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The Lean journey: have we got it wrong?

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Over the last three decades, there has been a vogue in manufacturing, and increasingly in services organisations to implement Lean. However, in many cases these journeys have not been as successful or sustainable as their architects had planned. The question is why have the results been worse than planned and have organisations got their implementation approach wrong? This paper considers this question and finds that the reason is largely due to the ‘easy’ results-oriented and tools-only approach of the organisations involved. It explores why this approach does not work using a critical-realist method in a longitudinal case organisation, based in Wales that has taken a different evolutionary approach and ultimately received Shingo Prize recognition. Its approach is based on principles-led behaviours, systems, and cultural change. This approach appears to be more successful and early indications are that it is more sustainable. The paper contributes to both the academic and practitioner communities by presenting a theoretical stage model and evolutionary framework of the development that the case company undertook as well as a discussion of how to overcome two barriers to successful Lean implementation. We therefore demonstrate how one can move beyond the common tool-based approach which has attracted the majority of criticism in the academic literature.

Keywords: Lean; principles; employees; behaviour; tools; systems; culture; sustainability

Introduction

The origins of Lean lie in the shop floors of Japanese manufacturers, in particular at Toyota Motor Corporation (Monden, 1983; Ohno, 1988; Shingo, 1989). Early emulation in the West in the 1980s largely consisted of the piecemeal copying of particular tools such as 5S and Kanban within what was at the time called ‘Just-In-Time (JIT)’. Other influences from improvement methodologies such as Total Quality Management and Six Sigma also contributed tools, understanding, and discipline. It was not until the publication in 1990 of the breakthrough book *The Machine That Changed The World* by Womack, Jones, and Roos (1990) that the term ‘Lean Production’ was popularised. This book showed evidence of a significant gap in performance between Toyota and other global car manufacturing companies. The effectiveness of the book, and Lean itself, lay in the simple but powerful message that success could be achieved through the removal of waste (‘Muda’ in Japanese). Womack et al. (1990, p. 15) indeed start the book with ‘Muda. It’s the one word in Japanese you really must know’.

There is an extensive literature on Lean and its evolution, with several excellent summaries provided by: Bhamu and Sangwan (2014); Bhasin and Burcher (2006); Holweg (2007); Samuel, Found, and Williams (2015). Since 1990, there have been a number of wider developments in Lean such as Lean and Green (Zokaei, Lovins, Wood, & Hines,

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2013), Six Sigma (Schonberger, 2008) and Leagile (Christopher & Towill, 2000). However, these lie beyond the scope of this paper.

Suffice it to say the major theme within Lean was, particularly in its early days, a focus on waste reduction, as illustrated by Jeffrey K. Liker's early definition of Lean: 'a philosophy that when implemented reduces the time from customer order to delivery by eliminating sources of waste in the flow of production' (Liker, 1996, p. 481).

There was a rapid take up of Lean after the publication of '*The Machine ...*' book. In many cases organisations received huge benefits (Sheridan, 2004; Sohal & Eggleston, 1994; Taylor & Brunt, 2001). Within companies the topic was dominated by the operations management, engineering, and supply chain practitioners. This was mirrored by interest from academics within these subject areas, resident both in Business Schools and in Engineering Schools, with a steadily increasing number of publications over time (Bhamu & Sangwan, 2014; Jasti & Kodali, 2015; Samuel et al., 2015). An exception to this was a body of literature from researchers (see below) who were in many cases much less positive about Lean.

Criticisms and gaps within Lean

Much of the literature on Lean is positive in terms of the results that can be achieved. However, there have been a number of areas where criticism has been levelled and gaps identified, notably:

- Confusion about what the term Lean actually means (Hallam, 2003; Stone, 2012).
- A lack of a standard implementation process (Anand & Kodali, 2010; Bhamu & Sangwan, 2014).
- Whether Lean can be applied in low-volume high-variety environments (Christopher & Towill, 2000; van Hoek, Harrison, & Christopher, 2001).
- An over focus on the operational versus the strategic level (Hines, Holweg, & Rich, 2004; Tennant & Roberts, 2001).
- Companies that use a piecemeal tools approach (Hines, Found, Griffiths, & Harrison, 2011; Seddon & Caulkin, 2007).
- Lack of, or inadequacy of, a coherent theory (Flynn, Sakkakibara, Schroeder, Bates, & Flynn, 1990; Schmenner & Swink, 1998).
- The transferability of Lean (Cooney, 2002; James-Moore & Gibbons, 1997).
- The negative effects on the workforce (Benders & Morita, 2004; Coffey & Thornley, 2006; Delbridge, Turnbull, & Wilkinson, 1992; Garrahan & Stewart, 1992; Williams et al., 1992).
- The missing role of people in the Lean approach (Bidanda, Ariyawongrat, Needy, & Norman, 2005; Kippenberger, 1998; Stone, 2012).
- The sustainability of Lean (Repenning & Sterman, 2001; Motley, 2004).

These criticisms and gaps are summarised in Figure 1. This figure describes these gaps in terms of inputs (what the starting point for Lean is; and what Lean itself is), process (how to employ Lean) and outputs (the results of Lean application). However, 'the most apparent void within the body of knowledge eschewing from the Lean literature was the lack of theoretical connections often associated with planned organisational change and HRD interventions' (Stone, 2012, p. 121).

In the research undertaken for this paper, we have sought to be cognisant of these various criticisms and gaps, and to ask ourselves this simple question about Lean: Have

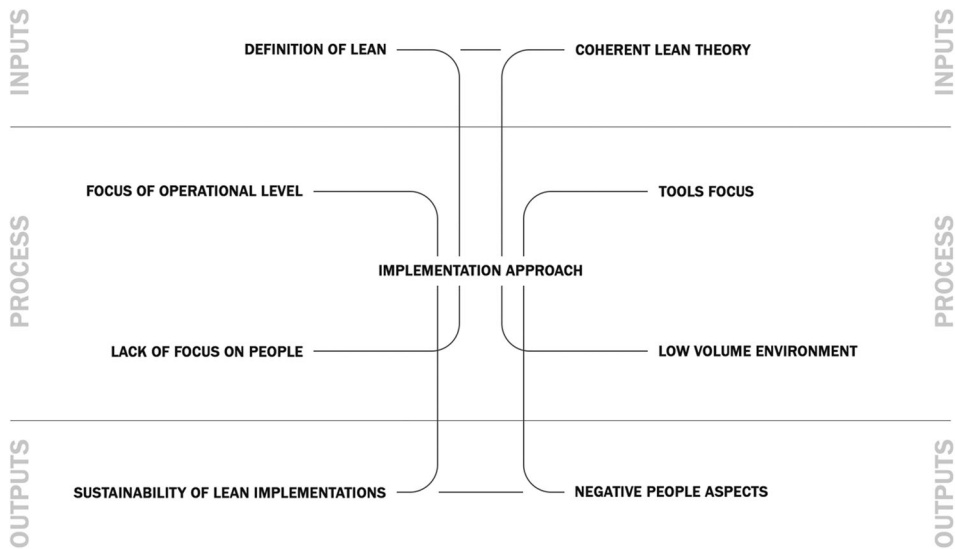


Figure 1. Lean literature gaps.

we got it wrong? What we mean by this is have we got the application of Lean wrong. If we, namely the academic community and the majority of practitioners, have got it wrong then we would expect to see poor sustainability and low levels of engagement in Lean activity.

The sustainability of Lean

As we noted above, much of the literature is positive about Lean – perhaps even a little too positive as it is more rewarding (and perhaps more publishable) to write a really good success story. Also many of the cases involve action research carried out by the researcher themselves. In this respect the work of Bateman (2001) is of interest in her independent study of a large multi-company Lean programme in the UK. She concludes that consultants dwell on the positives of Lean whilst being somewhat sketchy on their respective implementation records.

Sohal and Eggleston (1994) have suggested that only 10% of firms have an effective Lean philosophy implemented. In addition, Repenning and Sterman (2001), as cited in Bhasin and Burcher (2006, p. 56):

advocate that companies use initiatives almost as a fad and submit that whilst the: ‘number of tools, techniques and technologies available to improve operational performance is growing rapidly, on the other hand, despite dramatic successes in a few companies most efforts to use them fail to produce significant results’.

So, have we got it wrong in terms of our thinking and application of Lean?

Research methodology

The research methodology in this study is qualitative, and conducted over a longitudinal period using case study design (Yin, 2009) at a single organisation in a single location (Stake, 1998). The case study is a very popular and widely used research design in business research (Bryman & Bell, 2015), and it is useful for theory building

(Eisenhardt & Graebner, 2007). In this study it was required because of the need for a flexible and holistic research design (Hakim, 2000) that involves a combination of different methods in order to deal with the complexity and variety of data (Hartley, 1994; Yin, 2009).

A critical-realist approach was adopted. Additionally, principles of action research and learning were applied (Eden & Huxham, 1996) and this enabled one of the researchers (as an embedded consultant) and the case organisation (their client) to ‘collaborate in the diagnosis of a problem and in the development of a solution based on the diagnosis’ (Bryman & Bell, 2015, pp. 418–419). This also allowed the other two researchers to take a more detached and independent view of the case and mitigate the temptation to exaggerate the success of the work.

The case organisation

The case organisation is Vale, a nickel refinery located in Wales, UK. Access to the case location was provided over a seven-year longitudinal period from 2009 to 2016. The case company exhibited characteristics of an advanced Lean approach towards the end of this period as evidenced in achieving recognition against the Shingo Prize standard in 2014 (Shingo Institute, 2016a). The Shingo Prize is now developing as the de facto highest level achievement for companies in the Lean world (*Business Week*, 2000; Liker, 2004; Shingo Institute, 2016b). It is housed at The Shingo Institute in the Jon M. Huntsman School of Business, Utah State University, USA and is named after Shigeo Shingo who co-developed the Toyota Production System when working as a consultant for Toyota (Hogan, 2009). Dr Shingo received an honorary doctorate from Utah State University in 1988.

Limitations of the research

As with any research, our own approach had a number of limitations. These are the small survey size, issues around generalisation from the case and the coordination and cultural perspectives of the researchers. These are shown in Table 1, together with their causes as well as the researchers’ approaches to mitigate the effects of these limitations.

Table 1. Research limitations and mitigation.

#	Concern	Cause	Counter-point/Counter-measure
1	Small survey size	Requirement for detailed longitudinal insight into the case	Use of several qualitative methods
2	Lack of generalisability	Single case study	Single case organisation & generalisability was not the main concern
3	Coordination of research team	It was not possible for all of the researchers to take part in every research visit	Regular coordination of team members for discussion of research activity and theory building
4	Cultural bias of researchers	The research team is all based in the ‘Celtic fringe’ (Brittany, Cornwall [England], Ireland, Scotland & Wales) of Europe with its own unique epistemological perspective	Testing of the research findings at an international conference in Copenhagen

Research findings

Vale is one of the world's largest mining companies, and is headquartered in Brazil. It is the world's largest producer of iron ore and nickel. Its nickel refinery operation in Clydach, Wales, UK has 200 employees and an annual production of 40,000 tonnes of nickel pellets and powder. It is a continuous process plant operating 24 hours a day, 365 days a year. The site is over 100 years old, a classic brownfield site and has employees with typically very long staff service. The final product is of a very high level of purity and is sold to 280 customers in 30 countries including many Japanese electronics firms.

Like most manufacturing companies, Vale has undertaken continuous improvement activity for many years. From the mid-1990s to 2008 it had undertaken a series of tool-based initiatives including: Theory of Constraints, Strategic Supply Chain Management, and Six Sigma. All of these proved useful to the site, but none formed the basis of sustainable embedded change. We can characterise Vale's post 2008 continuous improvement in three phases:

1. Stabilising Production Processes 2008–2009
2. Developing Strategy Deployment and Continuous Improvement Systems 2010–2012
3. Embedding Sustainability 2013–2016.

Phase I. Stabilising production processes 2008–2009

This first phase could be regarded as the first major step towards sustainable excellence in the business and involved the use of a number of Lean and Six Sigma tools. Principal among these was the roll out of Standard Work for over 200 critical tasks, as well as the implementation of 5S widely across the site. A useful addition to this was the Problem Follow Up (PFU) approach whereby any employee could raise a concern about a Standard Work sheet, and their proposal would be discussed and in many cases, result in an improvement of the Standard Work.

In addition, the company had developed some expertise in structured problem solving for complex problems using a simplified version of Six Sigma it termed 'Analyse & Improve'. This was applied to larger improvement projects by Lean engineering experts. An example of this was the de-bottlenecking of the kiln involving the use of Overall Equipment Effectiveness and Failure Mode and Effect Analysis (FMEA).

We can, therefore, characterise this first stabilisation phase as a tool-based approach largely led by internal, and in some cases external, experts.

Phase II. Developing strategy deployment and continuous improvement systems 2010–2012

The second phase started with a systematic review of the site and its Lean maturity. The management reviewed Lean maturity with outside support against a five-point Lean maturity model ranging from 'Reactive', where there is no Lean activity to 'Way of Life' where Lean was the norm (Figure 2). There were five factors taken into account in this maturity assessment: Strategy Deployment, Value Stream Management, People, Tools & Techniques and Extended Enterprise. They judged themselves to be in the second 'formal' stage – a reflection of the fact that they had established a controlled, stable manufacturing environment by the end of 2009. They also identified where they wanted to reach three

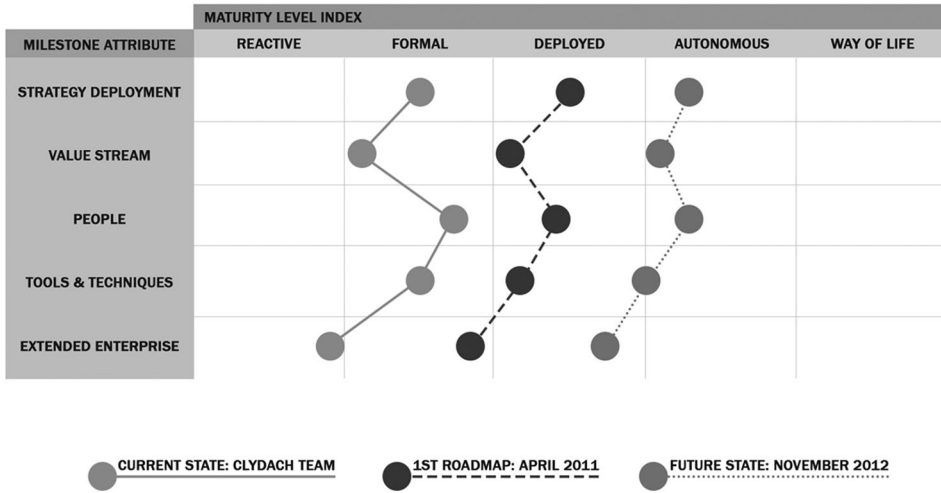


Figure 2. Lean maturity at Vale, January, 2010.

years later, as well as an intermediary point at the end of the first roadmap in 2011 (Figures 2 & 3).

The second phase involved a plan against all of these five elements; although in the summary document (Figure 3) the Tools and People elements are combined. This involved a series of improvement projects organised and sponsored by the management team. The core element of this activity was the central line involving the development of what management termed ‘Yellow Boards’ (Figure 4). These Yellow Boards were the visual manifestation of a Strategy Deployment system and Continuous Improvement system. They captured the purpose of the team, the process or activity the team undertook including

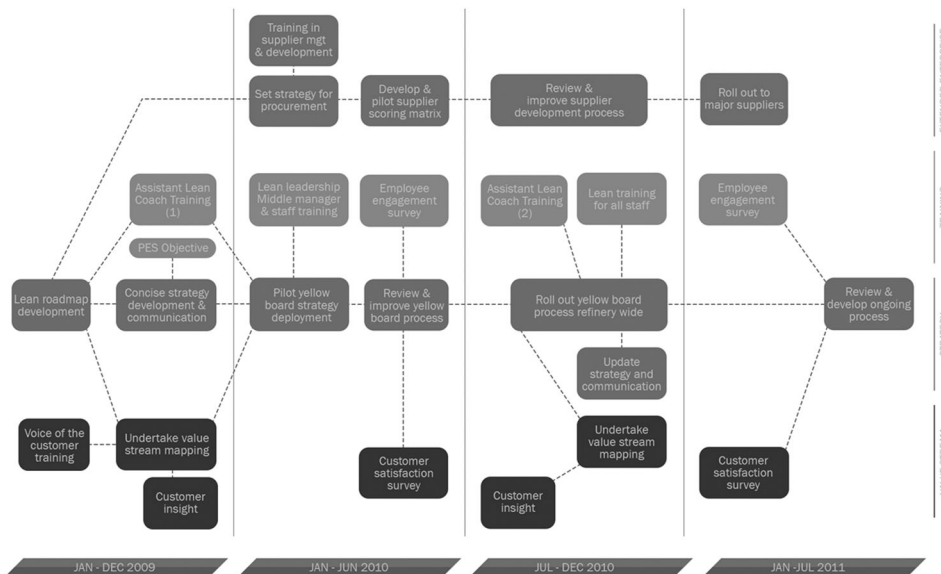


Figure 3. Continuous improvement roadmap.

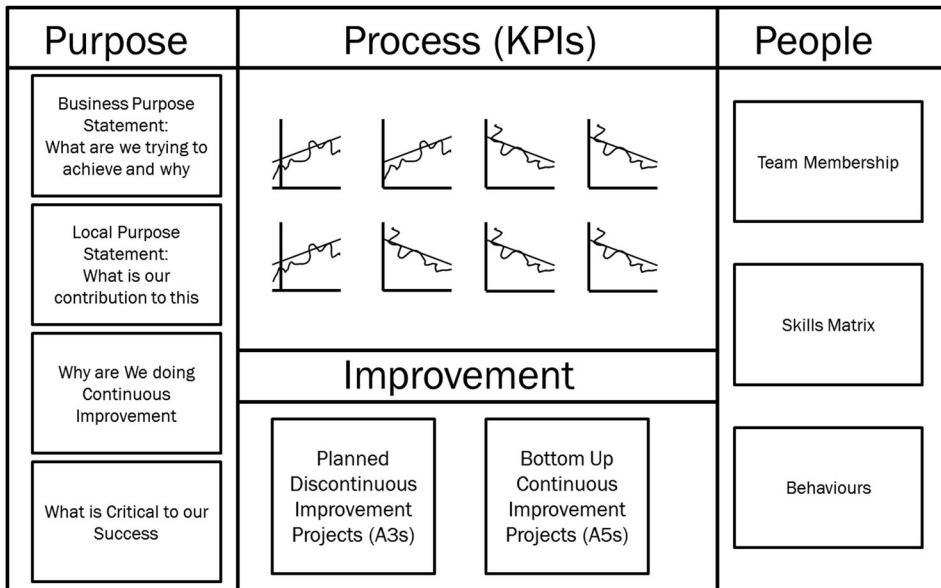


Figure 4. Yellow board (local version).

KPIs, improvement activity and people engagement. In total 15 Yellow Boards were introduced in this period: one at the business level, and a further 14 at the local team level in every area of the company, manufacturing, warehouse, and office. The initial trial was in the kiln area and laboratory testing area. These areas being chosen to show that what was now termed ‘Continuous Improvement’ rather than Lean could be applied anywhere in the business.

The Yellow Boards were made up of four parts and the general structure was standardised across the business (Figure 4). The main elements of the Strategy Deployment system were:

- A. At the Business Level:
 - i. A simple one page codification of the strategy for the site in terms of what the mission for the site was (‘We will ...’), what the key mechanisms or activities were (‘By ...’), and what would be the result (‘In order to ...’).
 - ii. A set of statements by the senior management team about why they were doing this activity.
 - iii. A summary of Critical Success Factors (CSFs) at their level again developed by the senior team.
 - iv. A set of Key Performance Indicators (KPIs) with targets and trends that were developed around measures that would gauge how well they were doing with the CSFs and encourage a behaviour around working on the right improvement activities to achieve the stated strategy. These measures were a balance of lead measures (such as Employee Engagement & Wellness Index), process measures (such as the Percentage of People taking part in Yellow Board meetings & Adherence to the Continuous Improvement Roadmap) and more traditional lag measures (such as Conversion Cost and Yield Rate).
- B. At the Local Team Level, an identical approach except:

- i. An additional page to the site level strategy codifying what a local team's contribution to the site strategy was, importantly developed by the team itself and checked by the senior team.
- ii. The 'Why Are We Doing Continuous Improvement', CSFs and KPIs were all developed by the teams themselves, not assigned by the senior team. Targets for these were then agreed between the local team and the senior team.

The Yellow Boards were not static 'Visual Displays', however, but were used to define strategy at each level and for the ongoing management of the local area and the Continuous Improvement system. This was achieved through:

A. At the Business Level:

- i. The development of a planned series of Discontinuous Improvement projects which were managed through an A3 process with progress checked weekly at the senior management team meeting. The projects were developed at the start of 2010 and were limited to six at any one time, with new projects added as existing projects were completed. These new projects could be developed as a response to the changing environment (for example, the price of nickel), new ideas from the team themselves, or through ideas escalated from local boards.

B. At the Local Team Level, an identical approach except:

- i. The addition of a bottom up Continuous Improvement process using a simpler A5 sized form (in essence a quarter of the size of the bigger A3 project sheets designed for smaller projects). The approach taken was termed PFU as it was an extension of the existing popular approach for improving Standard Work. The extension meant that any team member could raise suggestions which would be reviewed at the next local Yellow Board meeting. These meetings were held on a shift basis (where there was shift work); or on a daily basis; or, in the office environment, on a weekly basis. Hence ideas in most local teams were reviewed within 24 hours of being raised, and in offices at least weekly. The review would consist of the idea originator sharing their idea with the team and the team deciding whether it was worthy of implementation. If it was agreed that the idea should be implemented, it was either:
 - a. Assigned (in its A5 format) to one or more team members by the team leader; or
 - b. Upgraded to an A3 format if it was a major Discontinuous Improvement and added to the Discontinuous Improvement Gantt chart with a planned implementation time (in the manufacturing area this was often during a production planned downtime); or
 - c. Escalated to the senior team or transferred to another local team where the source of the problem might be.

In this second phase, there was an early light touch approach to the cultural aspects of change. This was captured in the People part of the Yellow Board, with a similar approach at both business and local levels, and included:

- A picture of each team member.
- A skills matrix for each team member which was updated as skills changed.
- A set of 11 behaviours that had been defined by the senior team (Table 2).

Table 2. Phase 2 – our behaviours (source: Vale).

#	Behaviour
1	We will actively demonstrate commitment to SHE.
2	We will not 'walk past'.
3	We will listen actively to other's opinions.
4	We will 'Go Look See'.
5	We will respect our colleagues' time.
6	We will do what we say.
7	We will challenge each other and the status quo.
8	We will recognize others and say thank you.
9	We will ask for and give positive and constructive feedback.
10	We will accept and learn from mistakes – no blame.
11	We will take responsibility for our own actions.

Phase III. Embedding sustainability 2013–2016

In the third phase, there was a greater focus on the sustainability of change. This included a wide range of actions, many of which were led by the senior management team. There was also a seamless integration of technical and people aspects of change. This is illustrated by way of four of the more noteworthy examples:

- A. Training and development of the leaders was undertaken within the business around gemba walks and coaching activity. This meant the site director and other key staff undertook regular walks around the local Yellow Boards to review the achievement of KPIs, improvement activity, and the culture embedded within the local teams. Depending on what was found, the team leaders and teams were recognised for their performance and/or coaching conversations were undertaken with a view to improving local skills and behaviour.
- B. Structured weekly conversations were undertaken by each team around the 'behaviour of the week' within the 'Our Behaviour' visual list (Table 2). This involved a standard work procedure for the Yellow Board meeting where individuals recognised another person in the business for their behaviour. If these were outside of the team the team leader took an action to pass on the public recognition to the person outside of the team. As this was considered so important, a record of the behaviour was kept. The behaviour that was recorded was that of recognising somebody else. A tally was kept of how many times an individual had recognised someone else and this was recorded on a table on the Yellow Board.
- C. The business was developing a learning and continuous improvement mentality whereby they were starting actively to challenge the systems that they had implemented to make them better. Although this last activity was helping to create a culture of continuous improvement, the business felt that it was still not engaging enough and that some people were perhaps not taking it as seriously as they might. The root cause was that the local teams had these behaviours imposed on them and in some cases did not understand why these behaviours were relevant. As a result, the management decided to undertake an extensive bottom up exercise of understanding from all employees what was good about the site and what could be improved. This also included the bottom up development of a set of behaviours that stemmed from consensus meetings of the employees rather than top down from the managers (Table 3). Although the resulting

Table 3. Phase 3 – our [new] behaviours (source: Vale).

#	Behaviour
1	We always assume positive intent.
2	Actively seek to understand and appreciate others, their roles, commitments, and efforts.
3	Always have the courage to speak up ... and when someone does, listen with humility, discuss with an open mind, and act.
4	When something goes wrong, we focus on the 'Why?' not the 'Who?'.
5	Challenge our own and others': <ul style="list-style-type: none"> • Negative assumptions, • Criticism behind others' backs, • Not taking responsibility, • Apathy, • Breach of our standards,

... and be open to challenge.

behaviours had many similarities to the existing set, the important thing was that they were owned by the employees themselves.

- D. Another improvement of an existing system was within the Continuous Improvement system. Although the existing system was good and engaged many of the employees, with around six ideas a year produced per employee, the senior managers decided that it could be improved upon. What was missing in the very good technical system were the cultural or behavioural aspects to encourage all employees to actively and enthusiastically take part. In essence there were three behaviours that the management wanted to encourage:
- i. All employees taking part in providing PFU suggestions rather than a smaller number of enthusiasts.
 - ii. All employees taking part in implementing the suggestions, again rather than the usual few.
 - iii. Good improvements that had worked within one team context being spread from one team to other areas within the business.

As a result, a measure was developed and implemented within each team which recorded for each team member up to a maximum of six ideas per year that had been developed by the individual and implemented by the team. Each of these was then written up by the individual in their own learning log. For each idea, the team member scored one point (up to a maximum of six points per year). For each of these ideas the individual could score a second point if they had led the implementation or been a significant team member. A third point was available if the idea was then spread to other parts of the business and implemented in at least one other area. Hence a maximum of 18 points was available to everyone at every level in the business. The number of points scored then contributed to the individual's annual bonus.

The results of these three phases of continuous improvement activity are very impressive; and what is more they are sustained over an extended period of time. These are shown in Table 4 and are within the realms of safety, improvement activity, productivity, environment, customer complaints, inventory, on time delivery and cost management. What is noticeable is that they cover a wide range of performance criteria and are over a period of time, not one-off achievements.

Table 4. Results of continuous improvement activity at Vale.

#	Result
1	Over 90% reduction in lost time injuries between 1999 and 2014.
2	Employees implemented over 1620 improvement suggestions between 2009 and 2014.
3	Average monthly production increased from 2770t/month in 2007 to 3532t/month in 2013 – an annual increase of over 9000t.
4	Energy efficiency improvement of 16% between 2008 and 2013 – a reduction of c.7200t of CO2.
5	100% of waste from the Refinery was re-used or recycled in 2014, avoiding landfill, up from 51% in 2008.
6	55% reduction in Refinery attributable customer complaints between 2008 and 2014 through CI work.
7	56% reduction in finished product inventory between 2008 and 2013 – a reduction of nearly 2000 tonnes of finished nickel.
8	Reduction in late shipments from more than 120 in 2008 to zero in 2013.
9	Maintained control of Refinery costs despite escalating input costs.

Discussion

In this paper, we have shown that Lean change can be successful and can be sustained (Table 4) in at least the case organisation. We can see a clear evolution through a series of stages, characterised as follows:

1. Tool-Based Change.
2. Systems-Based Change.
3. Cultural-Based Change.

This evolutionary journey is depicted in Figures 5 and 6. In Figure 5 we depict three stages with performance moving from highly variable (Tool-Based Change) to stable and slowly improving (Systems-Based Change) to consistent faster improvement (Cultural-

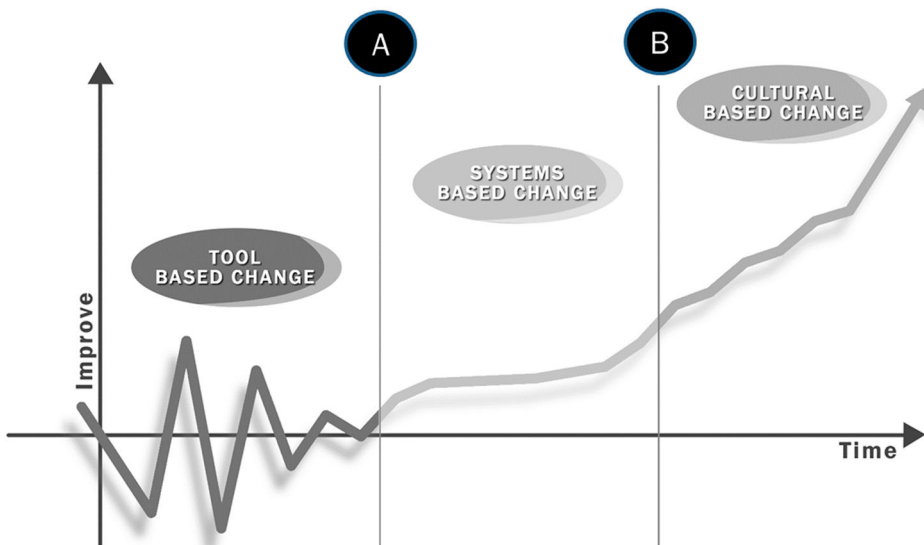


Figure 5. Lean maturity stages.

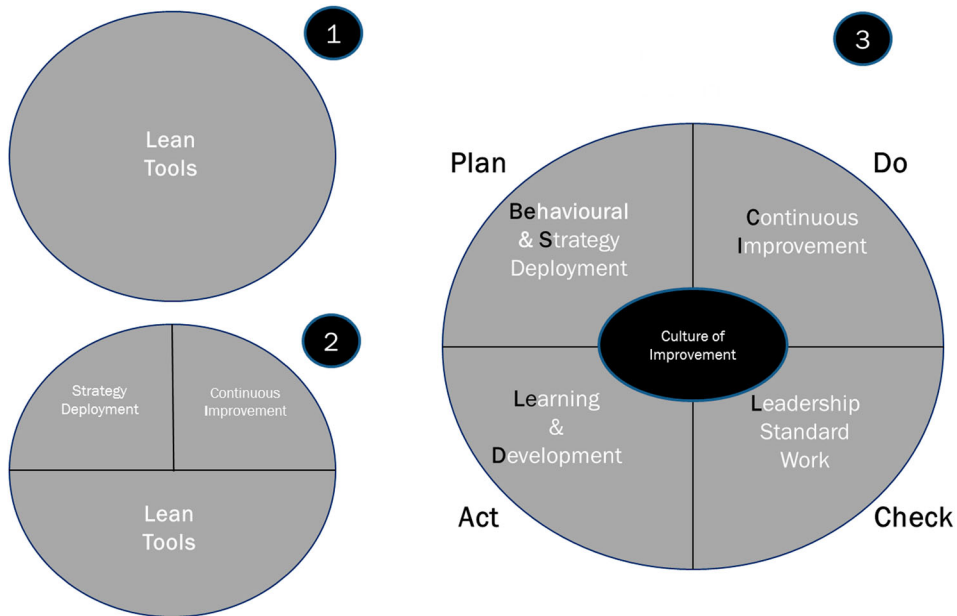


Figure 6. Lean maturity framework.

Based Change). In the first phase of its journey Vale's performance was variable and somewhat unstable. At this point improvement was characterised by the use of a series of tools such as 5S, FMEA, and PFUs. During this phase the business sought to use these tools to create stability. The approach was not yet holistic in nature but did lead to real tangible improvements. Hence in Figure 6(1) we show that the main emphasis was just on tools.

During its second phase (see Figures 5 and 6) Vale continued to apply well-chosen tools. However, it did this within the context of a coherent strategic roadmap. This involved the development of an improvement structure involving the use of two interlocking core systems, namely a Strategy Deployment system and a Continuous Improvement system. These core systems were focused around the 'Yellow Boards'. We should note that the key here was not the 'Yellow Boards' per se but rather the core operating systems. There was also an attempt to start developing the leadership and change management aspects of improvement, namely the use of 'Our Behaviours'. However, at this point, although helpful, these behaviours were largely disconnected with the Strategy Deployment and Continuous Improvement systems. Hence, here the emphasis was on a blend of tools and the systems of Strategy Deployment and Continuous Improvement (Figure 6(2)).

During the third phase of evolution the approach became rather more sophisticated. The business now commenced a more rapid and sustainable journey of culture change where the central feature was the development of a culture of improvement. This involved the evolution of the Strategy Deployment system into a more systemic Behavioural and Strategy Deployment System. Also, two further systems were added: Leadership Standard Work; and Learning and Development. It also involved looking at the business through not only the classic technical lens used within the Lean and Six Sigma world, but also a leadership and change management lens. It started to look at the four systems (see Figure 6(3)) as an inter-related set of core operating systems designed not only to produce change and

deliver business results, but also to allow the business continuously to improve the way that it operated by learning, adapting, and changing.

Hence in this third stage, we could envisage an organisation (in this case Vale) using an annual learning cycle where it planned what it was trying to achieve, why it was trying to achieve this, and deploying this information to all teams across the business with an appropriate set of behaviours (*Behavioural and Strategy Deployment system*). It then identified and undertook a series of planned and emergent improvement activities (*Continuous Improvement system*). Managers in the business checked whether this improvement was aligned to the business and local goals, and whether it was effective. If it was effective they gave appropriate reward and recognition. If it was less effective they gave support to local team leaders and managers (*Leadership Standard Work*). Finally, time was spent helping individuals and teams to learn, develop, and spread improvement activity. This involved the use of personal learning logs for all employees, coaching of individuals, and other mechanisms such as the spread of specific successful improvements from one area to other areas where these were relevant (*Learning & Development system*).

We believe this systematic Plan Do Check Act cycle, that we call here 'BE SCILLED (pronounced "Be Skilled")', is at the heart of Vale's sustained success (Figures 6).

However, we should be aware that such cases, in common with most other case studies of Lean, are the exception rather than the rule (Bateman, 2001). It would appear that most organisations are nowhere near as successful (Repenning & Sterman, 2001). So, what did Vale do that others failed to do?

Reviewing the evidence and connecting this with our Lean Maturity Stage model (Figure 5), it would appear that the key thing was that Vale found a way of rapidly and reasonably seamlessly moving from Stage 1 to Stage 2, and then later to Stage 3. We could regard this as overcoming two significant hurdles (A and B in Figure 5). Most organisations find this hurdling hard or impossible to do.

Hurdle A involved a move from the simple tool-based approach where a series of tools are used often in isolation. By adopting the 'Yellow Boards' and focusing on the Strategy Deployment and Continuous Improvement systems, Vale was able to align its approach and hence create a more systematic and aligned improvement journey. We suggest that most organisations adopting Lean fail to overcome this hurdle and hence they use a set of tools that are often in the wrong order or conflict with each other rather than a more aligned approach.

Hurdle B involved both the evolution of these systems as well as the use of two more systems allowing for a systematic BE SCILLED approach. This involves a considerable amount of leadership. In addition, it also involves the bringing together of often competing mindsets and functional skillsets. Lean people often see the world through a technical and process lens, whereas the more people-focused approach seen within the Human Resources community requires greater levels of emotional intelligence, empathy, and behavioural awareness. Bringing these together is akin to trying to cross a bridge wherein each of these communities starts from either side of the bridge but the bridge lacks a central piece, meaning that change is not sustainable. Hurdle B is about linking the bridge together and filling the usual gap between the two sides, as shown in Figure 7. This is almost certainly a bigger hurdle than the first one, and one very few organisations overcome.

Academic and management contribution and further research

In this paper, we have explored the Vale case and developed a framework to explain its successful journey and the hurdles it has sought to overcome. We believe the Lean Maturity

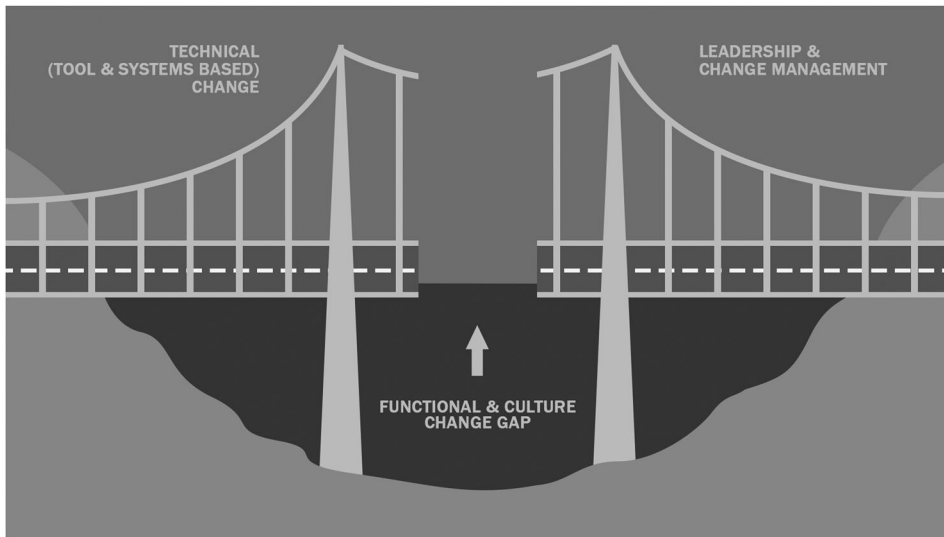


Figure 7. Moving from stage 2 to 3 – hurdle B (Adapted from Shingo Institute).

Stage model and BE SCILLED model have made a small step to help in the development of a coherent academic Lean theory framework and implementation route map as called for by authors such as Flynn et al. (1990) and Schmenner and Swink (1998). The approach demonstrated here helps to move our thinking of Lean as just an operational and tool-based approach forward by giving greater focus to the role of systems, people, and culture, an area of concern for authors such as Seddon and Caulkin (2007). In addition, we believe we have contributed to the debate about how such change can be made more sustainable as called for by authors such as Reppenning and Serman (2001) and Motley (2004). A summary of our contributions is provided in Table 5.

Specifically, these contributions also include a redefinition of Lean away from the application of a set of tools to reduce waste to a lifelong journey to create a culture of improvement based on a rigorous use of four core systems that ensures improvements are aligned, behaviours are exemplified, improvement is both planned and organic, systems are checked, and people are continually coached and developed. Both the case study presented here and the discussion around overcoming the two practical hurdles will also prove useful for practitioners wishing to take their own Lean journeys further and make them more sustainable. Indeed, this will help practitioners in their choice of implementation approaches (Anand & Kodali, 2010; Bhamu & Sangwan, 2014). Within this environment, those following the approach outlined here are also likely to increase their levels of staff engagement and show what Lean can achieve if applied appropriately as we have seen at Vale.

However, this paper is only a small step and further work is required. In particular, we have identified the following areas requiring future research:

- Whether the models we have described here are adequate to describe the journey that other organisations have taken to achieve sustainable enterprise excellence. We suggest that this requires both further case studies and wider multi-site quantitative study. This will allow for the further refinement and development of the models we describe here.

Table 5. Contribution of the paper.

Lean Criticism/Gap	Contribution	Level of contribution
Definition of Lean	A definition is provided in the conclusion that is applicable to the type of sustainable approach described in this paper.	Meaningful.
Coherent Lean Theory	A small step has been made in attempting to describe a framework for Lean enterprise excellence that can be implemented in a sustainable way.	Tentative step.
Implementation approach	A suggested three-step implementation approach is proposed that has proved successful in the case company.	Good for this single case. Requires further testing and validation.
Focus on operational level	Stages 2 and 3 of the approach show a move away from the operational level to a more strategic perspective.	Demonstration of need for strategic perspective to reach higher levels of Lean maturity.
Tools approach	Stages 2 and 3 of the approach show a move away from a tools-based approach.	Suggests that tools alone are not enough.
Lack of focus on people	The case and resulting model show that people are at the heart of successful, mature Lean implementation.	Positions people at the heart of Lean change.
Low-volume environment	Not addressed.	None.
Sustainability of Lean implementation	A case and framework are provided to show how a mature Lean organisation can create sustainable success.	Good, but limited to single case and requires further testing.
Negative people aspects	Not directly addressed, but the case and discussion reinforce the need to engage people and create a positive working environment where people are unlikely to feel alienated.	Limited.

- Whether it is possible to achieve a high level of performance with Lean (for instance tool based) without employing an approach similar to the one identified here at Vale and in the BE SCILLED model.
- Whether it is possible to skip a step and have a revolution rather than an evolution. It will be useful to test whether a principles-based approach and behaviour-based approach, coupled with tools and systems, can be applied successfully from the start of a Lean transformation. Will this be quicker? Will this be more effective? Will this be more sustainable? Such research questions are likely to require longitudinal case studies.

Conclusion

The early writers on Lean placed a heavy focus on Lean being about the removal of waste and the application of tools. As we quote above: ‘Muda. It’s the one word in Japanese you really must know’ (Womack et al., 1990, p. 15). We have shown that this approach, although perhaps helpful in the early stages of a Lean transformation, is unlikely to enable a mature or sustainable Lean journey. Indeed, such a mindset is likely to become an obstacle in its own right.

So: Have we got it wrong? Is the traditional waste reduction tool-based Lean approach wrong? The simple answer is yes. As we described above, we see Lean as a lifelong journey to create a culture of improvement based on a rigorous use of four core systems that ensures improvements are aligned, behaviours are exemplified, improvement is both planned and organic, systems are checked, and people are continually coached and developed.

In this paper, we have contributed to academia and practitioners by presenting a single case study. We have also developed a series of models, frameworks and hurdles (specifically Figure 5: Lean Maturity Stages; Figure 6: Lean Maturity Framework and Figure 7: Hurdle B) which make a modest contribution to our understanding of the application of Lean, how to overcome some of the current gaps in the literature, and a true theory for Lean. In order to validate this approach, we believe that significant further testing is required in a range of industries, and in different cultural settings, through further case studies and quantitative studies.

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