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Lean implementation frameworks: the challenges for SMEs

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Abstract

Implementation of lean manufacturing in any type of organizations can bring many benefits, such as reducing waste and improving operating efficiency. However, lean implementation is not a straightforward process. Although a number of frameworks have been presented, still many companies find it difficult to implement lean. Furthermore, most of these roadmaps are for large manufacturing companies, and not for small and medium enterprises. Unfortunately, there is not a recipe that if used can guarantee a successful implementation. Furthermore, unsuccessful implementation can have a great impact on organization's resources, but even more importantly, affect employees and their confidence in lean philosophy. In the present paper, the most prominent lean implementation frameworks will be discussed, under the prism of the needs of SMEs. The challenges for the SMEs in their lean journey are discussed.

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Keywords: Lean management; lean implementation; framework

1. Introduction

Lean manufacturing has a relevantly short history of about 60 years. The term "lean manufacturing" though is more recent, firstly proposed by Krafcik [1]. Lean manufacturing thus is basically the Toyota Production System (TPS) that evolved at Japan in the automotive sector after the Second World War. A short, comprehensive definition for lean manufacturing is the following [2]: "*Lean manufacturing is an integrated socio-technical system, whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability*". In a nutshell, lean manufacturing aims to achieve the same output with less input such as less time, less space, less human effort, less machinery, less material, less cost [3].

Although there is a tendency of oversimplification indicating that lean is a set of tools to be used for improving productivity, the situation is not that simple. Lean affects all aspects of an organization, and can be rather considered as a new management philosophy. Introduction thus of lean philosophy into any organization is quite complex and difficult. Several factors need to be considered when setting out to implement lean with stakeholders having conflicting interests.

In practice companies set out enthusiastically to implement lean, only to find out that this is not an easy journey with a guaranteed successful end. Unsuccessful implementation can have a great impact on organization's resources, but even more importantly, affect employees and their confidence in lean philosophy [4]. Roadmaps and frameworks have been developed that promise to guide organizations to fully implements a lean philosophy.

The implementation of lean in Small and Medium Enterprises (SMEs) pose even more challenges. As indicated by Achanga et al. [5], SMEs "require that the implementation costs and the subsequent benefits of lean manufacturing adoption, be projected upfront before they are able to commit". Further to this, SMEs compared to large organizations have limited resources, and in many cases the leadership lacks the long term commitment required.

In the present paper, the most prominent lean implementation frameworks will be discussed, under the prism of the needs of SMEs. The challenges for the SMEs in their lean journey are discussed.

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2. Methodology

The goal of the present paper is to assess the lean implementation framework from the SMEs perspective. Womack et al. claim that lean production is applicable in all companies despite their size [3]. However, as highlighted in the introduction, SMEs have certain constraints that encounter problems regarding implementation of lean production in their organizations.

To identify the problems, challenges and constraints that SMEs face, the methodology adopted was the structured literature review. The literature review is based on books, monographs, and mainly peer reviewed journal papers. The key topics under investigation was the existing lean implementation frameworks presented up to now and the key studies presented on SMEs and lean manufacturing.

3. Lean implementation frameworks

Several lean implementation frameworks have been presented in the last 20 years. These frameworks are usually roadmaps, guiding the organizations on how to implement lean manufacturing, highlighting the sequence of the lean tools to be introduced in the organization, and in some cases the success criteria.

In the following two sections, frameworks developed from both academia and consultancy firms are presented.

3.1. Academic lean implementation frameworks

Probably the first roadmap presented, was proposed by Shingo [6]. suggesting the key lean initiatives that should be introduced within the first year of the lean journey of a company. He identified fifteen lean tools and techniques such as SMED, poke yoke, Kanban etc. to be implemented. Kowalski also suggested a 10-step approach focusing in the development of effective working systems and standardization of work [7]. In a similar way, Beck suggested another 10-step model, focusing however in design and layout planning [8]. Kowalski and Beck roadmaps are compared in figure 1.

For the implementation of lean, Hilbert [9] suggested a two-phase model. The first phase is composed of seven steps that need to be completed, namely identifying a launch team, a production team and key leadership; establishing a shared vision among stakeholders; establishing a method of evaluating the performance of the change effort; establishing stability of current system; providing a definition for suitable policy to integrate social and technical aspects of "lean" elements; creating design process with regard to coordinating hardware and software resources to "leanness"; and offering necessary alternatives to solving the probable conflicts. The second phase is composed of four key stages: building a shared vision, planning and designing the change, managing the change, and celebration and continuous improvement. It is evident that Hilbert focus more on social, cultural, and educational aspects instead of just the use of tools and their operational components (in comparison to the approach proposed by Singo [6], Kowalski [7] and Beck [8]).

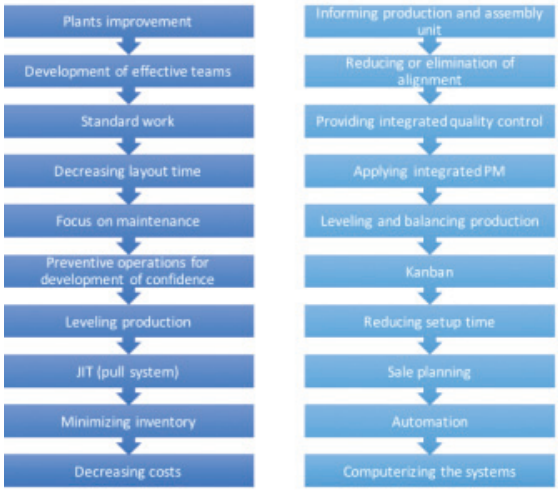

Fig. 1. Comparison of Kowalski (left) and Beck (right) roadmaps to leanness.

Åhlström [10] presented his own sequence for implementation of lean principles. Zero defects and decentralization and integration of functions should be first steps in implementation of lean. He identified as core principles the elimination of waste, setting up multifunctional teams, and pull scheduling. In support to these core principles, he suggested vertical information system and team leaders. Both core and supporting principles need to be considered by managers during the whole implementation time.

Anvari et al. [11] reviewed lean frameworks that have been presented between 1996 and 2001, and highlighted the key similarities that these frameworks exhibit. According to their study, three major stages can be identified when implementing a lean implementation framework: Preparation, design and Implementation. The leas steps that compose these stages are shown in table 1. Based on their findings the authors suggested a dynamic model for a lean roadmap to account for the volatile conditions and the high variability of the environment.

Table 1: The three lean implementation stages and the 22 steps as suggested by Anvari et al [11]

Lean Stage	Step
Stage 1: Preparation	Gap assessment strategic planning Understanding waste Establishing the objective Getting the organizational structure right Finding a change agent Creating an implementation team Training the staff in team building and lean principles Suppliers and customers involved Recognizing the need for change
Stage 2: Design	Mapping the value streams Analyzing the business for improvement opportunities Planning the changes Identify indicators to measure performance Creating a feedback mechanism

Stage 3: Implementation	Starting with a pilot project Starting the next implementation projects Evaluating and sustaining changes Changing the material SC systems and philosophies Selling the benefits of "lean" thinking Pursue perfection Expand the scope

Lean Aerospace Initiative [12] group at MIT, developed the "Enterprise Level Roadmap" as a set of processes and steps that senior management can use moving the enterprise to higher levels of lean performance. This roadmap is composed fo three main stages, the "Entry", the "Long term" and the "short term" cycle. For all these three stages, the roadmap provides requirements. A description of a top-level flow of primary activities is provided as a starting point. descriptions of key tasks required within each primary activity and finally it leads to discussion of issues, enablers, barriers, case studies and reference material relevant to each task in a common structured framework. This roadmap gives a holistic approach the whole of the enterprise. LAI also provides a roadmap for the transition of an existing production operation to a lean one, composed of seven phases. The key advantage of this roadmap is the integration of engineering, human resources, and business viewpoints are for providing a systematic implementation process.

Mostafa et al. [6] proposed a lean implementation framework composed of four phases. The phases are defined as conceptual, implementation design, implementation and evaluation, and complete lean transformation phase. Monitoring and controlling are integrated to all phases to ensure that the expected results towards lean transformation are delivered. Each phase is presented as a model with input and output and a set of tools that can be used for achieving the output. Indicatively for the second phase "Implementation design" the tools that can be used include VSM, AHP, SWOT analysis, QFD etc.

3.2. Lean implementation frameworks proposed by industry

Wright [14] presented a twenty-step implementation plan in the form of a roadmap. The various lean tools are sequenced in a logical order. Indicatively, the process starts with the formation of a team, and then several lean tools are to implemented such as 5S, TPM, Value stream mapping for the identification of the various types and sources of waste, etc. The idea behind the framework is to allow the introduction of line balancing the process line, introduction of pull (one-piece flow), and cellular manufacturing. The ultimate goal is to introduce a Kaizen philosophy in the organization. Obviously, the framework is not to be adapted as-is but requires adopting to the specific needs of the organisation.

Harbour [15] in a technical report oriented to the automotive industry, identified the importance of "people systems", as the critical factor for success in a lean implementation programme. He acknowledges that lean tools and methods are valuable, but the success depends on the way these are implemented. Thus he states that the success lies on the selection of the proper people's system, definition of the roles and responsibilities and the proper training. He has suggested four phases for the implementation of lean, namely: organizational development (phase I), discipline building (phase II), lean tools of quality, delivery and cost improvement (phase III) and continuous improvement and collaboration (phase IV).

Obviously, this is not an exhaustive list of the various lean implementation frameworks and models presented in the literature. However, the key finding out of this literature review is that there is no lean implementation framework developed specifically for the needs of SMEs.

4. Challenges for SMEs for implementing lean

4.1. Literature review

Surveys in various countries with regards the success of lean implementation, the critical success factors and the barriers have been reported. Lean implementation studies were found in the literature from 18 countries. In table 2, the key findings from literature review in such studies are summarized. The study of the relevant surveys allows for commonalities to be identified, and the key lean practices, success factors and barriers can be identified.

Table 2. Surveys in different countries with regards the success of lean implementation (ordered alphabetically per country and focused mainly within the last 10 years).

Country / Reference	**key findings**
Australia / [16]	Assessment of the degree of lean thinking introduction in 42 SMEs in Australia
Bangladesh / [17]	Lean tools adoption of lean tools in 9 garment manufacturing SMEs
Egypt / [18]	Major challenges and changes to be undertaken prior to implementation in 94 local manufacturing firms
Greece / [19]	Lean understanding and challenges for Greek SMEs
India / [20]	Assessment of the degree of adoption of lean tools into the continuous process industry and comparison to the discrete manufacturing.
India / [21]	Used analytical hierarchy process (AHP) for the paired comparison of the key elements (elimination of waste, continuous improvement, zero defects, JIT deliveries, pull of raw materials, multifunctional teams, decentralization, integration of functions and vertical information systems) in 52 manufacturing companies. Their key finding is that elimination of waste has maximum impact and integration of functions and vertical information system having least impact each whereas all other elements have in between.
India / [22]	Identification of barriers to successful implementation of lean construction in the Indian construction sector. The main barriers that were identified include: lack of exposure on the need to adopt lean construction, the uncertainty in the supply chain, the tendency to apply traditional management, the culture and human attitudinal issues, the lack of commitment from top management and non-participative management style for workforce
India / [23]	Investigation of the rationale behind using Lean in electrical and electronics manufacturing in India. The key (unexpected) result is that lean manufacturing is not adopted in order to win high market share in the international market but for preventive maintenance.

Iran / [24]	Identification of the barriers to implementation of lean in manufacturing companies
Italy / [25]	Comparison of the practices and expectations and perceptions of lean between lean implementing SMEs and SMEs that are thinking in initiating lean projects in Italian manufacturing sector. 105 SMEs participated in the survey.
Jordan / [26]	Investigation of the extent of implementation of six lean practices (equipment configurations, total preventive maintenance, visual control, new equipment/technologies, processes reengineering and shared vision of perfection) within 350 Jordanian manufacturing companies.
Kenya / [27]	The study sought to examine the extent to which lean manufacturing tools and techniques are adopted and their impact on factory time efficiency in 5 sugar processing industries.
Lebanon / [28]	Assessment of the extent lean tools are implemented in Lebanese pharmaceutical industry and identified relationships between the application of these tools (Kaizen, JIT, TPM and standardization) and the effectiveness of lean on the productivity.
Malaysia / [29]	Investigation of the adoption of lean manufacturing and the extend of adoption of lean techniques in the electrical and electronics industry in Malaysia.
Malaysia / [30]	The focus was in identifying the drivers and barriers towards lean implementation in Malaysian automotive sector. 60 automotive component manufacturers participated in the survey.
Malaysia / [31]	Assessment of the current status of lean implementation in Malaysian SMEs involved in the automotive component manufacturing industry. Their analysis indicated that importance of lean practices is acknowledged; however, it was highlighted that the level of actual implementation and practice is still low.
Malaysia / [32]	Focus on the critical success factors. 13 critical success factors with 78 elements were considered. Management commitment and leadership, quality management, continuous improvement and customer management were identified as the key ones. 97 automotive suppliers, mainly SMEs, participated in the survey
Pakistan / [33]	Focus on the critical success factors for lean six sigma implementations.
Slovenia / [34]	Assesment of eight critical factors (Value & customer, VSM, Pull and flow, Waste elimination, productive maintenance, Just in time, employee involvement and suppliers), for lean success. 72 medium and large size manufacturing companies assessed based on questionnaire
Spain / [35]	Investigation on the most used lean practices and the level of penetration in the specific market. 76 manufacturers in the ceramic tile industry participated.
Thailand / [36]	Focuses on the attitude and level of understanding toward the implementation of lean concepts. Results highlighted the need for training of the employees to lean concepts and thinking. 70 automotive manufacturing suppliers participated.
UK / [5]	Critical factors that constitute a successful implementation of lean production within manufacturing SMEs. 10 SMEs were interviewed
UK / [37]	Identification of the barriers to the successful implementation of lean projected. Three were highlighted as the most significant ones, namely: the lack of adequate lean awareness and understanding; the lack of top management commitment; and the cultural and human attitudinal issues.
USA / [38]	Identification of the differences in implementing lean practices between SMEs and large companies. 174 SMEs in manufacturing and one large manufacturer.
USA / [39]	Investigation of the significant performance/practice differences between lean suppliers and non-lean suppliers. 103 American first tier automotive suppliers participated in the survey

4.2. Why lean initiatives fail

Implementing lean manufacturing can be considered as any other change introduced to a company. Change is identified as the behavioural shift of "the organization as a whole, from one being to another". One the other hand management of change has been identified as "the process of continually renewing an organization's direction, structure, and capabilities to serve the ever-changing needs of external and internal customers". Kotter [40] indicated that only 30% of all change programs applied are successful. LaClai and Rao [41] echoed Kotter's research, indicating that 58% of change initiatives fail to reach the expected return. Eaton [42] presents even more dramatical data, based on Carmeron Group survey in 1997, stating that 75% of the change programmes eventually fail. In general, in literature it is easier to find reports of successful change programmes, rather than failures, as these are kept confidential due to the profound cost incurred. Some of the failures though are disclosed, mainly due to the high profile of the projects.

Therefore it is not a surprise that there are not many studies on lean manufacturing implementation failures, mainly since companies wish to protect and not disclose their investments that failed. However, it is a common understanding that many implementations do fail. In the few studies presented about failing implementations, the common root cases identified are related to:

- Lean suppliers
- Leadership
- Employee involvement
- Tools and techniques
- Business systems

Kumar and Kumar [43] focused on the barriers in the implementation of lean manufacturing, and grouped them into seven categories: management, resource, knowledge, conflicts, employee, financial and past experience.

Management can be both a barrier but also a driver for lean implementation. When considering management as a barrier, this is related to specific attitudes and behaviors such as exerting lack of focus for supporting lean manufacturing initiatives, failing to create urge of urgency, and does not have long term vision, to name few.

Per Kumar and Kumar [43], lack of necessary resources (labour, capital, communication etc.) prohibit the implementation of lean manufacturing. Furthermore, lots of companies that attempt to introduce lean practices (and eventually thinking) rely on consultants, thus resources for consultancy are key as well. The quality of the consultant is also critical, and in many cases superficial knowledge of the subject and lack of implementation practices results into confusion about Lean Manufacturing and can become an

obstacle in Lean Manufacturing implementation. It is thus evident that knowledge of the subject is of paramount importance as well. Absence of knowledge on lean philosophy and the various tools can be a great barrier in the implementation.

Resistance to change by the employees is a common barrier as well. This is covered a lot in the following chapter about change management. This resistance can be rooted to the fear of the unknown, fear of failure and complacency. In several studies, the research was focused in identifying and ranking the critical success factors as means to overcome the barriers for the implementation of lean manufacturing. Hamid [44] identified eight internal organizational factors and two external factors. Table 3 summarizes the critical success factors for lean implementation as per Hamid's classification.

Table 3. Critical success factors for lean implementation (adapted by [41])

Internal organizational factors
Top Management: leadership approach (strong vs. weak), top management commitment, support and involvement, and leadership quality.
Training and Education: knowledge management within the organization, employee skills, communication of changes within the organization.
Thinking Development: understanding of lean philosophy, lean learning curve.
Employees: engagement of employees, empowerment of employees, employees' teamwork culture, motivation, recognition and rewards.
Working culture: tradition, way of thinking, change management, and barriers to change.
Communication: the communication channels between top management and employees (both ways), communication of change initiatives
Resources: financial, employee resources and time.
External organizational factors
Customers Focus: customer relations and customer engagement (voice of the customer).
Government Intervention: government policy and legislation, political change in government, government mandates, and government support.

The literature thus review revealed a wide range of factors related to the successful implementation of Lean, that are summarized into:

- Organisational culture and ownership
- Developing organisational readiness
- Management commitment and capability
- Providing adequate resources to support change
- External support from consultants in the first instance
- Effective communication and engagement
- Strategic approach to improvements
- Teamwork and joined-up whole systems thinking
- Timing to set realistic timescales for change and to make effective use of commitments and enthusiasm for change.

5. Drivers and Barriers to lean manufacturing

The review of the papers with regards implementation of lean manufacturing in SMEs indicated the key drives and the main barriers for a company to introduce lean manufacturing.

The drivers, besides the obvious and well-advertised benefits (increase market share, increase customer satisfaction, increase sustainability of the company), are also having to do with improving the internal performance of the company (such as increasing flexibility, introduction of realistic and meaningful key performance indicators, desire). In some more mature companies participated in these studies, the goal was simply to employ the best practices.

The barriers in the implementation of lean manufacturing, can be linked to management, lack of necessary resources, resistance to change etc. Management can be both a barrier but also a driver for lean implementation as discussed in a previous section. Resources are critical as well, and their lack is a major barrier. The way of introducing lean (internally or externally through a consultant) is critical as well. Absence of knowledge on lean philosophy and the various tools can be a great barrier in the implementation. Resistance to change by the employees is a common barrier as well. This resistance can be rooted to the fear of the unknown, fear of failure and complacency. Salonitis and Tsinopoulos [19] classified the barriers into four groups: financial, top management related, workforce related and other barriers.

A force field analysis (a graphical way for assessing the driving and hindering factors for a planned change) can be used for summarizing these findings as shown in figure 2.

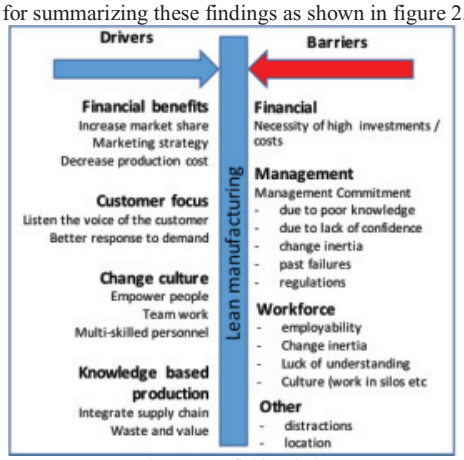

Fig. 2. Force field analysis

6. Conclusions

In the present study, the challenges that SMEs face when they begin their lean journey have been discussed through a structured literature review. Various lean implementation frameworks were reviewed, as well several studies focused on the implementation of lean on SMEs in various countries around the globe. The article focuses on roadmap based lean implementation approaches. There are however lean implementation frameworks based more on the lean principles rather than on a series of steps. Examples of such approaches have been presented by Villalba-Diez [45] and Fujimoto [46].

Drivers and barriers to the implementation were identified and presented in the form of a force field analysis. The key conclusion drawn is that is no unique roadmap to "leanness"; this needs to be tailored for every different organization.

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