

# EXAMPLES OF LEAN TECHNIQUES AND METHODOLOGY APPLIED TO UK ROAD SCHEMES

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## ABSTRACT

The Highways Agency (HA) is an executive Agency of the UK Department for Transport (DfT). The UK government has been instrumental in encouraging the UK public sector to find ways to improve efficiency and has launched a Continuous Improvement (CI) initiative across all government departments. The HA has successfully applied Lean Techniques as a driver to delivering CI. This paper aims at demonstrating how the HA is improving efficiency of road constructions projects and internal procedures using Lean methodology. The examples given will illustrate some of the techniques used at different stages of the UK road schemes programme and the benefit/s realised from their applications. Through these work examples readers will have an indication on how benefits were achieved, which account for a Return On Investment (ROI) greater than 20:1 and over £80 Million of efficiency savings to date.

## KEYWORDS

IGLC21, lean construction, Lean in UK road constructions and maintenance, Continuous Improvement in UK public sector.

## INTRODUCTION

The HA has successfully demonstrated improved efficiency and effectiveness of projects on Roads construction and maintenance by the application of Lean tools and techniques (Womack & Jones, 1996). From design to delivery by the application of techniques such as: Collaborative Planning (CP), the Sort, Set in place, Sweep, Standardize and Sustain (5Ss), process mapping; work activities are classified as Value Added (VA), Non Value Added (NVA), essential Non Value Added (E-NVA), waste is identified and agreement reached with supply chain which improves staff engagement and reduces overall delivery time. As described in its 2010/11 business plan (HA website, 2011) the HA was tasked by the UK Treasury with delivery of £114 Million in efficiency savings. Given the current economic position and the UK government's drive to reduce the National financial debt there has been considerable pressure to further reduce costs and improve value for money.

## BACKGROUND

The HA is an executive agency of the Department for Transport (DfT) of the United Kingdom (UK) and it is responsible for the operation, maintenance and improvement of the 7000 Km of Strategic Road Network (SRN) which comprises England's motorways and trunk roads. The size and complexity of the HA network is illustrated

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below (Figure1). The HA has around 3800 staff working in eight separate office locations in England.

Executive Agency of Department for Transport.

3800 staff across 8 offices, 8 traffic centres and 29 outstations across England.

Operate, maintain and improve 7000 Motorway and Trunk Road Network



Figure 1 – The Motorways (in blue) and Trunk Roads (in red) which forms the HA Strategic Road Network

The HA is organised in Directorates. Provision of new infrastructure is carried out by the HA's Major Projects (MP) directorate whilst maintenance of the network is undertaken by the Network Development and Delivery (NDD) directorate. In 2009/10 the HA spent £1Billion on capital projects and more than £1.5Billion on maintenance and other activities (HA website). Furthermore the HA has the Traffic Management Directorate (TMD), with over 1500 staff ensuring a continuous and safe traffic flow and also supporting the emergency services, travelling public and contractors on the road network. Lean methodology (Womack & Jones, 1996) has demonstrated to be an effective way to achieving the target savings (HA Lean website link) and it has been used by the HA as a main driver in delivering the UK Public Sector Continuous Improvement (CI) initiative.

The HA Lean Division was set up in April 2009 to support improvement of value for money delivery. This division was established following the successful piloting of Lean and Six Sigma methodologies (Deming, 1986) on several major projects, particularly on the M6 extension from Carlisle to Guards Mill, in which the use of Lean tools and techniques such as Collaborative Planning and Lean Visual Management resulted in savings of £4.7Million. The HA Lean strategy was firstly deployed within the supply chain community and Lean progress has been regularly measured using a HA developed tool named HALMAT (Highways Agency Lean Maturity Assessment Tool). This tool (HA Lean website) allows the HA to monitor the Lean embedment progress within the supply chain organisation processes and

procedures, thus ensuring the Lean approach becomes integral part of the organisational plan.

As result of the benefits realised following Lean deployment in the HA supply chain the HA Executive agreed on Lean deployment within the HA internal processes and procedures.

## THE HA LEAN PROJECT IMPROVEMENT ENGINE

Mostly the HA Lean project improvement follows the Define Measure Analyse Improve Control and Transfer (DMAICT) problem solving methodology (Womack & Jones, 1996) and will be evident in the examples given later in this paper.

Once a problem has been defined, identified or recognised it is important to generate a ‘Goal Statement’ (Furterer, 2009) describing the perceived problem and Lean tools and techniques proposed to solve it. The project Goal Statement helps the project team to remain focussed and prevents scope creep. The project purpose, main stakeholders, deliverables and success criteria are captured as a summary within a ‘Quad of Aims’. It is also important to clearly define the boundaries of the project by clearly identifying what is ‘in’ and/or ‘out’ of scope.

In order to ensure dissemination of the lessons learned from Lean projects it is a HA requirement that project managers prepare a Knowledge Transfer Pack (KTP) for each of the Lean improvement projects completed (HA Lean website). These KTPs are available in the HA public website, under specific subject areas and provide an overview of the problem or issue targeted, the approach used and the benefits achieved. Training is seeing as an important part of implementing Lean, hence the HA has developed a structured Lean training programme (Figure 2). The degree to which people are required to be developed will be based on their work activities and type of involvement with Lean Projects (Furterer, 2009).

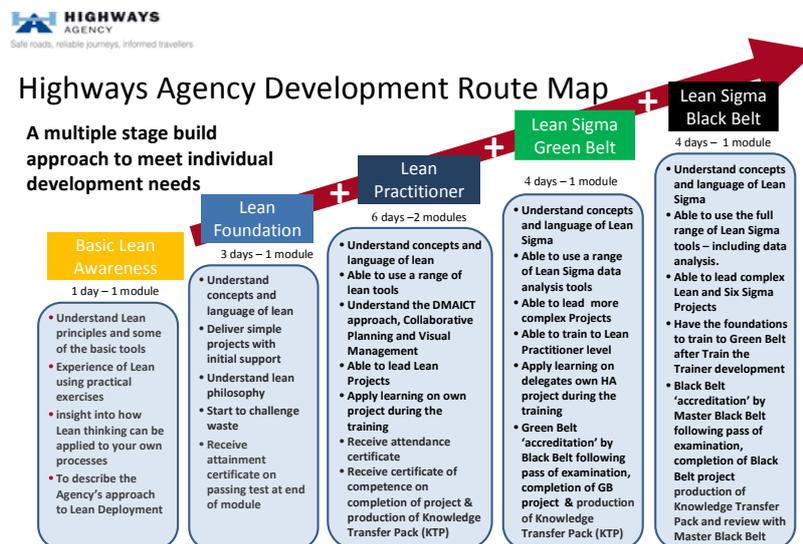


Figure 2 – The HA Lean development route map. Training increasing Lean capability within the HA supply chain and the HA staff. This is linked to individual work area.

## LEAN IMPROVEMENT IN PRACTICE – THE EXAMPLES

### THE A46 PROJECT

The A46 project was a £365 Million scheme involving construction of 28km of dual carriageway and 22 bridges. The use of Planned Percentage Complete (PPC), with the non-completion, root cause analysis and visual management displays led to cost savings of over £78,000.00

### MAIN LEAN TOOLS & TECHNIQUES USED

Last Planner (Ballard & Howell, 1998) with Planned Percentage Complete (PPC) Management tools were used for daily/ weekly monitoring of compliance to programme (Figure 3).

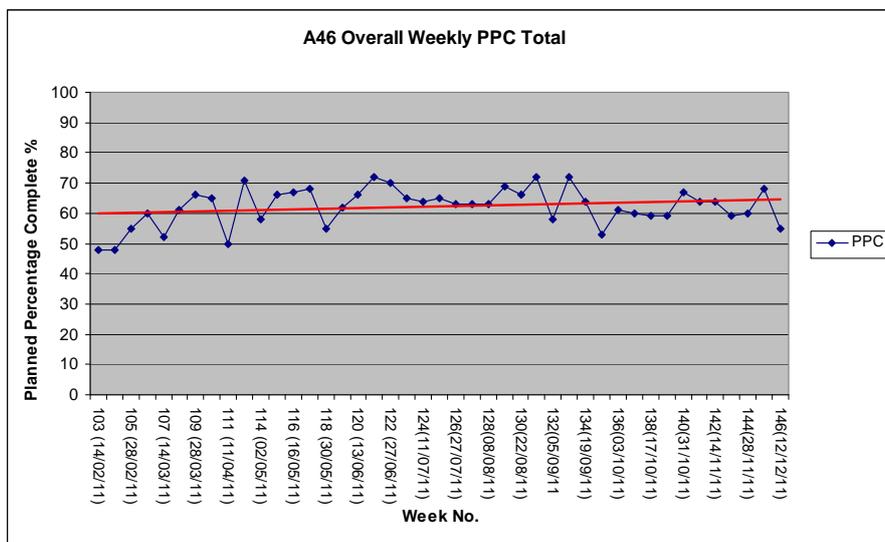


Figure 3– Planned Percentage Complete - weekly data collected for work activities

### HOW WAS IT DONE?

All ‘as built’ programmes submitted each week were analysed. The Reasons for Non Compliance (RNC) for each of the activities not completed in the timeframe specified were collected. Analysis of the RNC pointed out the problem area/s for completion and provided good evidence for the areas to be targeted for improvement first. One of the highest RNC identified related to the number of uncompleted programmes received (Figure 4).

A project team was formed which included representatives from the key players in the process. A strategy and scope for the Lean improvement project was agreed with the team as well as the Quad of Aims. Using SIPOC (Supplier, Input, Process, Output & Customers) analysis (Pyzdek, 2003) the team was able to identify potential causes that explain the variation in the outputs.

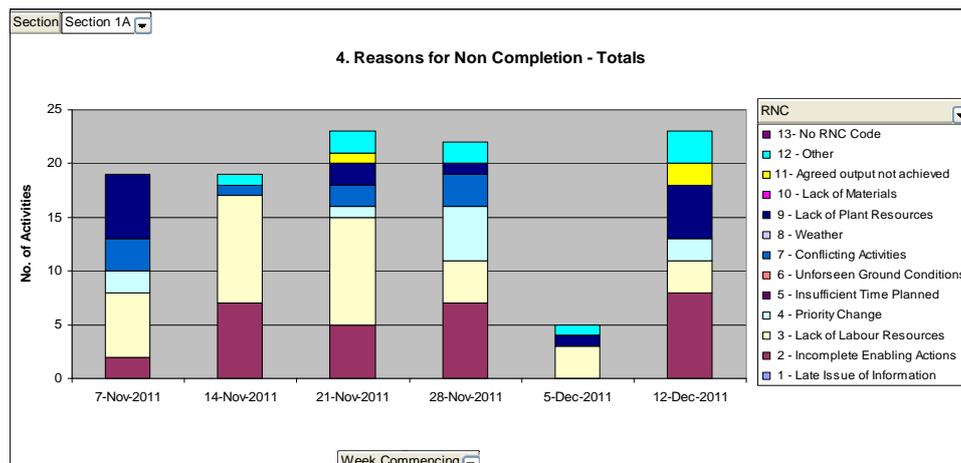


Figure 4 – Analysing the Reasons for Non-Completion (RCN)

The data was collected from the ‘as built’ programme for each key player. The PARETO analysis (Brook, 2006) was used to identify the dominant causes of the RNC for each of the Codes. Process Mapping was used effectively to identify the various work streams/ activities and differentiate those which ‘add value’ (VA), from those which are ‘non added value’ NVA and those ‘essential non added value’ (E-NVA) those not essential to the end product but essential for carrying out the work.

To further identify the potential causes for Non-completion for the RNC, root cause analysis, including brainstorming, 5 whys and the fishbone cause and effect diagrams (Brook, 2006) were used. It was also agreed with the project team to set up a Lean Visual Management (LVM) dashboard with daily reporting and analysis to improve planning and communications on progress. The following actions were taken to tackle the RNC:

- Meetings were arranged with engineers and section engineers regarding the correct completion of the programmes,
- Increased engagement with subcontractors to encourage them to supply programmes on time
- Sub-agents were required to provide programme into 3 weekly in advance of the weekly meetings (small batches).

### BENEFITS REALISED

As result from Lean intervention there was substantial improvement of project time, cost, quality sustainability and cultural change in the A46 scheme. These are qualified below:

**Cost:** There was an estimated 10% contribution to a 2 week reduction in programme. This resulted in 10 hours per week saving of staff time by using the ‘Dashboard’ as management tool.

**Delivery time:** Overall reduction in programme duration

**Quality:** ‘As built’ programmes submitted and checked with quality improvement of the completion of the as built programmes.

**Safety:** Working to programme resulted in reduction of numbers of sub-contractors working in one area at one time. As a consequence there was reduction on the number of ‘near misses’ thus improved safety

**Environmental (sustainability):** Reduction in activity duration also contributed to reduction of plant equipment usage thus CO2 emissions were also reduced.

**Cultural impact:** The increased awareness of the teams through the use of LVM

**Overall:** There was an increase from a 40% baseline to an average of 70% baseline.

## GETTING A BROWN TOURISM DIRECTION SIGN ON THE HA NETWORK

### Background

Brown signs are used in the UK to point out directions for places of public interest such as: picnic areas, leisure areas, parks, gardens, garden centres, museums, castles, historic sites etc. This Brown Signs project was set up as result of an increasing number of complaints and criticism from ministers surrounding the high cost and difficult process for our customers, ‘the public’ to obtain Brown tourist information signs. The HA Executive requested the Lean team to set up a project to consider and to recommend how best to tackle the issues in the current process on order to improve customer experience.

### How was it done?

This project was conducted following the Lean DMAICT methodology (Pyzdek, 2003). At the define stage the project team agreed on the ‘Quad of Aims’, thus establishing the purpose/ impact of the project, key stakeholders, deliverables and the success criteria. Another Lean tool used was the ‘voice of the customer’ (VOC) (Furterer, 2009) where members of the group took the position of the public (the customers to the process).

Their experience identified key issues and from it identified what should be measured which is Critical to the Quality (CTQ) (Furterer, 2009) of the process. A project scope charter with clear goal statement (Figure 5) was developed to prevent project scope creep on surrounding areas outside the control/ scope of the Lean project team. Among the ‘out of scope’ process were changes to HA Brown signs standards. The charter proved very useful tool to be used as a reference/ focal point throughout the project.

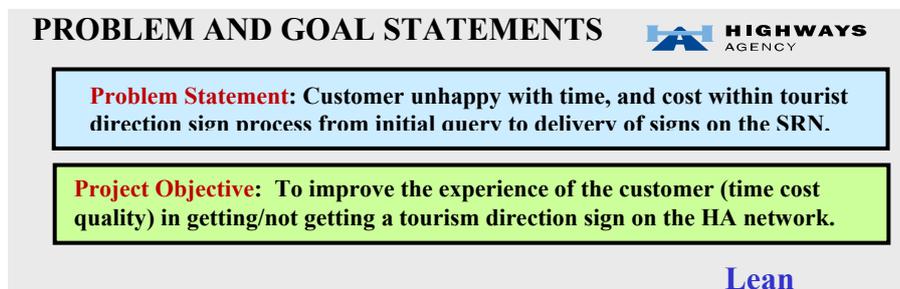


Figure 5 – Well defined ‘Problem statement and Project objective’ helped team focus and prevented scope creep

**The applied DMAICT methodology:**

**Define:** At the ‘Define’ workshop the project team had to agree on the problem definition and plan how to progress project and the milestones.

**Measure:** In order to measure and analyse the overall process data was collected from key points over the past three years and included:

- How many signs request were received?
- Where are they in relation to the HA network regions?
- When were those requested?
- Costs per sign?
- Which organisation acts as Service provider for the regions?
- What type of sign was requested?

**Analyse:** Analysis of the collected data (Figure 6) was carried out by a combination of Excel and MiniTab (Brook, 2006). The data analysis provided answers to the following questions:

- How many brown signs enquiries were received over a given period?
- How many applications were rejected?
- How many occasions the applicant did not proceed and how many processes were completed.

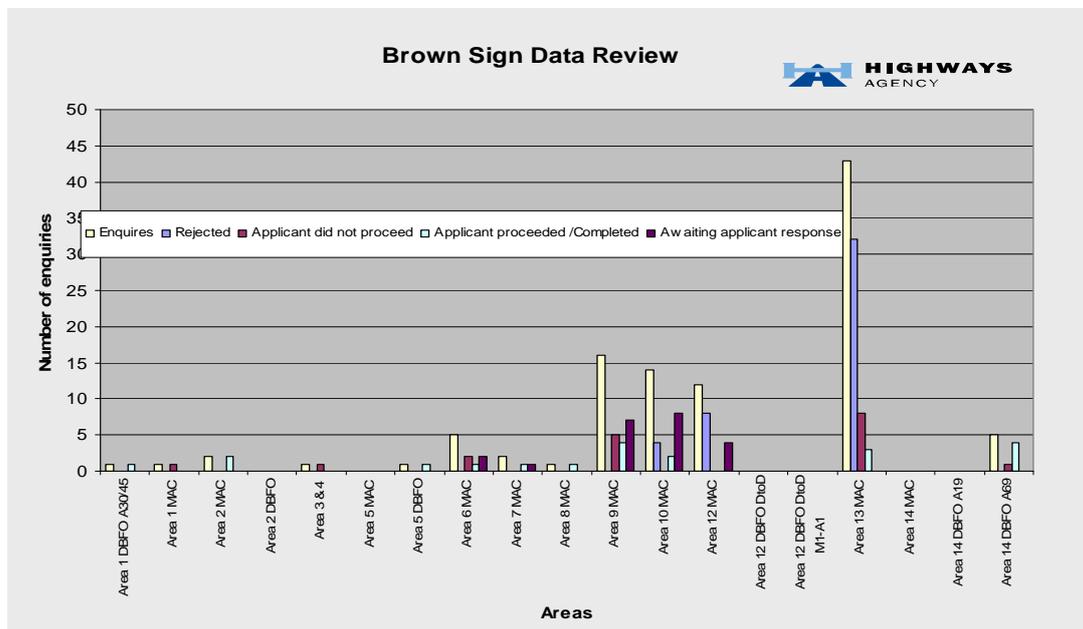


Figure 6 – MiniTab analysis comparing data collected across all areas of the HA Network

The data analysis suggested that from a large number of enquires (above 40 in certain regions) only a small number of brown signs actually got through to completion.

The project team explored some of the rational and the reasons 'why' non-completion occurred, this was accomplished by getting some project team members to act as customers and by using the information from the HA website. Thus trying to understand the path external customer would have to follow. One of the first findings was that the tourist information section of HA website provided no definite cost for signs. The process described was patchy and gave no indication on the types, sizes of signs available and the time taken to obtain the sign from initial customer enquiry to delivery. The complete process was found to take roughly a year.

Presently the time lapsed from query to obtaining section 278 agreement (which is a legal requirement necessary to obtain whenever a developer requests access for work in HA road network) varies between 153 and 730 days.

Although data was limited the following conclusions were drawn:

- There are wide variation of enquiries recorded across HA regions
- Only circa 20% of applications made proceed to completion
- There is limited information on why applications were not taken forward
- Analysis of the process range time for section 278 showed:
- Mean = 361 days
- Range between 153 and 730 days

There was inconsistency across HA with respect to cost estimation and the time to provide them.

The project team mapped out the process and applied time scales between key work activities. The root cause analysis identified the longest lead time as result of an extremely inefficient process. All wastes identified during process mapping were removed to reveal a new more efficient process. The project team also agreed other ways which improvements could be made to the customer experience and these are shown below.

**Improve:** The improvements the team decided to take forward were:

- Creating a model available on the HA website showing the customer an estimated up front cost of the process.
- Improving the web page to make it simpler for the customer to navigate around it and to find key information.
- Provide a more efficient process.
- Removing waste from the HA Contractors activities and shifting the point where the customer starts to pay, thus reducing overall costs.

### **Public Facing Process**

As result from this preliminary work the HA Brown sign website has being re-designed taking the view from the customer/ applicant perspective and including a new cost guidance. The guidance which is likely to be high level will help in providing customers with an idea of cost and to manage applicant expectations. The modified website will be further developed to include process timescale guidance. The web page will include a brief narrative and a PDF document summarising

customer process. Information on cost and time will be provided to customers at the onset of the process.

### **Internal Facing Process**

For the internal facing process the team mapped the 'As-Is' and improved the process. This will have direct impact on lead time and consistency in approach/service across HA regions. The process will continue to be improved. An overall HA 'Process Owner' has been identified. This will be communicated internally via the HA Way we Work (WwW) (HA website). A 'Data Capture Sheet' has been distributed to all HA regions to capture future time and cost intelligence for further analysis.

### **Transferability / Use on other schemes**

As result from the findings observed in this Brown signs Lean project the following recommendations have been made and accepted by the HA Executive:

- Training for other HA regions, which is already underway
- The new more efficient process to be placed in HA WwW
- The newly developed website will be also promoted through the Brown Signs working group
- A Knowledge Transfer Pack (KTP) has been produced and will be placed on the HA lean website
- A webinar will be organised to present the project and findings.

## **CONCLUSIONS**

From 2009 to date the HA has achieved tangible savings by application of Lean methodology in the UK Road schemes. Savings of over £80 Million have been attributed to Lean Intervention. These savings made considerable contribution to the efficiency savings of £114Million demanded by the UK Treasury.

Although Lean deployment has firstly targeted at the supply chain, the past years efficiency savings accomplished by use of Lean was used as evidence in support to justifying approval for implementing Lean internally to HA processes and procedures.

The HA developed Lean training programme has been instrumental in disseminating the Lean knowledge and increase capability across the supply chain and in-house. HA has in the last financial year trained further 54 staff to Foundation level and 43 to Lean Practitioner level and this is an important investment towards the Continuous Improvement culture.

Recent increase in resources to the HA Lean Division will allow for the internal deployment. All work developed by the Division can be viewed by accessing the HA public website. In addition several webinars have been delivered and are being planned to encourage knowledge sharing across the Lean practitioner community.

A lean project tracker has been developed to monitor the Lean projects and capture benefits. The tracker now contains 246 projects and monitors the benefits generated from these.

The HA had many individual Lean successes during the last 12 months including supporting the Managed Motorways schemes by undertaking 31 Lean projects with 4 already completed. The HA also completed 22 projects within the maintenance

community with realised savings of £3.5 million. Additionally, an internal pilot project introduced in HA Procurement has reduced the cycle time to European suppliers award process by 46 days.

Lean has been a recognised success within the HA road schemes. Savings of up to 30% on scheme completion have been reported by encouraging discussions among stakeholders at Collaborative planning meetings. The use of Visual Management boards on construction sites has shown to: improve overall staff engagement, improve quality and reduce safety related incidents. The use of 5S on-site design offices has ensured all work is done using the latest version of design and better organised on-site stores work efficiently on minimum stock and greatly reduced time for staff handling tools and materials at the start/ end of the work shifts.

The HA is only at the beginning of what will be a long journey but plans to continue with the Lean deployment programme to deliver the efficiencies required by the UK Government and improve engagement with its internal and external customers.

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