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Implementation of continuous improvement based on Lean Six Sigma in small- and medium-sized enterprises

Werner Timans[a*], Kees Ahaus[b], Rini van Solingen[c], Maneesh Kumar[d] and Jiju Antony[e]

[a]*Department of Manufacturing Engineering, Stenden University of Applied Sciences, PO Box 2080, 7801 CB Emmen, The Netherlands;* [b]*Faculty of Economics and Business, University of Groningen, Groningen, The Netherlands;* [c]*Faculty of EWI, Software Engineering, Delft University of Technology, Delft, The Netherlands;* [d]*Cardiff Business School, Service Operations, Cardiff University, Cardiff, UK;* [e]*Department of Business Management, Heriot Watt University, Edinburgh, UK*

Research has highlighted a need for a specific and practical implementation framework for deploying Lean Six Sigma (LSS) in small- and medium-sized enterprises (SMEs). The success of LSS implementation in SMEs is highly dependent on the extent to which an LSS deployment programme addresses the specific properties of SMEs. In this study we have evaluated an existing framework for Six Sigma implementation for SMEs [Kumar, M., Antony, J., & Tiwari, M. K. (2011). Six Sigma implementation framework for SMEs – a roadmap to manage and sustain the change. *International Journal of Production Research*, *49*(18), 5449–5467] using a multi-method triangulation approach. The objectives of this study were firstly to strengthen the foundations of the existing framework by uncovering evidence for some of its elements and, secondly, to identify the proposed revisions to the framework, especially focussed on its application in manufacturing SMEs. The results of our study are a collection of confirmations and revision proposals for the framework, leading to a revised conceptual framework.

Keywords: Lean Six Sigma; framework; sustainable implementation; SMEs

1. Introduction

Only a limited number of studies have been published on the implementation of Lean Six Sigma (LSS) in small- and medium-sized enterprises (SMEs). Some of these have focussed on the critical success factors and barriers in the implementation of Six Sigma, Lean or LSS approaches (Antony, Kumar, & Madu, 2005; Achanga, Shehab, Roy, & Nelder, 2006; Timans, Antony, Ahaus, & van Solingen, 2012). Only a few studies have focussed primarily on roadmaps for implementing LSS as a change programme for SMEs (Hansson & Klefsjö, 2003; Chakravorty, 2009; Kumar, Antony, & Tiwari, 2011).

The study by Kumar et al. (2011) clearly focuses on the implementation of a Six Sigma programme in SMEs. In this study, a framework for the implementation of Six Sigma is introduced (Figure 1) that includes instruments reflecting a lean manufacturing background. Because of this, the introduced framework supports the merger of lean manufacturing and Six Sigma, as inspired by George (2002) and Snee and Hoerl (2007). LSS combines two improvement approaches that originated from different parts of the world, as described by Dahlgaard-Park (2011). The main focus of the lean approach is

*Corresponding author. Email: werner.timans@gmail.com

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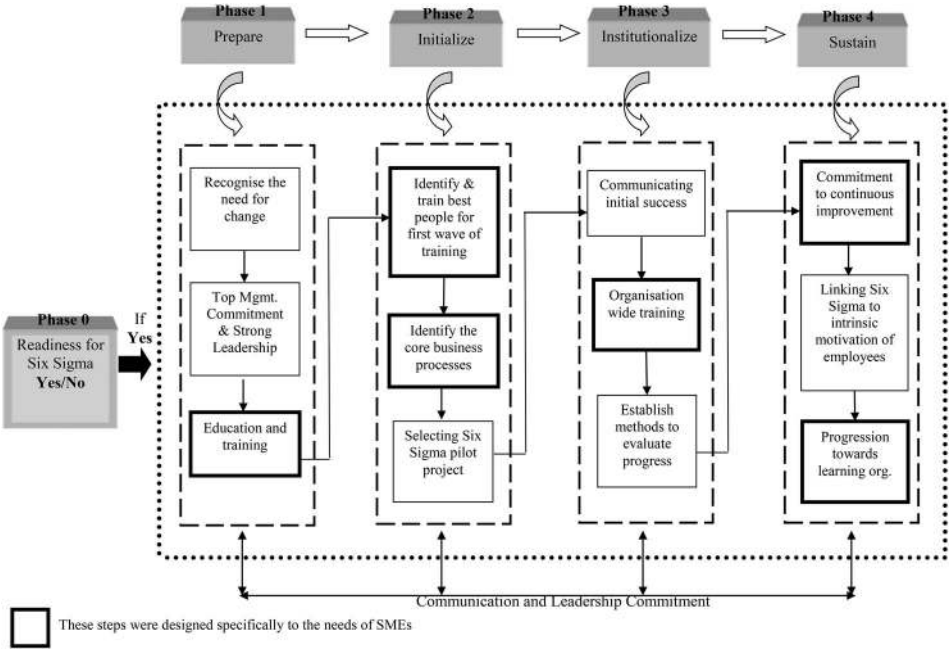

Figure 1. The framework of Kumar et al. (2011).

on improving the flow between processes and on reducing waste and variability, while Six Sigma mainly concentrates on improving the processes themselves by closely examining causal relations through the collection and analysis of real data. The two are not independent: Poor flow between processes and the existence of waste and variability may cause a deterioration of process performance; while on the other hand, low process performance may cause problems in the flow between processes and may result in waste and variability. Because of this, it makes sense to draw on Lean and Six Sigma simultaneously in an integrated way to address all the root causes of poor performance.

The framework proposed by Kumar et al. (2011) comprises five phases, including a preliminary 'Phase 0' that is focussed on testing the SME's readiness for Six Sigma (Kumar & Antony, 2010). The authors themselves indicated that their framework (Figure 1) had only been tested in three SMEs, and stated that 'its robustness needs to be checked and refined based on suggestions and comments from industry, practitioners and academics'. The objective of our research is to respond to this call by contributing to the further validation and improvement of the Kumar et al. framework. Our research intentions can be summarised in the following research questions:

(1) What supporting, confirmatory evidence can be found on the phases and steps of the framework proposed by Kumar et al. (2011)?
(2) What evidence can be found that the framework needs improvement? What revision proposals (Rps) can be formulated based on this evidence?
(3) What are the building blocks of a revised and validated framework that will meet the formulated proposals for revision while keeping the confirmed elements in place?

In the following sections of this paper, we first start by explaining our research approach and methods, which comprise a literature study, an expert focus group study,

and retrospective interviews in two companies with long-term experience in the deployment of LSS methods. In the next section, we present the results of our research as components of evidence that support the existing framework and add proposals for revisions. In the discussion and conclusion sections, we summarise and discuss our main results, and from there, reach a revised conceptual framework.

2. Research approach and methodology

In order to strengthen the basis of a framework with only limited validation, a focus group study makes sense. Bringing expertise from both consultants and practitioners together in a focus group that is balanced with respect to academic backgrounds and experience offers the opportunity to achieve good results within a short time frame. Relying on the results of one focus group alone, however, is precarious. We, therefore, strived for triangulation by firstly starting with a structured literature study to connect to contributions from other studies, and then by following up on the focus group with retrospective interviews to learn from practical experience from SME companies that have implemented LSS. The results from the three research methods are discussed and converted into a revised framework.

The research approach is depicted in Figure 2. The discussions lead to confirmatory evidence from, in this order, the literature, the focus-group research, and the retrospective interviews, and to proposals for revision.

2.1. *Structured literature search*

In our literature study, we searched for articles on issues relevant to implementation in a manufacturing context. Advanced search facilities were used in Science Direct, Emerald, Taylor & Francis, EBSCOhost and Springer databases, using the following keyword formulation: <'Six Sigma' OR 'Lean' OR 'Lean Six Sigma'> AND <'lmplementation'> AND <'Learning' OR 'Knowledge'>. The search was not restricted to articles that specifically focussed on SMEs because we wanted to first gain a broad picture of implementation issues. A list of 78 papers remained after limiting the search to peer-reviewed academic journals with references, restricting the timeframe to publications after 2003, and adding the additional condition that Six Sigma, Lean or LSS be explicitly mentioned in the abstract. We then excluded papers that were far outside the manufacturing context and added one additional article identified from the papers' references, which qualifications resulted in a final list of 19 articles.

2.2. *Focus group research methodology*

The Kumar et al. framework displayed in Figure 1 can be regarded as a theoretical model for change. Focus group research that aims to discuss existing theory is related to the experiential type of focus-group task, according to Fern (2001, p. 6) in his book, *Advanced Focus Group Research* (Table 1). For experiential tasks, a focus group should ideally have around 10–12 participants with some degree of homogeneity so the participants can share, exchange, and discuss ideas based on having comparable relevant knowledge in the field being studied (Fern, 2001, p. 180). We, therefore, invited experts in the field of LSS with backgrounds in practice and consulting. The group would thus be homogeneous with respect to LSS knowledge and experience but would differ with regard to the context of the members' experiences. Table 1 presents a summary of the backgrounds of the participating consultants and practitioners.

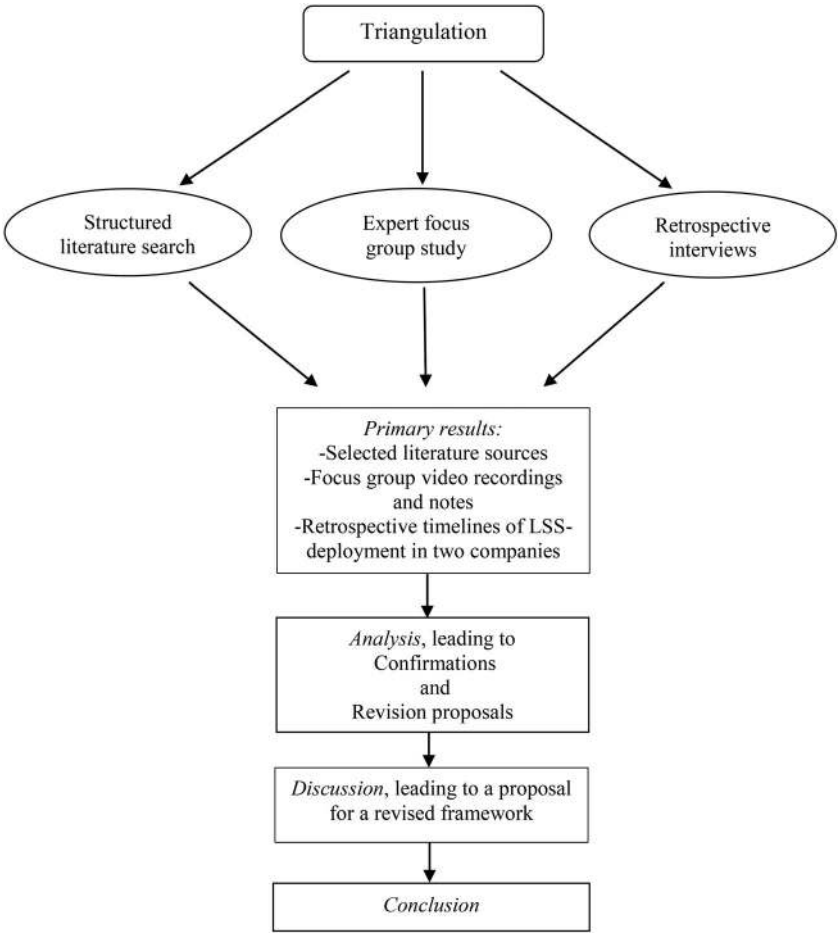

Figure 2. Research approach and methodology.

The customers of the first two consultants of Table 1 are predominantly SMEs. The other two consultants work mainly in larger companies, but they often working for small business units within these large companies. Practitioners 3 and 6 have wide

Table 1. Background and experience of the focus-group participants.

Background	Education level	LSS level	LSS experience (years)
Consultant	1. Master	MBB	12
	2. Master	MBB	12
	3. PhD	MBB	8
	4. Master	MBB	>12
Practitioner	1. PhD	Champion, MBB	>12
	2. Master	Champion, BB	4
	3. Master	Champion	5
	4. Master	Champion, BB	6
	5. Bachelor	Champion, BB	>12
	6. Bachelor	BB	7

experience in the SME context. Practitioner 6 was educated at the black belt (BB)-level in a large company (about 700 employees), but is now working full time as a BB in a high-tech manufacturing SME. The picture for the other practitioners is more diverse. Their employers are organisations above the SME-level, but managing/supervising projects in smaller business units is part of their work.

The programme set for the focus group meeting followed a three stage programme, an individual round, a second round in subgroups, and a third plenary round. In the third plenary round (video- and audio-recorded) final conclusions were formulated. Focus group research is not focussed on reaching complete unanimity (Krueger & Casey, 2009, pp. 19–20). However, the ideas of our focus group through the three rounds converged to final results with a high degree of consensus.

2.3. *Retrospective research in the industry*

We used additional retrospective interviews to add experiences from managers who have led the actual deployment of LSS in an SME company. We selected seven companies that were interested in our study. We visited them all to explain our research goals and to receive information about their deployment efforts. Only two companies appeared to have long-term experience in the deployment of a continuous improvement (CI) programme. Long-term experience was needed because experienced organisations would presumably have passed through different phases of deployment. These companies were visited again to interview managers who were involved in the deployment process from an early stage.

The interviews were focused on the LSS deployment steps in retrospect. Key to the process of collecting retrospective data is the need to reduce recall bias (Berney & Blane, 2003). We decided to use the lifegrid interview as our methodology for improving the validity and reliability of the results. These strategies have been seen as improving the accuracy of recalled data, particularly with reference to the time at which events happened.

3. Results and analysis

3.1. *Primary data and results from literature*

The complete list of selected articles is displayed in Table 2. Although some of the papers would fit in more than just one single category, we used the research focus to categorise the articles into four groups: Implementation frameworks, Strategic implementation issues, Culture development, and Learning and knowledge development.

3.2. *Primary data and results from our focus group study*

In the focus group session, the group first reflected on the framework of Kumar et al. (2011) as a whole and argued that the separation between Phases 2 and 3 was somewhat artificial and that these phases could be merged into one single phase. Phase 0, 'Readiness for Six Sigma', was regarded as very important, but the focus group argued that it should come later, as a management concern in the steps after the step 'Recognise the need for change', which was regarded as a logical first step in Phase 1.

The steps of the first phase were confirmed to be relevant, but the focus group proposed to incorporate the 'Identify core business' step of Phase 2 into the steps 'Top Management Commitment & Strong Leadership' and 'Education and training' (for management) of Phase 1. The focus group proposed to start the second phase ('Initialise and

Table 2. Selected articles.

Literature in categories		Research method	Main Results
Implementation frameworks	1. Chakravorty (2009)	Single case study in a large organisation	A six-step Six Sigma implementation model
	2. Hansson and Klefsjö (2003)	Multiple case study research	A three phase roadmap for implementing TQM in small organisations
	3. Kumar et al. (2011)	Multiple case study research, expert interviews, literature study	The roadmap presented in Figure 1, Six Sigma implementation in SMEs
Strategic implementation issues	4. Linderman, Schroeder, and Choo (2006)	Survey study, data collected from Six Sigma projects in a large organisation	Goals can be effective when project-teams adhere to the Six Sigma method and tools. However, when the tools and methods are not used rigorously setting challenging goals can be counterproductive
	5. Hilton and Sohal (2012)	Interviews with Master BBs, literature study	Technical (for instance, statistical, financial) and interpersonal attributes of BBs and Master BBs are identified as well as factors for success in deploying an LSS programme
	6. De Mast (2006)	Literature study	Competencies for disciplined and effective problem solving and decision-making behaviour can be developed by a strategic use of Six Sigma
	7. Shah, Chandrasekaran, and Linderman (2008)	Literature study, survey study	Using lean methods improves the likelihood of implementing Six Sigma methods too. Performance levels are raised when lean methods are extended with Six Sigma methods
	8. Timans et al. (2012)	Survey study and additional case study research	Ranking of critical success factors and barriers for LSS implementation in SMEs. Data on use and usefulness of LSS-tools. Overview of hard and soft measures to appreciate organisational performance
Culture development	9. Done, Voss, and Rytter (2011)	Multiple case study research	Best Practice Interventions carried out in SMEs are unlikely to develop sufficient capability for long-term change. For sustainable improvement an implementation programme is needed
	10. Jones (2005)	Single longitudinal case study	Entrepreneurship within project teams appeals to the

(*Continued*)

Table 2. Continued.

Literature in categories		Research method	Main Results
			development of a natural attitude to take initiatives, which is only feasible when social relations are optimised
	11. Zu and Fredendall (2009)	Survey study, regression analysis	Employee involvement, training, performance and recognition significantly affect the use of Six Sigma methodology. The Six Sigma role structure can be integrated in quality-oriented HRM practices
Learning and knowledge development	12. Arumugam, Antony, and Kumar (2013)	Survey study on projects in one single company, regression analysis	Six Sigma technical support to the project team and team psychological safety promote learning behaviour and knowledge creation in project teams and enhance the impact of Six Sigma projects
	13. Choo, Linderman, and Schroeder (2007)	Conceptualising study, formulation of propositions	A conceptual framework consisting of methodological and contextual elements for learning and knowledge creation
	14. Gutierrez Gutierrez, Bustinza, and Barrales Molina (2012)	Survey study, structured equation modelling	Six Sigma teamwork and process management positively affect the development of Absorptive Capacity (AC). AC and organisational learning orientation are significantly and positively related
	15. Hagen (2010a)	Literature review	Champions and BBs are examples of roles for which coaching capabilities are extremely important
	16. Hagen (2010b)	Survey study, principal component analysis, regression analysis	Results indicate that 'coaching expertise' explained most of the variance in project management performance for both BBs and team members
	17. McAdam, Antony, Kumar, and Hazlett (2011)	Multiple case study research	A model demonstrating the underlying routines for knowledge absorption processes. Propositions are defined relating the characteristics of SMEs to LSS implementation
	18. Mukherjee, Lapre, and Van Wassenhove (1998)	Survey study on projects in one single company, factor and regression analysis	Recommends conceptual learning alongside operational learning, especially when the applied technology is poorly understood
	19. Tu, Vonderembse, Ragu-Nathan, and Sharkley (2006)	Literature study, survey study, structural equation modelling	Dimensions of the AC concept, and an instrument for measuring AC

Institutionalise') with the selection and execution of a pilot project, and to organise the education of the project leader and team members within that project. The involvement of process owners was emphasised as very important, as process owners have a direct interest in the project outcomes.

The focus group missed a step regarding the organisation of the selection and support of next projects, coming after the successful completion of the first pilot project. 'Communicating initial success' and 'Establishing methods to evaluate progress' were confirmed to be important as separate steps. The focus group argued that the Sustain phase is very important. Embedding of changes realised in the previous phase in the existing management system, widening scope towards suppliers and customers, and 'learning faster' were regarded as the main issues of the Sustain phase. The focus group pleaded for special steps at the end of the first two phases for reflection on the progress of the implementation until then, to reconsider scope and ambitions.

3.3. *Primary data and results from our retrospective interviews*

The deployment of the programme as it has run in Company A is depicted in the timeline of Figure 3. In 2003 a consultant was invited by Company A's management to introduce Six Sigma. After this presentation, the management decided to start with the education and training of two BBs. The BBs and the consultant would then, afterwards, together train the members of the management team at the green belt (GB) level. From then, new GB-training sessions were led by the BBs without further assistance. The GB training took about five months, having two days of training planned each month, and in between, participants worked on a project. In 2003 the deployment was exclusively focussed on Six Sigma, but lean aspects came in in an evolutionary way. In 2005 basic operator training started. This training was introduced because shop-floor employees were only poorly involved prior to this step and occasionally showed some reluctance to cooperate. In the first version, this training took two days, which was shortened, afterwards, to one day, with an emphasis on lean.

Major problems in the deployment arose in 2007 and in 2011. In 2007, a gap was felt between the GB level and the Basic Operator level, and a new orange belt (OB) level was introduced to bridge this gap. The training of OBs contained tools to be used in teams like brainstorming techniques, root cause analysis using cause and effect diagrams, and on simple statistical measures. OB projects have a planning timeframe of 2–3 months. GB projects are more complex and have a planning timeframe of 3–6 months. In 2010, management decided to integrate Lean and Six Sigma completely. In 2011, management experienced a serious dip in performance at the GB level. Measures were taken with respect to the project-selection and -approval process by

Figure 3. Timeline of company A.

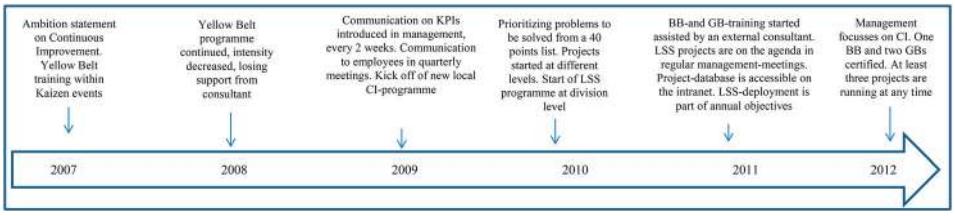

Figure 4. Timeline of company B.

strengthening the roles of the champion, the BB, and the process owner. One of the measures was to introduce the obligation for certified GBs to carry out at least one project each year as a condition to keep the certification valid. From 2005, the intranet-based supporting system has developed continuously and is accessible to management and project team members.

Company B's first lean-oriented deployment efforts date from 2007 when a bottom-up approach at the local level started, with the help of a British consultancy company, invited by the then holding company. In Figure 4, the timeline for Company B is depicted. Between 2007 and 2012, the ownership of the company changed a few times, which caused changes in the management and in management priorities. In 2009 the local production manager took the initiative to revitalise the programme as a CI programme. A selection was made of problems that had to be tackled within the next year, from a 40-points list. Project subjects were predominantly on waste reduction, 5S, OEE (Overall Equipment Effectiveness). For instance, the commonly called 5S-'Red Tag' sessions were organised around production machines (Marria, Williams, & Naim, 2012). By the end of 2010 decisions were made to reinforce the programme under the LSS banner at the division level. At the beginning of 2011, BB- and GB-training started for one BB- and two GB-candidates and were organised around projects.

3.4. *Confirmatory evidence and Rps*

3.4.1. *Confirmatory evidence*

From the results of the three research methods, elements of confirmatory evidence for the existing framework were inferred. From our literature review, we first identified two elements of confirmatory evidence that did not confirm parts of the framework itself, but referred to the usefulness of a framework and the need for external expertise. The first element of confirmatory evidence was on the need for a roadmap towards CI. Just setting up pilot projects is not enough to realise long-term change. Achieving sustainable improvement requires a comprehensive implementation programme (Shah et al., 2008; Done et al., 2011 – Sources 7 and 9 in Table 2). The second element was about the need for the temporary assistance of external experts. The assistance of external experts is advised for successful implementation (Done et al., 2011). The need for such a roadmap is also illustrated in the results of our retrospective interviews. The deployment in Company A was more top-down than it was in Company B, and the course of the implementation efforts was better structured than it was in Company B. Neither company's approach followed a framework for implementation exactly, but Company A's more disciplined top-down approach came close.

The confirmatory evidence for the framework of Kumar et al. (2011) is summarised in Table 3. The first column of Table 3 contains the steps within the phases of the framework

Table 3. Confirmatory evidence.

Phases and steps in the framework of Kumar et al. (2011)		Confirmed	Source of confirmatory evidence
Phase 1	Recognise the need for change	Yes	L: 1 and 2 F: Start with a statement of urgency for change. Is there a *burning issue* directly threatening the company's future, or is it just because many problems are *recurring problems* R: The need for better performance to meet customer expectations was the drive to embark on LSS. As such the need for change was recognised
	Top Mgmt. Commitment and Strong Leadership	Yes	L: 6, 8 and 13 F: Emphasise the Top-Mgmt.'s role with respect to defining purpose and scope of the programme and linking this to the organisation's mission and vision R: The approach of Company A was more top-down, showing less periods of falling back compared to company B. Company B followed a more bottom up approach in the beginning
	Education and Training	Yes	F: Management should be educated at LSS awareness level. The responsibility for the implementation programme has to be assigned to a member of the Mgmt.-team. The formation of a temporary steering team is proposed R: Company A started with management education. All members of the management team were trained at GB level. All educated members of the management team are prepared for a role as Champion
Phase 2	Identify and train best people for first wave of training	Yes, but not as a separate step	L: 5, 8, 13, 15, 16. Subjects covered are Project-management, LSS methods, Coaching skills F: The focus group regards this as important, but not as a separate step, prefers to connect training to projects R: Both companies have selected candidates for training at GB level, but training is always connected to the execution of a project
	Identify the core business processes	Yes, but not as a separate step	L: 1, connected to strategic analysis and process mapping (not in a specific SME-context) F: This is recognised as to be important, but the identification of core business processes should come earlier R: This has been part of the initial management discussions, internal and

(*Continued*)

Table 3. Continued.

Phases and steps in the framework of Kumar et al. (2011)		Confirmed	Source of confirmatory evidence
			with consultants. Later on is has been a management concern, in particular when falling back was observed
	Selecting Six Sigma pilot project	Yes	L: 4, 10, 12 on goal setting and Six Sigma projects, on social safety within project teams F: Criteria for the first pilot project are chance for success and the general recognition of the project's relevance and impact
Phase 3	Communicating initial success	Yes	F: Strongly supported, together with celebrating initial success
	Organisation wide training	No	F, R: Training on different levels is important, but is not a separate step in deployment. Training has to be connected to projects R: Company A introduced a basic training (one day) for shop-floor employees to gain commitment on the shop-floor. This does not justify *Organisation wide training* as a separate step
	Establish methods to evaluate progress	Yes	F: Recognised as management responsibility. Regular reviews of on-going projects, taking measures for improvement. Seeking for spin-off projects R: In both companies project results are presented to the management team and discussed with the management. In both companies the management has taken measures to revitalise the programme
Phase 4.	Commitment to CI	No	F: Commitment to CI is important, but the development of dedicated managers cannot be connected to one single step
	Linking Six Sigma to intrinsic motivation of employees	Yes, but not as a separate step	L: 10, 11, 12, 13 18. Subjects covered are Rewarding and recognition, Social environment, Team-work, Knowledge development F: The focus group argued that this is important, but it cannot be covered by a step in an implementation framework
	Progression towards learning org.	Yes, but not as a separate step	L: 10, 12, 13, 14, 18. Subjects covered are learning, active attitude towards taking initiatives, measurement of progress in learning abilities F: Supported as reflecting cultural change in which *driving to the best* and *learning faster* are main characteristics. But it is a long-term process

Notes: L: literature (numbers refer to literature sources of Table 2), F: focus group, R: retrospective interviews.

Table 4. Revision proposals.

Rps		Motives and explanation
Rp 1	Reduce the number of phases, into Phase A (Recognise and Prepare), Phase B (Initialise and Institutionalise) and Phase C (Sustain). Incorporate a Readiness test in Phase A	L: Hansson and Klefsjö (no. 2 in Table 2) and George (2002) also propose a three phase model. George (2002) discerns three phases: (1) Initiation, (2) Resource and Project selection plus Implementation, and (3) Sustainability and Evolution F: In practice the first step would always be *recognise the need for change* and therefore proposes to incorporate the Readiness test in Phase A. The focus group did not see a reason to separate the phases *Initialise* and *Institutionalise*
Rp 2	Incorporate *Identifying core business processes* in Phase A	F: The focus group argued that *Identifying core business processes* (part of phase 2 in Figure 1) could better be transferred to the first phase. In mobilising commitment of management the identification of core business processes is an important issue
Rp 3	Let Phase B start with a pilot project	F: The focus group believed that in Phase B the selection of a first pilot project should come first. The project leader must be selected with a focus on the skills needed to lead a team
Rp 4	Connect the education of a project-leader to a project. Let educated project-leaders educate new project-leaders. Educate team-members within a project	F, R: The focus group pleaded to first select a project and to organise education within that project. The managers interviewed in our retrospective research did not fully support that view, but acknowledge that carrying out a project should be part of the education F, R: The focus group and the managers interviewed in our retrospective research emphasised that educated project leaders should be able to educate new project leaders (train the trainer approach)
Rp 5	Identify process owners. Involve the process-owners in the project-definition. Communicate to process-owners frequently in the course of the project	L: Hilton and Sohal (no. 5) F: Management must be keen to involve process owners – process owners have the most direct interest in project results R: This is confirmed by the managers interviewed in our retrospective research
Rp 6	Involve shop-floor employees from the earliest stage through communication and training within projects	R: The interviewees emphasised that involving shop-floor employees from the beginning of deployment is crucial. In company A the involvement of shop-floor employees was postponed to a later stage, giving internal resistance an opportunity to rise
Rp 7	Start developing a system for project selection, planning, administration and	F: The focus group missed this issue in the framework of Figure 1 R: Both companies A and B of our

(*Continued*)

Table 4. Continued.

Rps		Motives and explanation
	support, as soon as the first selected project starts	retrospective research have such a supporting system in place, accessible for teams and supervisors
Rp 8	Discuss the progress of the deployment in regular management meetings	F: The focus group proposed that at the end of the phases A and B the management should specifically reflect on the scale and ambition of the programme R: Overviewing the history of the deployment in both companies, a few periods of severe falling back are visible. In the course of the deployment efforts periods of falling back seem to occur almost natural. Evaluation of the deployment and reconsidering plans regularly is necessary
Rp 9	In Phase C integrate LSS procedures in the existing management system	L: Zu and Fredendall (no. 11) emphasise this with respect to HRM-practices on employee involvement, training and performance and recognition F: The focus group argued that in Phase C (Sustain) embedding of new LSS procedures into normal operations is the first priority, including arrangements for educational programmes and rewarding
Rp 10	In Phase C widen scope towards customers and suppliers	F: In the Sustain phase widening the scope towards external relations is due, in the first place to customers and suppliers
Rp 11	Develop and implement an instrument for the evaluation of progress with respect to learning abilities	L: Based on our literature study we propose to adopt the concept of Absorptive Capacity (no. 14, 17 and 19). The instrument to measure Absorptive Capacity as developed by Tu et al. (19) could be used in practice F: The focus group argued that one of the characteristics of sustaining would be the improvement of abilities to learn

Notes: L: literature (numbers refer to literature sources of Table 2), F: focus group, R: retrospective interviews.

proposed by Kumar et al. (2011). The table shows which steps are confirmed as completely or partly relevant as indicated by our research and makes clear which sources deliver the confirmatory evidence.

3.4.2. *Proposals for revision*

From our primary research results, 11 Rps were inferred. The Rps and the motivation for these Rps are displayed in Table 4. How the Rps lead to a proposal for a revised framework is explained in the discussion (Section 4). The focus group strongly recommended first educating a project leader and then the team members, after selecting the first pilot project. Our retrospective interviews delivered a slightly more moderate view, but coupling education with projects was commonly agreed upon.

4. Discussion, proposal for a revised framework

This study has strengthened the justification for the framework of Kumar et al. (2011) and has thus contributed to the validation of the framework. Up to this point, our first two research questions have been answered, on supporting confirmatory evidence for the framework of Kumar et al. (2011) and on what Rps can be formulated. The third research question was 'What are the building blocks of a revised framework, meeting the formulated proposals for revision while keeping the confirmed elements in place'. Based on the results of our study, we propose a revised framework as depicted in Figure 5. The revised framework is the answer to the first part of this research question.

To answer the second part, we briefly explain how the confirmatory evidence and the Rps lead to the revised framework depicted in Figure 5. The phases A and B of the revised framework depicted in Figure 5 contain practically all elements of the phases 0, 1, 2, and 3 of the original framework of Figure 1. Table 3 shows that except from *Organisation wide training* all steps of the phases 0, 1, 2, and 3 of the original framework are fully or partly confirmed. The major modifications (see also Table 4) are in the reduction of the number of phases, the embedding of *Identify core business processes* in the steps of phase A, in removing the separation between training and project execution, and in the new step B3. Figure 5 suggests that step B3 is a closed step, but in fact the system building can already begin during the pilot project, and the system will develop evolutionarily over time, far beyond step B3.

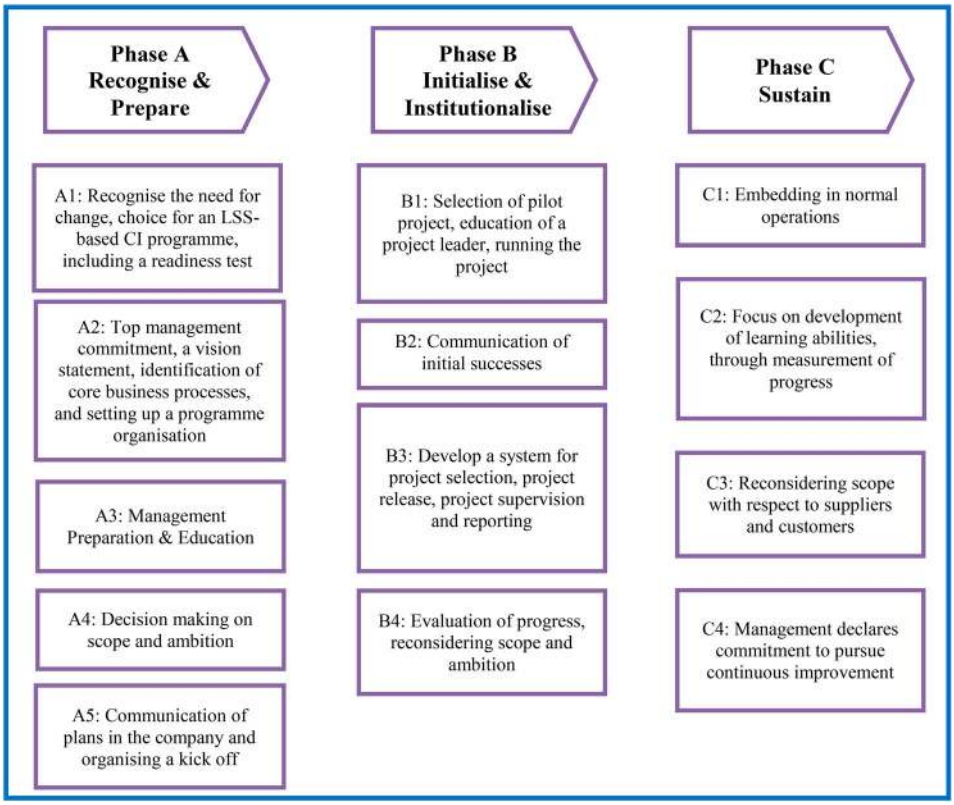

Figure 5. Phases and steps of the revised framework.

Progression towards a learning organisation is the common focus of the Sustain phases of both the original and the revised frameworks. The major differences are in the step C1 of the revised framework, emphasising the need to embed what has been developed in the programme into normal operations, and in the focus to measure the progress in the development of learning abilities (step C2). Measurement of progress is a fundamental issue in quality management. The steps B3 and C2 both focus on the evaluation of progress, step C2 specifically on the measurement of progress in learning abilities, which is, according to Bessant, Caffyn, and Callagher (2001) and De Mast (2006), connected to the enhancement of innovative power.

Of course, sustaining is never ending, but Phase C comes to an end when the embedding of all measures for change have reached a level from which the organisation will be able to develop further in an evolutionary way. The last step, Step C4, is to emphasise that pursuing further CI is a key responsibility for the management.

5. Conclusion

We expanded the theory on the deployment of LSS in SMEs with a stronger foundation for the framework of Kumar et al. and expanded upon this framework with a revised version that requires confirmations and (probably) revisions as well.

We realise that our research has certain limitations, despite the use of three research methods in triangulation. The availability of highly qualified literature focussing on CI based on LSS in SMEs is limited, and we cannot deny the fact that our focus group results are based on a single focus group session in a Dutch context. Also, we found only two companies with sufficient experience in the deployment of CI with whom to organise our retrospective interviews. Nevertheless we believe that the revised framework is applicable to a wide range of sizes and types of industry. For SMEs, especially for the very small ones, facing the constraint of the resource barrier will be the main challenge. For the management, important challenges will be to carefully consider the scope and ambitions of the programme linked to the company's strategic objectives, and to seek cooperation with similar companies and knowledge institutions in regional networks.

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