COMPANY OVERVIEW

DPS

COMPANY WEBSITE
www.dpsgroupglobal.com

DPS Engineering is a global Project Management and Engineering company providing project and programme management, procurement, design, construction management, health and safety management, commissioning, qualification and start-up. Our sector expertise spans many markets including Biotechnology, Pharmaceutical, Medical Technologies, Oil and Gas, Advanced Technology, Food & Beverage, Energy, Science & Education. DPS has more than 1600 employees globally, with 14 offices located in Europe, Middle East, Asia, and the USA.

OVERVIEW & BACKGROUND TO THE LEAN INITIATIVE

AUTHOR

Richard Casey

This case study examines how Lean principles and tools can be utilised to improve construction projects schedules and costs via the identification and mitigation of delays. The goals of this project were to determine how Last Planner® System (LPS) constraint data could be utilised to identify activities to complete a Lean intervention on one of DPS's ongoing construction projects, and if an improvement roadmap could be generated. To establish a baseline for comparison, DPS completed a literature review of construction delays on international projects. DPS then used delay data generated by the LPS of schedule management from a project in flight to identify opportunities for improvement in a Kaizen event. Lean tools and processes were then utilised during the Kaizen to identify solutions and implement the improvements.

LEAN INITIATIVE UNDERTAKEN – LEAN THINKING, TOOLS, TECHNIQUES

The project was completed in three phases:

i. Phase 1 – DPS determined common causes of delays on construction projects by developing a ranking table of construction delays for comparison with existing DPS construction projects.

ii. Phase 2 – DPS then determined the most common causes on delays on construction projects currently being managed by DPS ATG by researching six weeks of data from LPS variance information; collating and analysing the variances into a Pareto of opportunities; using Pareto data to identify activities for investigation; and utilising direct observation to determine the current status of labour productivity and the main causes of delays on construction projects.

iii. Phase 3 – DPS made targeted improvements on an ongoing construction project by facilitating a Kaizen event and utilising Lean tools to identify and make improvements.

Implementation

A project steering team was formed consisting of five project managers from DPS ATG. Four of the project managers were directly responsible for the construction management activities on the projects, and the fifth manager was utilised as an independent observer for the data gathering and progress of the team. The agreed goal was "to determine if Lean tools could be utilised to identify projects that could reduce the overall construction execution schedule by >10% and corresponding costs by >10% by the reduction of delays identified by analysis of LPS information". The case study was completed in four stages.

Stage 1 – Data Gathering
Level 1 data analysis – LPS variance. The team gathered 6 weeks of variance (delay) date from the LPS constraint data and collated and characterised into a Pareto.
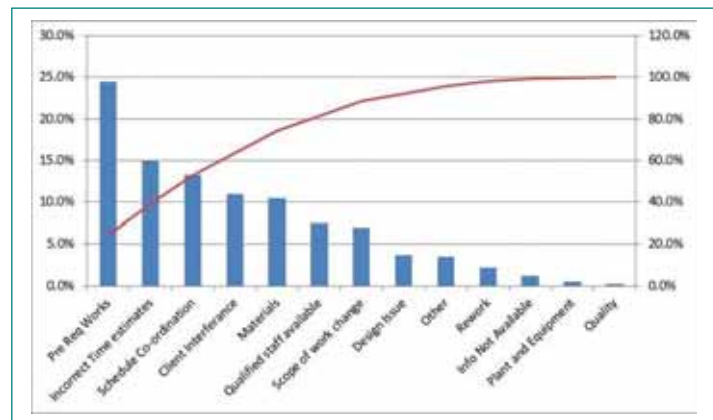

Figure 1. Most Common Delays in Construction Execution on DPS ATG Projects

On review of the findings with the project steering team, it was agreed to focus on determining the causes of prerequisite works and incorrect time estimates. The agreed goal was restated as being "to determine if Lean tools could be utilised to identify projects that could reduce the overall construction execution schedule by >10% and corresponding costs by >10% via the reduction of delays during prerequisite works and improving incorrect time estimates".

Level 2 data analysis – LPS Percentage Plan Complete (PPC). DPS completed a deeper analysis of the PPC performance to identify what project activities caused the most prerequisite and incorrect time estimate delays. The following activities were identified as low PPC performing (avg. <70%):

• Containment Installation

- Pipe-fitting and Welding
- Raised Ceiling Installation

To facilitate an additional level of detail, and to identify the specific areas of investigation, a direct observation exercise was completed on each activity.

Level 3 data analysis – Gemba and Direct Observation. In a manufacturing environment, Overall Equipment Effectiveness (OEE) provides a mechanism to identify untapped capacity by identifying and eliminating impacts to equipment availability, speed, and quality. In a construction environment where the trade resource is the equivalent of equipment, the use of direct observation utilising OEE principles can be utilised to determine the main causes of impacts to Trade Labour Productivity. The DPS Productivity Manager completed a direct observation exercise with the crews completing the top three identified activities over a five-day period to establish the average productivity of the trades during that period, as well as the main causes for non-value-added (NVA) activities. The impact to the trades' productivity was categorised into twelve impact areas (excluding safety).
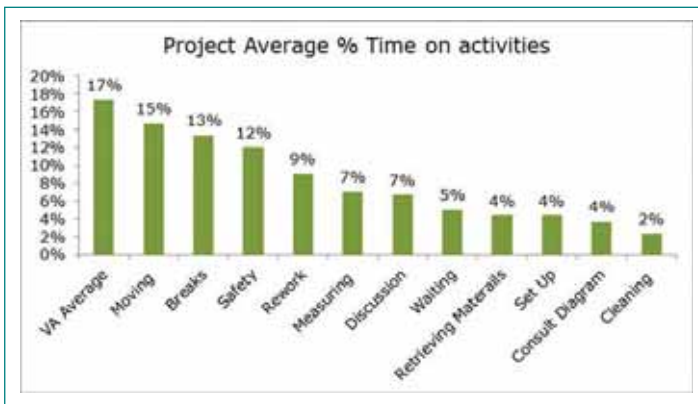

Figure 2. Construction Labour Productivity pre-Kaizen Project Implementation

The average trade productivity was measured at 17% for the project. This indicated that 83% of a trade's day was spent on activities other than what they were being paid to do. At this stage, DPS deemed that enough data had been gathered to move to the Kaizen phase of the project.

Stage 2 – Kaizen Preparation
DPS presented the data to the onsite construction management team and outlined the reasons why the Kaizen was to focus on prerequisite works delays and incorrect time estimates. The timeframe for the Kaizen was agreed as one week, but the continuous improvement duration was agreed as five weeks incorporating one week for the Kaizen event; three weeks to implement findings; and one week to complete a recheck to see if the desired improvements were made. As the concept of Lean was new to the construction team, it was agreed that tactile and demonstrable tools would be used that could be replicated by the trade companies on other projects and sites.

Stage 3 – Kaizen Event
DPS facilitated training on the basics of Lean, including Lean principles, the 8 wastes, the infinity matrix process, the concepts of value-add (VA), necessary non-value-add (NNVA), and NVA, and the direct observation process. The

research data was then presented to the Kaizen team members, and the Kaizen team agreed to focus on four major activities during the Kaizen:
i. Waste walks post-training to identify sources of waste.
ii. Brainstorm session using an Infinity Matrix to identify Just Do It (JDI) improvements on any delays.
iii. Targeted reductions in Motion during ceiling tile installation using direct observation.
iv. Targeted improvements in Materials Management onsite using a 5S exercise.

The Kaizen goals were agreed as a >10% reduction in delay causing activities and a >10% reduction in project costs due to the reduction of NVA activities.

Brainstorm Session – Infinity Matrix – A brainstorming session was completed to identify a list of JDI improvements which were changes to be made that were within the control of the project team and required negligible cost and effort. An Infinity Matrix was used so as to help the construction team determine what activities could be improved.

Table 1. Infinity Matrix post-Brainstorm Session

Motion Improvement – There were multiple observations of excessive moving but the Kaizen team decided to focus on the movement associated with installing ceiling tiles. A direct observation was completed, and the use of the Spaghetti diagram showed the crew how the practice of placing the pallet of ceiling tiles in one location increased their walking distance as the day went on. The proposal from the team was to put the material pallet on wheels and move the pallet with the team as they moved across the construction area.

5S Improvement – For retrieving materials, the team identified two areas for improvement: walking distance to the material shed; and materials not stored correctly. As a JDI improvement, it was proposed to move the material shed closer to the work place and a 5S activity was planned for the Materials storage areas. One shed was audited and a full 5S was completed to reorder all materials. Bins were to install bins to sort parts into their required positions. A reorder Kanban system and set minimum stock levels for re-ordering. Finally, cable rolls were installed to ease identification and cutting of cable lengths. The team agreed to proliferate the 5S activity to the other materials sheds onsite.

Report-out – The Kaizen team had identified 12 specific improvements to implement over the remainder of the project which was appreciated by the client and was agreed to be implemented over the following 30 days.

Identified Potential Schedule Savings – Schedule savings were calculated based on full elimination of the NVA activity. While it was recognised that this would not be achievable, the Kaizen team wished to proceed with that target. To this point, a 16% reduction in schedule impacts was proposed by the Kaizen team.

Table 2. Schedule Reduction Duration Calculation

Activity	Team Size	Hrs per week	Duration Weeks	Total Project
Containment	3	360	11	3960
Piping	3	360	13	4680
Ceiling	4	480	18	8640
			Project Hours	17280
			Target Saving	2733
			% Savings	16%

Identified Potential Cost Savings – Cost savings were calculated based on an average cost per hour rate of €32.50 for each hour saved due to full elimination of the NVA activity. To this point, a potential cost saving of €88,822 was proposed by the Kaizen team as being achievable via productivity improvements from a reduction in delays.

Stage 4: Implementation Plan
The improvements identified were broken into three phases (per Table 3), and the 30-day roadmap was published to the onsite construction team with agreement that a 4-week check-in would be completed.

Table 3. Three-Phase Improvements

Phase1	Phase2	Phase3
2 weeks	2-4 weeks	4 weeks
Just Do it	Purchasing required	Process change
Vices to be installed on all work benches	Spur Audits completed	Pre walks of area's
Mobile band saw to be installed	Material Pallets on Wheels	Horizontal Welding
Individual drawings to be provided to each team	Material Bins installed in Materials shed	Pre Marking of Area's
	Power Tools	

LEAN INITIATIVE IMPROVEMENTS & IMPACT

The project was closed out at the start of March 2018 with a review of the project results with the team. The project was deemed successful as a total of twelve improvement projects were identified with a targeted increase in labour productivity of 63%, a targeted reduction in schedule of 16%, and a target of €88,822 in cost savings.

Result 1 – Labour Productivity Increase
Average labour productivity for the three main activities measured was shown to have increased by 64%. The improvement was driven primarily by a reduction in moving, rework, measuring, and retrieving materials which was all driven by the implementation of the Kaizen improvement activities.

Figure 3. Construction Labour Productivity Improvement post-Kaizen Project Implementation

Result 2 – Kaizen Measured Cost Reduction
Overall cost reduction on the project was calculated at €41,190 versus a goal of €88,822 which equated to a 46% achievement of the goal set by the Kaizen event. While still a great achievement the loss of €46,642 in savings was attributed to the late implementation of improvements.
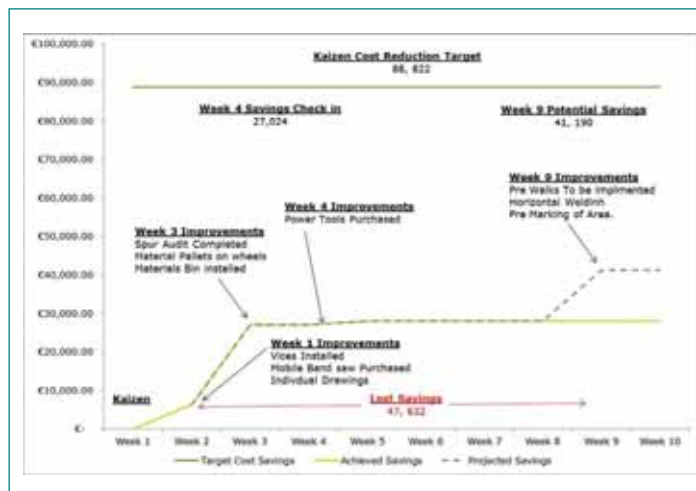

Figure 4. Construction Cost Improvement post-Kaizen Project

Result 3 – Kaizen Measured Schedule Reduction
Overall schedule reduction on the project was calculated at 905 hours versus a goal of 2733 hours, which equated to a 33% achievement of the goal set by the Kaizen event. While still a great achievement, the loss of 1827 hours in savings was again attributed to the late
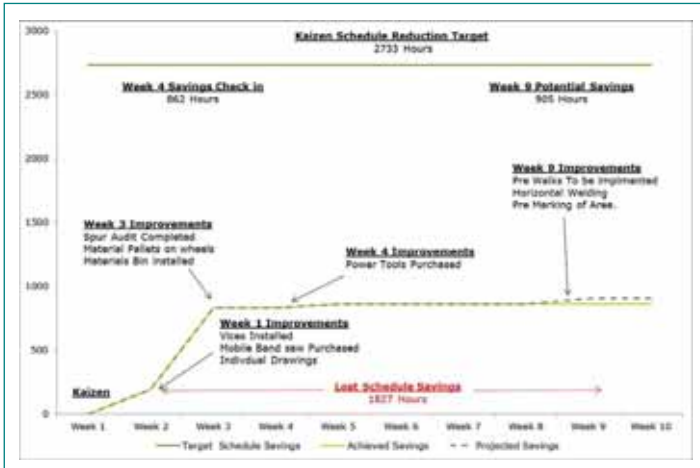
Figure 5. Construction Schedule Improvement post-Kaizen Project

implementation of improvements.

Improvement Summary
The implementation of the project proved that Lean tools and principles could be applied to the construction industry and that delays in construction can be measured, quantified and improved. While Lean principles could be used, as construction is a tangible industry it was necessary to use tools that could be quickly applied to the construction activities and the tools had to be thoughtfully selected for the construction audience. The use of the 8 wastes, the infinity matrix, direct observation and the 5S provided tangible and observable improvements for the trades. This helped significantly to encourage their participation.