

Lean implementation in small and medium enterprises: Literature review

Abdullah Alkhoraif^{a,*}, Hamad Rashid^b, Patrick McLaughlin^a

^a Cranfield University, College Rd, Cranfield MK340AL, United Kingdom

^b University of Sharjah

ARTICLE INFO

Keywords:

Lean manufacturing
Lean Implementation (LI)
Small and Medium Enterprise (SME's)
Literature review
Organizational Culture (OC)
Critical Successful Factors (CSFs)

ABSTRACT

There have been many literature reviews carried out on Lean implementation (LI) in larger organisations with specific focus on the automobile industry. Lean implementation among Small and Medium Enterprises (SMEs) has not been so extensively researched. This paper attempts to bridge this gap by reviewing the literature that discussed Lean implementation in SMEs with a perspective of identifying the main challenges faced. We applied the Systematic Review Methodology proposed by Tranfield et al. (2003). This methodology allows for more comprehensive and profounder analysis along three stages: planning, conducting, and reporting. For this study, 403 papers were utilized, with their titles, abstracts and keywords separately studied at early stages of the review. These were collated from specific databases that included: ABI/INFORM Global, Taylor & Francis, Emerald, Sage, Inderscience, BSCO Business Source Premier, ScienceDirect and Scopus. The collected information was classified into four categories for more synthesis. The aim of this study is to establish the current position of global understanding of Lean implementation in SME's, including examining the main categories of Lean implementation in the context of SMEs. Next, an inclusive discussion of associated Critical Success Factors (CSFs) for Lean implementation within SME's is established that can be used as guide for SME's owners and managers. Suggestions for future research orientations are thus provided.

1. Introduction

These days, markets are characterised by strong competitive forces, honed over the years [180]. The competitive nature of organisations has been encouraged by macroforces influencing both supply and demand. Supply has been influenced by the rise in globalisation and the deregulation of trade, which has allowed companies to trade with greater ease on a global scale [70]. In addition, advancements and accessibility to technology have facilitated better supply abilities among companies [70]. Demand has been shaped by the increase in options available to customers, who now take time to determine the best value or product available when deciding to purchase an item [13]. Companies now need to realise that they must increase their competitive capabilities in order to trade profitably in the markets today. This consists of a recognition of what the customer considers of value combined with the most effective methods of operation and production in order to provide customers with what they want so as to generate profits for the company [20]. The “Lean” business ideology [14] is a business method that promotes efficiency and elimination of waste, while also focusing on a high level of awareness of what the customer wants [13,153]. Due to this ideology the method has been adopted by many companies so as to direct their outlooks and exertions to best

improve their operations. This shows how Lean is not limited to one type or size of company, but rather all types, sizes and industries that strive to increase their competitive advantages, operations and profits in the regional and global markets. This review explains how Lean manufacturing tactics should be altered to suit each individual company, a belief encouraged by Cooney [33] who states the value of the universal business environments, the character of the buyer/supplier relationship and the construct of social and political establishments. The researcher will additionally discuss the significance of the business cycles that influence the individual functions in companies.

Zhou [197] would be considered the main researcher into SMEs adopting Lean methods. To date, the research has mainly focused on larger companies implementing it [40], in particular in the automobile industry. However, it should be acknowledged that SMEs can also take advantage of the Lean methodologies as long as they can successfully adapt them to suit their individual situations. Any company, regardless of size, faces challenges and the Lean methods have proven themselves beneficial, especially in the manufacturing industry, over the years. This has been supported by the number of companies adopting the methods and the large number of studies carried out that have supported its success in their results [80].

Companies come under one of two sizes: Large Enterprises (LEs);

* Corresponding author.

E-mail address: a.a.alkhoraif@cranfield.ac.uk (A. Alkhoraif).

and Small-Medium Enterprises (SMEs). It is noticeable that the level of integration of Lean manufacturing in SMEs is quite low [154] and that even knowledge of it is poor also [3]. Many reasons for this have been identified, some of which will be discussed later on in this review. Although there have been many studies based on the general implementation of Lean [73,78,121] the majority of the research has concentrated on large enterprises and has omitted SMEs ([23,57]). This discrepancy is significant and deserves rectification. Therefore, this study will complete a review on the Literature relevant to the implementation of Lean in SMEs and will attempt to identify the main issues and obstacles to this.

This study started by a preliminary limited-scale review of contemporary literature in Lean implementation with a focus on SME's. This initial review comprised 25 papers that explored literature spanned through the previous 15 years in the field. The purpose of the preliminary review was to establish researchable gaps that – when answered – can provide for better understanding of Lean implementation within SME's. Simple template analysis approach was applied to basically identify these researchable gaps that are then presented in the following set of research questions that this review will aim to answer:

- Q1 What are the main categories (and their characteristics) that have been identified in research studies that addressed Lean in SMEs?
- Q2 What are the inhibitors and enablers of Lean implementation in SMEs manufacturing firms?
- Q3 What are the most usual barriers and challenge facing lean implementation in manufacturing SMEs?
- Q4 What is the impact of contemporary research studying lean implementation on practitioners within manufacturing SME's?
- Q5 What areas could be further researched on this topic that would benefit SMEs when implementing Lean?

This review aims to achieve a contribution of three folds:

- To provide an all-inclusive categorized literature review on the implementation of Lean methods in SMEs which is currently lacking.
- To provide information, guidelines and suggestions regarding Lean implementation for SME owners and managers.
- To suggest areas of further research for academia in the future.

The current review will be presented via the following structure:

2. Contextualization of this review

2.1. An overview of lean

Lean implementation refers to a company's management philosophy and a long-term strategy [107]. In summary, it can be described as 'doing more with less' and, although this may seem a simplification, it sums up the Lean concept as a more efficient use of the resources available, when needed. Waste, both time and materials, is identified and removed so as to maintain quality while reducing manufacturing costs [153]. The successful implementation of Lean does not solely rely on the application of specific tools. There have been studies carried out that have identified several factors that can prove to be barriers to success. Bhasin [14] has identified several such barriers arising in both small and medium sized companies, as well as large companies, while Hancock and Zayko [69] have also recognised issues faced by manufacturing companies while implementing Lean. On the other hand, successful implementation has several factors associated with it. Abernathy et al. [2] identified that Japanese automobile companies, for example, Toyota, have a high implementation success rate due to their tenacity in thorough planned management of employees, resources and equipment," an observation agreed by Liker [108]. The researcher explains that long-term planning and diligence is of more importance than

short-term gratification and that successful companies recognise this and plan accordingly. Dombrowski et al. [40] have identified several areas of activities that Lean consists of, including: continuous improvement; workplace organisation; 5S; process standardisation; visual management; total quality management (TQM); total productive maintenance (TPM); just-in time (JIT); and production levelling (heijunka).

The term "Lean" was first used by Krafcik [94] in his thesis for the Massachusetts Institute of Technology and was used to describe the Toyota Production System (TPS) [153]. It was then referenced in two books, *The Machine that Changed the World* [189] and *Lean Thinking* [190], which lead to its mainstream introduction. Lean became a concept designed to describe the multiple activities carried out by Japanese companies that explained their heightened competitiveness advantages at that time. This was known as the "Japanese Way of Working". Elements of the "Lean Idea" include: operations methods (such as zero inventories [68]; just-in-time (JIT) [89] and lots of small volumes [24]; the reinforcing of quality processes demonstrated by complete productive maintenance (TPM); and total quality management (TQM). Also included were empowered workers and employee contributions which questioned the bureaucratic top-down management structures and four function-orientated structures of organisation that had conventionally characterised many "western" companies [77].

This interpretation of Lean was validated by Shah and Ward [155] who organised the Lean factors into four 'bundles': just-in-time bundle; total quality management bundle (TQM); total productive maintenance (TPM) bundle; and human resources management (HRM) bundle. To successfully implement these Lean factors in a company required a co-ordinated approach, steadfast management and a transparent alignment with the company's structural plan. Taking these factors into account, Lean would appear to be the opposite of the mass production method of manufacture, which is characterised by the competitive advantage of economies of scale. This is a bulk cost advantage considered to be advantageous, but in reality, creates substantial ineffectiveness between the functions. The Lean method opposes this as it makes companies and their supply chains concentrate on reducing waste – materials and time, and any activity that did not add value to the customers.

Some of the benefits of the Lean method include increasing a company's efficiency and effectiveness at an operations level. In addition to the apparent benefits there are less obvious benefits of Lean implementation:

(1) Supply chain members incorporation – the members of a supply chain become co-dependent and so have a common goal to achieve Lean implementation. This is translated across the entire supply chain, typified by the Japanese Keiretsu supply networks [100]. These networks are based on a foundation of trust and common goals and can increase capabilities across the whole supply chain network. This explains how the development of inter-organisation links built to facilitate Lean implementation among companies leads to greater collaboration and strategic so-operation between the supply chain members. (2) Lean facilitates a high-speed of learning – Spear [162] explored that this advantage can be sustain. He clarified that by:

- The problems Identified and corrected in fast way;
- Solving the problems in better way to structure new knowledge; and
- Sharing this knowledge more efficient across the firm.

As part of the Lean process, these cooperative and collaborative behaviours are developed, and these are then developed at an increasingly rapid rate, more so than companies who have not introduced the Lean method. There are obviously many direct and indirect advantages to Lean but, in general, there is no single comprehensive definition for it. There have been many studies completed on the Lean method and many results reached. However, this has only led to several interpretations of what it actually is and what precise "characteristics

should be identified with the Lean concept" [13].

Pettersen [131] tried to summarise the Lean method by categorising it into four main approaches. He used the works of Hines et al. [73] and Shah and Ward [153] as his base and built on their proposals:

- "Leanness", an operational philosophy;
- "Lean thinking", a strategic philosophy;
- "Tool box Lean", an operational practice; and
- "Becoming Lean", a strategic practice.

This highlights the various types of Lean and warns researchers to consider the different categories as Lean refers to different things to different people. In general, however, there are some common features shared by all categories of Lean [153]:

- To constantly look for and concentrate on those values important to customers;
- To align the function of the main and supporting processes with the delivery of these customer values;
- To make sure that the organisation as a whole is concentrating on supporting these processes so as to eliminate waste;
- To ceaselessly improve the fundamentals, for example, improving quality, capabilities, empowering individuals and teams and encouraging affiliations between other companies;
- To promote and encourage a system-wide belief in constant improvements.

2.2. An overview of SMEs

Organizations such as SMEs are enormous role and function in sector of manufacturing for around the world in term of production employment generation. In addition, Emerging technologies and globalization have a massive impact on SMEs. SMEs firms are trying roughly to apply a new methodologies /approaches /principle like Lean to fulfil continues performance. Unluckily, for the concept of adopting Lean Manufacturing has not been applied by a large number of Small and Medium Enterprises (SMEs) regarding to the fright to time, cost and posterior advantages. Authors explored Critical Successful Factors (CSFs) of Lean implementation within SMEs include: organization culture, finance position, expertise and skill, performance of evaluation system, and leadership style and management [3,133]. Panizzolo et al. [129] proposed that Lean manufacturing permeation in Indian SMEs and explored that organizational culture, vision and the strategy drives substantial improvement in the organization performance, most of the failure for implementing Lean in SMEs are: using wrong tool, using one tool to solve the problems, misunderstanding the situation, badly decision-making process, poor of external support such as customers, government, suppliers, organizational culture (wrong strategy and vision) and wrong consultants will collapse the implementation of Lean in SMEs to be successful [145]. In contrast, LEs are more successful to implement Lean Manufacturing usage than SMEs ([109]; [183]; [155]). However, firms were using Lean tools such as 5S, JIT, TQM, etc., observed considerable improvements in delivery cycles, lead time, quality levels and productivity, rejection rates, and satisfaction of the customer [109,161].

Although Lean has been accepted as a method capable of vast improvements within company operations, several researchers have stated that, for the most part, only larger companies have implemented Lean and done so successfully ([155]; [13]). This has raised the issue of whether SMEs would be able to benefit from the use of Lean methods, a matter of importance as the Lean method is generally accepted to be vital for the development of the World's economies. In the literature, it is worth noting how SMEs are defined. Importantly, that is no one definitive definition worldwide [89], although the European Commission (EC) have agreed on a description.

This is not the same as in China or the US as, for example, in the

Table 1
SMEs definitions in different countries.

Area	Definition of SMEs
Australia	To 200 employees
Canada	To 199 employees
China	To 999 employees
EU & UK	To 250 employees
USA	To 499 employees

former, SMEs should only have less than 999 employees, while in the latter, this number is 499. Table 1 illustrates the differences in SMEs worldwide.

Although it is important to keep in mind the differences between the various definitions for SMEs, of greater importance in this study is whether there is a difference in how LEs versus SMEs apply Lean methods [144]. The issue here is whether a company's size is a determining factor in whether Lean methods can be applied in a company. This research will try to answer this question by examining the literature based on SMEs and Lean and the issues related to this. The initial explanation for Lean would indicate that any Lean-based improvements are beneficial and even initiating Lean methods at the simplest stage of production will change and improve the overall values and beliefs of the company and its supply chain partners. This initial definition of Lean is obviously simpler and quicker to employ, which indicates that the scope of Lean needs to be determined for this literature review into Lean and SMEs. In addition, the financial outlay needed to introduce a full version of Lean could be out of the financial range of SMEs. Other aspects that need to be considered alongside the size and available resources of the company include the level of control the SME has over its supply chain and the influence it has over the demand for its products (some of the research has identified that this can heavily determine success rates, e.g. levelling off demand variability) [46,47]. Additional factors that influence the success rate for implementation are an experienced and capable management with a focused vision and commitment to the Lean method, an invested workforce with a strong commitment to training, a salary and remuneration system that promotes success for the Lean method, a strong performance measurement system, an encouraging organisational culture and a commitment to quality. These can all be used to determine the extent that SMEs will be successful, or not, when implementing Lean.

Several studies have been carried out on the Lean method literature, including the evolution of Lean by Hines et al. [73], the ancestry of Lean production by Holweg [78], a guideline synopsis of Lean by Moyano-Fuentes and Sacristan-Diaz [121], and finally a literature review on Lean manufacturing by Bhamu and Singh Sangwan, [13]. None of these studies, however, have specifically examined the implementation of Lean in SMEs as they all focused on large companies or Lean in general. The aim of this research, therefore, is to bridge this omission in the literature and complete a review on Lean implementation in SMEs and to supply information to SME owners and managers who wish to apply Lean methods and, finally, to propose further topics for research for academics and researchers.

Source: [53], no date; [36]; Ministry of Industry and Innovation Technology of PRC [117], 2011)

SMEs are the most common size of company in Europe and make up 99% of all companies in the EU according to the EU Commission [53] and provide 90 million workers with jobs. Guidelines issued by the EU Commission outline the regulations for a company to be described as small or medium, which include turnover or employee numbers. These two figures don't have to be considered concurrently for a company to be deemed small or medium.

Wymenga, et al. [193] have stated that SME companies in Europe are well behind those in Japan and the USA, particularly in relation to the competitive capabilities. European SMEs lack innovation and financial backing from their governments and, in addition, do not see the

benefit of introducing new management methods or even researching them like, for example, the Middle East where there is very little research carried out on Lean implementation [87]. On the other hand, a company's size may provide benefits, for example, in their ability to be flexible to change with their manufacturing processes (Floyd and McManus, [55]). Also, smaller companies can respond quicker to the changing needs of their customers because they can observe the need to increase variety quicker. Additionally, Deros [38] has explained how small and medium enterprises are better able to present personalised services, which they can use as a competitive advantage. Most importantly is that because SMEs are usually young companies, they are staffed by younger employees with a more fluid organisational structure who may be more inclined to try innovative ideas and take risks. These authors also point out how SMEs are responsible for minimising the efficiency disparity between the EU and the USA. These ideas have been validated by Seitz [151] who stated that SMEs are, by their disposition, better able to become Lean. He explains this statement by listing the company advantage that could enhance the implementation of Lean methods. These include: centralisation of power; empowering the workforce; simplifying the difficulty of interactions; organised communication; a fast decision-making process; transparent plan for the future; and the willingness to deliberate every idea and every employee's opinion. These were chosen because they are the characteristics of SMEs that potentially could cause barriers for the implementation of Lean.

This research aims to investigate these aspects through the literature review.

3. Review methodology

The aim of this research was to complete a literature review on lean implementation in SMEs, based on the research questions. It was decided to use the systematic review methodology [178] for several reasons. First, the systematic review can achieve a clear, scientific and reproducible process of analysis from previous research, ([166,178]). Second, although there are other systematic review guidelines available ([5], [48], and [152]), the version proposed by Tranfield et al. [178] was deemed the most appropriate. This is because this method expanded the medical science systematic review method and applied it to management research, including greater descriptive details on exhibiting results and evaluating the literature [139,174].

This method had been extensively used across the management research area, in both innovation and organisational learning [178] for example (e.g. [11,34,139]) operations management and the supply chain [30,63,166] and in the management of small companies (e.g. [56,85,111]). The systematic review devised by Tranfield et al. [178] suggested three stages for review: the planning stage; the conducting stage; and the reporting/dissemination stage.

3.1. Planning stage

A review panel was established during the planning stage made up of four researchers, all experienced in academia and industry. This was done to comply with Tranfield et al.'s [178] recommendations that a group be created consisting of experts from the relevant area. Following four meetings, the direction of the systematic literature review was agreed, the research questions were formulated and the criteria to be included and excluded were defined (see Table 2).

English-language papers were included, from both academic and trade journals as the researchers agreed that scholars frequently publish their findings on Lean in trade journals. However, newspapers, magazines and reports were not included as it was felt that these pieces provided only a glimpse into lean implementation instead of the comprehensive specific information or debate required for this research. Working papers were also omitted as it was felt that these contained personal opinions, and that these could be changed. During the

meetings, the researchers also agreed on the bibliographic databases to be used, and included Taylor & Francis, Emerald, ABI/INFORM Global, EBSCO Business Source Premier, Scopus, Sage, Inderscience finally ScienceDirect and the core databases in the area of business and management. In addition, keywords were established for searching the literature. As the topic of this study is Lean implementation within SMEs, 'Lean' and 'SMEs' were the main phrases used in the literature search. Also, because 'Lean' was established subsequent to 1988, phrases such as TPS and JIT [150] were also included as keywords in the research as they are core components of Lean. SME is short-hand for small medium enterprise so small organisation, small business and small company were used in the search also. The panel's expertise was beneficial for providing suggestions for cross-checking the viability and strength of the method used, for example by identifying omissions or exclusions among the search phrases, periods of time or suitable databases. This provided validation for the systematic review process.

3.2. Conducting stage

At the conducting stage, 'search strings' were composed from the search phrases agreed in the planning stage (see Table 3). Every search sentence was then input in an identical manner into the bibliographic databases and organised by abstract, title and keywords. The result was 405 papers, with a cut-off date of the 2nd of Dec 2017.

These 405 papers were then reviewed by each researcher to ensure that their title, abstract and keywords matched the focus of the research. This resulted in 196 papers being excluded as inconsequential. Among these were non-academic literature, for example, 'grey literature' and other writings that did not include information into Lean implementation matters in SMEs. This led to an additional 70 papers being excluded as they were listed in two or more databases. This left 126 papers, containing either empirical research or conceptual research, that were again reviewed independently by the same four researchers for relevance. These papers were then entered an Excel spreadsheet and their information noted. This included the title, the publication year, authors, journals and further aspects of the articles that included the research topic, Lean implementation method, methods used in the research, areas of geographic research and the authors' profiles. Any papers that seemed ambiguous were classed as 'unsure' and were reviewed by the other three panel members for revision. The researchers and the panel had a discussion on the reasoning behind the panel's decisions and suggestions and a consensus decision was agreed for each item. This level of scrutiny and cross-checking of the documents for the literature review was to improve the validity of the study and the results. This sorting and subcategorising of the 126 papers distinguished four main categories among them (like the method used by Suarez-Barraza et al. [166] in Lean literature review). The final organisation was reviewed, cross-referenced and agreed by the entire panel.

3.3. Reporting and dissemination stage

As per the Tranfield et al. [178] method, it is recommended that this stage should include two sections: a descriptive analysis; and an analysis of the categories input onto an Excel spreadsheet, to present the "current state map" from the selected articles a descriptive analysis was undertaken. Secondly, four key categories that emerged from the literature review in categories analysis presented an in-depth look. In addition, a critical analysis of the review presents a discussion of how some factor strongly effecting the adopting of Lean Implementation (See Fig. 2 for literature review methodology).

Table 2
Critical paper of selection.

Criteria	Reasons
Inclusive criteria	
Papers written in English	Most leading academic journals are published in English
Papers published in both academic and trade journals	The authors recognised many Lean-related articles written by scholars are published in trade journals
Papers study Lean implementation issues	This review is designed for Lean implementation
Papers focus on SME	SME is the main focus of this review
Exclusive criteria	
Newspapers, magazines and reports	These types of articles were more likely to provide a snapshot of Lean implementation
Working papers	These often represent researchers' temporary thinking and are subject to change
Papers do not focus on Lean and SME They	They do not fit the thematic areas of this review
General commentaries or grey literature They	They do not provide sufficient insights into the research area

Table 3
Keyword search.

Search string combinations	Database
(Lean implementation) AND (small and medium enterprise)	ABI
(Toyota Production System (TPS)) AND (small and medium enterprise)	EBSCO
(Just in Time (JIT)) AND (small and medium enterprise)	ScienceDirect
(Lean) AND (small and medium business)	Emerald
(Toyota Production System (TPS)) AND (small and medium business)	SAGE
(Just in Time (JIT)) AND (small and medium business)	Scopus
(Lean) AND (small and medium organization)	Inderscience
(Toyota Production System (TPS)) AND (small and medium organization)	Taylor & Francis
(Just in Time (JIT)) AND (small and medium organization)	
(Just in Time (JIT)) AND (small and medium company)	
(Toyota Production System (TPS)) AND (small and medium company)	
(Just in Time (JIT)) AND (small and medium company)	
(Lean) AND (small and medium manufacturing (SME))	
(Just in Time (JIT)) AND (small and medium manufacturing (SME))	
(Lean implementation) AND (small and medium manufacturing)	
(Toyota Production System (TPS)) AND (small and medium manufacturing)	
(Toyota Production System (TPS)) AND (small and medium manufacturing)	

4. Review findings

4.1. First fold of findings: descriptive analysis

A descriptive analysis of Lean SMEs literature considered in this section. Tranfield et al. [178] described that the descriptive analysis should consist of a "descriptive account of the field" by sorting the literature into categories. These categories are the research methods, distribution of author profile and geographic areas.

4.1.1. Research methods used to investigate lean implementation in SME's

The single case study was the main method of research used in the 126 papers, which made up 34% of the overall documents (see Fig. 3) (e.g. [66,110,160,195]). Surveys made up 30% of the documents (e.g., [25,43,83,102,140]). At 16% were the conceptual papers that were based on the development of theoretical frameworks, models or guides for SMEs to implement Lean (e.g. [84,182]). The shortage of research into Lean implementation in SMEs in multiple case studies, mixed methods research and action research now becomes apparent. Only 14 papers (11%) used multiple case studies (e.g. [3,165]). A further 9 papers (7%) used mixed methods, to include surveys, interviews or case studies [14,102,133,176]. As explained by Bhasin [14] mixed methods is the best method to guarantee validity of the results, for example a questionnaire, as the various data sources can be cross-checked and cross-referenced. A recent study carried out by Emmitt et al. [50] using an action research method detected and introduced variations in a small building company with the introduction of Lean. Emmitt et al.'s [50] used Lewin's [105] action research processes and proposed a comprehensive account of Lean implementation and included details of the collaboration between the researchers and the practitioner to apply Lean methods. Hence, this led to the opportunities for researcher to apply other methodology such as grounded theory and ethnography

[16].

4.1.2. Division of the global research field

Nearly all research in Lean implementation is carried out by academicians utilize manufacture information. In aggregate, 104 of researchers (82.78 %) are essentially in the academic field [3,42,43,71,72,75,95,153] also only 6 authors (4.78 percent) are practitioners (e.g. [41,79,147,167,168]). In total, 16 of the researchers (12.44 percent) are both academics and practitioners (see Fig. 4).

4.1.3. Geographic areas associated with research in the field

Out of the 126 papers 87 detailed the geographic area used. During the analysis stage, it became apparent that the majority of previous research has been based in western regions as 32% of the papers were EU based, 29% in the USA (United State of America) and Canada and 8% were from New Zealand and Australia (see Fig. 5 and 6). In Asia (West Asia countries) which is arguably a major player in the global market, only 20 of the papers (28%) were based here (e.g. [64,95,102,106,129,137,143,158,168]). Of these 20 Asian papers, it was found that the majority of them were based in India. Only 2 of the papers were concerned with the implementation of Lean in China and these examined Wenzhou's industrial industries [133] and the automobile industry in Taiwan [64]. There are currently 10 million SMEs in China, or 90% of all of China's companies, which make up 60% of China's overall GDP [7]. This would indicate the importance of further research into Chinese SMEs and their progress with Lean implementation and a necessity for additional SME Lean research in the World's other developing areas such as South America, Africa and the Middle East.

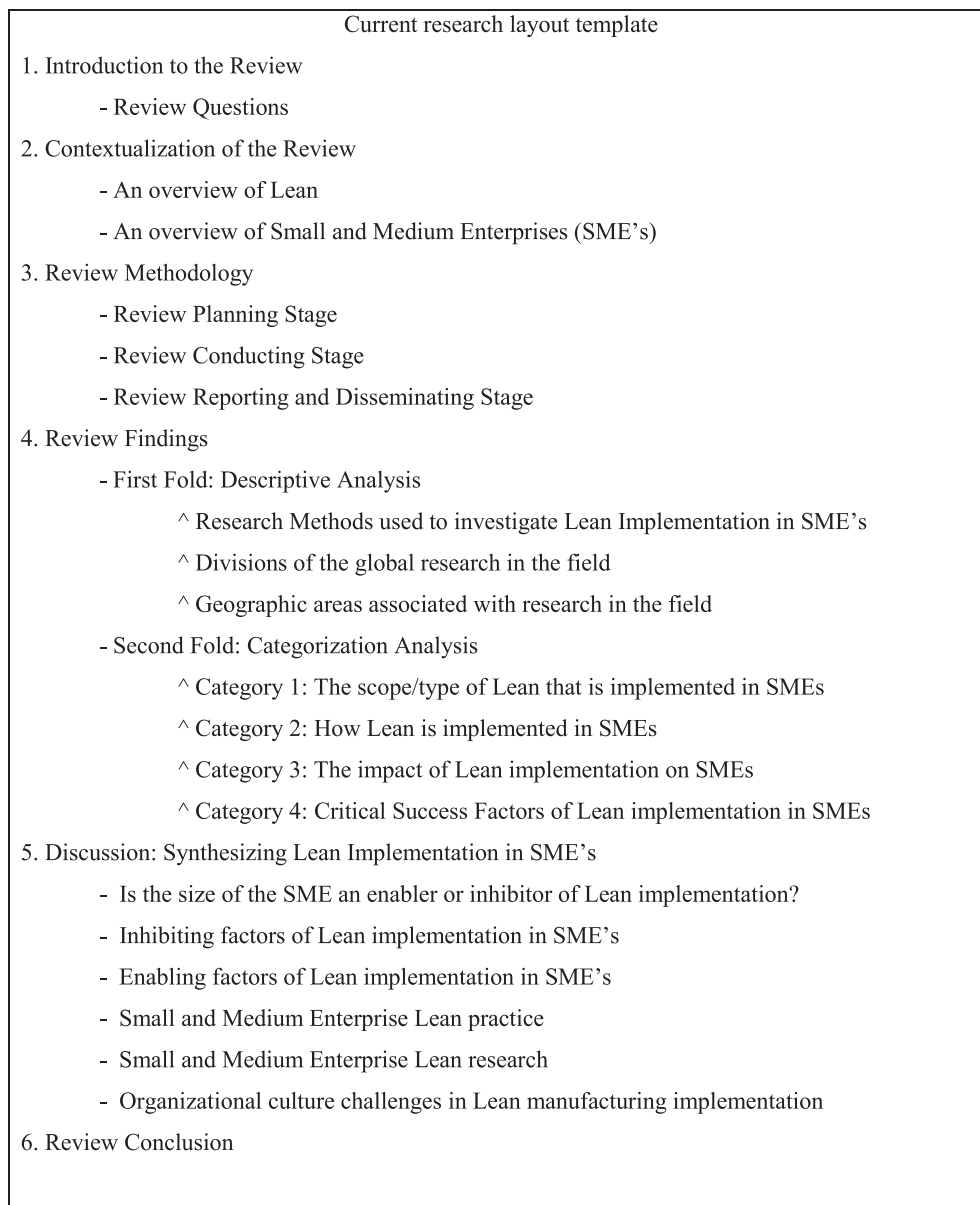


Fig. 1. Current research layout template.

4.2. Second fold of findings: categorization analysis

Tranfield et al. [178] stated that investigation into the literature review categories would explain the extent of whether there is an agreement or not regarding the categories of applicable literature review areas and would highlight the developing categories and prospective questions for the research. There were four main categories recognised from the categorising and subcategorising exercise, completed in a manner similar to that used by Suarez-Barraza et al. [166] in literature previous lean literature review:

- Category 1: examined the Lean range/type found in the literature as used by SMEs;
- Category 2: reviewed on the degree to which Lean is implemented in SMEs;
- Category 3: assessed the influence of Lean implementation on SMEs; and
- Category 4: assessed Lean implementation in SMEs' critical success factors (CSFs).

4.2.1. Category 1: the scope/type of lean that is implemented in SMEs

The model or process used for Lean implementation in SMEs was identified in the literature review by its apparent stress on internal operations (Table 4). The studies by Wanitwattanakosol and Sopadang [182] and AlManei et al. [9] made reference to the importance of including supply chains within lean implementation roadmaps and frameworks. This agrees with the results of a study by Bhasin [14] on Lean in UK manufacturing companies where he discovered that although 80% of the companies had implemented Lean internally, only 20% had applied it to their entire value chain. Referring to Pettersen's [131] typology of Lean, SMEs would seem to be concentrate more on operations, the Lean method implementation seen as a variation of an operational custom or an operational belief. SMEs wouldn't often consider it strategic or beneficial to connect and integrate with their supply chain partners. This is in contrast to the Lean in LEs literature, where it is usually considered to be a strategic belief. Also, Stuart and Boyle [165] stated that Lean application is not often observed outside of the factory of SMEs. However, Karlsson and Ahlstrom [89] argue that Lean is applicable to SMEs supply chains, although there is not much to indicate if this is true.

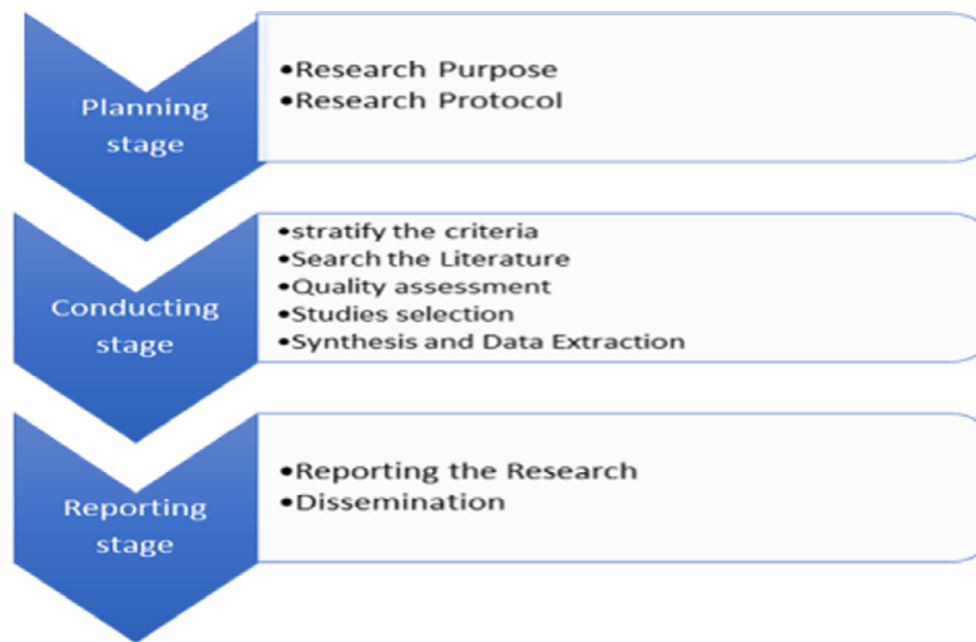


Fig. 2. Methodology stage.

4.2.2. Category 2: how lean is implemented in SMEs

Most of the studies based on Lean in SMEs is focused on how SMEs go about implementing Lean. There are two subcategories to the categorisation analysis:

- 1 Approaches to implement Lean in SMEs. The literature shows that there are many approaches and Lean tools available to SMEs that would help to implement the Lean method (see Table 5). There are several articles that discuss and demonstrate this (Table 5). Some of these tools include mapping tools, Value Stream Mapping (VSM), Kanban and 5S/6S work place organisation schemes that can work in conjunction with visual management. TPM and standardised work are two other options.

There are several less popular tools mentioned in the SME Lean literature, including 5 Whys, Small Lot Sizing and Single Minute

Exchange of Die, Level scheduling and Kaizen (SMED). Bhasin [14] discussed the unpopularity of some tools among SMEs compared to the popularity of those same tools among LEs. SMEs also seem to prefer a more varied choice of tools, rather than LEs, when implementing Lean. Mathur et al. [113] advise SMEs to choose and use the simpler less expensive tools because of the limited time and budgets available to them. Despite this advice, there is very little in the literature that discusses the justification or motivation for the selection and permutations of the tools or methods used. This seems to be an obvious omission as the holistic approach is best recommended for the successful implementation of Lean [76].

- 1 How other supporting initiatives can be combined with the Lean approach in SMEs. There is another aspect worth noting in the literature and that is the blending of Lean methods with additional supportive methods (Table 6). The most common method is the

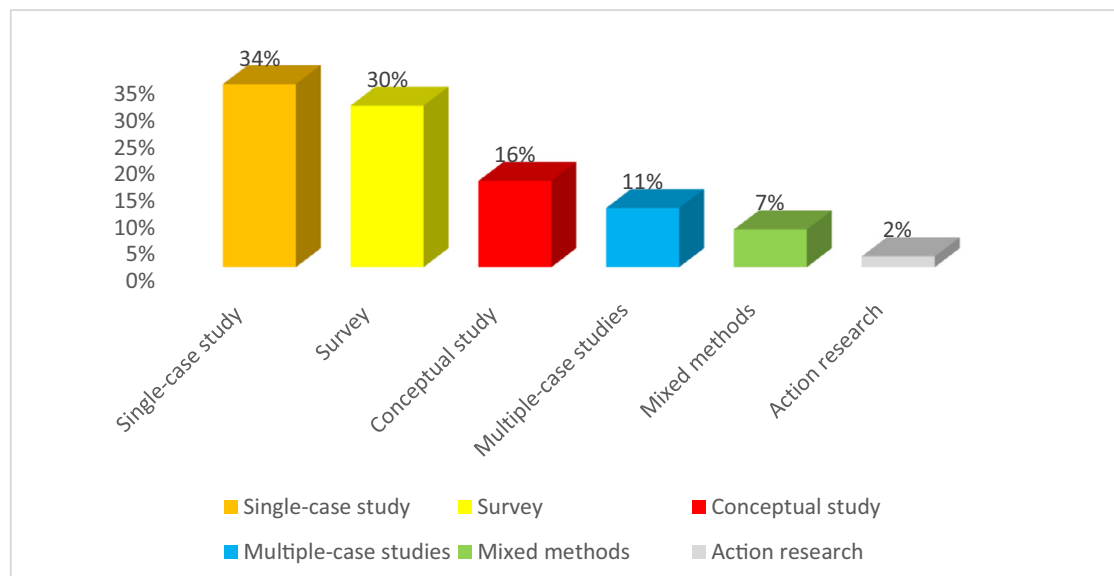


Fig. 3. Research method percentage of papers.

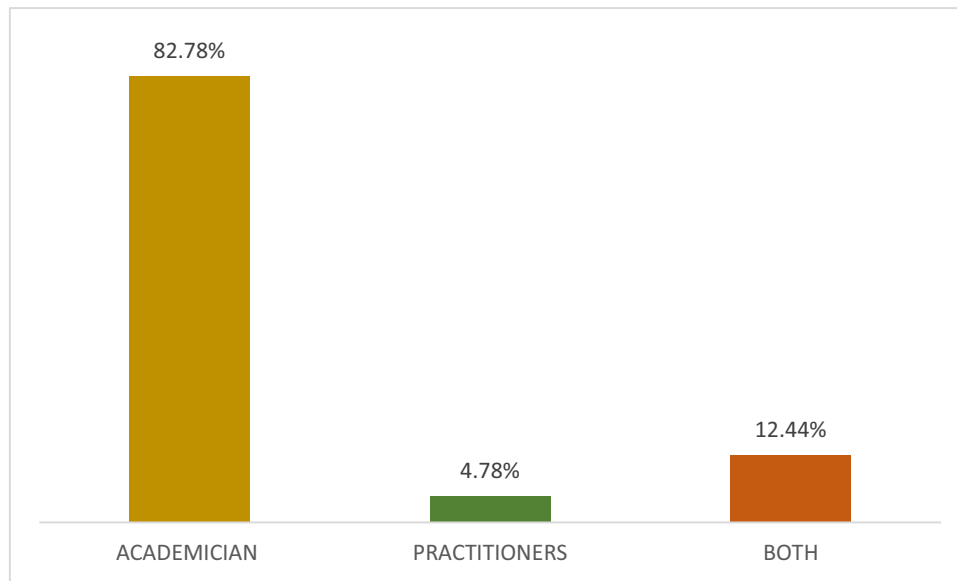


Fig. 4. Distribution of author profile.

implementation of Lean and Six Sigma. Six Sigma is a method that focuses on quality control and assists improvements by collecting data and completing statistical analysis [123], with the end goals to be the reduction of manufacturing and services costs and an increase in customer satisfaction [172]. Lean and Six Sigma have an obvious connection and several SMEs are making use of this. Where this has occurred, it is observed that some researchers who have used Lean with Six Sigma have developed their own models, or Lean Sigma models, while others have generated less specific processes or methods for implementing Lean in SMEs. The focus in the Lean Sigma model is on assimilating certain Lean applications into the DMAIC methodology (define measure, analysis, improvements and control). A case of this is where Kumar et al. [95], Roth and Franchetti [146] and Thomas et al. [172] detail the use of Lean tools, for

example VSM and TPM, for every stage of DMAIC. Gnanaraj et al., [58] criticised this approach because they argued that the majority of SMEs were unable to implement Lean for various reasons and so, taking these into account, they suggested the DOLADMAICS model ([57]a, p. 300). This version considers the features specific to SMEs that would hinder them and devises solutions through 5 levels ([58], 2012). This was a much more realistic model applicable to SMEs and included both Lean and Six Sigma factors. There was very little practical evidence that verified the entire implementation of this model.

IT is another extremely important support system for Lean implementation and indeed all aspects of modern-day company operations. This means that systems such as Material Requirements Planning

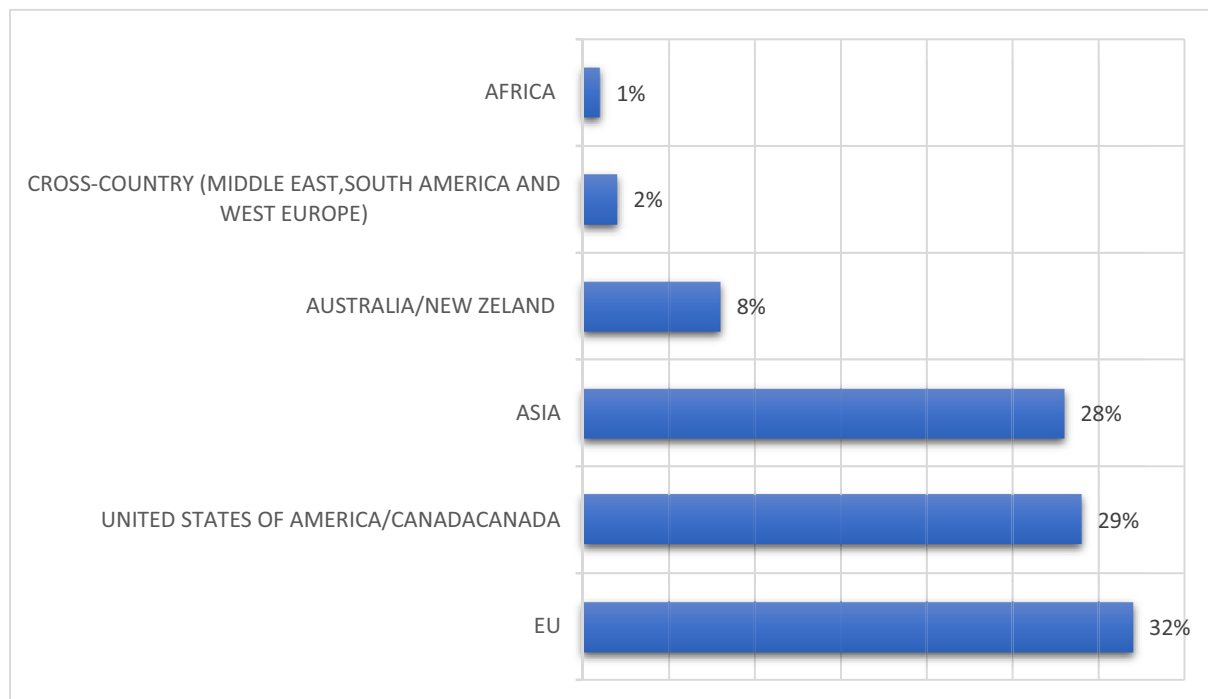


Fig. 5. Geographic area percentage of papers.

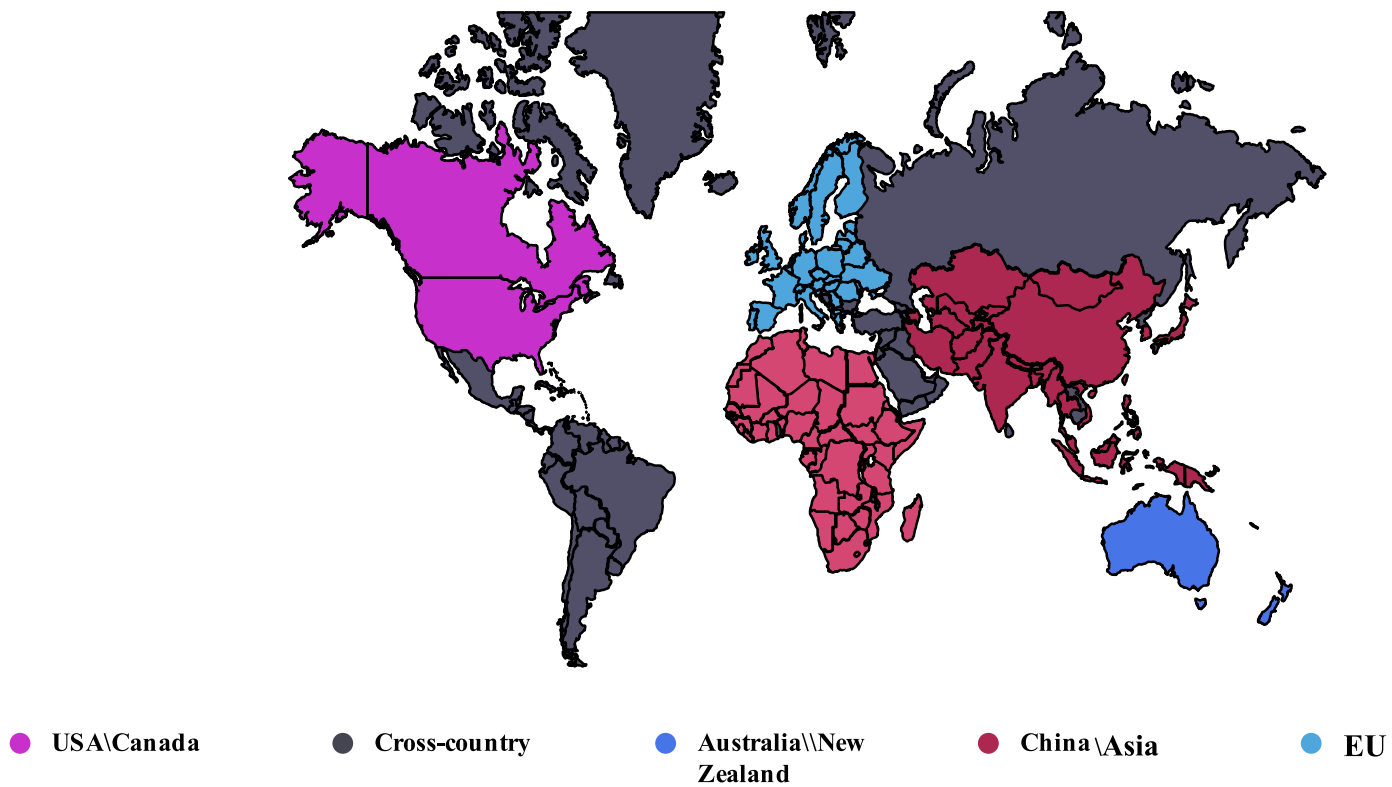


Fig. 6. Geographic map.

Table 4
Lean implementation process.

The scope of the implementation processes	Authors
External – supply chain	[182]; AlManei et al. [9]
Internal – production and operation processes	([31,40,57,64,66,95,160,172,146]; [59]; [17]; [116]; [179])

(MRP) and Enterprise Resource Planning (ERP) are necessary for every SME planning to introduce Lean. Powell, et al. [135] devised a system for incremental IT implementation over a long period of time to take into account the Lean method of operating. Some of the other approaches sometimes combined with Lean include Accounting Method, Cellular Manufacturing, Project Management, Quality Function Deployment (QFD), Theory of Constraints (TOC) and Quick Scan although none of these are as popular [80].

4.2.3. Category 3: the impact of lean implementation on SMEs

Generally, Lean implementation is examined at a micro level (the in-house manufacturing or processes of operation in SMEs) resulting in waste reduction arising as the main goal for the implementation of Lean

in SMEs. Lean SMEs are mainly focused on efficiency incentives for example decreases in stock, storage, time (i.e. substitution time, distribution time, lead time and throughput time) and the price of products, all of which, if successful, can provide huge benefits to SMEs [19,62,110]. Quality and efficiency (the use of the workforce) are two other areas where progress is important [43,43,106,146]. Among the literature, only one study mentions Lean implementation in the supply chain (see Category 1), while several studies discuss the results of Lean on SMEs in terms of suppliers and customers [60,160,181]. Again, only one paper could be found that detailed the financial benefits of Lean implementation in SMEs, which would seem an obvious area of importance [198].

This means that there could be a possible lag between execution and

Table 5
The key main tools used in SMEs.

Lean tools	Authors
Value stream mapping (VSM)	Kumar et al. [95]; Lummus et al. [110]; [27]; Roth and Franchetti [146]; Wanitwattanakosol and Sopadang [182] and [184]
TPM	Gunasekaran and Lyu [64]; Lee, [102]; Gunasekaran and Cecille, Gunasekaran and Cecille, [65]; Kumar et al. [95]
5S/6S and visual management	Gunasekaran and Lyu, [64]; Gunasekaran and Cecille, [65]; Kumar et al. [95]; Rose, Deros and Rahman, [144]
Fishbone diagram	Sohal and Naylor, [160] and Thomas et al. [172]
Kanban	Sohal and Naylor, [160]; Lee, [102]; Abdul-Nour, Lambert and Drolet, [1]; Gunasekaran and Cecille, [65]; Roth and Franchetti, [146]
Kaizen	Deb, et al (2010) and Rose et al. [144]
5 whys	[27] and Deb et al (2010)
Level scheduling	Sohal and Naylor [160]
Small lot sizing	Mathur et al. [113]
SMED	Chin and Rafuse [31] and Mathur et al. [113]
Standard work	Gunasekaran and Lyu, [64]; [27] and Rose et al. [144]

Table 6
Supporting approaches for implementation of Lean.

Other approaches	Authors
Six sigma	Kumar et al. [97]; Kumar et al. [96]; [173]; Nabhani and Shokri [123]; Gnanaraj et al. [[58]; [59], Roth and Franchetti [146]; [28] and [177]
IT (MRP, ERP, computer simulation, CAD/CAM and fuzzy system)	Santacecilia, [148]; Chin and Rafuse [31,106], Achanga et al. [4], Wanitwattanakosol and Sopadang [182], [52], Powell et al., [135] and Iris and Cebeci [83]
Accounting (ABC accounting and VSM accounting)	Chiarini, [29]
Cellular manufacturing	Boughton and Arokiam [19]
Project management	Abdul-Nour et al. [1]
QFD	Ramaswamy et al. [138]
TOC	Lee [102]
Quick scan	Thomas et al. [173]

Table 7
Critical for assessing the impact of Lean on SMEs.

Efficiency (e.g. waste reduction, cost reduction, quality and productivity improvement)	[[54]; Kaufman, [90]; [112]; Erem and Massey, [51]; [23,60,64,66,132,160]; [183]; [19]; Kinney and Wempe, [91]; [110,158]; Koh et al., [93]; [150]; [62]; Kalafsky, [86]; [119]; [137,146]; Deb et al., 2010; [106]; Thun et al., [175]; Bhasin, [15]; [113]; Mazanai, [114]; [129,181]; [198]; [28]; [50,144]; Seay and Narsing, [149]; [38,43]; [12]; Cunha et al., [35]; Lande et al., [101])
Effectiveness	
Organisational Cultur	[[112]; Albliwi et al., [6]; Wong, [191]; Stock et al., [163]; Lacksonen et al., [99]; Kamis, [118]; Testani and Ramakrishnan, [170]; [14,43]; Bortolotti et al., [18]; Knapp, [92]; Oudhuis and Olsson, [126]; Pakdil and Leonard, [128]; [3]; Burdett, 2007; Woehl, [188]; [116])
Employee empowerment	[150]
Employee motivation, interests and ability	[60,64,66,132,160]

any monetary benefits, but Chiarini's [29] analysis of accounting benefits from implementation show that the impact cannot be clearly observed from conventional methods of accounting. A further tendency observed is where few researchers have examined how certain CSFs for the implementation of Lean in SMEs can be altered or developed. Some of these CSFs include employee participation, support from senior management, dedication to the goal, teaching and learning, and changes to the organizational culture. Increased motivation among employees, interests and ability [60,64,66,129,132,160] and the empowerment of employees [150] were examined, however Manoochehri [112] alone illustrated changes in organisational culture through the implementation of JIT. This can all be observed in Table 7, which clearly shows that the Lean SME research has mainly concentrated on improvements in efficiency as opposed to effectiveness.

4.2.4. Category 4: Critical Success Factors (CSFs) of lean implementation in SMEs

Only a single study could be found that focuses on examining CSFs for Lean implementation in SMEs [3]. The results of this study so far have identified that organisational culture, governance and management's strategies, funding availability, employee professionalism and ability are the most important aspects for a SME to take into account when trying to implement Lean successfully. CSFs are, however, mentioned both directly and indirectly in several of the other papers (see Table 8). When these papers were examined, several trends became apparent. The first is that Achanga et al. [3] considered employee involvement and participation to be additional and important factors. Panizzolo et al. [129], p. 785] agreed that by including employees in quality improvement initiatives and increasing their levels of independence and accountability has been extremely beneficial in certain improvements in the performances of companies. [76], (p. 18) also verified this view, stating that it is vital to include all staff in the process of implementing Lean, regardless of the dimensions of the company. Other regularly observed CSFs include senior management assistance and dedication, teaching and learning and organizational change (which includes the beliefs, plans and vision of the company), all of which support Achanga et al.'s [3] findings. Additionally, Panizzolo et al. [129] corroborated this view by stating that willingness, senior assistance and dedication, competence and willingness to alter an

organisation's culture and the improvement of skills among individuals and teams were some of the crucial factors to include for successful Lean implementation in SMEs. Further newer emphasis on cultural factors of individuals that can facilitate a change towards adopting lean and overcoming human and cultural barriers was presented by De-Santis et al. [39] who showed that reducing uncertainty, identifying future orientation and adopting an institutional collectivism are key inputs in such an orientation. . Although Bhamu and Singh Sangwan, [13] agreed that these were all vital aspects they argued that they were crucial aspects for companies of any size and so not specific to SME concerns. Ormsby et al. [125] first stated that small companies should be urged to promote a supportive environment in its supply chain partners to successfully implement JIT. So and Sun [159] showed how the continuous use of Lean in SMEs shows beneficial influences from supplier integration policies, for example, the sharing of information and including ebusiness. The importance of incorporating customers and working in unison with supply chain members was also highlighted by Timans et al. [177]. This would indicate that the inclusion of supply chain members should be an important addition to the CSF list (this was not mentioned in Achanga et al.'s [3] study. Panizzolo et al. [129], p. 786] explained the importance of top management and their level of commitment towards a long-term vision of added value for not just customers, but society in general, and to the improvement and support of employees and partners. Importance of management commitment towards lean was further recently emphasized by Mutingi et al. [122]. In another fold, Mazany [115] stated that the main barrier to successful implementation isn't technical but human. In the papers, Achanga et al. [3] pointed out the financial restrictions of SMEs but only a single study identified available finances as a CSF. This would indicate the lack of a definitive agreement towards the relevance of available finances in SMEs for implementing Lean successfully. It is also important to note that the research into CSFs goes beyond internal organisation to the supply chain in recognition of how necessary it is to incorporate suppliers and customers.

Two more important CSFs to consider are communication and personal experience. Lee [102] claimed that only by maintaining direct communication between management and the workforce would JIT implementation be successful. Timans et al. [177] discussed the relevance of personal experience, for example a prior role as a quality

Table 8
Summary of CSF.

CSFs	Authors
Employee involvement and participation	Chin and Rafuse [31], Gupta and Brennan [66], Mazany [115], [103], Ramaswamy et al. [138], Kumar et al. [96] and Panizzolo et al. [129]; AlManei et al. [9]; [26].
Effective Leadership	[21]; Bamber and Dale, [10]; Lewchuk, Stewart and Yates, [104]; Motwani, [120]; Papadopoulou and Özbayrak, [130]; [3,192]; Sim and Rogers, [157]; Boyle and Scherrer-Rathje, [22]; Puvanavaran et al., [136]; [156]; [26].
Top management support and commitment	Chin and Rafuse [31], Lee et al. (1994), Lee [102], Achanga et al. [3], (Kumar et al., [96]; Emmitt et al. [50], Panizzolo et al. [129], Rose et al. [143] and Timans et al. [176]; [156]); AlManei et al. [9]; [26].
Training and education	Gupta and Brennan [66], Lee [102], Ramaswamy et al. [138], Achanga et al. [3], Kumar et al. [96], [177] and Dora et al. [44]; AlManei et al. [9]; [26]; Mutingi et al. [122].
Organisational culture (change, strategy, vision and performance evaluation system)	[3]; Kumar et al. [95], Panizzolo et al. [129], Timans et al., [176]; Bhamu and Singh Sangwan, [13]; Ravikumar et al., [141]; Rymaszewska, [46]; Dora, Kumar and Gellynck, [45]; Gupta, Sharma and Sunder M., [67]; Lande, Shrivastava and Seth, [101]; Albliwi et al., [6]; ([112]; Albliwi et al., [6]; Wong, [191]; Stock, McFadden and Gowen, [163]; Lacksonen et al., [99]; Kamis N. Mohammed, [118]; Testani and Ramakrishnan, [170]; [14]b; [43]; Bortolotti, Boscari and Danese, [18]; Knapp, [92]; Oudhuis and Olsson, [126]; Pakdil and Leonard, [128]; [3]; Burdett, 2007; Woehl, [188]; [116]; [156]; AlManei et al. [9,26,26].
Financial capability	Achanga et al. [3] and Ravikumar et al. (2013a, b); [156,26].
Supply chain integration	Ormsby et al. [125], [103], Kumar et al. [96] and So and Sun [159,156]; AlManei et al. [9].
Direct or good communication	[103], Rose et al. [143] and [177]; [156,26].
Personal experience	Achanga et al. [3] and Timans et al. [177]; AlManei et al. [9].
Technical factors (on-going improvement, JIT concepts on shop floor, etc.)	Chin and Rafuse [31]

manager, as a CSF. Despite this, however, there is little actual evidence for these CSFs as Lee came to his conclusion following a conceptual analysis and Timans et al. [177] devised his results following a single interview. It has been suggested, at this point, that successful Lean implementation requires a clear guiding framework and not a reliance on the Lean tools, although this is not summarised in the papers reviewed. There have, however, been several standard frameworks proposed to facilitate synchronised use of Lean tools and methods (see [66]).

A usual starting point for Lean implementation is to develop engagement and education between employees and managers to prepare them for Lean. Chin and Rafuse, [31]; Gunasekaran and Lyu [64] and Van Landeghem [179] agreed with this when they recommended starting with training and developing employees and managers instead of diving straight in with Lean tools. Chin and Rafuse [31] also suggested continuing this education and learning throughout the Lean implementation. Dombrowski et al. [40] completed an exercise where he equated and compared three methods of acquiring Lean-based information, that could be taught at various stages of the process. There will be a summary of the results and conclusions reached in this research that will be illustrated later that can educate SMEs on how to implement Lean.

5. Discussion: synthesizing lean implementation in SME's

5.1. Is the size of the SME an enabler or inhibitor of lean implementation?

SMEs are, obviously, smaller than LEs, but the relevance of that for this research is whether size influences a company's ability to successfully implement Lean? The literature would seem to suggest that it does, in both the company and the supply-chain, and also that several aspects of SMEs that are of actual advantage when applying Lean.

5.2. Inhibiting factors of lean implementation in SME's

A consideration in relation to size is the issue of the control over the supply chain. This plays a part in the degree to which a SME can develop dependable supplier networks and how much they can include them into the Lean scheme. Dowlatshahi and Taham [47] and Wilson and Roy [186] explained how the usually smaller volumes produced by SMEs limited their negotiating powers in contrast to the larger suppliers. Finch [54] further said that including customers and suppliers in

JIT delivery and standardised workloads was unrealistic as SMEs had not the negotiating power with their suppliers. Manoochehri [112] expanded on this and stated that in order to fully implemented JIT, the company, regardless of magnitude, needs to be able to:

- Alleviate demand;
- Produce merchandise or parts in smaller JIT runs; and
- Take receipt of component materials from suppliers in the necessary amounts at the correct time.

Manoochehri [112] accepts that, due to the status of the majority of SMEs in the marketplace, they are unable to achieve the first and third of these. This would indicate that Lean in SMEs is more like JIT production (i.e. an improvement in the operations through waste reduction) rather than JIT delivery, where it can be included into the supply chain. Therefore, it is more common for SMEs to promote the JIT process and aim for influencing the Lean supply chain, instead of actual compulsory practice (see e.g. [129]).

A study carried out by Karlsson and Ahlstrom [89] considered whether the Lean method and principles could be used by SMEs. The results stated that, for the most part, they could the principles concerned with procurement and distribution would need to be adapted for SMEs. No other found paper in the literature review examined SMEs ability to apply Lean to their supply chains. Further barriers to Lean application within SME's were identified by Shrimali et al. [156] who listed lack of support of top management, resistance to change from the middle management as main drawbacks. Other barriers that arose from the literature for Lean implementation were at an operational level and included poor processes and quality control systems ([103] and [102]). Additionally, in SMEs, the majority of the workforce are taken up with day-to-day operations and so any changes to these operations could be difficult. Organisational culture would seem to be the remedy for this as this would include more than just a plan for improving operations [129]. The benefit of this is that it would also manage the organisational strategic issues needed for Lean implementation and the HR department, for example: developing the employees, encouraging authorisation and inclusion in making decisions and guaranteeing that there is an accommodating organisational culture for Lean (if none, develop it). Most of the research didn't take the importance of organisational culture into account, focusing instead on operations and not considering any of the cultural issues and factors that need to be managed simultaneously [3,44,98,171]. Another study by Chaple et al.

Table 9
Enablers and inhibitors for SMEs.

Aspects	Enablers	Inhibitors
Supplier relationship	Suppliers may be highly dependent on a SME focusing a market niche (there are no other customers for the supplier to switch to, so SME has more power to influence the Lean agenda) [89]	SMEs may lack the market power to influence supplier network in adopting Lean practices ([61]; [125]; [103], [47,102,186]; Mazanai, [114]); AlManei et al. [9]
Intra-SME Organizational	Owner's long-term commitment to survival and profitability can give Lean the backing and support it may need [142]; Bevilacqua et.al. [12]	Potential lack of vision, management commitment and support as the SME leader may be highly involved in day to day operations and other matters ([103]; [102,129]; Rymaszewska, [46]; [186,195,156])
	Multi-skilled, cross-functional employees better positioned to be able to support Lean process improvement across the organisation ([142]; [103])	Lack of support for training and knowledge development required for Lean initiatives ([61]; [47,102]; Mazanai, [114]; [129] Rymaszewska, [46]; Yang et al., [194])
	Higher level of group teamwork and cohesiveness, a feature of the Lean way of working ([103]; [47]) Ease of communication (Rymaszewska, [46]; Winston and Heiko, [187])	Workforce fluctuation (SME employee turnover maybe higher so the knowledge of Lean may be more easily lost) (Rymaszewska, [46]; Williams, [185])
	Supporting a culture change towards lean implementation thus overcoming human barriers (resistance) towards it [39]	Lack of adequate skills of lean processes within SME's higher management and supervisory levels [26]
Operational		Poorer process and quality control tools and systems ([103], [102])
Financial	Government support more likely to be available [47] – but dependence on outside agencies like consultants to implement Lean can be problematic (Hu et al., [82])	Lack of sufficient funding and capital ([61]; [125]; [103]; [47]; Mazanai, [114]; Rymaszewska, [46]; [173])
Customer relationship	More direct contact with customers [142]	Lack of infrastructure and facilities [19,129,196]) Less able to influence demand volatility and variability ([19,47]; Rymaszewska, [46])

[26] showed that lean application within SME's may also be hindered due to insufficient management time, lack of adequate supervisory lean processes skills and, in fact, inadequate senior management specialized skills in the field.

Financially, the majority of the researchers explained that most SMEs lacked the budget necessary for the implementation of Lean ([61]; [125]; [103]; [47]; Thomas et al., implementation [173]; Mazanai, [114]) and buildings or amenities (Bought on and Arokiam, 2000; [129]). The continuous implementation of a full Lean method necessitates large financial outlays prior to any benefits being observed and most SMEs simply may not have this level of finances available to them, in addition to the time needed for education and the development of knowledge (see e.g. Mazanai, [114]). Take, for instance, infrastructure, which has been identified as a key performance indicator (KPI) system supportive of Lean but is also a barrier for SMEs as they might not have needed such a system previously, compared to LEs. In the same vein, Zhang et al. [196] highlighted that successful implementation of lean usually requires advanced technologies of high costs, that may not be available for SMEs. In consequence they would rely on their conventional manufacturing facilities, thus resulting in lean implementation failures.

Also, SMEs may not have the budget to employ specialised Lean facilitators. From the point of view of the customer, some of the papers stated that varying demands was a problem for SMEs as, due to their size, they had limited control over their customers with which to direct trends. This made them predictable and secure ([19,47]; Rymaszewska, [46]).

5.3. Enabling factors of lean implementation in SME's

Karlsson and Ahlstrom [89] noticed that SMEs usually focused on certain areas of business, which meant that their suppliers were reliant on them because there are no other alternative buyers available. This actually provided the SMEs with the ability to direct the supply chain, which provides a counterbalance to the barriers discussed above. SMEs have other beneficial factors for implementing a Lean strategy. Communication is a vital component of successful strategy, both up, and down, within the company hierarchy and among roles and sections [89]. This actually suits the structure of SMEs because some of their main characteristics include a lot of groups working together and a positive culture of interconnection that aren't limited by functional limitations. Also, communication in small companies is more straight

forward and staff and management work closer together, which enables greater opportunities for one-on-one interaction [47]. Production systems in SMEs are more adaptable due to their smaller size and are able to manufacture products in small runs to comply with multiple requirements of their customers [103]. This actually gives them the advantage over LEs that are designed around economies of scale for their product manufacturing policies. SME leadership can also be of benefit as SMEs are usually owned privately. Therefore, the owner usually has a long-term focus with a strong commitment to progressing and maintaining their business.

This is vital for a successful Lean implementation, so it is extremely supportive if the owner/leader is committed to the Lean strategy [142]. This is also recently concluded by Bevilacqua et.al [12] who showed that operations in SME's – by default – could largely reflect the owner/mangers way of thinking – including positive adoption of various lean processes and tools. Again, due to size, the owners/leaders of SMEs also have greater access to their customers and can better appreciate and foresee their needs and values. This gives them the ability to respond quicker, which is a vital component in any Lean project.

As mentioned previously, SMEs can often experience difficulties when trying to finance a serious project like Lean, however, Dowlatshahi and Taham [47] highlighted that there is often support and grants available from governments or other agencies that specifically focus on SMEs. Unfortunately, dependence on external assistance, like a consultant, for implementing Lean can cause its own problems [81]. Table 9 illustrates the barriers and benefits connected to the size of an organisation when considering SMEs trying to implement Lean. So, although there are some obvious advantages to a smaller size, SMEs are generally at a disadvantage when it comes to implementing Lean. Therefore, the barriers to this need to be eliminated or reduced or the benefits need to be used to their maximum advantage.

5.4. Small and medium enterprise lean practice

There are implications for practitioners in this paper. It contains a comprehensive list of Lean CSFs and possible enablers and barriers for an effective and workable Lean implementation, which practitioners need to know when they begin their project. These CSFs and possible enablers and barriers were collated during this systematic review and provide a guide for the SME owners, managers and practitioners.

The very first thing a SME needs to consider when introducing Lean is the organisational culture. The owners or managers need to ensure

that this is supportive and fully engaged in Lean implementation. Operational issues need to be reviewed during the planning process for Lean and these can include organisational level issues, for example, planning the investment strategy (when to buy new equipment or improving the processes surrounding the existing equipment), which are key for an SME strategic implementation plan. SMEs need sufficient resources to finance Lean and not need immediate performance awards to come through.

Also, because of the various types of Lean, the owners/managers need to agree the version they plan on implementing before beginning. This version can be reviewed and amended during the process. In addition, SME owners or managers need to continuously pursue external sources of funding and support, for example, from government agencies or Lean specialists.

Lean success depends on recognising what is considered as 'of value' by the customers. This, therefore, needs to be established from the outset and will guarantee that SMEs can direct the Lean process towards a concise comprehension of what the customer values. These values could be constantly reviewed as they sometimes change. SMEs usually have a flat organisational structure and work to informal working relationships. This enables direct and rapid communication between management and employees. This type of structure allows a more efficient dispersal of the Lean method throughout the SME and guarantees employee engagement. Employee training is another vital issue to consider for Lean implementation, but SMEs have long been considered remiss in the development of knowledge, which is necessary for Lean. This is why SME owners or managers may find that the use of specialists may be beneficial. Prior to the commencement of the Lean implementation, SMEs need to be assured of their processes' quality, components and end products. Lean eliminates time and inventory waste but needs a 'right first time' operation. If quality is inconsistent this could mean a failure of Lean, which has disastrous consequences for the customer. A quality audit is recommended to determine if a company is ready to commence Lean or not. Due to the financial and human resource constraints experienced by SMEs, the most necessary Lean tools need to be applied initially (for example visual management, 5S/6S, VSM and Standard Work) in addition to organisational improvements such as performance evaluation systems and appraisal criteria, while the more complicated tools (TPM) and supportive initiatives (IT) that require greater financial outlay, time and training (performance investment) can be introduced later on in the Lean project. It is important to recognise that no improvement in organisational performance might be apparent until, at minimum, the basic tools have been utilised. This reflects the time lag that occurs between the implementation of Lean and any visual benefits. This was explained by Chiarini's [29] review of the usual accounting process that prevents any immediate observable advantages of the implementation of Lean.

The "performance improvement" stage requires constant financial input, but the performance benefits are apparent. Another characteristic of SMEs is their inability to influence their supply chain due to their size so, instead, it is recommended that they utilise Lean internally up to the point of their supplier. This paper concludes that implementing Lean is a long-term process and that SMEs need to take the long-view approach by improving their organisational process gradually.

5.5. Small and medium enterprise lean research

One of the aims of this review was to identify areas of additional research on Lean implementation. These areas will be detailed as follows. Initially, three areas became apparent from the 'descriptive' literature review. The first is that there was very little research carried out that used grounded theory and ethnography, the mixed method, or action research when researching Lean implementation in SMEs. These methods are particularly good for obtaining a more in-depth view of Lean implementation in SMEs. Second, most of Lean research up until

now has focused on the Western countries and have largely ignored developing countries such as the Middle East and Asia. Suitable aspects of research based on this could include comparative case studies of SMEs implementing Lean in developed versus developing countries to determine the application of Lean tools in SMEs in developing economies. Third, Lean's current focus is in academia, mainly due to its origins in the academic sector, but, as it is now finding popularity in the manufacturing sector, research is needed in this context.

Six areas for further research became apparent from the 'categories' literature review. It was obvious that prior studies had mainly concentrated on methods used to implement Lean in SMEs. Further, focusing on soft issue is needed for example, influenced by organisational culture, rather than on technical and tools issue on why certain tools and techniques were chosen. Lean also needs to be scrutinised at a higher organisational and theoretical level, which would explore issues concerned with strategy and philosophy. Additionally, areas such as why Lean is adopted by SMEs, how it is assimilated into their existing strategies and how Lean influences business direction and culture in SMEs are all worth investigating. Lean is a method with substantial ramifications to the way an entire company is operated. A study on the difference between SMEs and LEs based on this would also be worth investigating. As previously discussed, SMEs are limited in the extent of their influence over their supply chain, but this is seen as a crucial component for a fully implemented Lean method and so would seem to be an important area to research further. Again, as discussed previously, the size of SMEs causes certain issues in comparison to LEs, so an area for further study is: how much of an issue is this when implementing Lean?

Another area worth concentrating on is the financial issues faced by SMEs. Monetary capabilities and the effect on Lean in SMEs, in addition to financial benefits from Lean should all be reviewed. Research should also be carried out on the operational benefits that go beyond developments in improvements.

Finally, because much has been made of the issue of organisational size when implementing Lean, this has been identified as a common and vital issue for SMEs. Further information is needed on the differences and similarities in Lean implementation between SMEs and LEs in regards their sizes. Further empirical studies, for example longitudinal studies, would be useful for additional examining of CSFs discovered in prior research, and to assess their effectiveness for both SMEs and LEs. In addition, there is a need for a framework for SMEs manufacturing to facilitate Lean implementation by leveraging aspects of organizational culture.

5.6. Organizational culture challenges in lean manufacturing implementation

First, the link among organization culture as well as Lean manufacturing implementation is highly critical and sensitive. The different between nations have different labor intensity, development, culture, customs relation, industrialization position, education and training, land cost, traffic situation, etc. firms should take these challenge matters into their consideration when adopting and apply Lean manufacturing. Organizational cultural contribute for Lean cooperation is recommended to apply and the implementation basics of the Lean manufacturing ([127]; Chen and Meng, 2010a). Organizational cultural variation relate fundamentally for the openness and change's resistance internally [37]. The gaining of Lean manufacturing implementation relies on broadly on the work firm's practices. For instance, Toyota have done in 1990s works with skill based on practices from a seniority based on strategy planner. Several crucial work firms' practices widespread to the manufactories that succeeded implemented the principle of Lean manufacturing are: discipline and control, standardization, team-based organization, continuous training as well as learning, multi skilling, participation, empowerment, reward system, common values, commitment, methods of work, communication, etc. [49,124]. In the

beginning of the research Lean implementation has indicated that the function of rewarding system, the support of the management level, accounting management system. [21,88,89,192]. Conti et al. [32] used the model of Karasek job stress to relate Lean shop floor application and practices to expected operator overwork and found that the overwork and lead to stress, also is notable at managerial scale in operating the system of Lean implementation and designing teams and not just only in the level of workshop scale.

The globalization has caused more demands for organizations in terms of labour market and many SMEs organization are hiring contractual operators to support their productivity to stay sustainable and Lean. Organizations should train temporary labour to progress the effectiveness as well as the efficiency of the lean implementation continues improvement initiatives, also should control as well as manage develop [169]. Organisational culture that is supportive to Lean is of huge advantage to a company when implementing Lean [74,108]. Involving the employees from all functional areas of the company is of great benefit as their input and feedback can determine whether Lean implementation is successful or not. Inclusion increases employee participation and having ideas listened to increases their job satisfaction levels. It also promotes positive team work, provides opportunities to demonstrate leadership qualities and problem solving. Storch and Lim [164] explained how Lean requires effective application, which in turn necessitates open and effective communication between all concerned participants of the value operation.

Prior to the introduction of Lean, all parties need to agree and satisfied with the goals and objectives. Change, in general, usually requires some form of training and development, and this is true for Lean implementation also, which requires multi-skilled, adaptable workers This is supported by Mutingi et al. [122]. Finally, organisational culture can be a powerful, positive enabler for Lean in SMEs [8]. Table 10 illustrates some of the factors associated with HR that can assist the implementation of Lean [13].

6. Review conclusion

There is a consensus that SMEs are a crucial component for a strong, successful economy. Lean is a well-established method of organisational philosophy that enables companies to improve operations and trade more effectively with greater value and less waste. Taking both into account, it is no wonder that the topic of Lean implementation in SMEs is such an important issue and a matter of concern that there is such poor take up of Lean among SMEs [155].

This research has demonstrated the lack of information and knowledge concerned with the implementation of Lean in SMEs, in comparison with implementation among LEs. The aim of this research is to bridge this gap through completing an inclusive comprehensive evaluation of academic research writings referring to the implementation of Lean in SMEs. Tranfield et al.'s [178] procedure for classifying the literature was the method used here after deemed most appropriate as it does so through explanatory and category lines. This is a major advantage of the current study over the previous reviews done on the

Table 10

Organizational culture-related important factors for successful Lean implementation.

Culture (organizational societal and societal)	Dealing with inhibition
Communication	Performance feedback
Hiring, contractor, recruiting, and training	Focus on deployment and policy
Communication	Development of employee
Communication	Leadership quality
Human resource systems	Multi-functional sector and team
Spread out knowledge into decision making.	
Responsibilities and roles	

topic; being more systematic, broader, and deeper. The presentation of the harvested information in a detailed tabular arrangement adds more usability of the current review.

The explanatory part of the current research identified that SME Lean research consists mainly of single case studies and survey research methods. Most of SME Lean research base has concentrated on Lean implementation in smaller manufacturing companies in the Western countries. Four main categories were identified through the comprehensive analysis of the literature: what type of Lean is applied by the SMEs; how its applied and implemented; the effect of Lean implementation on SMEs; and finally, what are the critical successful factors for the implementation of Lean in SMEs? Analysing these main categories has resulted in nine suggested areas for further research for academics.

It is hoped that the gathering of the information contained in this research will provide a comprehensive understanding of Lean in SMEs, in contrast to the current, fragmented views currently held [13]. The overall contribution of the current study can be specifically claimed as per the following points:

Research methods:

- The use of the systematic review methodology [178] is demonstrated to be adequate for a large extensive review like the current study.
- The current paper showed that academic research on lean for SME's is mostly based on discrete single case studies (34%), Surveys (30%), conceptual papers that were based on the development of theoretical frameworks, models or guides (16%). It further showed lack of research that applies multiple case studies, mixed methods research, or action research in contemporary research in the field. This is an identified methodological gap that needs addressing.
- As explained by Bhasin [14] mixed methods is preferred for studying lean implementation in SME's to guarantee validity of results when it comes to complex fields like lean implementation in SME's where various data sources can be cross-checked and cross-referenced.

Conceptual and theoretical confirmatory gain of the current study:

- It is concluded that Critical Successful Factors (CSFs) of Lean implementation within SMEs include: organization culture, finance position, expertise and skills, performance of evaluation systems, and leadership style and management.
- It is concluded that Major barriers to successful Lean implementation in SME's embrace inadequate organizational culture (wrong strategy and vision), using the wrong Lean tool, using one Lean tool to solve many interlinked problems, misunderstanding of the firm's situation (especially financial state), incapable decision-making process, inadequate know-how outsourcing, poor external support such as that involving customers, government, and suppliers.
- This research showed that SMEs would not often consider it as a strategic or beneficial matter to connect and integrate with their supply chain partners. This contrasts with the Lean applications in LE's, where it is usually considered to be a strategic belief.
- This research showed that literature would seem to suggest that the size of the firm would influence lean implementation, in both a company and its supply-chain. The current standpoint of literature suggests that, for the most part, only larger companies have implemented Lean and done so successfully.

Practical implications gain from this current study:

- There are implications for practitioners in this paper that include a comprehensive list of Lean CSFs and possible enablers and barriers for an effective and workable Lean implementation, which practitioners need to know when they begin their projects.

- This paper concludes that implementing Lean is a long-term process and that SMEs need to take the long-view approach by improving their organizational process gradually.
- This research discussed that some other quality approaches are sometimes combined with Lean. Examples include Accounting Method, Cellular Manufacturing, Project Management, Quality Function Deployment (QFD), Theory of Constraints (TOC) and Quick Scan although none of these are as popular [80]. Table 6 Supporting approaches for implementation of Lean

Future orientations for research as identified by this current study

This paper identified three core area for academic research improvement in the topic:

- The first is that there was very little research carried out that used grounded theory and ethnography, the mixed method, or action research when researching Lean implementation in SMEs. These methods are particularly good for obtaining a more in-depth view of Lean implementation in SMEs.
- Second, most of Lean research up until now has focused on the Western countries and have largely ignored developing countries such as the Middle East and Asia. Suitable aspects of research based on this could include comparative case studies of SMEs implementing Lean in developed versus developing countries to determine the application of Lean tools in SMEs in developing economies.
- Third, Lean's current focus is in academia, mainly due to its origins in the academic sector, but, as it is now finding popularity in the manufacturing sector, research is needed in this context.

Thus, it is demonstrated that the current study has more authorizing and comprehensive approach, rather than being just a standard narrative review on the subject of Lean implementation in SMEs, thus approvingly answering the set five research questions.

Limitation of this systematic review: This research has several limitations. The first is in relation to the precise terminology agreed for the literature search, which may have meant that certain papers were omitted. Additionally, there may have been limitations due to the availability of the literature sources [48]. The researchers used 6 main databases to compile the papers for the review, which meant that certain books or theses not online may have been unavailable for this review. Four researchers participated in the process of gathering, screening, and final selection of papers at the start of the review. There were multiple disagreements between the researchers in regard to the inclusion and classification of some papers. Although a research panel was formed [178] to decide on the disagreements on the 'unsure papers' after cross-referencing and application of a certain screening criteria, unfortunately, bias on some of the papers may still exists even after the final selection was done. A further issue in the review relates to the combination of various arrangements of data [134] due to the various methods of data collection used for within the review pool of selected papers. Survey methods were used to generate quantitative results, but the majority of the case study research papers have resulted in qualitative findings. This study, therefore, makes use of qualitative analysis to sort and analyse the main categories in the literature, instead of meta-analysis, which is more popularly used in medical science [178].

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.orp.2018.100089](https://doi.org/10.1016/j.orp.2018.100089).

References

- [1] Abdul-Nour G, Lambert S, Drolet J. Adaptation of jit philosophy and kanban technique to a small-sized manufacturing firm; a project management approach. Computers & Industrial Engineering 35. Elsevier {BV}; 1998. p. 419–22. [https://doi.org/10.1016/S0360-8352\(98\)00123-5](https://doi.org/10.1016/S0360-8352(98)00123-5).
- [2] Abernathy FH, Dunlop JT, Hammond JH, Weil D. Retailing and supply chains in the information age. Technol Soc 2000;22(1):5–31. [https://doi.org/10.1016/S0160-791X\(99\)00039-1](https://doi.org/10.1016/S0160-791X(99)00039-1).
- [3] Achanga P, Shehab E, Roy R, Nelder G. Critical success factors for lean implementation within SMEs. J Manuf Technol Manag 2006;17(4):460–71. <https://doi.org/10.1108/17410380610662889>. Edited by S. Saad.
- [4] Achanga P, Shehab E, Roy R, Nelder G. A fuzzy-logic advisory system for lean manufacturing within SMEs. International Journal of Computer Integrated Manufacturing 2012;25(9):839–52. <https://doi.org/10.1080/0951192X.2012.665180>.
- [5] Adolphus M. Available at: www.emeraldgroupublishing.com/research/guides/methods/literature2.htm?; 2011. part 7.
- [6] Albliwi SA, Antony J, Arshed N, Ghadge A. Implementation of Lean Six Sigma in Saudi Arabian organisations. International Journal of Quality & Reliability Management 2017;34(4):508–29. <https://doi.org/10.1108/IJQRM-09-2015-0138>.
- [7] Alkhoraif A, McLaughlin P. Organizational culture aspects that facilitate Lean Implementation: A Pilot Study. International Journal of Agile Systems and Management 2018;11(2):1. <https://doi.org/10.1504/IJASM.2018.10012787>.
- [8] Alkhoraif A, McLaughlin P. Organisational Culture that Inhibit the Lean Implementation. Proceedings of the European business & management conference. 2016 Available at: http://papers.iafor.org/papers/ebmc2016/EBMC2016_31127.pdf.
- [9] AlManei M, Salonitis K, Xu Y. Lean implementation frameworks: the challenges for SMEs. Procedia CIRP 2017;63:750–5. <https://doi.org/10.1016/j.procir.2017.03.170>.
- [10] Bamber L, Dale BG. Lean production: A study of application in a traditional manufacturing environment. Production Planning & Control 2000;11(3):291–8. <https://doi.org/10.1080/095372800232252>.
- [11] Becheikh N, Landry R, Amara N. Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993–2003. Technovation 2006;26(5–6):644–64. <https://doi.org/10.1016/j.technovation.2005.06.016>. Elsevier {BV}.
- [12] Bevilacqua M, Ciarapica FE, D' D, Ettorre NA, Mazzuto G, Paciarotti C. Total quality control through value stream mapping: a case study of small medium enterprises. International Journal of Integrated Supply Management 9. Inderscience Publishers; 2014. p. 94. <https://doi.org/10.1504/IJISM.2014.064361>.
- [13] Bhamu J, Singh Sangwan K. Lean manufacturing: literature review and research issues. Int J Oper Prod Manag 2014;34(7):876–940. <https://doi.org/10.1108/IJOPM-08-2012-0315>. Emerald Group Publishing Ltd.
- [14] Bhasin S. Analysis of whether lean is viewed as an ideology by British organizations. J Manuf Technol Manag. 2013;24(4):536–54. <https://doi.org/10.1108/17410381311327396>. Emerald.
- [15] Bhasin S. Performance of Lean in large organisations. Journal of Manufacturing Systems 31. Elsevier {BV}; 2012. p. 349–57. <https://doi.org/10.1016/j.jmsy.2012.04.002>.
- [16] Binder M, Edwards JS. Using grounded theory method for theory building in operations management research. Int J Oper Prod Manag 2010;30(3):232–59. <https://doi.org/10.1108/0144357101024610>.
- [17] Bortolotti T, Danese P, Romano P. Assessing the impact of just-in-time on operational performance at varying degrees of repetitiveness. International Journal of Production Research 2013;51(4):1117–30. <https://doi.org/10.1080/00207543.2012.678403>.
- [18] Bortolotti T, Boscarri S, Danese P. Successful lean implementation: Organizational culture and soft lean practices. International Journal of Production Economics 160. Elsevier; 2015. p. 182–201. <https://doi.org/10.1016/j.ijpe.2014.10.013>.
- [19] Boughton NJ, Arokiam IC. The application of cellular manufacturing: a regional small to medium enterprise perspective. Proc Inst Mech Eng Part B J Eng Manuf 2000;214(8):751–4. <https://doi.org/10.1243/0954405001518125>. {SAGE} Publications.
- [20] Bowersox DJ, Closs DJ, Stank T, Keller SB. How supply chain competency leads to business success. Supply Chain Manag Rev 2000;4(4):70–8.
- [21] Boyer KK. An assessment of managerial commitment to lean production. Int J Oper Prod Manag 1996;16(9):48–59. <https://doi.org/10.1108/01443579610125589>.
- [22] Boyle TA, Scherrer-Rathje M. An empirical examination of the best practices to ensure manufacturing flexibility. Journal of Manufacturing Technology Management 2009;20(3):348–66. <https://doi.org/10.1108/17410380910936792>.
- [23] Brown KL, Inman RA. Small business and {JIT}: a managerial overview. Int J Oper Prod Manag 1993;13(3):57–66. <https://doi.org/10.1108/01443579310026032>. Emerald.
- [24] Burcher P, Dupernex S, Relph G. The road to lean repetitive batch manufacturing. Int J Oper Prod Manag 1996;16(2):210–20. <https://doi.org/10.1108/01443579610109938>. Emerald.
- [25] Burns OM, Rishel TD. A study of characteristic differences between small JIT and non-JIT manufacturer. J Bus Entrep 1994;6(2):1–10.
- [26] Chaple AP, Narkhede BE, Akarte MM, Raut R. Modeling the lean barriers for successful lean implementation: TISM approach. Int J Lean Six Sigma 2018. <https://doi.org/10.1108/IJLSS-10-2016-0063>.
- [27] Chen JC, Li Y, Shady BD. From value stream mapping toward a lean/sigma continuous improvement process: an industrial case study. International Journal of Production Research 48. Informa {UK} Limited; 2010. p. 1069–86. <https://doi.org/10.1080/00207540802484911>.
- [28] Cheng C-Y, Chang P-Y. Implementation of the Lean Six Sigma framework in non-profit organisations: A case study. Total Quality Management {&} Business Excellence 23. Informa {UK} Limited; 2012. p. 431–47. <https://doi.org/10.1080/>

- 14783363.2012.663880.
- [29] Chiarini A. Lean production: mistakes and limitations of accounting systems inside the SME sector. *J Manuf Technol Manag* 2012;23(5):681–700. <https://doi.org/10.1108/17410381211234462>. Edited by K. Bates.
 - [30] Chicksand D, Watson G, Walker H, Radnor Z, Johnston R. Theoretical perspectives in purchasing and supply chain management: an analysis of the literature. *Supply Chain Manag Int J* 2012;17(4):454–72. <https://doi.org/10.1108/13598541211246611>. Edited by R. Wilding. Emerald.
 - [31] Chin L, Rafuse BA. Small manufacturer adds JIT techniques to MRP. *Prod Inven Manag J* 1993;34(4):18–21 Available at: <http://search.proquest.com/openview/847d755334221483ec44f01ea2e995a2/1?pq-origsite=gscholar&cbl=36911>.
 - [32] Conti R, Angelis J, Cooper C, Faragher B, Gill C. The effects of lean production on worker job stress. *Int J Oper Prod Manag* 2006;26(9):1013–38. <https://doi.org/10.1108/01443570610682616>.
 - [33] Cooney R. Is “lean” a universal production system? *International Journal of Operations & Production Management* 2012. MCB UP Ltd; 2002. p. 1130–47. <https://doi.org/10.1108/01443570210446342>.
 - [34] Crossan MM, Apaydin M. A Multi-dimensional framework of organizational innovation: a systematic review of the literature. *J Manag Stud* 2009;47(6):1154–91. <https://doi.org/10.1111/j.1467-6486.2009.00880.x>. Wiley-Blackwell.
 - [35] Cunha L, de O, Alves JM, Cunha L, de O, Alves JM. Application of Lean Manufacturing and Quality Management in Aeronautical Industry. *International Review of Mechanical Engineering (IREME)* 8. Praise Worthy Prize; 2014. p. 592–8. <https://doi.org/10.15866/IREME.V8I3.887>.
 - [36] Cunningham LX. SMEs as motor of growth: a review of China's SMEs development in thirty years (1978–2008). *Human Syst Manag* 2011;30(1–2):39–54. <https://doi.org/10.3233/HSM-2011-0736>. IOS Press.
 - [37] Delgado C, Ferreira M, Castelo Branco M. The implementation of lean Six Sigma in financial services organizations. *J Manuf Technol Manag* 2010;21(4):512–23. <https://doi.org/10.1108/17410381011046616>. Edited by M. Leseure.
 - [38] Deros BM. Critical success factors for implementing lean manufacturing in Malaysian automotive industry. *Res J Appl Sci Eng Technol* 2014;8(10):1191–200.
 - [39] DeSanctis I, Ordieres Mere JB, Bevilacqua M, Ciarapica FE. The moderating effects of corporate and national factors on lean projects barriers: a cross-national study. *Prod Plan Control* 2018;29(12):972–91. <https://doi.org/10.1080/09537287.2018.1494345>.
 - [40] Dombrowski U, Crespo I, Zahn T. Adaptive configuration of a lean production system in small and medium-sized enterprises. *Prod Eng* 2010;4(4):341–8. <https://doi.org/10.1007/s11740-010-0250-5>.
 - [41] Doolen TL, Hacker ME. A review of lean assessment in organizations: an exploratory study of lean practices by electronics manufacturers. *J Manuf Syst* 2005;24(1):55–67. [https://doi.org/10.1016/S0278-6125\(05\)80007-X](https://doi.org/10.1016/S0278-6125(05)80007-X).
 - [42] Dora M, Kumar M, Gellynck X. Determinants and barriers to lean implementation in food-processing SMEs – a multiple case analysis. *Prod Plan Control* 2016;27(1):1–23. <https://doi.org/10.1080/09537287.2015.1050477>.
 - [43] Dora M, Kumar M, Van Goubergen D, Molnar A, Gellynck X. Operational performance and critical success factors of lean manufacturing in European food processing SMEs. *Trends Food Sci Technol* 2013;31(2):156–64. <https://doi.org/10.1016/j.tifs.2013.03.002>. Elsevier Ltd.
 - [44] Dora M, Kumar M, Van Goubergen D, Molnar A, Gellynck X. ‘Operational performance and critical success factors of lean manufacturing in European food processing SMEs. *Trends Food Sci Technol* 2013;31(2):156–64. <https://doi.org/10.1016/j.tifs.2013.03.002>. Elsevier (BV).
 - [45] Dora M, Kumar M, Gellynck X. Determinants and barriers to lean implementation in food-processing SMEs – a multiple case analysis. *Production Planning & Control* 2015;27(October):1–23. <https://doi.org/10.1080/09537287.2015.1050477>.
 - [46] Dorota Rymaszewska A. The challenges of lean manufacturing implementation in SMEs. *Benchmarking Int J* 2014;21(6):987–1002. <https://doi.org/10.1108/BJL-10-2012-0065>.
 - [47] Dowlatshahi S, Taham F. The development of a conceptual framework for just-in-time implementation in (SMEs). *Prod Plann Control* 2009;20(7):611–21. <https://doi.org/10.1080/09537280903034305>. Informa (UK) Limited.
 - [48] Easterby-Smith Mark Thorpe, Richard, Jackson PR. *Management Research*. London: SAGE Publications; 2012.
 - [49] Emiliani M, Stec D. Using value-stream maps to improve leadership. *Leadersh Organ Dev J* 2004;25(8):622–45. <https://doi.org/10.1108/01437730410564979>.
 - [50] Emmitt S, Pasquire C, Mertia B. Is good enough “making do”? *Constr Innov* 2012;12(3):369–83. <https://doi.org/10.1108/1471471211244622>. Emerald.
 - [51] Erem SA, Massey TK. ‘Designing effective just-in-time research for small business. *Journal of Business and Entrepreneurship* 1990;2(2):69–78 Available at: <http://search.proquest.com/openview/a403a57402e6284e0927a1b465166e3e/1?pq-origsite=gscholar&cbl=33312> (Accessed: 20 June 2017).
 - [52] Esan AO, Khan MK, Qi HS, Naylor C. Integrated manufacturing strategy for deployment of (CAD/CAM) methodology in a (SME). *Journal of Manufacturing Technology Management*. Emerald 2013;24(2):257–73. <https://doi.org/10.1108/17410381311292331>.
 - [53] European Commission. (no date) Guide to EU definition of SME, 2011 Available at: http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition/index_en.htm; 2011, Accessed date: 15 May 2015.
 - [54] Finch B. Japanese management techniques in small manufacturing companies: A strategy for implementation. *Production and Inventory Management*. The Society 1986;27(3):30–8 Available at: <http://dl.acm.org/citation.cfm?id=15267> (Accessed: 20 June 2017).
 - [55] Floyd D, McManus J. The role of SMEs in improving the competitive position of the European Union. *Eur Bus Rev* 2005;17(2):144–50. <https://doi.org/10.1108/09555340510588011>.
 - [56] Garengo P, Biazzo S, Bititci US. Performance measurement systems in (SMEs): A review for a research agenda. *Int J Manag Rev* 2005;7(1):25–47. <https://doi.org/10.1111/j.1468-2370.2005.00105.x>. Wiley-Blackwell.
 - [57] Gnanaraj SM, Devadasan SR, Muruges R, Shalij PR. (DOLADMAICS): a model for implementing Lean Six Sigma in contemporary (SMEs)’. *Int J Serv Oper Manag* 2010;7(4):440. <https://doi.org/10.1504/ijssom.2010.035707>. Inderscience Publishers.
 - [58] Gnanaraj SM, Devadasan SR, Shalij PR. Current state maps on the implementation of lean and Six-Sigma paradigms and an exclusive model for deploying Lean Six-Sigma in (SMEs). *Int J Prod Qual Manag* 2010;5(3):286. <https://doi.org/10.1504/ijpqm.2010.032070>. Inderscience Publishers.
 - [59] Gnanaraj SM, Devadasan SR, Muruges R, Sreenivasa CG. Sensitisation of (SMEs) towards the implementation of Lean Six Sigma—an initialisation in a cylinder frames manufacturing Indian (SME). *Production Planning & Control* 23. Informa (UK) Limited; 2012. p. 599–608. <https://doi.org/10.1080/09537287.2011.572091>.
 - [60] Golhar DY, Stamm CL. The just-in-time philosophy: a literature review. *Int J Prod Res* 1991;29(4):657–76. <https://doi.org/10.1080/00207549108930094>.
 - [61] GOLHAR DY, STAMM CL. The just-in-time philosophy: A literature review. *International Journal of Production Research* 1991;29(4):657–76. <https://doi.org/10.1080/00207549108930094>.
 - [62] Grewal C. An initiative to implement lean manufacturing using value stream mapping in a small company. *Int J Manuf Technol Manag* 2008;15(3/4):404. <https://doi.org/10.1504/ijmtm.2008.020176>. Inderscience Publishers.
 - [63] Grubic T, Fan I-S. Supply chain ontology: Review, analysis and synthesis. *Comput Ind* 2010;61(8):776–86. <https://doi.org/10.1016/j.compind.2010.05.006>. Elsevier (BV).
 - [64] Gunasekaran A, Lyu J. Implementation of just-in-time in a small company: a case study. *Prod Plan Control* 1997;8(4):406–12. <https://doi.org/10.1080/095372897235217>. Informa (UK) Limited.
 - [65] Gunasekaran A, Cecille P. Implementation of productivity improvement strategies in a small company. *Technovation* 18. Elsevier (BV); 1998. p. 311–20. [https://doi.org/10.1016/S0166-4972\(98\)00005-4](https://doi.org/10.1016/S0166-4972(98)00005-4).
 - [66] Gupta SM, Brennan L. Implementation of just-in-time methodology in a small company. *Prod Plan Control* 1995;6(4):358–64. <https://doi.org/10.1080/09537289508930290>. Informa (UK) Limited.
 - [67] Gupta S, Sharma M, Sunder M. V. Lean services: a systematic review. *International Journal of Productivity and Performance Management* 2016;65(8):1025–56. <https://doi.org/10.1108/IJPPM-02-2015-0032>.
 - [68] Hall RW, A. P. I. C. S. Zero inventories. *Homewood: Homewood*; 1983.
 - [69] Hancock WM, Zayko MJ. Lean production: implementation problems. *IIE Solut Inst Ind Eng* 1998;30(6):38–43. Inc. (IIE).
 - [70] Harvey M, Speier C, Novecevic MM. A theory-based framework for strategic global human resource staffing policies and practices. *Int J Human Resour Manag* 2001;12(6):898–915. <https://doi.org/10.1080/09585190122394>. Informa (UK) Limited.
 - [71] Hilton RJ, Sohal A. A conceptual model for the successful deployment of Lean Six Sigma. *Int J Qual Reliab Manag* 2012;29(1):54–70. <https://doi.org/10.1108/02656711211190873>. Edited by J. Antony.
 - [72] Hines P, Francis M, Found P. Towards lean product lifecycle management. *J Manuf Technol Manag* 2006;17(7):866–87. <https://doi.org/10.1108/17410380610688214>.
 - [73] Hines P, Holweg M, Rich N. Learning to evolve. *Int J Oper Prod Manag* 2004;24(10):994–1011. <https://doi.org/10.1108/01443570410558049>. Emerald.
 - [74] Hines P, Martins AL, Beale J. Testing the boundaries of lean thinking: observations from the legal public sector. *Public Money Manag* 2008;28(1):35–40. <https://doi.org/10.1111/j.1467-9302.2008.00616.x>.
 - [75] Hines P, Rich N, Bicheno J, Brunt D, Taylor D, Butterworth C, Sullivan J. Value stream management. *Int J Logist Manag* 1998;9(1):25–42. <https://doi.org/10.1108/09574099810805726>.
 - [76] Hines P. How to create and sustain a lean culture. *Development and Learning in Organizations: An International Journal* 2010;24(6). <https://doi.org/10.1108/dlo.2010.08124fad.007>. p. dlo.2010.08124fad.007.
 - [77] Hines P, Found P, Griffiths G, Harrison R. *Staying lean*. Productivity Press; 2011. <https://doi.org/10.1201/b10492>.
 - [78] Holweg M. The genealogy of lean production. *J Oper Manag* 2007;25(2):420–37. <https://doi.org/10.1016/j.jom.2006.04.001>. Elsevier (BV).
 - [79] Howell K. An introduction to the philosophy of methodology. Sage; 2012 Available at: https://books.google.co.uk/books?hl=en&lr=&id=uYkRagAAQBAJ&oi=fnd&pg=PT9&dq=An+introduction+to+the+philosophy+of+methodology&ots=iHieyTVNL&sig=JgB4TFzYalZOnVZBo4_VvmV786s, Accessed date: 26 April 2016.
 - [80] Hu Q, Mason R, Williams SJ, Found P. Lean implementation within SMEs: a literature review. *J Manuf Technol Manag* 2015;26(7):980–1012. <https://doi.org/10.1108/JMTM-02-2014-0013>.
 - [81] Hu Q, Mason R, Williams SJ, Found P. Lean implementation within SMEs: a literature review. *J Manuf Technol Manag* 2015;26(7):980–1012. <https://doi.org/10.1108/JMTM-02-2014-0013>. Edited by H. Kotzab, Xavier Brusset and Christop.
 - [82] Hu Q, Mason R, Williams SJ, Found P. Lean implementation within SMEs: a literature review. *Journal of Manufacturing Technology Management* 2015;26(7):980–1012. <https://doi.org/10.1108/JMTM-02-2014-0013>.
 - [83] Iris C, Cebeci U. Analyzing relationship between (ERP) utilization and lean manufacturing maturity of Turkish (SMEs). *J Enterp Inf Manag* 2014;27(3):261–77. <https://doi.org/10.1108/jeim-12-2013-0093>. Edited by Dr Cengiz Kahraman Dr Ba'csar Öztay'csi. Emerald.
 - [84] John CHST, Heriot KC. Small suppliers and (JIT) purchasing. *Int J Purch Mater*

- Manag 1993;29(4):11–6. <https://doi.org/10.1111/j.1745-493x.1993.tb00256.x>. Wiley-Blackwell.
- [85] Johnson MP, Schaltegger S. Two decades of sustainability management tools for {SMEs}: how far have we come? *J Small Bus Manag* 2015;54(2):481–505. <https://doi.org/10.1111/jsbm.12154>. Wiley-Blackwell.
- [86] Kalafsky RV. Export challenges and potential strategies. *Journal of Small Business and Enterprise Development*. Emerald 2009;16(1):47–59. <https://doi.org/10.1108/14626000910932872>.
- [87] Karim MA, Aljuhani M, Duplock R, Yarlagadda P. Implementation of lean manufacturing in Saudi manufacturing organisations: an empirical study. *Adv Mater Res* 2011;339:250–3. <https://doi.org/10.4028/www.scientific.net/AMR.339.250>.
- [88] Karlsson C, Åhlström P. Assessing changes towards lean production. *Int J Oper Prod Manag* 1996;16(2):24–41. <https://doi.org/10.1108/01443579610109820>.
- [89] Karlsson C, Åhlström P. A lean and global smaller firm? *Int J Oper Prod Manag* 1997;17(10):940–52. <https://doi.org/10.1108/01443579710176915>. Emerald.
- [90] Kaufman SB. Order out of chaos. *CFO* 1987;3(7):30–5.
- [91] Kinney MR, Wempe WF. Further Evidence on the Extent and Origins of {JIT}'s Profitability Effects. *The Accounting Review* 77. American Accounting Association; 2002. p. 203–25. <https://doi.org/10.2308/accr.2002.77.1.203>.
- [92] Knapp S. Lean Six Sigma implementation and organizational culture. *International Journal of Health Care Quality Assurance* 2015;28(8):855–63. <https://doi.org/10.1108/IJHCQA-06-2015-0079>.
- [93] Koh SCL, Demirbag M, Bayraktar E, Tatoglu E, Zaim S. The impact of supply chain management practices on performance of {SMEs}. *Industrial Management & Data Systems*. Emerald 2007;107(1):103–24. <https://doi.org/10.1108/02635570710719089>.
- [94] Krafcik J. Triumph of the lean production system. *MIT Sloan Manag Rev* 1988;30(1):41 Available at: <http://search.proquest.com/openview/a6938b5d5125c061cc9881c8014c9bd/1?pqorigsite=gscholar>, Accessed date: 26 April 2016.
- [95] Kumar M, Antony J, Singh RK, Tiwari MK, Perry D. Implementing the lean sigma framework in an Indian {SME}: a case study. *Prod Plan & Control* 2006;17(4):407–23. <https://doi.org/10.1080/09537280500483350>. Informa {UK} Limited.
- [96] Kumar M, Antony J, Douglas A. Does size matter for Six Sigma implementation? *The {TQM} Journal*. Emerald 2009;21(6):623–35. <https://doi.org/10.1108/17542730910995882>.
- [97] Kumar M, Antony J, Singh RK, Tiwari MK, Perry D. Implementing the Lean Sigma framework in an Indian {SME}: a case study. *Production Planning & Control* 17. Informa {UK} Limited; 2006. p. 407–23. <https://doi.org/10.1080/09537280500483350>.
- [98] Kumar MK, Rajan AJ, Navas RKB, Robinson SS. Application of lean manufacturing in mass production system: a case study in Indian manufacturing unit. *Proceedings of the international conference on industrial engineering and engineering management IEEE*; 2014. <https://doi.org/10.1109/ieem.2014.7058729>.
- [99] Lacksonen T, Rathinam B, Pakdil F, Gülel D. Cultural issues in implementing lean production. *III Annual Conference and Expo*. 2010. 2010.
- [100] Lamming R. Squaring lean supply with supply chain management. *Int J Oper Prod Manag* 1996;16(2):183–96. <https://doi.org/10.1108/01443579610109910>. Emerald.
- [101] Lande M, Shrivastava RL, Seth D. Critical success factors for Lean Six Sigma in SMEs (small and medium enterprises). *The TQM Journal* 2016;28(4):613–35. <https://doi.org/10.1108/TQM-12-2014-0107>.
- [102] Lee CY. JIT adoption by small manufacturers in Korea. *J Small Bus Manag* 1997;35(3):98–107.
- [103] Lee GL. The “pros” and “cons” of total quality management for smaller firms in manufacturing: Some experiences down the supply chain. *Total Quality Management* 1995;6(4):413–26. <https://doi.org/10.1080/09544129550035341>.
- [104] Lewchuk W, Stewart P, Yates C. Quality of working life in the automobile industry: A Canada-UK comparative study. *New Technology, Work and Employment* 2001;16(2):72–87. <https://doi.org/10.1111/1468-005X.00078>.
- [105] Lewin K. Action research and minority problems. *J Soc Issues* 1946;2(4):34–46. <https://doi.org/10.1111/j.1540-4560.1946.tb02295.x>. Wiley- Blackwell.
- [106] Li H-HJK, Tan KH, Hida A. Sustaining growth in electronic manufacturing sector: lessons from Japanese mid-size {EMS} providers. *Int J Prod Res* 2011;49(18):5415–30. <https://doi.org/10.1080/00207543.2011.563897>. Informa {UK} Limited.
- [107] Liker J. Becoming lean: Inside stories of US manufacturers. *Qual Prog* 1997;32(3):107. Productivity Press.
- [108] Liker J. The toyota way: 14 management principles from the world's greatest manufacturer. McGraw-Hill; 2004 McGraw-Hill. Retrieved November Available at: https://scholar.google.co.uk/scholar?q=The+Toyota+Way+-+14+Management+Principles+from+the+World's+Greatest+Manufacturer&btnG=&hl=en&as_sdt=0%2C5#1, Accessed date: 26 April 2016.
- [109] Lowe J, Oliver N. High-Performance manufacturing: evidence from the automotive components industry. *Organ Stud* 1997;18(5):783–98. <https://doi.org/10.1177/017084069701800504>.
- [110] Lummus RR, Vokurka RJ, Rodeghiero B. Improving quality through value stream mapping: a case study of a physician's clinic. *Total Qual Manag Bus Excell* 2006;17(8):1063–75. <https://doi.org/10.1080/14783360600748091>. Informa {UK} Limited.
- [111] Macpherson A, Holt R. Knowledge, learning and small firm growth: a systematic review of the evidence. *Res Policy* 2007;36(2):172–92. <https://doi.org/10.1016/j.respol.2006.10.001>. Elsevier {BV}.
- [112] Manoochehri. JIT for small manufacturers. *J Small Bus Manag* 1988;26(4):22.
- [113] Mathur A, Mittal ML, Dangayach GS. Improving productivity in Indian SMEs. *Prod Plan Control* 2012;23(10–11):754–68. <https://doi.org/10.1080/09537287.2011.642150>. Informa {UK} Limited.
- [114] Mazanai M. Impact of just-in-time ({JIT}) inventory system on efficiency, quality and flexibility among manufacturing sector, small and medium enterprise ({SMEs}) in South Africa. *Journal of Business Management*. Academic Journals 2012;6(17). <https://doi.org/10.5897/ajbm12.148>.
- [115] Mazany P. A case study. *Int J Oper Prod Manag* 1995;15(9):271–88. <https://doi.org/10.1108/01443579510099788>. Emerald.
- [116] Medbo L, Carlsson D. Implementation of Lean in SME, experiences from a Swedish national program. *International Journal of Industrial Engineering and Management* 2013;4(4):221–7.
- [117] Ministry of Industry and Innovation Technology of PRC (MIIT). The classification of SMEs Available at: www.gov.cn/zw/gk/2011-07/04/content_1898747.htm; 2011.
- [118] Mohammed Kamis N. Impact of Organizational Culture in adopting the Environmental Management System : A practical study in the State Company for Glass and Ceramic Industry. *Journal of Economic and Administration Sciences* 2012;4(8):204–40.
- [119] Moosa K, Sajid A. Critical analysis of Six Sigma implementation. *Total Quality Management and Business Excellence* 2010;21(7):745–59. <https://doi.org/10.1080/14783363.2010.483100>.
- [120] Motwani J. A business process change framework for examining lean manufacturing: a case study. *Industrial Management & Data Systems* 2003;103(5):339–46. <https://doi.org/10.1108/02635570310477398>.
- [121] Moyano-Fuentes J, Sacristán-D\iaz M. Learning on lean: a review of thinking and research. *Int J Oper Prod Manag* 2012;32(5):551–82. <https://doi.org/10.1108/01443571211226498>. Emerald.
- [122] Mutingi M, Isack HD, Kandjeke H, Mbhwah C. Barriers and enablers of lean tools in medical laboratory industry: a case of Namibia. *Proceedings of the 2017 International Symposium on Industrial Engineering and Operations Management*. IEOM; 2017. July 24–25.
- [123] Nabhani F, Shokri A. Reducing the delivery lead time in a food distribution {SME} through the implementation of six sigma methodology. *J Manuf Technol Manag* 2009;20(7):957–74. <https://doi.org/10.1108/17410380910984221>. Emerald.
- [124] Olivella J, Cuatrecasas L, Gavilan N. Work organisation practices for lean production. *J Manuf Technol Manag* 2008;19(7):798–811. <https://doi.org/10.1108/17410380810898750>.
- [125] Ormsby JG, McDaniel SW, Gresham AB. Behavioural considerations for small businesses and JIT. *J Bus Entrep* 1994;6(1):51–8.
- [126] Oudhuis M, Olsson A. Cultural clashes and reactions when implementing lean production in a Japanese-owned Swedish company. *Economic and Industrial Democracy* 2015;36(2):259–82. <https://doi.org/10.1177/0143831X13505118>.
- [127] Pérez-Porras D, Loera-Hernández I, Caffarel-Rodríguez G, Aceves-Campos N. Diagnosing and Enhancing Innovation Capabilities in SMEs. In *IIIE Annual Conference*. Proceedings. Institute of Industrial and Systems Engineers (IISE); 2014. p. 3472.
- [128] Pakdil F, Leonard KM. The effect of organizational culture on implementing and sustaining lean processes. *Journal of Manufacturing Technology Management* 2015;26(5):725–43. <https://doi.org/10.1108/JMTM-08-2013-0112>.
- [129] Panizzolo R, Garengo P, Sharma MK, Gore A. Lean manufacturing in developing countries: evidence from Indian SMEs. *Prod Plan Control* 2012;23(10–11):769–88. <https://doi.org/10.1080/09537287.2011.642155>.
- [130] Papadopolou TC, Özbayrak M. Leanness: experiences from the journey to date. *Journal of Manufacturing Technology Management* 2005;16(7):784–807. <https://doi.org/10.1108/17410380510626196>.
- [131] Diagnosing and Enhancing Innovation Capabilities in SMEs', (Figure 1) Pettersen J. Defining lean production: some conceptual and practical issues. *TQM J* 2009;21(2):127–42. <https://doi.org/10.1108/17542730910938137>. Edited by S. M. Dahlgaard-Park. Emerald.
- [132] Phillips M. Industry mindsets: Exploring the cultures of two macro-organizational settings. *Organ Sci* 1994;5(3):384–402 Available at: <http://pubsonline.informs.org/doi/abs/10.1287/orsc.5.3.384>, Accessed date: 26 April 2016.
- [133] Pingyu Y, Yu Y. A review on lean manufacturing practices in small and medium enterprises. *Int J Innov Manag Technol* 2010;1(2):220–5.
- [134] Pittaway L, Robertson M, Munir K, Denyer D, Neely A. Networking and innovation: a systematic review of the evidence. *Int J Manag Rev* 2004;5-6(3–4):137–68. <https://doi.org/10.1111/j.1460-8545.2004.00101.x>. Wiley-Blackwell.
- [135] Powell D, Riezebos J, Strandhagen JO. Lean production and {ERP} systems in small and medium-sized enterprises: {ERP} support for pull production. *Int J Prod Res* 2013;51(2):395–409. <https://doi.org/10.1080/00207543.2011.645954>. Informa {UK} Limited.
- [136] Puvanasvaran P, Megat H, Sai Hong T, Mohd.Razali M. The roles of communication process for an effective lean manufacturing implementation. *Journal of Industrial Engineering and Management* 2009;2(1). <https://doi.org/10.3926/jiem.2009.v2n1.p128-152>.
- [137] Rahman S, Laosirihongthong T, Sohal AS. Impact of lean strategy on operational performance: a study of Thai manufacturing companies. *J Manuf Technol Manag* 2010;21(7):839–52. <https://doi.org/10.1108/1741038101077946>. Emerald.
- [138] Ramaswamy NR, Selladurai V, Gunasekaran A. Just-in-time implementation in small and medium enterprises. *Work Study*. Emerald 2002;51(2):85–90. <https://doi.org/10.1108/00438020210418818>.
- [139] Rashman L, Withers E, Hartley J. Organizational learning and knowledge in public service organizations: A systematic review of the literature. *Int J Manag Rev* 2009;11(4):463–94. <https://doi.org/10.1111/j.1468-2370.2009.00257.x>. Wiley-Blackwell.

- [140] Ravikumar MM, Marimuthu K, Parthiban P, Zubar HA. Evaluating lean execution performance in Indian (MSMEs) using {SEM} and {TOPSIS} models. *Int J Oper Res* 2016;26(1):104. <https://doi.org/10.1504/ijor.2016.075652>. Inderscience Publishers.
- [141] Ravikumar MM, Marimuthu K, Parthiban P, Zubar HA. Critical issues of Lean implementation in Indian micro, small and medium enterprises - an analysis. *Research Journal of Applied Sciences, Engineering and Technology* 2014;7(13):2680–6.
- [142] Ronstadt R, Rudolph WJ. Just-in-time and small business evolution. *Entrep Theory Pract* 1990;14(4):51. doi: Article.
- [143] Rose ANM, Deros BM, Rahman MNA. Critical success factors for implementing lean manufacturing in Malaysian automotive industry. *Res J Appl Sci Eng Technol* 2014;8(10):1191–200. <https://doi.org/10.19026/rjaset.8.1084>. Maxwell Scientific Publication Corp.
- [144] Rose MANM, Deros BM, Rahman MNA. Lean manufacturing perceptions and actual practice among Malaysian {SME}'s in automotive industry. *Int J Autom Mech Eng* 2013;7:820–9. <https://doi.org/10.15282/ijame.7.2012.2.0067>. Universiti Malaysia Pahang Publishing.
- [145] Rose AMN, Deros BM, Rahman MNA. Development of framework for lean manufacturing implementation in SMEs. The 11th Asia Pacific Industrial Engineering and Management Systems Conference. 2010. p. 7–10. (December).
- [146] Roth N, Franchetti M. Process improvement for printing operations through the {DMAIC} Lean Six Sigma approach. *Int J Lean Six Sigma* 2010;1(2):119–33. <https://doi.org/10.1108/20401461011049502>. Emerald.
- [147] Salem R, Musharavati F, Hamouda AM, Al-Khalifa KN. 'An empirical study on lean awareness and potential for lean implementations in Qatar industries. *Int J Adv Manuf Technol* 2016;82(9–12):1607–25. <https://doi.org/10.1007/s00170-015-7421-7>.
- [148] Santacecilia PT. Increasing manufacturing competitiveness through information technology: a case study. *Production & Inventory Management Journal* 1992;33(2):80 Available at: <http://search.proquest.com/openview/d9e3dc941673fafa4a0c9e2b0ce33bca/1?pq-origsite=gscholar&cbl=36911> (Accessed: 21 June 2017).
- [149] Seay S, Narsing A. Transitioning to a lean paradigm: A model for sustainability in the leasing and rental industries. *Academy of Strategic Management Journal* 2013;12(1):113.
- [150] Seetharaman A, Sreenivasan J, Bathamenadan R, Sudha R. The impact of Just-in-Time on costing. *International Journal of Management and Enterprise Development* 4. Inderscience Publishers; 2007. p. 635. <https://doi.org/10.1504/ijmed.2007.014986>.
- [151] Seitz T. Lean enterprise integration: a new framework for small businesses. Massachusetts Institute of Technology; 2003.
- [152] Seuring S, Gold S. Conducting content-analysis based literature reviews in supply chain management. *Supply Chain Manag Int J* 2012;17(5):544–55. <https://doi.org/10.1108/13598541211258609>. Edited by R. Wilding. Emerald.
- [153] Shah R, Ward PT. 'Defining and developing measures of lean production'. *J Oper Manag* 2007;25(4):785–805. <https://doi.org/10.1016/j.jom.2007.01.019>.
- [154] Shah R. Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management* 2003;21(2):129–49. [https://doi.org/10.1016/S0272-6963\(02\)00108-0](https://doi.org/10.1016/S0272-6963(02)00108-0).
- [155] Shah R, Ward PT. Defining and developing measures of lean production. *Journal of Operations Management* 2007;25(4):785–805. <https://doi.org/10.1016/j.jom.2007.01.019>.
- [156] Shirmali AK, Soni VK, Pawar SS. Interpretive structural modelling of identified barriers to lean implementation in SMEs. *Proceedings of the MATEC web of conferences*. 183. EDP Sciences; 2018. p. 01008.
- [157] Sim KL, Rogers JW. Implementing lean production systems: barriers to change. *Management Research News* 2008;32(1):37–49. <https://doi.org/10.1108/01409170910922014>.
- [158] Singh L, Bhardwaj A, Sachdeva A. Quality management practices vs. performance of {SMEs}: an empirical study of Indian industries. *Proceedings of the 2006 technology management for the global future - {PICMET} 2006 Conference IEEE*; 2006. <https://doi.org/10.1109/picmet.2006.296826>.
- [159] So S, Sun H. Supplier integration strategy for lean manufacturing adoption in electronic-enabled supply chains. *Supply Chain Manag Int J* 2010;15(6):474–87. <https://doi.org/10.1108/13598541011080455>. Emerald.
- [160] Sohal AS, Naylor D. Implementation of JIT in a small manufacturing firm. *Prod Inven Manag J* 1992;33(1):20.
- [161] Sohal AS, Egglestone A. Lean production: experience among Australian organizations. *Int J Oper Prod Manag* 1994;14(11):35–51. <https://doi.org/10.1108/01443579410068639>.
- [162] Spear S. Chasing the rabbit. New York: McGraw-Hill; 2009.
- [163] Stock GN, McFadden KL, Gowen CR. Organizational culture, critical success factors, and the reduction of hospital errors. *International Journal of Production Economics* 2007;106(2):368–92. <https://doi.org/10.1016/j.ijpe.2006.07.005>.
- [164] Storch RL, Lim S. Improving flow to achieve lean manufacturing in shipbuilding. *Prod Plan Control* 1999;10(2):127–37. <https://doi.org/10.1080/095372899233280>.
- [165] Stuart I, Boyle T. Advancing the adoption of Lean in Canadian SMEs. *Ivey Bus J* 2007;71(3):1–6.
- [166] Suárez-Barraza MF, Smith T, Dahlgard-Park SM. Lean service: a literature analysis and classification. *Total Qual Manag Bus Excell* 2012;23(3–4):359–80. <https://doi.org/10.1080/14783363.2011.637777>. Informa {UK} Limited.
- [167] Sui Pheng L, Joo Chuan C. Just-in-time management in precast concrete construction: a survey of the readiness of main contractors in Singapore. *Integr Manuf Syst* 2001;12(6):416–29. <https://doi.org/10.1108/EUM000000006107>.
- [168] Sukwadi R, Wee H-M, Yang C-C. Supply chain performance based on the lean-agile operations and supplier-firm partnership: an empirical study on the garment industry in Indonesia. *J Small Bus Manag* 2013;51(2):297–311. <https://doi.org/10.1111/jsbm.12016>. Wiley-Blackwell.
- [169] Tan KH, Denton P, Rae R, Chung L. Managing lean capabilities through flexible workforce development: a process and framework. *Prod Plan Control* 2013;24(12):1066–76. <https://doi.org/10.1080/09537287.2011.646013>.
- [170] Testani MV, Ramakrishnan S. Lean leadership readiness for change: A methodology for lean change readiness and continuous improvement. 62nd IIE Annual Conference and Expo. 2012. p. 2138–47.
- [171] Testani MV, Ramakrishnan S. Lean transformation leadership model: leadership's role in creating lean culture'. *Proceedings of the Industrial Engineering Research Conference*. 3. 2011.
- [172] Thomas A, Barton R, Chuke-Okafor C. Applying lean six sigma in a small engineering company—a model for change. *J Manuf Technol Manag* 2008;20(1):113–29. <https://doi.org/10.1108/17410380910925433>. Emerald.
- [173] Thomas A, Barton R, Chuke-Okafor C. Applying lean six sigma in a small engineering company—a model for change. *Journal of Manufacturing Technology Management*. Emerald 2008;20(1):113–29. <https://doi.org/10.1108/17410380910925433>.
- [174] Thorpe R, Holt R, Macpherson A, Pittaway L. Using knowledge within small and medium-sized firms: a systematic review of the evidence. *Int J Manag Rev* 2005;7(4):257–81. <https://doi.org/10.1111/j.1468-2370.2005.00116.x>. Wiley-Blackwell.
- [175] Thun J-H, Drüke M, Hoenig D. Managing uncertainty—an empirical analysis of supply chain risk management in small and medium-sized enterprises. *International Journal of Production Research* 49. Informa {UK} Limited; 2011. p. 5511–25. <https://doi.org/10.1080/00207543.2011.563901>.
- [176] Timans W, Antony J, Ahaus K, van Solingen R. Implementation of lean Six Sigma in small- and medium-sized manufacturing enterprises in the Netherlands. *J Oper Res Soc* 2011;63(3):339–53. <https://doi.org/10.1057/jors.2011.47>. Springer Nature.
- [177] Timans W, Antony J, Ahaus K, van Solingen R. Implementation of Lean Six Sigma in small- and medium-sized manufacturing enterprises in the Netherlands. *Journal of the Operational Research Society*. Springer Nature 2011;63(3):339–53. <https://doi.org/10.1057/jors.2011.47>.
- [178] Tranfield D, Denyer D, Smart P. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *Br J Manag* 2003;14(3):207–22. <https://doi.org/10.1111/1467-8551.00375>. Wiley-Blackwell.
- [179] Van Landeghem H. A management system for sustainable lean implementation. *Handbook of research on design and management of lean production systems*. IGI Global; 2014. p. 173–87. <https://doi.org/10.4018/978-1-4666-5039-8.ch009>.
- [180] Veliyath R, D'Aveni RA. 'Hypercompetition: Managing the Dynamics of Strategic Maneuvering'. *The Academy of Management Review* 1996;21(1):291. <https://doi.org/10.2307/258639>.
- [181] Wadhwa RS. Implementing continuous improvement in metal casting: case study of an aluminum foundry. *Adv Mater Res* 2012;622–623:433–6. <https://doi.org/10.4028/www.scientific.net/amr.622-623.433>. Trans Tech Publications.
- [182] Wanitwattanakosol J, Sopadang A. A framework for implementing lean manufacturing system in small and medium enterprises. *Appl Mech* ..., 2012;110:3997–4003 Available at: <http://www.scientific.net/AMM.110-116.3997>, Accessed date: 26 April 2016.
- [183] White RE, Pearson JN, Wilson JR. {JIT} Manufacturing: A Survey of Implementations in Small and Large U.S. Manufacturers. *Management Science*. Institute for Operations Research and the Management Sciences ({INFORMS}) 1999;45(1):1–15. <https://doi.org/10.1287/mnsc.45.1.1>.
- [184] White GRT, James P. Extension of process mapping to identify "green waste". *Benchmarking: An International Journal*. Emerald 2014;21(5):835–50. <https://doi.org/10.1108/bij-07-2012-0047>.
- [185] Williams P. Understanding just-in-time manufacturing. *Production Engineer* 64. Institution of Engineering and Technology ({IET}); 1985. p. 36. <https://doi.org/10.1049/tpe.1985.0177>.
- [186] Wilson MMJ, Roy RN. Enabling lean procurement: a consolidation model for small and medium-sized enterprises. *J Manuf Technol Manag* 2009;20(6):817–33. <https://doi.org/10.1108/17410380910975096>. Edited by N. Beaumont. Emerald.
- [187] Winston R, Heiko L. Just-In-Time and Small Business Evolution. *Entrepreneurship Theory and Practice* 1990;14(4):51–64. <https://doi.org/10.1177/104225879001400408>.
- [188] Woehl JH. How leadership styles reflect on lean manufacturing practices and culture. *ProQuest Dissertations and Theses*. Capella University; 2011.
- [189] Womack J, Jones D, Roos D. Machine that changed the world. Simon and Schuster; 1990.
- [190] Womack JP, Jones DT. Lean Thinking: banish waste and create wealth in your corporation. New York: Simon and Schuster; 1996 Available at: <https://books.google.com/books?id=QZrZAAAQBAJ&pgis=1>.
- [191] Wong M. The Role of Culture in Implementing Lean Production System. *Advances in Production Management Systems*. Boston, MA: Springer US; 2007. p. 413–22. https://doi.org/10.1007/978-0-387-74157-4_49.
- [192] Worley JM, Doolen TL. The role of communication and management support in a lean manufacturing implementation. *Manag Dec* 2006;44(2):228–45. <https://doi.org/10.1108/00251740610650210>. Edited by C. Cassell.
- [193] Wymenga P, Spanikova V, Derbyshire J, Barker A. Are EU SMEs recovering from the crisis? Annual Report on EU small and medium sized enterprises 2010/2011. *Proceedings of the amount of Chinese SMEs*. 2011 Available at: http://news.xinhuanet.com/fortune/2010-05/14/c_12102294.htm.
- [194] Yang T, Yang H, Wang X. The implementation of {ERP} in the {SMEs} innovation.

- 2010 3rd International Conference on Computer Science and Information Technology IEEE; 2010. <https://doi.org/10.1109/iccsit.2010.5563861>.
- [195] Yogesh M, Chandramohan G, Arraka R. Application of lean in a Small and Medium Enterprise (SME) segment-a case study of electronics and electrical manufacturing industry in India. *Int J Sci Eng Res* 2012;3(8):1.
- [196] Zhang L, Narkhede BE, Chaple AP. Evaluating lean manufacturing barriers: an interpretive process. *J Manuf Technol Manag* 2017;28(8):1086–114.
- [197] Zhou B. Lean principles, practices, and impacts: a study on small and medium-sized enterprises (SMEs). *Ann Oper Res* 2016;241(1–2):457–74. <https://doi.org/10.1007/s10479-012-1177-3>. Springer Nature.
- [198] Zhou B. Lean principles, practices, and impacts: a study on small and medium-sized enterprises (SMEs). *Annals of Operations Research* 2012:1–18. <https://doi.org/10.1007/s10479-012-1177-3>. (Krafcik 1988).



DSPACE

<https://dspace.org/>

Lean implementation in small and medium enterprises: Literature review

Alkhoraif, Abdullah; Rashid, Hamad; McLaughlin, Patrick

2018-12-07

Elsevier

<https://doi.org/10.1016/j.orp.2018.100089>

Abdullah Alkhoraif, Hamad Rashid and Patrick McLaughlin. Lean implementation in small and medium enterprises: Literature review. Operations Research Perspectives, Volume 6, 2019, Article number 100089