findings

Improving Productivity through Minimising Production Disrupters and Variability

Partnering with William Haley Engineering Ltd during the early phases of the project provided design and buildability insights, which contributed to an efficient construction process. This allowed clarification of the design intent by addressing constructability considerations before works commenced on site, ensuring a 'design for construction/delivery' approach that aligns with the project programme constraints.

By adopting the Construction Productivity Taskforce's measurement framework during the full lifecycle of a storage building, the project team wanted to:

- Better understand the main disruptors and enablers that impact on construction productivity, so that these issues could be better addressed and solutions developed to eliminate them from the delivery process. Given the relative geographical remoteness of the project, it was viewed that there was a heightened risk of productivity disruptors such as logistics, material delivery and maintain labour levels. If these items could be better identified and measured, then it would be easier to identify appropriate solutions to mitigate these risks.
- Improve understanding of potential challenges in measuring productivity to refine measurement on future builds

Data was collected using daily diaries, Excel spreadsheets initially and then Airtable collected in accordance with the CPT Measurement Framework.

Following early engagement and planning, the project team focused on two specific productivity measures. These were: (1) piececount (number of steel pieces installed per day) and, (2) labour productivity (pieces per worker per hour). In both cases, these were assessed against planned and actual outputs. Along side these measures, the project team measured the variability in production output and recorded any factors disrupting or enabling productivity using site diaries as part of the medium-short-term production control process used.

Over the course of the project, the results of this study showed some clear trends in how productivity was being impacted and what were the main factors involved (Table 1). The results also showed the high variability in production output that was experienced during the course of the works (*Figure 3 Piececount variability based on crane usage (University of Cambridge)*

and *Figure 4 Production variability experienced across a typical working week (University of Cambridge))*.

By using this data, the project team was able to focus short-medium term planning on improving communication and co-ordination to reducing the disruptors and thereby reducing variability in production output. The project team also incorporated the findings of this study into their medium-short term planning process to improve the accuracy of the planning process against planned deliveries and work sequences.

Disrupter	Occurrence (%)
Design issues (errors/missing details)	14-20%
Material deliveries/ logistics	8-16%
Activity scheduling clashes	6-12%
Weather conditions	5-10%

Table 1 Key disrupters impacting on productivity.

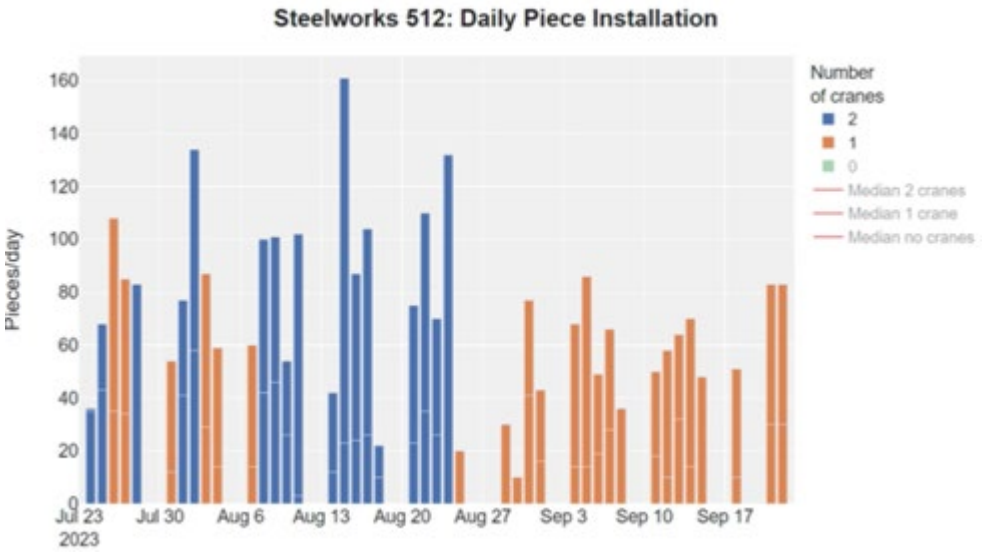

Figure 3 Piececount variability based on crane usage (University of Cambridge)

Production was greater when there were 2 cranes on site but this did not double productivity. Severe weather impacted production at the end of September.

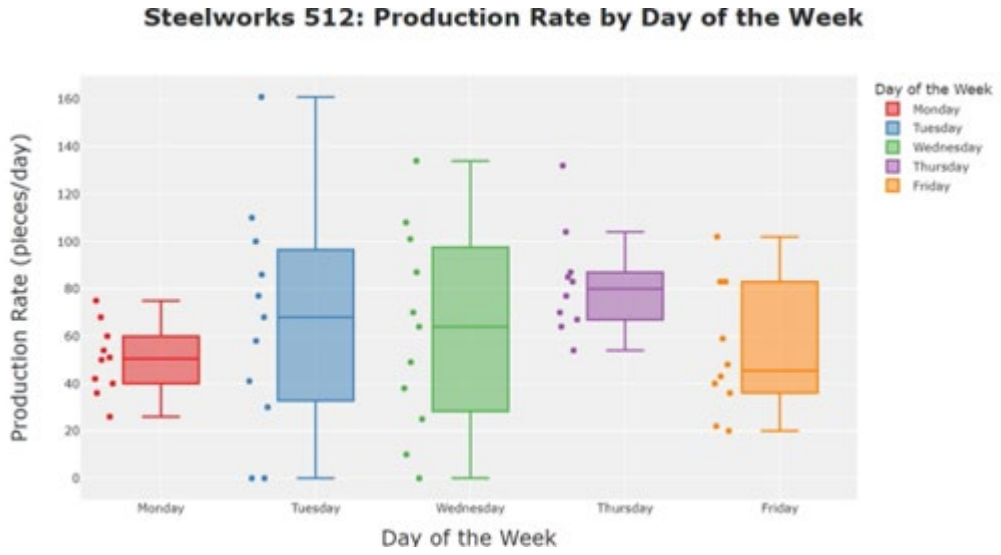

Figure 4 Production variability experienced across a typical working week (University of Cambridge)

Improving Design Delivery Certainty and Control

From a design perspective, the project involves design complexity with over 4,000 design activities required across 14 individual buildings and worksites. Skanska and its design partners recognised that delivering the design on time was a key success factor to overall project success that needed strong control over the development and delivery of the design.

To ensure certainty in design delivery and control, the project team utilised Adept Management Ltd bespoke 'Flow' digital design planning system, previously known as the 'Analytical Design Planning Technique' (ADePT Technique). This approach provides a systematic means to plan and co-ordinate design delivery in detail and integrate with the procurement and construction programme. Once the baseline 'Integrated Design Programme' is established the project team then utilised the 'Flow' systems unique approach to harnessing 'last planner' principles in ensuring design delivery and production control (*Figure 5 Illustration of the design 2-week lookahead delivery and reporting cycle using "Flow"*). Through regular fortnightly reporting cycles, each of the consultants and stakeholders utilised dedicated workplans extracted from the programme that highlighted their key tasks to be done over the subsequent two-week period. The system provides a simple user interface for reporting, with key members of the team enabled to report progress on tasks, key issues impacting the progress and any constraints to be overcome to enable those forthcoming tasks to progress as planned.

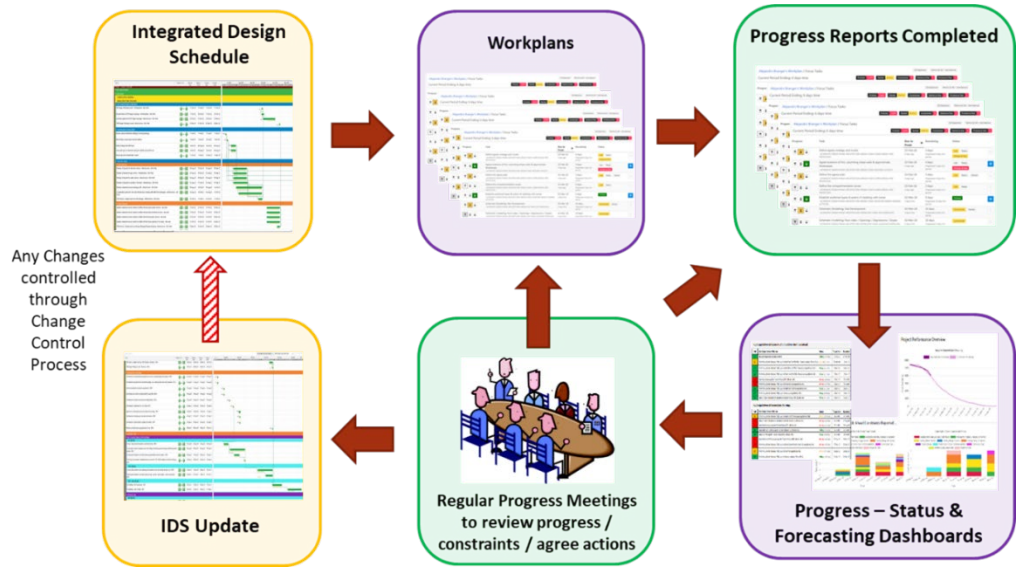

Figure 5 Illustration of the design 2-week lookahead delivery and reporting cycle using "Flow"

A key benefit of this approach was the simple user interface provided for reporting, with key members of the team enabled to report progress on tasks, key issues impacting the progress and any constraints to be overcome to enable those forthcoming tasks to progress as planned (*Figure 6 A typical output from Flow summarising key issues impacting design delivery*).

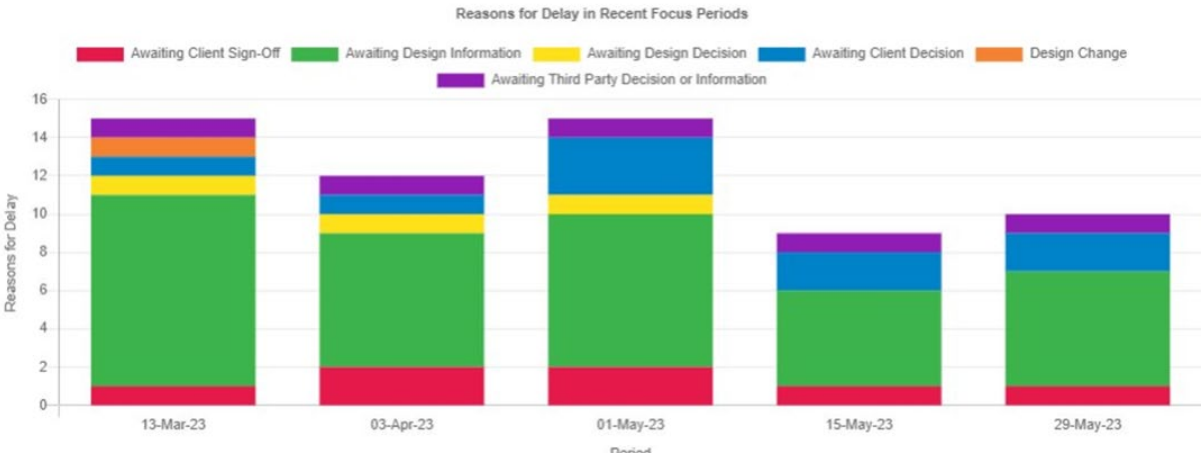

Figure 6 A typical output from Flow summarising key issues impacting design delivery

By using the Flow digital platform, the project was able to better control design delivery to maximise design productivity.

The key benefits gained from using Flow were:

- Provided overall visibility on design progress, status and issues to focus on using a "Last Planner" short term (2-week lookahead basis) enabling design production control to be managed in co-ordination with procurement and construction programmes (*Figure 5 Illustration of the design 2-week lookahead delivery and reporting cycle using "Flow"*).

- Provided visibility for the entire project team on the key sequence in which they needed to work to achieve the challenging timescales
- Enhanced collaborative engagement with the construction team and the consultant team to review programme activities that are relevant to that particular programme period. For example, highlighting technical and programme blockers which can be acted upon to improve efficiency.
- The structured approach provided by Flow enabled a consistent line of communication with the remote located team members and a rigorous means of capturing both the progress and issues that were impacting the team so that timely action could be taken.
- Identifying early warning on the risks to delivery and visibility of the critical chain of tasks to identify where action could be taken.
- Ensuring the construction team were able to progress in line with the project programme with the required design information being delivered with certainty.
- Assisted the project team in assessing the impact of proposed changes of the overall project programme. This provided improved visibility of the impact of change that could be more efficiently reported to the client.
- The provision of a focused and accurate reporting dashboard to assist in project reporting to the team and to the client.

Recommendations

This case study provides several valuable lessons that can be applied to future construction projects:

1. **Early engagement in design and collaboration** with supply chain partners was essential to ensure certainty in design delivery and the buildability of the design. This approach resulted in a 'design for construction/delivery' that aligns with the project's programme constraints.
2. **Establishing specific success metrics:** The project delivery team effectively implemented the use of metrics to gain deeper insights into productivity. By continuously measuring design progress, steel piece count, labour productivity and production variability, the project team was able to implement tactical solutions and adjust the workflow that resulted in productivity gains. However, they identified that material delivery and logistics can impact production so this data needs to be included in the cycle time of production as well as the type of pieces being installed.
3. **Embracing digital tools to optimize project outcomes:** Utilizing Adept Management's "Flow" digital design management platform to manage design delivery was key to the success of delivering the design in line with the procurement and construction programme. It ensured the construction team was able to progress in line with the project programme with the required design information being delivered with certainty.
4. **Planning for External Factors**: The project delivery team learned the importance of planning for external factors, on this relatively remote site, such as traffic and mechanical failures. By considering worst-case scenarios, they were able to maintain a steady workflow and ensure timely delivery of the structural steelwork.

References & Acknowledgements

"Measuring Construction Site Productivity: A Seven-Step Framework for Success", Construction Productivity Taskforce, 2022 (https://bethebusiness.com/our-thinking/measuring-construction-site-productivity-a-seven-step-framework-for-success/)

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