



LEAN Construction in the Road Maintenance Sector

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LEAN Construction in the Road Maintenance Sector

Introduction

Under the auspices of the National Road Maintenance Review opportunities to embed LEAN Construction philosophy within the public road maintenance industry was suggested as an avenue worthy of further investigation.

As such a subgroup of the NRMR Stakeholder Group took part in a lean construction workshop to explore opportunities to improve performance of roads maintenance in Scotland by the adoption of Lean Techniques.

Agencies present at the workshop all recognised that LEAN principles, and demonstration projects, had been tried within their organisations. This was mainly as part of a wider corporate initiative rather than something targeted to the road maintenance sector.

There was also a feeling that previous attempts to use LEAN had be directed towards discrete improvement activities, such as 5S or Kaizen, rather than developing a broader understanding of LEAN principles and regarding it as a “core skill” within the team, similar to other technical skills that would exist in the sector.

It was felt that there would be merit in looking at a pilot to explore the potential for LEAN to be taught as a core skill to a team.

As a result of this and subsequent discussions with Transport Scotland it was agreed that a bid should be made to the SRRB for a wider pilot.

The aim of the pilot was to:

Embed lean construction philosophy within the public road maintenance industry, through three separate but linked improvement projects involving staff from Aberdeenshire Council, Dumfries and Galloway Council and Transport Scotland.

6ix Consulting Ltd were invited to provide a proposal for Lean Roads maintenance training and facilitation services.



Initial Proposal

The proposal was to train three cohorts of learners in LEAN Thinking applied to Roads using the Business Improvement Techniques (BIT) SVQ to embed the learning.

Three separate, but linked, Improvement Projects were proposed involving staff from Aberdeenshire Council, Dumfries and Galloway Council and Transport Scotland.

Activities within the Councils were to focus primarily on operational improvements to maintenance operations.

Activity within Transport Scotland was to either focus on improving Transport Scotland's own internal processes or seek to improve supplier performance by identifying where Transport Scotland can become a "better customer".

Project Description

The Approach

The principles that informed the approach were grounded in the philosophy of Lean continuous improvement.

Customer Focus is the starting point where teams are encouraged to view processes through the customer's eyes to establish what adds value and what does not. It is essential that at this very early stage participants are able to clearly distinguish Value and Waste from a lean thinking perspective.

A high level of Empowerment and Engagement is achieved by taking a "learning by doing" approach. "Lean doing" is just as important as "lean thinking" and so the training process is based around the delivery of real improvement projects scoped by the delegates under our guidance and congruent with the organisations vision. The aim is to make LEAN directly relevant to the "Day Job", rather than being seen as an "add on" initiative.

It was expected that the project teams would achieve tangible savings within the life of the training. Wherever possible improvement activities were undertaken by cross-functional teams to engender closer understanding between organisational departments and enhance team learning.



Teams were chosen from individuals who had the day to day responsibility for the task at the centre of the Improvement Project. They had the authority to make changes to the processes, and these changes had the potential to impact directly on their “Day Job”.

Structure of the Pilot

As outlined above, three discrete organisations were involved in the project. The pilot was therefore split into 3 cohorts, one from each organisation. However, to maximise the potential for shared learning and knowledge transfer, the programme allowed for joint sessions at critical stages.

The 3 stages of the Pilot are explained in the following sections.

[Train three cohorts of learners in Lean Thinking applied to Roads using the Business Improvement Techniques SVQ to embed learning](#)

Three separate Improvement Projects were undertaken, with candidates from Aberdeenshire Council, Dumfries and Galloway Council and within Transport Scotland.

Activities within the Councils primarily focused on operational improvements to maintenance operations. Whereas activity with Transport Scotland was focus on improving Transport Scotland’s own internal processes and seeking to improve supplier performance by identifying where Transport Scotland can become a “better customer”.

[Example Activities and Training Structure](#)

Improvement Activities were based around the following 3 phases:-

[Diagnostic phase 1](#)

- Analysis of past and current performance
- Identification of issues and improvements
- Quantification of current problems in terms of time, cost and quality.
- Risk Analysis
- Planning improvement activities

Teams were taught how to analyse performance metrics and data to identify opportunities using the lean philosophy.



Improvement phase 2

Deployment of appropriate tools as needed by the process or project in focus.
These may include:-

- **Collaborative Planning**
 - A Master Programme is formed collaboratively by the suppliers who will actually do the work, assisted by the main contractor, design team and client. This is followed by detailed analysis of the planned activities due in the first five weeks of the project, ensuring that all resource and information is in place well before tasks are due to start.
 - The collaborative planning process is maintained throughout the project by means of weekly meetings of the trades foremen on site, which serve to plan next week's work in detail as well as update the original five week time window. Delivery performance is measured to the day and any reasons for plan failure captured to provide a focus for improvements.
- **Workplace Organisation**
 - Based on the 5S or 5C system of workplace organisation, this technique seeks to ensure the safest and most efficient workplace is established, maintained and improved.
- **Visual Management Systems**
 - How to use Visual Management to help keep a process in control, prevent errors and enhance communication.
- **Problem Solving Techniques**
 - Advanced techniques for tackling more complex problems such as fishbone cause and effect, pareto analysis and 5Why root cause analysis.
- **Failure Mode Effect Analysis (FMEA)**
 - Planning to protect the delivery of a project by the detailed consideration of all potential causes of plan failure. Both Preventative and containment actions must be in place.
- **Flow Process Analysis**
 - Value stream analysis of a process leading to quantifiable improvement.



- **Line of Balance and Batch Size reduction**
 - Takt Time, the minimisation of work in progress and highly visual programming techniques – a lean approach to construction planning and control.

Knowledge sharing and review workshops

As an aim of the pilot was to ensure the maximum learning is gained, the programme allowed for three additional workshops to bring all three cohorts together, namely:

1. Launch workshop to understand the programme and clarify aims and objectives
2. Mid term review – presentations from each cohorts to the others to share what has been learnt so far – successes and difficulties to date
3. End of programme review – to award certificates, share achievements and discuss next steps.

Evaluation and Review

The final aspect of the Pilot was to review the learning and outcomes that were delivered to the candidates. The programme therefore included a role for academia. Prof Horner from University of Dundee carried out engagement sessions with the candidates as the pilot progressed to allow analysis of the learning and understanding that was developed throughout the process.



Cohort Project Summaries

Aberdeenshire Council

This was a practical Improvement Project that considered the value of time lost due to incorrect or incomplete information flowing from the Design Phase to the Construction Phase of a project.

Using LEAN techniques the team evaluated every step in the current process to identify that elements that had potential to negatively impact on the “customer” or in this case the owner of the next step in the process who relied on that piece of information to advance the project.

This piece of work allowed the Team to develop a new “Job Status Tracker”. As well as highlighting programming deadlines and interconnections between tasks, it also provided information for a visual Performance Board. This is now used at a Team level to identify and mitigate scheduling conflicts across a wide programme of works.

Formal evaluation of the savings attributed to the Job Status Tracker is still ongoing. However, the principles are currently being built into a new Scheme Progress and Financial Monitoring Suite that is being developed for all Teams to deliver the 2017/18 programme of works.

Dumfries and Galloway Council

This was a very practical Improvement Project that considered the variation in productivity and cost of pothole repairs.

At an operational level Dumfries and Galloway Council is split into four regions. An initial analysis of the available data showed that there was considerable cost variation in the cost of pothole repairs across the regions.

Initial data was not sufficient for a full depth analysis of the differences, so a number of controlled trials were initiated to determine an optimum methodology and establish a performance Base Line.

As part of this process Best Practice from all regions was captured.

Analysis of the controlled trials and the existing best practice allow optimum resourcing and methodology to be agreed and put into trial.

Early indications are that the project has been very successful with trials evidencing a 50% reduction in cost per m² and also significant productivity improvements.



The team now wish to continue to apply the learning to other areas.

Transport Scotland

While engaged in the public road maintenance sector, the role of Transport Scotland is somewhat different to the two Local Authority Cohorts involved in the project. Transport Scotland uses an outsourcing model to delivery maintenance responsibilities. For this project TS chose to focus on the application of lean principles to their activities as a client (in the management of the Operating Company Contract) and as a public sector information provider when fulfilling their duties as Civil Servants supporting Government.

The assembled team comprised selected members from each of the teams in TRBO rather than all members being from a single team. The intention was identify areas for improvement that cut cross team boundaries and to distribute the learning across the Directorate.

The group initially looked at aspects surrounding correspondence and the response to parliamentary correspondence, freedom of information requests and ministerial correspondence. This examination identified an overly convoluted clearance process but also revealed a very high success rate in meeting deadlines. This led to the development of a refined process with greater clarity between teams on timescale and the impact of delays.

Although all team members are impacted by correspondence, some experience a greater impact than others and subsequent discussions led to the identification of a number of more localised projects by individual members, to which the group then turned their collection attention seeking improvement. These included:

- Improved arrangements for monthly OC progress meetings supported by a streamlined reporting regime.
- Team and personal workload management – visual management
- Publication for Road Orders related to speed limit changes

Towards the end of the pilot, the group spent some time exploring how collaborative programme planning could be applied to the routine maintenance programmes with Operating Companies. This led to the submission of a funding bid to CITB to support a wider project applying the lean principles learned. This bid was unsuccessful and TS have since been exploring other avenues.

Evaluation

As outlined previously the Pilot looked to deliver two main outputs, namely:

1. Deliver formal Business Improvement Techniques (BIT) SVQ qualification
2. Embed LEAN philosophies with the cohorts

Qualifications

This BIT qualification consists of the following mandatory and optional units. Note that the majority of the new knowledge required should naturally occur as a result of the facilitated improvement projects.

Level 2 -Total 6 Units

L2 Mandatory Units (must do all)

- Complying with Statutory Regulations and Health and Safety Requirements
- Contributing to effective team working
- Applying Workplace Organisation Techniques
- Applying Continuous Improvement Techniques (Kaizen)
- Creating Visual Management Systems

L2 Optional Units (must do 1 of these)

- Applying Problem Solving Techniques
- Applying Flow Process Analysis

Qualification Success Rate

27 candidates started the Diploma programme as outlined above.

At conclusion of the pilot 18 candidates had successfully completed the BIT qualification, a success rate of some 67%.

While in itself, that is a reasonable success rate, it has to be borne in mind that one organisation was not in a position to fully engage in the process, as outlined previously in the report, during the entire period of the Pilot.

If evaluation of the results is limited to the two organisations that fully were in a position to fully commit to the pilot then the pass rate is 16 from 17, or 94%. This is



obviously an outstanding pass rate, and does appear to indicate that the approach was successful in delivering that particular outcome.

Embedment of LEAN philosophies

To assess the level of embedment within the cohorts the understanding of LEAN principles and the perceived level of expertise in LEAN application was analysed at various stages throughout the pilot.

This analysis focused on 3 key indicators:

- Extent that LEAN assists with “Day Job”
- Expertise in LEAN techniques
- Value of LEAN

From inception of the Pilot to conclusion, the views of participants changed as follows (Scored out of 5):

- Extent that LEAN assists 2.4 to 4.0
- Expertise in LEAN 3.1 to 3.7
- Value of LEAN 3.5 to 4.2

At the final report out session participants were also asked to highlight the main benefits of the programme. The main recurring themes were:

- team/group working
- process mapping
- identifying opportunities
- eliminating waste/improving efficiency
- SOPs/standardisation

At the report final workshop information on the content and delivery of the programme was also evaluated (Scored out of 5)

Consistency of Content	4.2
Delivery was consistent	4.4

Conclusions

The aim of the Pilot was to:

Embed lean construction philosophy within the public road maintenance industry, through three separate but linked improvement projects involving staff from Aberdeenshire Council, Dumfries and Galloway Council and Transport Scotland.

While the projects, outlined previously, that each organisation chose to work are important, the main issue under evaluation was the level of embedment that this structured approach achieved.

At the outset of the programme it was recognised that a number of LEAN initiatives had existed in various Local Authorities. While some of these delivered results there was a concern that the techniques were not focused on the public road maintenance industry and that the lessons learned from these discrete initiatives were not continued as a core way of working.

The approach in this trial was focused on a deeper understanding of LEAN philosophies directly targeted to the road maintenance sector. The targeted approach was considered to be something quite different to the previous LEAN initiatives, which had tended to be generic as they were part of wider corporate programmes.

Another unique feature of this pilot was that as well as demonstrating relevance to the “day job”, the programme intended to deliver a tangible personal result through award of a Diploma qualification. Again this qualification was not a generic LEAN diploma, but one focused on LEAN in the construction sector.

During the pilot, individual members of the three cohorts were asked to evaluate three indicators as a proxy for their broader understanding of LEAN and its applicability to their “day job”.

The first evaluation, at the initial workshop returned the following (scored out of 5):

- Expertise in LEAN 3.1
- Extent that LEAN assists 2.4
- Value of LEAN 3.5



Interestingly the evaluation of expertise in LEAN was relatively high. This is possibly related to the exposure that almost all participants had to LEAN through previous initiatives undertaken in their workplace. However, with that relatively high expertise score, it was surprising that the extent to which LEAN assisted with the day job was scored quite so low.

During the final workshop, participants' views were sought again: The final evaluation returned the following:

- Expertise in LEAN 3.7
- Extent that LEAN assists 4.0
- Value of LEAN 4.2

Perhaps understandably the increase in the “expertise” indicator was not that pronounced. As individuals started from a relatively high base this may have been expected. However, there were considerable improvement in the other two indicators.

It may be that case that with this greater understanding of what LEAN could do to assist with the “day job” and the value that could be driven through LEAN principles, participants had re-evaluated their initial expertise level.

In any event, it does seem to clear that the approach improved all 3 factors, and most encouragingly the improvement in factors related to the job they did, and the value that could be driven by LEAN, increased by the most.

In addition to their own understanding the participants were asked to identify the most important elements of the pilot. The recurring themes were:

- team/group working
- process mapping
- identifying opportunities
- eliminating waste/improving efficiency
- SOPs/standardisation

Interestingly, working as part of their team, their normal day to day colleagues, was the highest ranked feature. The approach was something novel in this pilot, as the cohorts were chosen to be individuals who routinely worked together and had day to day responsibility for the activity under consideration.



Finally, the participants were asked to consider the way in which the course was taught. Two indicators were chosen, and evaluated at the final workshop. The results are shown below (scored out of 5).

Consistency of Content	4.2
Delivery was consistent	4.4

These scores are high, and would seem to indicate that the mix between academic information exchange and relating to the “day job” resulted in a programme that was valued by the participants.

From the results, it would appear that this approach has gone some way to validate the importance of LEAN in the road maintenance sector in the minds of the participants in the trial. In essence the pilot has increased “embedment” of the principles within those teams.

Although supposition, the results do suggest that delivery of the programme to a team was a valuable element of the pilot. Where the cohort was a team that routinely worked together on a task, such as the two Local Authority Cohorts, the level of engagement was high and the ultimate end project was good.

Interestingly the achievement of a recognised qualification was not reported as a significant factor in the evaluation of the programme. However, the consistency of content and delivery was scored highly. This is perhaps correlated to that requirement to meet the set parameter of the BIT Diploma.

These conclusions are based on information collected during the pilot and at the final workshop session. While the results are encouraging, they do nothing to evaluate the sustainability of the application of LEAN principles with the teams involved. This may be a step that is worthy of further consideration.

Appendix 1 – Pre Programme Presentation Session

AGENDA

25th November 2014

Location: Tayside Contracts, Inveralmond Industrial Estate, Ruthvenfield Rd, Perth PH1 3EE

Roads Maintenance Lean Review Scoping Workshop

09:30 - 09:45	Arrival and coffee	ALL
09:45 - 09:50	Background - why we are here	Phillip McKay
09:50 - 10:00	Introductions and expectations	Steve Ward
10:00 - 10:20	Understanding Lean Thinking	Malcolm Horner
10:20 - 10:40	Understanding Lean Thinking	Steve Ward
10:40 - 11:00	Discussion	All
11:00 - 11.15	Coffee	All
11:15 - 11:45	Lean Doing v Lean Thinking - some practical examples	Steve Ward



11:45 - 12:15	Where's the fat in your organisation?	Malcolm Horner
12:15 - 12:45	What are the barriers to eliminating it?	Malcolm Horner
12:45 - 13:30	Lunch	ALL
13:30 - 14.00	Agreeing priorities	Malcolm Horner
14:00 - 14:30	Outline of the Business Improvement Techniques Diploma and the Programme	Steve Ward
14:30 - 15:00	Summary and Next Steps	Steve Ward
15:00	Close	



Appendix 2 – Initial Pilot Workshop

AGENDA

20th January 2015

Location: Station Hotel, 1 Leonard Street, Perth PH2 8HE. (Please note that Parking is at the rear of the Hotel and not the Station car park)

Roads Maintenance Lean Review

Scoping Workshop

09:30 - 09:50	Arrival and coffee	ALL
09:50 - 10:15	Background - why we are here and who's who	Malcolm Horner
10:15 - 10:40	The Marshmallow Challenge	Andrew McElwee
10:40 - 11:20	Understanding Lean Thinking	Steve ward
11:20 - 11.40	Coffee	All
11:40 - 12:35	Examples of Business Improvement Techniques Diploma Projects	Andrew McElwee



S C O T S

12:35 - 12:45	Improvement Priorities From Pre-Launch WS	Malcolm Horner
12:45 - 13:30	Lunch	ALL
13:30 - 15:00	Project Scoping (Identification and Quantification)	Andrew McElwee (+ML/SW)
15:00 - 15:15	Coffee	All
15:15 - 15.45	Feedback Presentations and Summary	Malcolm Horner
15:45 - 16.00	Next Steps	Steve Ward



Appendix 3 – Evaluation Questionnaire



6ix Consulting - Embedding Lean Thinking
Transport Scotland mid-term review workshop 25 June 2015

Name:

Organisation

1. What are the principal objectives of your organisation?
2. How do you contribute to these objectives?
3. On a scale of 0 to 5 where 5 means a great deal, to what extent has the training helped you contribute to the fulfilment of these objectives?
4. What have been the three most useful aspects of the training?
5. What have been the three least useful?
6. On a scale of 0 to five where five is expert, what was your knowledge of Lean thinking before training started?
7. On the same scale, what is your knowledge now?
8. Is Lean of any value to you? Please respond on a scale of 0 to 5 where 5 is of the greatest value



9. If so, in what way?

10. What do you consider to be the most important features of Lean for your organisation?

11. What are the Lean tools that will help you fulfil your role more effectively?

12. What are your plans for implementing lean in the future?

13. On a scale of 0 to 5 where 5 is excellent, how do you rate the quality of the training you have received a) in respect of content,

and b) in respect of delivery?

14. Please provide any other comments overleaf