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LITERATURE REVIEW OF LEAN MANUFACTURING IN SMALL AND MEDIUM-SIZED ENTERPRISES

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ABSTRACT

Small and medium-sized enterprises (SMEs) represent an important component of the economy in both developed and developing countries. Nowadays, the competitive industrial environment is encouraging these companies to redesign their manufacturing practices. Lean manufacturing (LM) has been widely implemented in several industries and has been shown to have had a positive impact on the performance and development of companies. This review aims to examine this impact on the performance of manufacturing companies, to emphasize the recent progress of LM amongst SMEs worldwide, and to show that most successful LM initiatives are those implemented in SMEs and large companies. However, very small businesses (VSBs) are struggling to introduce LM into their management systems. A new approach has been developed to establish a new lean implementation framework that could be adapted to the specific context of VSBs.

Keywords: Benefits; Lean implementation; Lean manufacturing; SMEs; Very small businesses

1. INTRODUCTION

Small and medium-sized enterprises (SMEs) play a major role in international economies and represent a vital component of economic growth in emerging ones. Therefore, SMEs are considered as one of the main contributors to GDP and employment worldwide (Saleh & Ndubisi, 2006).

In Europe, SMEs employ 93 million people and generate 57% of the added value. Most SMEs (93%) are micro businessed employing fewer than ten employees (Muller et al., 2017). In Morocco, according to Moroccan Confederation of SME statistics, SMEs represent 95% of the the economic fabric. Indeed, they are considered to be a vital source of wealth and job creation, constituting 40% of production and 31% of exports (CDVM, 2011). However, SMEs are presently struggling to maintain their competitiveness due to the high competition in the economic context. Therefore, they are concentrating on focusing their efforts on reducing costs and producing more customized products, in smaller batch sizes and with a short lead time. LM practices and techniques could help improve the performance of manufacturing companies, as well as reducing their costs.

LM is a set of techniques that aims to increase the creation of value and reduce all types of waste. The process was developed by Taiichi Ohno during the creation of the Toyota production system (TPS) in the 1950s (Rauch et al., 2017).

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Many companies in different fields all over the world have launched initiatives and projects to introduce Lean practices (Narayanamurthy et al., 2018; Bajjou & Chafi, 2018a; Bajjou & Chafi, 2018b). Typical lean methods have been applied for many years in order to structure lean production process in certain multinational companies; initially specialized ones in the automotive industry, but later ones in other industrial sectors, including smaller companies (Rauch et al., 2017).

According to previous research based on different contexts, SMEs have also successfully introduced Lean practices in Europe (Ulewicz & Kucęba, 2016; Antosz & Stadnicka, 2017); in Malaysia (Rose et al., 2017); Brazil (Ferreira et al., 2016); India (Verma & Sharma, 2017; Gandhi et al., 2018); Morocco (Fakkous et al., 2015; Belhadi at al., 2016; Bajjou & Chafi, 2018c), and Italy (Matt & Rauch, 2013; Rauch et al., 2017), amongs to the countries.

This review paper aims to highlight the positive impact of Lean on company performance, as reflected in operational, strategic, administrative and human aspects. The paper also indicates that LM has proved its efficiency in performance improvement in large companies, as well as SMEs. In order to develop a new Lean strategy which could be suitable for very small businesses (VSBs), we suggest an approach to the design of a new framework for Lean implementation adapted to small company characteristics.

2. RESEARCH METHODOLOGY

The Lean philosophy was developed at the beginning of the automotive industry. Nowadays, it is starting to be more integrated into different fields (for example, the construction, health and manufacturing industries, and administration) and is considered as a new way of designing management systems in order to improve process efficiency (Garre et al., 2017; Bajjou & Chafi, 2018d; Bajjou et al., 2019).

This review is based on a detailed literature review analysis. The research was conducted by combining two groups of key words, as presented in Table 1. The review combines all relevant articles published after 1990, the year of publication of Womack et al.'s famous book "The Machine that Changed the World" (Womack et al., 1990). This book played a major role in the spread of LM around the world.

Table1 Documentary research details

Period	Database used	Key words group 1	Key words group 2
1990-2019	Google scholar Science direct Springer link Elsevier	▪ Lean ▪ Lean manufacturing ▪ Lean benefits ▪ Lean frameworks ▪ Lean implementation	▪ SME ▪ Small businesses

As shown in Figure 1, the methodological approach of the paper consists of synthesizing the literature, identifying research gaps and recommending new research areas.

3. LEAN MANUFACTURING: MAIN CONCEPTS

Lean manufacturing is a production system originally developed by Toyota in Japan in the 1950s, and to date continues to make the group more successful. It is also called "Lean Management" (Drew et al., 2004) and was a concept well known in the United States in the 1980s (Liker., 2004).

The literature shows different definitions of Lean that vary depending on the interpretation of certain authors and companies (Liker., 2004; Womack & Jones., 2005).

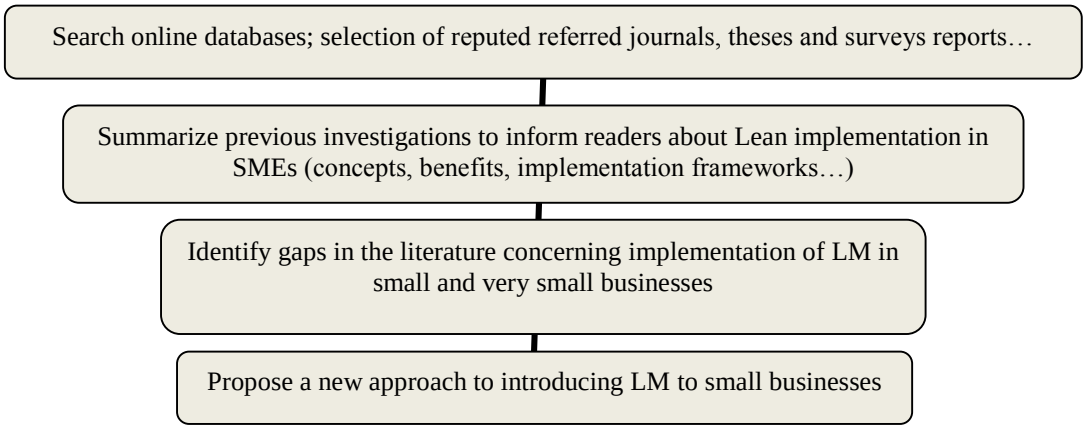

Figure 1 Research methodology flowchart

According to Drew et al. (2004) "Lean is a whole integrating many principles, tools and techniques whose aim is reducing all sources of value chains inefficiencies and meanwhile bridging the gaps between actual performance and customer requirements". Lyonnet (2010) defines Lean according to six main concepts:

1) Waste elimination: to create effective value, it is necessary to identify waste and to eliminate any action that does not create value for customers. Therefore, eight forms of waste were identified (MUDA in Japanese): overproduction, waiting times, useless transportation, steps without added value (over-processing), excessive inventories, unnecessary human movements, defective part production (quality defects) and under-utilization of human potential.
2) The just-in-time operating mode involves "bringing the right part to the right place at the right time with the right amount".
3) Quality: industry aims to develop the best methods in order to improve quality, ranging from the Quality Control concept to Total Quality Management. The main goal of promoting perfect quality is to provide a product that meets customers' expectations (Lyonnet, 2010).
4) Continuous improvement (Kaizen in japanese): it is a process based on a set of efficient actions, productivity, processes… Kaizen is a state of spirit and a work culture, but above all a management practice, using tools and resources. Kaizen generally includes methods such as 5S, Kanban, SMED, TPM.
5) Visual management reveals the state of production; it consists of using visual means such as billboards on which a set of indicators are published. The 5S method, Kanban, and Andon systems are the main visual management techniques.

Employee management gathers all the principles of team work, multifunctional teams, versatility and staff involvement.

4. LEAN APPROACH IMPACTS ON INDUSTRIAL PERFORMANCE

Lean manufacturing aims to improve the whole system, to optimize costs, quality and delivery time, and to improve staff safety (Drew et al., 2004). These benefits have been classified into three main categories: operational, administrative and strategic (Kilpatrick, 2003).

4.1. Operational Benefits

The main operational benefits include an 80% reduction in stock (Kilpatrick, 2003); a 70% to 90% reduction in quality defects (Prakash & Prasad, 2014); and an average increase of 50% in productivity, which consequently reduces manufacturing costs (Kilpatrick, 2003; Demeter & Matyusz, 2011). Moreover, several operational impacts have been reported, such as a reduction

in cycle time of 90 % (Kilpatrick, 2003; Demeter & Matyusz, 2011); improvements in stock rotation (Demeter & Matyusz, 2011); a reduction in occupied spaces of 75% (Kilpatrick, 2003); and a reduction in change over times of up to 70%.

- Reductions in cycle time/lead time/delivery time: "lead time", or crossing time, is the time which elapses between the beginning of a process and its end. It is a usual indicator of Lean. Cycle time refers to the time interval separating two similar consecutive entities or events in the same process. Therefore, eradicating waste effectively reduces both lead-time and cycle time (by 90%) (Kilpatrick, 2003), which influences delivery time positively.
- Reduction in production costs: as a result of the reduction in production time, the operating costs incurred by the use of various resources (energy, wages, working time etc) will also be significantly reduced. LM is considered as a cost-cutting mechanism and a guideline for creatinga world-class organization (if implemented properly).
- Stock reduction/space reduction: LM aims to optimize the use of all production resources for the company. In fact, LM tools allow stock reduction, human resource optimization, and a reduction of occupied spaces of 75% (Kilpatrick, 2003).
- Increased productivity/quality: LM improves productivity and product quality through system-wide changes, including manufacturing processes and work efficiency. Several research studies have reported that Lean practice implementation leads to an increase of 70–90% in quality (Prakash & Prasad, 2014) and 50% in productivity (Kilpatrick, 2003).

These benefits have been observed in both large enterprises (LEs) and small and medium-sized ones (SMEs) operating in many sectors of activity, including services (Kilpatrick, 2003; Demeter & Matyusz, 2011).

4.2. Administrative and Strategic Benefits

Most organizations have implemented Lean to improve operational indicators; however, its administrative and strategic benefits are also impressive (Kilpatrick, 2003). In terms of the administrative benefits of LM, these mainly include:

- Simplicity of administrative processes.
- Reduction in control errors (Kilpatrick, 2003).
- Providing customers with better service quality.
- 25% increase in customer order accuracy in terms of quality and delivery.
- Reduction in turn-over and resulting attrition costs.
- Reduction in administrative costs.

As for strategic benefits, these relate to an increase in sales volume (20%) and in revenues by almost 40% for companies that have implemented the Lean approach (Kilpatrick, 2003). Improvements in service level have also been highlighted following LM deployment within French SMEs (Baglin & Capraro, 1999).

4.3. Lean impacts on staff

LM benefits do not only cover operational, strategic and administrative performance. Human resources are among the vital pillars of LM success within an organization (Drew et al., 2004), and many research studies have identified positive impacts of the Lean system on staff. LM implementation contributes to improving employee motivation (Baglin & Capraro, 1999; Treville & Antonakis, 2006), developing new skills, fostering versatility, improving working conditions (Saurin & Ferreira, 2009) and enhancing staff skills through solving problems and training (Treville & Antonakis, 2006).

Other studies have revealed that Lean can reduce stress and make employees happy. Therefore, the Lean system influences the whole business because of its various positive impacts. It can help

ensure the whole company is committed to continuous improvement and is focused on customer expectations. Moreover, the Lean approach helps to improve employee relationships with management, and encourages teamwork based on effective productivity, rigor, discipline, and organization.

Figure 2 summarizes most of the positive Lean impacts on staff mentioned in the literature, together with the operational, strategic and administrative benefits that contribute to improving enterprises performance.

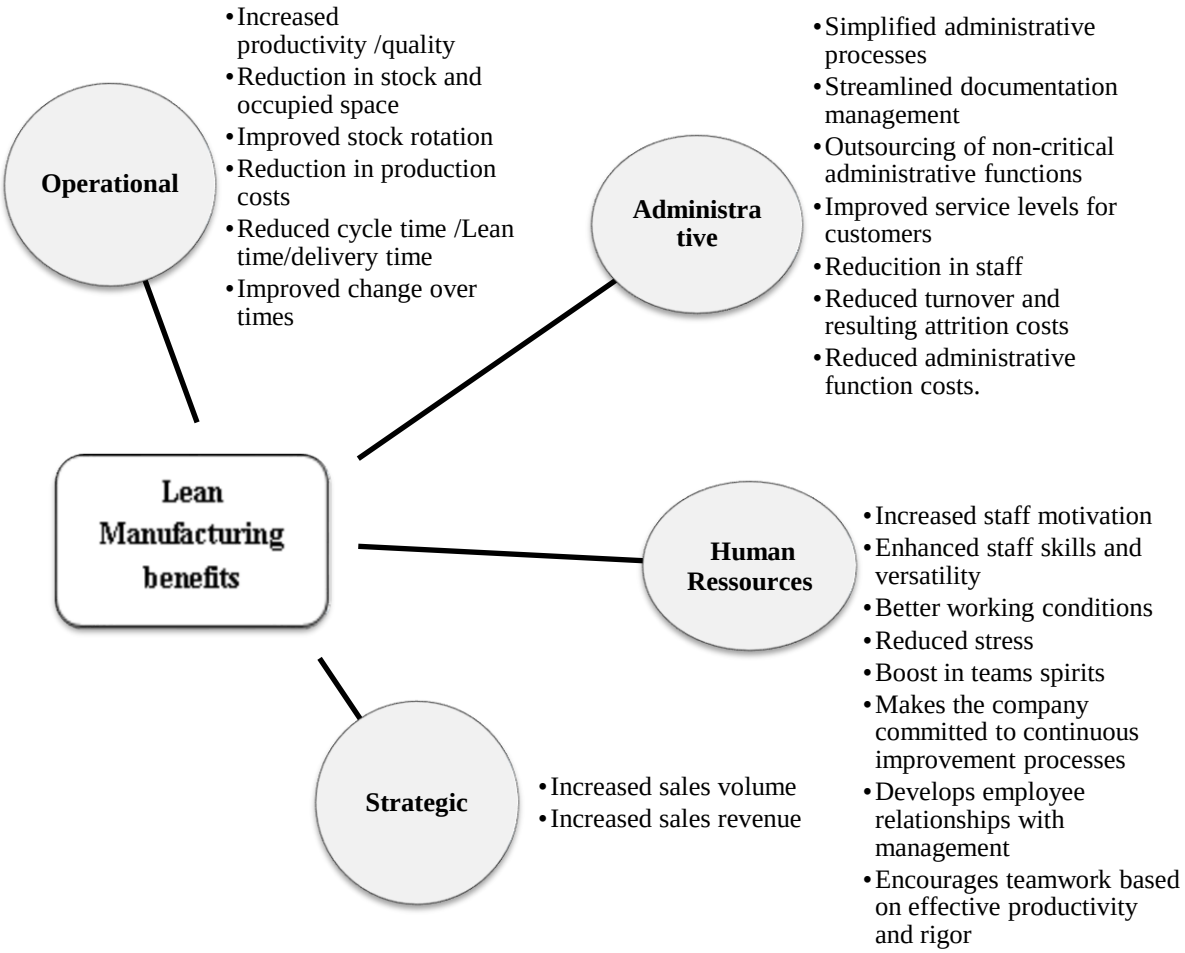

Figure 2 Lean manufacturing contribution to boosting performance

5. LEAN MANUFACTURING IN SMEs

SMEs are the backbone of economies. Therefore, to survive in a very competitive environment, these companies need to improve their current systems and meet customer needs. Lean manufacturing is one of the best management practices for all industries. In Europe, SMEs makea strong contribution in terms of enhancing efficiency and improving productivity（Bakås et al., 2011）. This provides the basis for the European Commission to support the Innovative Productivity project in European Regions (ERIP). The project comprises six partner countries (Norway, Belgium, Sweden, Germany, Netherlands and United Kingdom). A common methodology for implementing Lean manufacturing practices has been developed by the ERIP partners and tested in participating SMEs (from each country, 4–7 small and medium-sized enterprises were selected) (Bakås et al., 2011).

The industrial sector in Greece has recognized the important role of LM in improving industrial performance. Indeed, a study conducted by Salonitis and Tsinopoulos (2016) focused on the assessment of LM implementation and the impact of this change on the organization. Their objective was to determine the level of LM understanding, and identify barriers and success factors to implement an effective Lean process.

In SMEs, quality and production departments are more interested in the Lean approach than other company components. In Italy, Rauch et al. (2017) reviewed the application of Lean in the R&D departments of SMEs; their survey of 54 SMEs showed that the implementation of Lean had high potential for improvement and optimization in product development.

In Malaysia, SMEs represent 96% of all enterprises, produce 30.7% of total industrial output and generate 26.3% of total added value (Albliwi et al., 2014). Malaysia took the initiative to benefit from LM and started a program in 2006 within the scope of the Malaysia-Japan Motor Co-operation (MAJAICO). The program aimed to improve the automotive spare part manufacturing sector by producing higher value-added products, and to improve production capacity and competitiveness by the means of Lean production systems (Mamat et al., 2015).

The Lean concept has become well known around the world. For instance, in Morocco the INMAA (Moroccan Initiative for Improvement) program was initiated in 2011 by the Moroccan Ministry for Industry Trade and New Technologies and Maroc-PME. The mission of the INMAA program is to deploy the principles of LM in the Moroccan industrial fabric, particularly amongst SMEs and very small businesses (VSBs). In 2015, an assessment of the Lean maturity level in Moroccan SMEs was made based on a survey of 18 companies that had been involved in the INMAA program. Overall, this showed that most SMEs were in the process of integrating Lean principles (Fakkous et al., 2015).

Table 2 reviews several studies addressing Lean manufacturing within SMEs in several countries. The methodology used, research objectives and main results of selected articles are outlined in the table.

6. APPROACHES TO THE IMPLEMENTATION OF LEAN IN SME

Shingo, an engineer at the Toyota company, was the first to suggest a roadmap for Lean implementation. In fact, he presented the first actions that should be undertaken during the first year of Lean transformation. He identified fifteen Lean tools and techniques to be implemented, such as SMED, Poke Yoke and Kanban. In addition, Kowalski (1996) and Beck (1999) proposed a 10-step Lean implementation model. A comparison of the two approaches shows that Kowalski's model focuses more on efficient work system development and task standardization. On the other hand, Beck’s model concentrates on production resource design and implementation (AlManei et al., 2017). Hilbert (1998) has also suggested a two-phase model (see Table 3). Most of steps in this model go far beyond the operational aspect and focus more on the social and cultural.

Anvari et al. (2011) analyzed the Lean implementation approaches presented in the literature between 1996 and 2001, and highlighted the main similarities present. According to their study, three major steps could be identified when implementing a Lean approach: preparation, design and implementation. The different steps of this approach are presented in Table 3. They also suggested a dynamic roadmap model for Lean implementation, taking into account economic data volatility and environment variability.

Table 2 Research articles addressing Lean manufacturing in SMEs

Authors	Investigated Country	Methodology	Research objective	Main results
Rose et al. (2017)	Malaysia	Case studies (Six SMEs and four large companies).	• Explore preparations for Lean implementation. • Investigate the benefits and barriers of LM deployment.	- A Lean project begins by constituting the Steering Committee. - Implementation of 5S is the easiest of the Lean practices. - All companies started implementing LM on the production line that has most waste.
Ferreira et al. (2016)	Brazil	- Literature review. - Semi-directed interviews and visits. - Case study of a bakery.	Lean implementation in micro and small bakery companies in Brazil based on the Wilson model.	The implementation approach used - VSM (Value Stream Mapping) - 5S - Kaizen - Improvement actions - Lean assessment
Matt and Rauch (2013)	Italy	- Interviews with 10 small businesses (10-49 employees). - Practical case study of a company of 25 employees working in furniture manufacturing.	Analyze the current situation of the deployment and implementation of LM in small businesses.	- Most small businesses consider that implementing Lean is expensive and time-consuming. - Lean is less known amongst most small businesses. Sometimes, these companies put in place LM practices without realizing that they are LM.
Ulewicz and Kucęba (2016)	Poland	Questionnaire survey.	Present the obstacles faced by SMEs when implementing the Lean concept.	Lean barriers: lack of knowledge, poor understanding of Lean, lack of support, lack of preparation, limited financial resources, SMEs are not sufficiently convinced by the benefits of Lean.
Antosz and Stadnicka (2017)	Poland	-Case study: Questionnaire survey of 49 companies (53% medium and 14% micro).	• Investigation of LM in SMEs.	The sample studied shows that: - 94% of companies confirmed that waste elimination is their main objective behind implementing LM. - LM techniques that were applied (in decreasing order) 25% 5S, 20% "5 why", 16% SMED, 16% group work, 12% standardization, 12%TPM.

Belhadi et al. (2016) developed an effective roadmap that included all the prerequisites (processes, tools, success factors) required to implement an appropriate Lean approach in SME and took into account SME characteristics (Table 3), as it was developed based on their own experience.

Table 3 presents a comparison between the three suggested frameworks; from it we can conclude that there are several points in common between them. However, the literature does not claim that there is one standard process for Lean implementation that suits all organizations.

Table 3 Comparison of the main LM implementation approaches studied in the literature

Anvari et al. (2011)	Belhadi et al. (2016)	Hilbert (1998)
Preparation	Pre-implementation	Step 1
- Assess the strategic planning gaps. - Understand the waste. - Set up goals. - Obtainthe right organizational structure. - Identify global change factors. - Create a lean team. - Train staff about lean principles. - Involve customers and suppliers. - Recognize the need for change.	- Devise a lean policy/establish lean objectives. - Create a lean team. - Train the lean team. - Define the initial scope for implementing LM. - Deploy the master plan. - Define and evaluate relevant Lean indicators.	- Nominate a lean team. - Establish a shared vision. among all stakeholders. - Assess the effort needed for change. - Ensure the current system is stable enough. - Define the appropriate policy to incorporate lean practices. - Create a design process for "leanness". - Provide alternatives and solutions to resolve potential conflicts.
Design	Implementation (execution)	Step 2
- Map thevalue stream. - Identify opportunities for improvement. - Plan the necessary changes. - Identify relevant indicators to measure performance. - Create a feedback mechanism.	- Upgrade staff and workstations. - Ensure that lean culture is deployed. - Model and analyze the current situation. - Identify opportunities for improvement. - Implement pilot projects.	- Build a shared vision. - Design and plan changes. - Handle changes. - Assure continuous improvement.
Implementation	Generalization	-------
- Start with a pilot project. - Launch the subsequent implementation projects. - Assess and maintain changes. - Change systems and philosophies. - Sell the benefits of thinking "Lean". - Pursue perfection. - Extend the scope of the Lean process.	- Follow-up the results. - Ensure that Lean goals are accomplished. - Capitalize and standardize lean practices. - Generalize best practices. - Extend the Lean perimeter.	

7. DISCUSSION AND CONCLUSION

Various studies related to Lean manufacturing in SMEs have been conducted, focusing on, for example, Lean advantages, implementation steps, key success factors, implementation barriers, and level of maturity. Lean has proven its effectiveness through many initiatives discussed in the literature. However, these initiatives are generally related to the experience of large companies and SMEs and do not take into account the specific context of very small businesses (VSBs).

VSBs have become the focus of scientific study in recent years, as they play an increasingly important economic and social role and are generally the nerve center of the economy (Matt & Rauch, 2013). Despite the multitude of Lean implementation frameworks presented in the literature, VSBs are still struggling to implement LM in their organizations (Doolen & Hacker, 2005; Matt & Rauch, 2013; Dora et al., 2014; Rymaszewska, 2014; Zhou, 2016; Antosz & Stadnicka, 2017). Indeed, Lean implementation is not a simple process that only consists of

copying roadmaps from large and medium companies. The review of the existing key Lean implementation frameworks has revealed the main gaps in the literature and emphasized the lack of an appropriate framework for very small businesses.

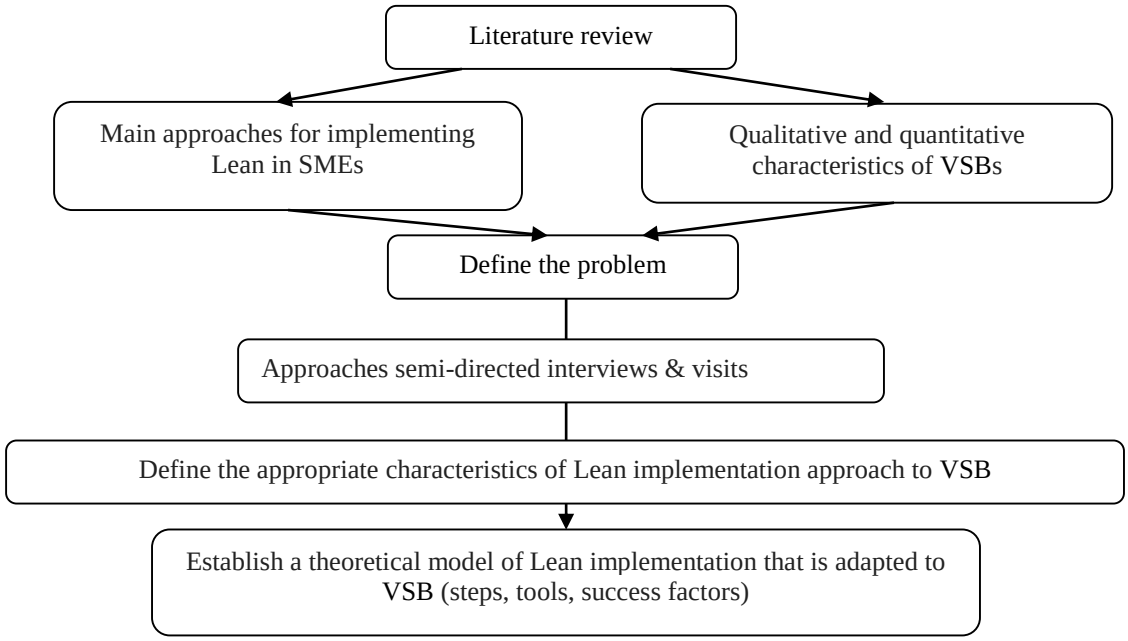

Figure 3 Proposed approach to developing a new Lean implementation framework suitable for very small firms.

For this reason, we suggest an approach to converting the use of Lean by SMEs to the needs of VSBs (Figure 3). It is necessary to start by exploring the existing Lean approaches and examining the main Lean implementation frameworks.

We propose the following approach:
Conduct a literature review to collect Lean implementation approaches and successful initiatives in SMEs. The goal is to juxtapose these steps with developing a new framework, which is convenient, effective and especially suitable for specific VSB features. The implementation framework should contain all the items (processes, tools, success factors) needed to implement Lean in very small businesses.

- Put together all the quantitative and qualitative features related to VSBs in order to design a Lean approach more suitable to their context.
- Conduct an investigation by means of semi-structured interviews and visits to VSEs who have experienced the implementation of Lean to discover the approach taken, the difficulties encountered and the success factors of their experiences.
- Collect and analyze relevant data in order to define the characteristics of the future Lean approach intended for small businesses.
- Establish a theoretic model of Lean implementation adapted to VSB (steps, tools, success factors).

One important limitation of this study is the lack of previous research on the topic. This explains why the proposed approach (Figure 3) is based on Lean manufacturing in SMEs.

Further research should be conducted to identify specific characteristics of very small enterprises to develop an implementation strategy adapted to these companies' requirements. Moreover,

there is an urgent need to conduct an exploratory study of different manufacturing companies in order to assess their level of readiness to implement Lean manufacturing.

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