A NEW LEAN CHANGE METHODOLOGY FOR SMALL & MEDIUM SIZED ENTERPRISES

Joris April[a], Daryl Powell[b], Bart Schanssema[c]

a. PhD student, University of Ghent, Dpt. Industrial Management, Technologiepark 903, B-9052 Zwijnaarde, Belgium; joris.april@ugent.be (Corresponding Author).

b. PhD student, Institute of Production and Quality Engineering, Norwegian University of Science and Technology, S.P. Andersens Veg 5, NO-7491 Trondheim, Norway.

c. Project Manager, N.V. NOM, Regional Development Agency for the Northern Netherlands, Paterswoldseweg 310, 9728 BM Groningen, Netherlands.

Abstract: SMEs find it difficult to implement productivity improvement tools, particularly those associated with Lean Manufacturing. Larger companies have more success due to greater access to resources. To provide the SMEs with a way to implement Lean sustainably, the European project ERIP develops a new lean change methodology for SMEs. In this paper the methodology is explained and three test cases show the strength of the methodology. The method is a sequence of achieving management and company support, starting with data analysis and identifying problems and consequently solving these problems. Within the workshops, training of employees is conducted. The three test cases show that even through limited efforts, a good productivity improvement can be achieved in a sustainable manner.

Keywords

Lean Manufacturing, small and medium-sized enterprises, optimization, sustainable innovation, change management.

1. INTRODUCTION

As low-cost economies are growing rapidly, EU manufacturers are under increasing pressure to be more innovative and flexible. Lean Manufacturing is a proven method of increasing productivity. While large companies seem to have embraced manufacturing philosophies such as Lean and Six Sigma, empirical evidence suggests this is not the case for SMEs [Shah & Ward]: “despite organisational inertia

effects, large firms are more likely to implement lean practices than their smaller counterparts". [Von Axelson, 2009] adds that Lean knowledge is mainly tied up in large manufacturers and has not at all been widely spread and embedded in SMEs.

SMEs are however very important within the EU economic structure (EU definition; an SME has than 250 FTE). This is acknowledged in European Commission policies. In the most recent annual SME report commissioned by the EC, [Audretsch et al], the importance of SMEs is evidenced: 99% of the Europe's non-financial companies are SMEs. These account for 67% of employment in the EU. As [Antony et al] rightfully states, SMEs also act as suppliers to larger organisations and thus their "footprint" is even larger than these numbers make it seem. SMEs are shown to have a lower labour productivity and lower profitability than their large counterparts, but are acknowledged as essential for economic growth, innovation and knowledge transfer. Their strategic importance and their lower ability to attract knowledge to boost labour productivity and competitiveness have incited the EC to support the European Regions for Innovative Productivity (ERIP) project through the "Interreg North Sea Region" programme. The project is a partnership between government (regional development agencies), knowledge institutions and companies operating with 6 partners: England; Belgium; The Netherlands; Germany, Sweden and Norway.

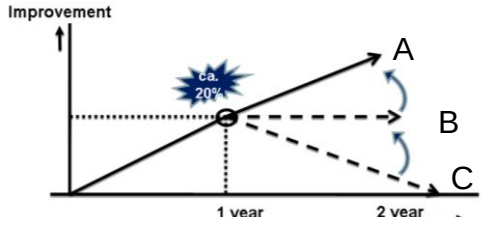

Figure 1 Sustainable improvement [Bateman & David].

The project wants to facilitate Lean implementations in SMEs by proposing a "Lean Change Methodology" 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. 24 SMEs will be actively testing the method. That knowledge networks are an adequate way to introduce Lean principles in SMEs, is backed by the Swedish empirical research in [Von Axelson, 2009]. Both the network itself as the transferred knowledge and improvements in the individual companies need to be sustainable. A performance pattern that typically emerges in SMEs implementing Lean techniques is initially

encouraging results, but a later fall back (2 years after implementation start – scenario B and C in Figure 1). Sustainability in improvement for an SME means continuing the improvement effort [Bateman & David], be it with or without external support (A in Figure 1).

Trying to understand the difficulties SMEs have in implementing Lean, we could start by studying what diversifies them from their large counterparts [Von Axelson, 2007]: Resources, Management and Organization. The latter two seem to create beneficial circumstances for Lean implementation in SMEs. Management style tends to be short-term oriented [Antony et al] without much strategic alignment and performance follow-up [Smart et al]. However management is usually small and centralized [Von Axelson, 2007], multidisciplinary 'hands-on' [Smart et al], informal and people oriented [Antony et al], [Ghobadian & Gallear]; all of these last elements would be rather beneficial for a Lean programme to be implemented. Good top-management leadership has higher leverage in small companies and is the major critical success factor for Lean in an SME [Achanga et al].

Looking at the flat hierarchical organisation structure in an SME ([Antony et al], [Ghobadian & Gallear]), the informal climate with flexible work planning ([Antony et al], [Ghobadian & Gallear], [Von Axelson, 2007]) could harm standardization efforts. However, they have a more important positive impact: more flexibility, higher impact of the individual on performance, low resistance to change. Involving people in initiatives comes naturally in SMEs [Smart et al]. There is a more direct relationship with customers and communication is more effective [Antony et al]. The right organisational culture is cited as a key success factors in [Achanga et al].

From the above reasoning one could conclude that SMEs offer a more suitable environment for successful Lean implementation. However, limited resources (skills, labour time and financial resources) cause the main implementation difficulties ([Antony et al], [Ghobadian & Gallear]). In practice this is the limiting factor for an SME's Lean implementation efforts, while [Achanga et al] finds Finance and Skills/Expertise to be two of the critical success factors. Training budgets and staff development are absent and due to limited resources short-term profitability is usually the main goal [Antony et al].

2. THE LEAN CHANGE METHODOLOGY

2.1. About the setup of the method

The "Lean Change Methodology" as described in the ERIP project is not very specific in its detail and chronology; which areas are to be improved and by which tools is largely dependent on the individual situation and trying to prescribe these decisions would lead to non-acceptance and resistance to change. This means some steps can be skipped or slightly re-arranged. Evaluation during the tests in 24 SMEs will yield the final methodology, along with guidelines for introducing Lean principles in SME's. As Lean is a management method for continuous improvement, the main pursuit within the SMEs is the adoption of such a method. Given the short project timeframe available (1 year of guided activities) for such a turnaround, a good mix of theoretical training sessions versus "trial & error" by the SMEs themselves is needed. Due to scarce resources the method cannot be too complex, see [Nabhani & Shokri] where Lean Six Sigma is partly simplified for an SME context. [Von Axelson, 2009] suggests that high-level theory is usually not useful. This is backed by [Mulhaney et al]: companies struggle to appreciate how to implement solutions, not which to implement. The basis for the method is the experience in the different regions, most notably the MAS-NEPA method in England, which has already helped more than 150 companies with more than 250 employees achieve sustainable productivity improvement. ERIP adds onto the NEPA experience the transnational learning network, wherein Lean is spread more efficiently and with lower costs and efforts, in addition to provide a peer pressure effect both by other SMEs and trainers. Sustainability is pursued; by focussing on embedding core Lean principles through the simplified methodology, SMEs should be able to keep momentum going after one year of coaching and reiterate through the methodology steps.

2.2. The Step framework of the Lean Change Methodology

A. Preparation phases

A formal agreement (S1) was put together, stating the requirements and engagements expected from the tester SMEs in order to maximize the chance that the SME will stay committed for the whole project period. By signing such an agreement, top management

clearly demonstrates their commitment. When either of both parties falls short of their agreed engagements, the agreement can be cancelled. Initial visits are very essential to build mutual trust; [Von Axelson, 2009] shows this is essential in an efficient knowledge network.

Because SMEs generally have a limited management structure, the change agent(s) that will drive the continuous improvement efforts are identified beforehand. A general diagnostic (S2) is undertaken to describe the operations and to document the chosen focus area. A semi-structured "Productivity Needs Analysis" (PNA) [Herron & Braiden] interview of the management team yields an assessment of the operational excellence of the SME and guides the first improvement initiatives. Value Stream Mapping is an option at this stage.

Management's expectations are listed and would ideally be translated into KPI targets to be reached after 6 months and after 1 year. Within this discussion, strategic alignment and management's willingness to change must be ensured by the ERIP team members. The KPI objectives described above are put on a time scale, in improvement cycles of 1 to 3 months each, covering 1 year (Action plan – S4). The assembled core team to execute the action plan should include representatives from (or all of) the operators, area supervisor (needed for sustainability reasons) and management. The company appoints a change agent to lead the improvement team. If cycles take place in different focus areas, a different core team could be selected for each. The SME core team then needs to be trained in the Lean Change Methodology as well as in the basic Lean principles that underpin it. The Lean introduction (S3) training could consist of a one day workshop, with theoretical sessions and a business game. This step is not strictly embedded in the chronology but must be finished before local workshops (Cc1-Cc6) start.

B. Local Area improvement cycles

In the action plan formulated in S4, a number of local area workshops (not necessarily all focusing on the same area) are described. As the project progresses, some companies might move on from strictly local initiatives (5S, standard work, visual management) to value stream-wide workshops to improve flow, planning and production control, for example. A fixed minimal set of "before, during, and after"

measurements are decided upon for research purposes, but also for sustaining momentum in each company; [Von Axelson, 2009] argues that qualitative measures might suffice in early implementation stages but later on a more quantitative approach needs to show the bottom-line effects.

C. Diagnostic phase of Improvement cycle

This session is conceived to get initial buy-in and involvement from the SME core team working on the improvement cycle. All operators/supervisors of the selected focus area provide a list of problems, which are put on post-its and clustered by priority/benefit and investment/effort, so practical PDCA-lists can be put together based on them (step CC1). Experience has shown that this often eliminates issues which would otherwise hinder progress in the improvement cycle. It creates a sense of trust, ownership and involvement in operators which see some of their (sometimes already timely) daily irritations and problems solved. After this (step CC1) the team is more receptive for some introduction training on VA/NVA and the 7 wastes. Training should ideally be interactive with discussion directly applied to the situation at hand in the SME (step CC2 – focus on the basis for Lean: Visual Mgt, 5S, Standard work).

After the basic training the first local measurements are prepared, these are the indicators that are linked to the improvement tools and activities for this cycle and are possibly different from the general KPI's to be measured in the M steps. A Value Stream Map (VSM) may be created at this phase. All employees from the focus area need to be briefed and prepared for actions to take place. After analysis of the gathered data from KPIs and the VSM, priorities for the improvement cycle can be set.

D. Local Improvement Workshops

Based on the KPI-targets and the diagnostic phase, the ERIP team members can choose the appropriate set of Lean tools and techniques to apply. These are explained through practical examples and short presentations, but they are most importantly applied immediately (Kaizen workshops- Cc4). Afterwards, follow-up visits are planned regularly to see if the changes are not only sustained but also that the company is managing to roll-out the introduced

techniques to all (relevant) areas other than the initial focus area (step CC5). An implementation plan for the roll-out is composed.

Every month the results are reviewed (Step CC6); based on internal KPI follow-up by the company – this could also involve some benchmarking and comparison from similar improvement cycles in peer companies participating in the project across regions. This peer comparison serves as a reinforcement to keep the momentum. If an SME is doing extremely well, it will motivate them. If an SME is lagging, then seeing that other SMEs achieve better results will reinvigorate them by showing that goals are attainable.

E. Other and final phases

A local exemplar visit (step S5) with operator teams from each SME allows operators to relate with the operators from the exemplar, regarding similar Lean tools they are using themselves, and also to serve as a reward/recognition for the operators. Not only does it show good practice, it gives the SMEs one more opportunity to meet, discuss and exchange experience with both peers and the exemplar company. This step is not embedded in the chronology of the other steps, and can be undertaken at any given time. To recognize the SME management and Lean team, they should report the final results of each cycle to their SME peers, preferably in an international setting. It has been very clear in our recent empirical experience that the "peer group" effect within the national and transnational SME clusters is very important; at informal discussion opportunities after common trainings, very vivid discussions and experience exchange take place. After the project, companies will be evaluated to see if the changes are in fact sustainable, and companies are encouraged to repeat the methodology steps through sequential 1-year improvement plans.

3. CASE ONE: THE NETHERLANDS

The Showcase SME in the Netherlands is an agricultural equipment manufacturer, with approximately 100 employees and an annual turnover of EUR 10 million.

3.1. Pre-Diagnostic Meeting

The management team presented the company, and the NEPA engineer presented the workshop format. Commitment of all

participants was agreed on. The focus area was determined. The PNA was perceived of little value. Data was gathered from problem boards on the shop floor: improving on the not-right-first-time issues were the workshop goal.

3.2. Diagnostic Phase

The diagnostic phase consisted of data analysis and teach-points on problem solving and data analysis. The basic principle of the diagnostic is to get the root cause of the problem. Using Pareto analyses, the issues were divided into manageable problems. Most problem causes were incorrect parts, followed by unavailable parts. With respect to incorrect parts, the major problem was in the welding area. The problem was that parts were not welded according to drawing specifications. Using a cause and effect diagram [Ishikawa] the team suggested problem causes and these were ranked. The main cause was the lack of clearly defined process-steps for the welding process. Further consideration of the problem board data revealed that most delivery problems were planning-related. The team decided to extend the diagnostic phase, the problem was too complicated to identify the root cause.

3.3. Improvement Workshop

The aim of the improvement workshop is to solve the diagnosed problems by eliminating the root causes and waste. For the first parts welding instructions were made in consultation with welders. Using video observation a waste elimination session took place. The team adapted the welding area to reduce walking, bending and reaching. A manipulator was introduced for easily turning of the jig. Lead time for one part was reduced by about 20%.

The analysis of planning started with a process-flow map. All team members indicated a problem at the intake of purchased goods. Most also indicated a problem at the point where Kanbans have to be taken out of the system. A third group recognized a data accuracy problem. Therefore, three improvement activities were initiated: delivery dates have to be planned in such a way that deliveries are leveled more evenly over the week; the warehouse operator will mark an area which for goods received awaiting acceptance; and responsibility for the supply of tools, protection, grease etc. will be transferred to production management.

On the final day of the workshop, a presentation was delivered to the management team. The expectations and the outcomes were discussed. An open point list was created showing points and responsibilities. Overall, the team was positive as was the management.

4. CASE TWO: FLANDERS

The Showcase SME in Flanders is an automotive electronic passive components manufacturer, with 30 employees (FTE) and an annual turnover of EUR 2 million.

4.1. Pre-Diagnostic Meeting

Firstly the ERIP team members make sure the company accepts and understands the do-it-yourself bottom-up team approach. Management support and engagement was ensured in the procedure and in the first meetings, where a formal agreement was signed. The ERIP team and trainers merely assist delivering the appropriate knowledge and guiding the change process within the SMEs. Thereafter, an interview was undertaken in order to get a clear understanding of the business environment for the company, as well as to prepare the KPI measurements for the diagnostic phase. A short version of the PNA [Herron & Braiden] was used.

4.2. Diagnostic Phase (3 day workshop)

The SME team was made up out of three operators and the production manager. A presentation was given explaining the purpose of the project and the workshop, the core concepts of Lean manufacturing and waste reduction, and the need for continuous improvement. The PDCA circle of [Deming] was introduced, as well as the 7 wastes and a systems view of processes. Performance measures were introduced. Team expectations tended to be more focused on smaller operational details. Management expectations were more high-level (i.e. skill-development and teamwork).

A strategic high-growth product with some quality and capacity issues was chosen for a pilot analysis. A process flow analysis was conducted. Simultaneously, a routing chart was drawn showing the product movement from workplace to workplace. Afterwards, a clear overview of the process and its deficiencies led the local improvement efforts. Based on this analysis and the previously mentioned quality

issues, one sub-process was selected for in-depth operational analysis using a video of the work cycle.

At the end of the discussions, countermeasures were listed and put on a PDCA-follow up list. They were also prioritized using a 2-scale division: High/Low effort and High/Low cost. A list of small improvements was made which were classified in three categories: reducing operator movement, changing sequence of activities, and changing the actual method.

4.3. Improvement Workshop

Due to the abundance of operator movement and walking, the team started by reorganizing and standardizing the workplace. Several new layout proposals were drawn up by the team and evaluated for feasibility as well as for the amount of reduction in distance traveled. The distance traveled was reduced by 50%. After reorganizing the layout of the workplace, 5S and standard work are the next logical next steps. A short 5S presentation was given, followed by the immediate application of the first 3 steps (Sort, Set in order, Shine) on the workplace for the studied process. The remaining 2 steps (Standardize, Sustain) are anticipated by drawing up a rollout plan and introducing 5S checklists and audit rounds. A captured video of the new work method showed that the non-value added time was reduced by 36%.

As a final topic, the quality issues for the process were discussed and root causes are traced using by an Ishikawa diagram [Ishikawa] combined with the 5 Why-technique. A few root causes were identified, resulting in an experimentation plan. To conclude the team listed the learning points, out of which ”Watching things from a distance can give a lot more insight in processes” and “Now we are able to apply these methods ourselves” were prominent.

5. CASE THREE: SWEDEN

The showcase SME in Sweden was an electrical- and electronic equipment manufacturer, with 55 employees and an annual turnover of EUR 10 million.

5.1. Pre-Diagnostic Meeting

The pre-diagnostic meeting allows all team members to understand the whys, whats, and wherefores of the ERIP change methodology. A factory tour was taken. During the factory tour, it was decided which area would be the focus of the showcase event. Some company expectations were also defined: gains in productivity; cycle time reductions; the introduction of continuous improvement initiatives; and the standardisation of work tasks.

5.2. Diagnostic Phase

Following a visit to the shop floor, the first step of the diagnostic was to map the process. Perhaps most important from the process mapping exercise was the evaluation afterwards – What did we learn? The results illustrated that it was unclear as to how production was ordered / initiated. It was apparent that quality problems due to supplier defects were common, and several areas were identified that can be simplified (e.g. – a simple pull system could be introduced for pre-assembly). There were high levels of inventory and workplace organization was also unclear in places, and could generally be improved.

The next step was to evaluate what the data was telling us. This was supported by the teach points Data analysis and the 7 measures, which demonstrated an example of the use of pie charts and Pareto charts for analysis of NRFT (not-right-first-time) data. Data analysis in the ERIP methodology is always based on the Deming cycle [Deming]. An issue that was noticed, however, was the difficulty encountered in retrieving, understanding and evaluating the data. This resulted in a very time consuming process.

From process mapping, it was identified that the flow of materials and material locations generated a large amount of waste. Therefore, the assembly processes were recorded on video. Having captured the assembly processes, the team was split into groups and began to evaluate the assembly process for waste elimination. It was decided that the entire assembly process could be simplified by changing the work area layout, material locations, and the type of tools and tool locations, which became the focus areas for the workshop.

5.3. Improvement Workshop

During the improvement workshop, the focus was upon improving the material flow through waste elimination and improved workplace organization. By considering the wastes which were identified in the diagnostic phase, two main improvement areas were identified, namely tooling locations and stock locations. The first team had a focus on tooling locations and 5S, whilst the second team focused on stock locations and visual management.

Once the improvements were completed, the assembly process was once again video recorded and analyzed. However, the improvements seemed to have a detrimental effect, with an increase in cycle time of more than 10%. This was due to the fact that the operator had not actually participated in the workplace organization exercise, and so had to search for many of the components, thus losing momentum. On the other hand, it was agreed that the overall workplace organization had improved, and that cycle time reductions would occur once the operator has become accustomed to the new layout. The team has also prepared a roll-out plan for further improvement activities, including a review of KPIs, further work with material flow, and the creation of standard operating procedures.

The team made a number of conclusions, which included developing an ability to look at problems from new perspectives, and to use simple techniques. Perhaps the most important outcome: the team now has a keen ambition to continue the improvement activities.

6. DISCUSSION AND CONCLUSION

As previously mentioned, a good way to become more productive is through the application of new production techniques such as Lean Manufacturing. Though large companies have already embraced Lean and profit from the use of it, the implementation of Lean techniques in SMEs remains largely constrained by the lack of resources, knowledge and know-how. We identify that SMEs need a methodology to sustain productivity improvement. To this end, the ERIP project was set up by partners from 6 regions in the North Sea area. The goal of ERIP (a partnership between government, universities and companies) is to develop a Lean Change Methodology suitable for SMEs.

In the Netherlands, we saw a lead time reduction of 20%. In Flanders, the distance travelled by the operator was reduced by 50% and NVA time reduced by 36%. And, although in Sweden we initially saw a 10% increase in cycle time, with further work on standard operating procedures, this cycle time can be drastically reduced. From the showcase events described here, the ERIP lean change methodology appears to be an effective method of sustainably introducing lean tools and techniques into SMEs. By introducing small teams within SMEs to a range of lean tools, companies can embark upon a lean journey of continuous improvement with limited funds and resources. By guiding them intensively for a one year period, companies should be able to reiterate the steps in sequential improvement plans and embed the principles with minimal external support. In future research, a formal evaluation framework capturing relevant operational and organizational measures will be established and deployed for formal evaluation of the methodology and its sustainability.

It is intended that the ERIP lean change methodology be continuously developed and fine-tuned to suit the needs of the SME. By creating clusters in each region around exemplar companies and knowledge institutions, ERIP develops a transnational network of knowledge and practical expertise for implementing lean practices in SMEs throughout Europe. The SME learning network (which if proven successful will be sustained by obtaining follow-up funding) provides the needed external support for SMEs that larger companies don't need and is a novel approach.

7. REFERENCES

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

Antony, J., Kumar, M., Madu, C. N. (2005). "Six sigma in small- and medium-sized UK manufacturing enterprises", in International Journal of Quality and Reliability Management , 22 (8): 860-874

Audretsch, D., van der Horst, R., Kwaak, T., Thurik, R. (2009). "First Section of the Annual Report on EU Small and Medium-sized Enterprises", source:

http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/index_en.htm

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

Deming, W.E. (1982). Out of the Crisis, MIT Center for Advanced Engineering Study, Cambridge, MA, ISBN: 0-91-137901-0.

Ghobadian, A., Gallear, D. (1996). “Total Quality Management in SMEs”, in International Journal of Management Science , 24 (1): 83-106.

Herron, C.; Braiden, P.M. (2006). “A methodology for developing sustainable quantifiable productivity improvement in manufacturing companies”, in International Journal of Production Economics, 104 (1): 143-153.

Ishikawa, K. (1990). Introduction to Quality Control. , Productivity Press, ISBN: 4-90-622461-X

Mulhaney, A., Sheehan, J., Hughes, J. (2004). “Using ISO9000 to drive continual improvement in a SME (Case study)” in The TQM Magazine , 16 (5): 325-330.

Nabhani, F., Shokri, A. (2009). “Reducing the delivery lead time in a food distribution SME through the implementation of six sigma methodology”, in Journal of Manufacturing Technology Management , 20 (7): 957-974.

Shah, R., Ward, P. T. (2003). “Lean Manufacturing: context, practice bundles, and performance” in Journal of Operations Management , 21: 129-149.

Smart, P. A., Maull, R. S., Childe, S. J., & Radnor, Z. J. (2004). “Capitalizing on thematic initiatives: a framework for process-based change in SMEs”, in Production Planning & Control , 15 (1): 2-12.

Von Axelson, J. (2007). “On The Development of production methods for transfer to small to medium-sized enterprises” (Unpublished doctoral dissertation), Royal Institute of Technology, Stockholm, Sweden.

Von Axelson, J. (2009). “Developing Lean Production implementation methodology for SME learning networks” in EurOMA 2009 Conference Proceedings, Göteborg, Sweden.

ACKNOWLEDGEMENTS

This research is made possible through funding from the ERDF, through the Interreg IVB North Sea Region Programme.