23rd Annual POMS Conference, Chicago, Illinois

Applying a BITESIZE lean change methodology to intermodal terminal operations

Daryl Powell; Erik Gran

SINTEF Operations Management,
SINTEF Technology and Society,
SP Andersens Veg 5, 7491 Trondheim, Norway

Abstract: *Lean has been applied successfully in manufacturing since the 1990s, and has more recently extended to service operations. However, applications within intermodal freight terminals are still lacking. In this we paper, we apply a BITESIZE lean change methodology that was developed for the systematic application of lean practices in SMEs to a Norwegian intermodal terminal, and demonstrate the applicability of a selection of lean tools and techniques for improving material flow out of context of the traditional application areas of lean production.*

Introduction

This paper addresses the task of applying lean practices outside of the traditional context of discrete manufacturing and assembly operations. By calling on experiences with the use of a lean change methodology developed for the deployment of lean practices in small- and medium-sized enterprises (SMEs), lean tools are systematically applied to an intermodal freight terminal. We illustrate how lean practices can be more generally applied to alternative environments by the use of a less resource-intensive implementation process. We also conclude that the application of lean practices to intermodal terminals can drive all players that participate to deliver high levels of operational efficiency and effectiveness.

Research Question and Research Method

The research question that will guide this investigation is “how can lean practices be applied out-of-context to improve material flow in intermodal freight terminals?”

Based on the “how-type” research question (Yin, 2009) and the previous experience of the authors with an intermodal freight terminal in Norway, case study research was selected as the appropriate methodology to investigate the application of lean practices to improve material flow in intermodal terminals. Before we address the case, we give the theoretical background regarding lean production and the implementation of lean practices.

Lean Production

Lean production is based on the principles and working processes of the Toyota Production System (TPS), and has been defined as doing more with less (Womack et al., 1990). In its simplest terms, lean production can be described as the elimination of waste (Liker, 2004). Though Liker (2004) suggests that the goals of lean production are highest quality, lowest cost, and shortest lead time, it has been most prominent in the discrete, repetitive assembly-type manufacturing operations (Powell et al., 2009).

Existing Lean Implementation Methodologies

Åhlström (1998) suggests that existing research on the implementation of manufacturing improvement initiatives supports the idea that there are sequences for improvement activities in manufacturing. For example, Roos (1990) suggests that it is first necessary to change employees’ attitudes to quality, in order to achieve material flow which contains only value adding operations. Storhagen (1993) suggests that job rotation and teamwork are required early on in order to support continuous improvement and change.

Extant literature in the form of international academic journals and educational textbooks was examined in order to identify existing processes and methodologies for the implementation of lean production. The most frequently cited implementation processes were Womack and Jones (1996); Åhlström (1998); Hobbs (2004); and Bicheno and Holweg (2009). Common elements from each of the four aforementioned lean implementation processes were identified, and a subsequent comparison can be seen in Table 1.

Each of the authors documents a very intensive lean implementation process, requiring a great amount of time and resources. This is thought to be one of the reasons why large companies seem to have embraced the lean manufacturing philosophy quite successfully, whilst empirical evidence suggests this is not the case for SMEs (e.g. Achanga et al., 2006). In contrast to their larger counterparts, SMEs lack many of the resources required for such an intensive implementation process, including time, money, and knowledge. As such, the EU project “European Regions for Innovative Productivity” (ERIP) was setup to develop a lean change methodology for the effective implementation of lean practices in SMEs.

Table 1: ***A Comparison of Lean Implementation Processes***

	Bicheno and Holweg (2009)	Hobbs (2004)	Womack and Jones (1996)	Åhlström (1998)
Initial education	X		X	
Establish strategic vision	X	X	X	
Organizational structure for change			X	X
Define and establish teams	X	X	X	X
Define performance goals	X		X	
Implement basic foundations of lean	X			
Define products	X	X	X	
Define processes	X	X	X	
Establish zero defect mentality	X			X
Ongoing training / learning	X		X	
Vertical information systems	X		X	X
Layout for flow	X	X		
Lean accounting	X		X	
Pull system	X	X		X
Continuous improvement	X	X	X	X

The ERIP project, which concluded in December 2011, was a partnership between government (regional development agencies), knowledge institutions and manufacturing companies operating in six partner countries: England; Belgium; The Netherlands; Germany, Sweden and Norway. The aim of the project was to facilitate lean implementations in SMEs by proposing a Lean Change Methodology (LCM) adapted to small companies, and also by setting up a knowledge network – the so-called “Innovative Productivity Centre” that actively provides support, training and knowledge exchange in each partner region.

Experiences in Norway, and likewise from the other partners, confirmed the reasons given in the literature for failed lean attempts in SMEs, as the lack of resources in the SMEs was witnessed firsthand. Thus a less intensive implementation process was required.

A BITESIZE Lean Change Methodology

As a result of the ERIP project, a less intensive LCM was developed to enable the implementation of lean practices in SMEs (Figure 1). This methodology was tested on 24 SMEs throughout Europe, with promising results.

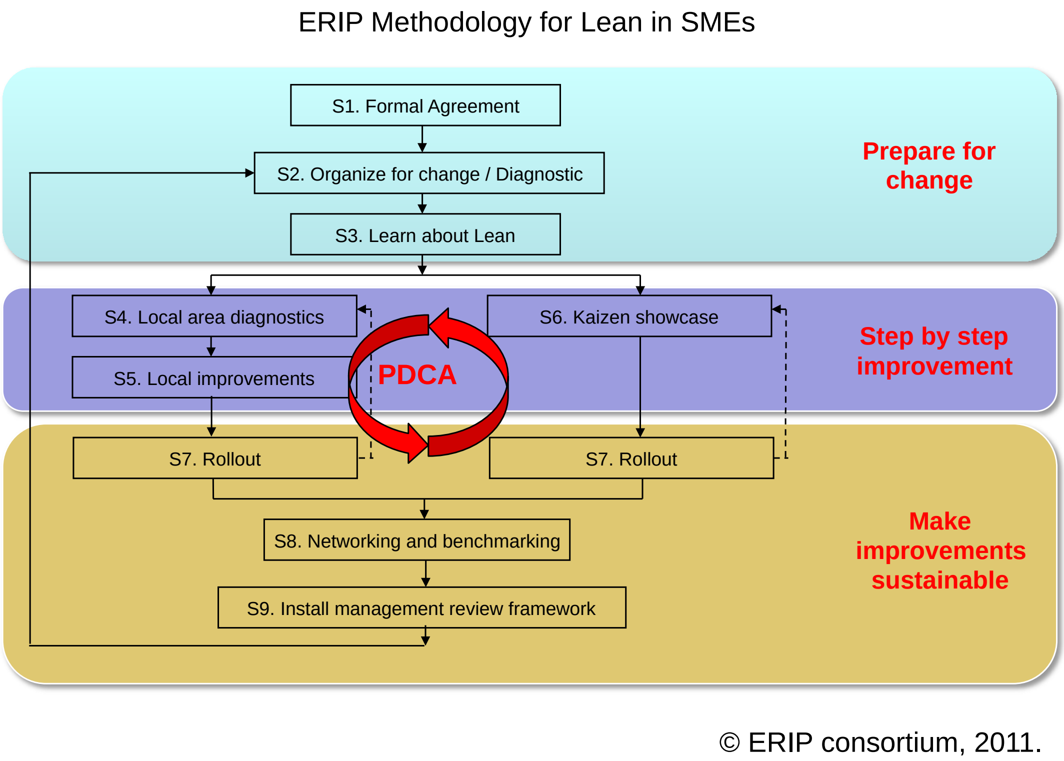

Figure 1: ERIP Lean Change Methodology

In the Norwegian SMEs, the ERIP methodology was further reduced to its constituent parts in order realize a simplified and manageable BITESIZE approach to lean change. The inspiration for such an approach stems from BBC BITESIZE, which is the name given to the BBC's free online study support resource for school children in the United Kingdom (British Broadcasting Company, 2012). BBC BITESIZE is designed to give a simplified and manageable approach to exam revision. Both the ERIP LCM and The BITESIZE methodology are based on the Industry Forum MasterClass Process Improvement Activity (see Bateman and David, 2002 for a detailed description of this approach). Such a methodology uses the plan-do-check-act (PDCA) cycle (Deming, 1986) as a platform for diagnostic activity in order to identify improvement areas and to suggest lean practices as countermeasures which will improve operational performance. As such, the BITESIZE methodology consists of three core phases – the pre-diagnostic; the diagnostic workshop; and the improvement workshop/s (Figure 2).

Figure 2: The BITESIZE Lean Change Methodology

Pre-diagnostic

The pre-diagnostic phase consists of the first initial meeting with the company. A standard presentation is given to the company representatives to give an overview of the lean philosophy and the need for continuous improvement. Based on the principle that SMEs have short lines of communication and mostly a limited management structure (one owner or general manager, and a limited number of middle management positions), the people that will drive the actions in the SME and maintain momentum should now be identified as the *company change agents*. If the owner of general manager will not be directly involved, he should at least clearly demonstrate his commitment to the lean change process, as failure to do so constitutes a clear risk of failure for the SME. Finally, a formal agreement is made at this point in order to maximize the chance that the SME will stay committed for the whole project period.

The pre-diagnostic event should take approximately one half of a day.

Diagnostic workshop

Having established change agents within the company and given a clear signal for the need for lean change, the next step is to determine the focus area for improvement activities. A list of KPIs was determined as part of the ERIP project:

- Not right first time (NRFT)
- Delivery schedule achievement (DSA)
- People productivity
- Stock turns
- Overall equipment effectiveness (OEE)
- Value-added per person (VAPP)

These should be analyzed and used to identify areas for improvement. However, in many of the 26 ERIP SME testers, it was found that these fundamental KPIs were not being used. Therefore, rather than use all of them, it was decided to use existing KPIs and focus upon those that currently give the poorest results. As a platform for the diagnostic activity, the PDCA cycle is systematically applied along with basic analysis tools, such as process mapping, Pareto analysis etc.

The diagnostic workshop has shown to take approximately two days.

Improvement workshop

Following the diagnostic activity, a focus area will have been identified. The next step is to apply the PDCA cycle to assist in the deployment of improvement activities. Usually, these activities will be the implementation of lean practices which act as countermeasures to the problems identified during the diagnostic. For example, standard work (Ohno, 1988) can be applied to reduce and eliminate variation in processes, or the single-minute exchange of dies (SMED) system (Shingo, 1985) can be applied to reduce set-up and changeover times to improve flow.

The improvement workshops can vary between three and five days.

A description of intermodal terminals will now be given in order to set the context of the investigation, before we address the previously defined research question in the context of a single case study.

Intermodal Terminals

The official definition of intermodal transport produced by the United Nations Economic Commission for Europe (UNECE) is *"the movement of goods in one and the same load unit or road vehicle, which uses successively two or more modes of transport, without moving the goods themselves when changing modes"* (Vrenken, 2011).

Intermodal transport fulfills an important role on the European transport arena, because of its use of standard load units, which are carried by road as well as by sea, inland waterways and rail (Vrenken, 2011). This has a clear benefit as to the process time when changing form one transport form to the other, so seen from the view of customer value intermodal transport is a logical choice. As lean production can be described as one at a time, completely flexible, no waste flow (Bicheno and Holweg, 2009), intermodal terminals are logical candidates for the application of lean production principles.

Case Study: Alnabru-terminal

Alnabru terminal is an intermodal freight-terminal that is located at Alnabru in Oslo, Norway. It was opened in 1907, and in 2008 the terminal was rebuilt to increase capacity. The Alnabru terminal is the hub of the Norwegian cargo railway system and is mainly used for shuttle trains with intermodal transport units such as containers and semi trailers. In a proposal for the National Transport Plan 2010-2019, Avinor et al (2008) emphasized that it is of national interest to create conditions for efficient terminal operations at Alnabru terminal. The Norwegian National Rail Administration wants to increase the capacity of the rail network, and to improve operational efficiency. Alnabru terminal is currently run by a single terminal operator, CargoNet, and several train operators and freight distributors use the terminal.

Some of the major freight distributors joined with the terminal/train operator CargoNet and defined a common improvement project PROFIT for the Alnabru terminal cluster. The project gained financial support from the Norwegian Research council (NFR) and was started in 2008 with SINTEF Technology and Society as the research partner in the project consortium. The major goals of the project were to identify and analyze possible improvements in overall terminal efficiency and use these results to design and implement changes in terminal operations.

As part of the PROFIT project, lean production was considered as a prime candidate to improve the operational efficiency of Alnabru terminal, as central to lean production is the elimination of waste. Though somewhat “out-of-context”, the philosophy and working practices associated with lean production are nowadays being applied to environments other than the discrete parts manufacture found within the automotive industry. For example, not only has lean been applied to other branches of manufacturing, such as the process industry (King, 2009), but also to healthcare (Hadfield et al., 2006); construction (Alarcon, 1997); and services (Sarkar, 2007).

Pre-diagnostic

Firstly, a lean-team was established on the terminal. The team consisted of representatives from the terminal operator CargoNet, as well as representatives of each of the freight distributors – Schenker; Bring; and Posten. Having coached the team on the basic fundamentals of lean production, SINTEF chose to persist with the application of the BITESIZE lean change methodology.

Diagnostic workshop

A total of three diagnostic workshops were held at Alnabru terminal to investigate the potential application of lean practices in order to improve intermodal terminal operations. This paper refers to only the first diagnostic workshop.

During the first workshop, following a process-flow mapping activity for the arrival of trucks at the terminal, the Gate-in process was quickly identified as a bottleneck process and an obvious area for improvement. The Gate-in operation showed excessive variation in processing time, which was due to a lack of a standard communication mechanism. For example, though few drivers were prepared with a printed ticket when they arrived at the Gate (clearly showing container number, train number, vehicle registration number etc), many drivers had identification numbers scribbled on the back of their hands, whilst there were also difficulties in communication with foreign drivers. Therefore, it was suggested that the use of a type of Kanban solution would reduce the variation in processing time at Gate-in by providing a standardised communication mechanism.

Improvement workshop – Kanban as a standard communication mechanism

Kanban, which is Japanese for card or signal, was developed to provide authorization for the production or transportation of parts and components for just-in-time (JIT) production, and is a central element of the Toyota Production System (Ohno, 1988). Originally, Kanban was a simple printed card that travelled with the products. Recent developments have seen versions of electronic Kanban (e-Kanban), which can use barcodes and in some cases radio frequency identification (RFID) tags (Lage Junior and Godinho Filho, 2010). Put simply however, unless an operator receives a Kanban, parts or components should neither be produced nor transported. We suggest that a type of Kanban could be used at Alnabru terminal to provide authorization to transport containers to and from the trains. This could be the most basic of printed cards in its simplest form, or it could be a printed barcode with scanning equipment at the gate, or even a full-blown automatic RFID solution.

The variation at Gate-in was also in part due to a lack of standard work procedures, for example for the ad-hoc rebooking of containers onto earlier or later trains, as well as the process for customs clearance. Here it was suggested that another fundamental principle of lean could be applied – standard work. Standard work is also used within lean production to control, reduce and eliminate variation in processes (Shingo, 1981). By creating standard work processes on the Gate-in process, the variation in this process can be significantly reduced and properly controlled.

Discussion and Conclusion

By examining typical lean change methodologies for manufacturing environments and considering them in the context of SMEs, a less intensive LCM was developed by the ERIP partners. From the ERIP methodology, a simplified BITESIZE approach was developed based on the core three phases identified in Bateman and David (2002): Pre-diagnostic, Diagnostic workshop, and Improvement workshop. By applying the BITESIZE LCM at Alnabru Terminal in Norway, we have demonstrated how lean practices can be applied out-of-context to improve material flow in intermodal freight terminals.

We suggest that our BITESIZE approach has many more applications outside of the discrete manufacturing environments typically associated with the application of lean practices.

Acknowledgements

This research was made possible by the EU project European Regions of Innovative Productivity (ERIP), financed through the Interreg program, and the SINTEF project PROFIT, which has been financed by the Research Council of Norway.

References

Achanga, P., Shehab, E., Roy, R. & Nelder, G. 2006. Critical success factors for lean implementation within SMEs. *Journal of Manufacturing Technology Management*, 17 (4)**,** 460-471.

Alarcon, L. 1997. *Lean Construction* Rotterdam, A.A. Balkema.

Bateman, N. & David, A. 2002. Process improvement programmes: a model for assessing sustainability. *International Journal of Operations & Production Management,* 22 (5)**,** 515-526.

Bicheno, J. & Holweg, M. 2009. *The Lean Toolbox*, Buckingham, PICSIE Books.

British Broadcasting Company. 2012. BBC BITESIZE. *BBC Learning* [Online]. Available: http://www.bbc.co.uk/schools/gcsebitesize/ [Accessed 29 January 2012].

Deming, W. E. 1986. *Out of the Crisis*, Cambridge, Massachusetts Institute of Technology.

Hadfield, D., Holmes, S., Fabrizio, T. & Tapping, D. 2006. *Lean Healthcare: 5 Keys to Improving the Healthcare Environment,* Chelsea, MI, MCS Media, Inc.

Hobbs, D. P. 2004. *Lean Manufacturing Implementation: a complete execution manual for any size manufacturer*, Boca Raton, FL, Ross Publishing.

King, P. L. 2009. *Lean for the Process Industries: Dealing with Complexity,* New York, Productivity Press.

Lage Junior, M. & Godinho Filho, M. 2010. Variations of the kanban system: Literature review and classification. *International Journal of Production Economics,* 125 (1)**,** 13-21.

Liker, J. K. 2004. *The Toyota Way: 14 Management Principles From the World's Greatest Manufacturer,* New York, McGraw-Hill.

Ohno, T. 1988. *Toyota Production System: Beyond large-scale production* New York, Productivity Press.

Powell, D., Alfnes, E. & Semini, M. 2009. The Application of Lean Production Control Methods within a Process-Type Industry: The Case of Hydro Automotive Structures. *APMS 2009: International Conference on Advances in Production Management Systems.* University of Bordeaux, Bordeaux, France: Springer.

Roos, L.-U. 1990. *Japanisering inom produktionssystem: Några fallstudier av Total Quality Management i brittisk tillverkningsindustri, (Japanisation in Production Systems: Some Case Studies of Total Quality Management in British Manufacturing Industry). Swedish,* Göteborg, Handelshögskolan vid Göteborgs Universitet.

Sarkar, D. 2007. *Lean for Service Organizations and Offices: A Holistic Approach for Achieving Operational Excellence and Improvements,* Milwaukee, Wisconsin, ASQ Quality Press.

Shingo, S. 1981. *A Study of the Toyota Production System,* New York, Productivity Press.

Shingo, S. 1985. *A Revolution in Manufacturing: The SMED System,* New York, Productivity Press.

Storhagen, N. G. 1993. *Management och flödeseffektivitet i Japan och Sverige. (Management and Flow Efficiency in Japan and Sweden). Swedish,* Linköping, Linköping University.

Vrenken, H. 2011. Innovative Intermodal Transport. *European Intermodal Research Advisory Council* [Online]. Available: http://www.eirac.eu/documents/EIA%20Handbook.pdf [Accessed December 2011].

Womack, J. P. & Jones, D. T. 1996. *Lean Thinking: Banish Waste and Create Wealth in Your Corporation,* New York, Simon and Schuster.

Womack, J. P., Jones, D. T. & Roos, D. 1990. *The Machine that Changed the World,* New York, Harper Perennial.

Yin, R. K. 2009. *Case study research: design and methods,* Thousand Oaks, California, Sage Publications.

Åhlström, P. 1998. Sequences in the Implementation of Lean Production. *European Management Journal,* 16 (3)**,** 327-334.