An appraisal on barriers to implement lean in SMEs

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Abstract

Purpose – Global competition has intensified pressure on small- and medium-sized enterprises (SMEs) to implement lean. Recently, the debate has converged to the role of lean implementation barriers (LIBs). The purpose of this paper is to contribute to this debate by exploring the LIBs in SMEs through three case studies.

Design/methodology/approach – A case study approach was employed followed by interpretive structural modelling (ISM) to model the interrelationship among the LIBs.

Findings – This study reveals that lack of management commitment, leadership and resources are the key barriers to lean implementation in SMEs in India. Furthermore, poor communication between different levels of the organisation and inadequate dissemination of the knowledge of lean benefits also creates hindrance in lean implementation. Managerial implications of the identified barriers for lean implementation in SMEs have been discussed.

Originality/value – The research regarding lean implementation in SMEs is scarce. This study is the first attempt of its kind to identify the lean barriers in a small industry setup through mathematical analysis.

Keywords Lean manufacturing, Case studies, Small- and medium-sized enterprises

Paper type Research paper

1. Introduction

The roots of lean manufacturing lie in the Toyota Production System which was launched and executed by Toyota (Krafcik, 1988). Realising the enormous benefits, lean manufacturing was adopted by other automotive manufacturers across the world. The application of lean, however, is not limited to the automobile sector; instead, other sectors such as manufacturing, service, construction, hospitality and process industries have also been benefited from the implementation of lean (Suárez-Barraza *et al.*, 2012; Bhamu and Sangwan, 2014). These sectors have witnessed the positive impact of lean on the operational, financial, social and environmental performance of the organisation (Shah and Ward, 2007; Fullerton and Wempe, 2009; Demeter and Matyusz, 2011; Hofer *et al.*, 2012; Bhattacharya *et al.*, 2014; Khanchanapong *et al.*, 2014; Chaplin *et al.*, 2016; Yadav *et al.*, 2018a, b). Previous research in this field has focussed upon the large enterprises. However, its application in small- and medium-sized enterprises (SMEs) has been seldom studied so far.

SMEs are considered as the backbone of developing economies as they significantly contribute to employment creation (Singh, 2011; Singh *et al.*, 2010). Nowadays, SMEs are

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facing several problems related to productivity, quality, customer satisfaction and delivery. Motivated by successful implementations of lean in large enterprises, SMEs have also started adopting lean (Alaskari *et al.*, 2016; Manfredsson, 2016; Thomas *et al.*, 2016; Yadav, Khandelwal, Jain and Mittal, 2018). SMEs are characterised by a simple organisation structure, flexible production process, receptivity to change and low risk (Hudson-Smith and Smith, 2007; Darcy *et al.*, 2014). These characteristics create a positive environment for lean initiatives.

Despite the encouraging conditions, SMEs continue to encounter barriers which hinder them from implementing lean. For the fruitful adoption of lean in SMEs, effective management of lean implementation barriers (LIBs) is critical (Achanga *et al.*, 2006; Bhasin, 2012; Dora *et al.*, 2016). According to an estimate, merely 10 per cent of organisations have successfully adopted lean practices (Bhasin and Burcher, 2006). Ineffective management of LIBs could be a reason for such scant successful implementation (Dora *et al.*, 2013). Furthermore, according to Jadhav *et al.* (2014), barriers not only affect the implementation of lean, but also influence one another.

In this study, an attempt has been made to identify the LIBs for SMEs and to develop a hierarchical model which demonstrates the interrelationship between the LIBs. Three case studies were conducted to identify the LIBs. Further, interpretive structural modelling (ISM) method is used to model the LIBs. The remainder of this paper is organised as follows: the next section throws light on the literature review and Section 3 describes the research methodology used in this study. Further, in Section 4, the cases are demonstrated, and the identified LIBs are discussed. The ISM model for LIBs is illustrated in Section 5, and theoretical and managerial implications are discussed in Section 6. The study finishes with conclusions, limitations and scope of future research.

2. Literature review

After a successful implementation of lean by large enterprises, now SMEs have also started adopting lean to improve operational, financial, social and environmental performance (Chaplin *et al.*, 2016). Extant literature reports various tangible and intangible benefits of lean implementation (Panizzolo *et al.*, 2012; Powell *et al.*, 2013; Vinodh *et al.*, 2014; Dora *et al.*, 2016; Alaskari *et al.*, 2016; Manfredsson, 2016; Thomas *et al.*, 2016). However, in context to SMEs, literature indicates that most of the studies have presented only one or two aspects of lean implementation, for instance, lean constructs and practices (Shah and Ward, 2007; Fullerton and Wempe, 2009). However, only a limited part of literature has focussed on other important concerns such as barriers to lean implementation in SMEs. Similar to other performance improvement initiatives, lean is also supposed to harbour enormous difficulties (Dora *et al.*, 2016). It has been reported in the literature that dealing successfully with the LIBs while transforming to lean is mandatory for the fruitful adoption of lean (Jadhav *et al.*, 2014).

A few researchers have studied identification of LIBs. One such study is by Jadhav *et al.* (2014) in which 24 LIBs for large enterprises have been identified. It is, however, argued that LIBs for the large enterprises considerably differ from the LIBs for SMEs (Bhasin, 2012). As mentioned by Antony *et al.* (2016), the characteristics of SMEs are significantly different from large enterprises; therefore, it is expected that the LIBs will also be different. The organisational structure of SMEs is typically very simple with very few levels, resulting in high visibility and accessibility of its top management to the lowest level (Carlos Pinho, 2007; Laufs *et al.*, 2016). This promotes quick decision-making and swift implementation of management strategies (Kotey, 2005; Hudson-Smith and Smith, 2007). However, such positives are often countered by a lack of expertise and limited specialisation. On the other hand, large enterprises have a complex structure with high levels of management.

The authorities and responsibilities are distributed at different levels. Hence, the LIBs for large enterprises may not be applicable to SMEs.

After reviewing a plethora of literature, a set of LIBs are extracted and summarised in Table I. For successful implementation of lean principles, the commitment of top management is vital (Achanga *et al.*, 2006; Worley and Doolen, 2006; Timans *et al.*, 2012; Dora *et al.*, 2016). It is a primary responsibility of management to educate and motivate the employees to support the adoption of lean at all levels. It is imperative that top managers are committed to a long-sight vision of performance and enhancement of the employees' involvement in improvement programmes (Panizzolo *et al.*, 2012). Additionally, the establishment of participative organisational culture is also a crucial factor for successful lean implementation (Panizzolo *et al.*, 2012; Zhou, 2016; Dora *et al.*, 2013). A long-term

Barriers	References for lean
Lack of management commitment and leadership	Abolhassani *et al.* (2016), Dora *et al.* (2016), Hu *et al.* (2015), Marodin and Saurin (2015), Jadhav *et al.* (2014), Dora *et al.* (2013), Panizzolo *et al.* (2012), Timans *et al.* (2012), Singh *et al.* (2010), Scherrer-Rathje *et al.* (2009), Fryer *et al.* (2007), Achanga *et al.* (2006), Worley and Doolen (2006), Houshmand and Jamshidnezhad (2006), Sánchez and Pérez (2001)
Organisational culture	Abolhassani *et al.* (2016), Dora *et al.* (2016), Jadhav *et al.* (2014), Dora *et al.* (2013), Bhasin (2012), Panizzolo *et al.* (2012), Timans *et al.* (2012), Zhou (2016), Cudney and Elrod (2010), Liker and Hoseus (2007), Stock *et al.* (2007), Bhasin and Burcher (2006)
Lack of communication	Hu *et al.* (2015), Marodin and Saurin (2015), Jadhav *et al.* (2014), Bhasin (2012), Timans *et al.* (2012), Cudney and Elrod (2010), Scherrer-Rathje *et al.* (2009), Worley and Doolen (2006)
Lack of resources	Abolhassani *et al.* (2016), Chaplin *et al.* (2016), Dora *et al.* (2016), Marodin and Saurin (2015), Jadhav *et al.* (2014), Dora *et al.* (2013), Bhasin (2012), Zhou (2016), Eswaramoorthi *et al.* (2011), Wong and Wong (2011), Pedersen and Huniche (2011), Kumar and Antony (2008), Achanga *et al.* (2006), Hudson *et al.* (2001)
Resistant to change	Abolhassani *et al.* (2016), Dora *et al.* (2016), Marodin and Saurin (2015), Jadhav *et al.* (2014), Bhasin (2012), Sohal and Egglestone (1994)
Lack of employees' involvement	Abolhassani *et al.* (2016), Dora *et al.* (2016), Hu *et al.* (2015), Marodin and Saurin (2015), Jadhav *et al.* (2014), Panizzolo *et al.* (2012), Wong and Wong (2011), Cudney and Elrod (2010), Upadhye *et al.* (2010), Scherrer-Rathje *et al.* (2009), Sim and Rogers (2008)
Lack of training and skills	Dora *et al.* (2016), Hu *et al.* (2015), Albliwi *et al.* (2014), Jadhav *et al.* (2014), Dora *et al.* (2013), Bhasin (2012), Mathur *et al.* (2012), Timans *et al.* (2012), Zhou (2016), Singh *et al.* (2010), Achanga *et al.* (2006), Worley and Doolen (2006), Sánchez and Pérez (2001), Karlsson and Ahlström (1996)
Cultural difference	Hu *et al.* (2015), Jadhav *et al.* (2014), Cudney and Elrod (2010), Achanga *et al.* (2006)
Lack of cooperation and mutual trust between management and employees	Jadhav *et al.* (2014), Staudacher and Tantardini (2007)
Lack of understanding lean benefits (measuring benefits)	Abolhassani *et al.* (2016), Marodin and Saurin (2015), Bhasin (2012), Vinodh and Balaji (2011), Shah and Ward (2007)
Incompatibility of lean with the company bonus, rewards or incentives systems	Jadhav *et al.* (2014), Cudney and Elrod (2010), Upadhye *et al.* (2010), Wong *et al.* (2009)
Backsliding to old methods	Abolhassani *et al.* (2016), Marodin and Saurin (2015), Jadhav *et al.* (2014), Bhasin (2012), Wong and Wong (2011), Emiliani and Stec (2005)
Lack of supplier involvement	Jadhav *et al.* (2014), Upadhye *et al.* (2010), Salaheldin (2005), Abdul-Nour *et al.* (1998)

Table I.
Barriers to implement lean (not specific to SMEs)

orientation, teamwork and excellent communication are also vital for a transformation to lean (Dora *et al.*, 2016). Further, SMEs typically employ a workforce with relatively limited skills and often regard training as a luxury (Achanga *et al.*, 2006; Mathur *et al.*, 2012; Albliwi *et al.*, 2014), while a lean transformation requires a high level of expertise and training. The engagement and empowerment of employees are also crucial in the lean drive (Hu *et al.*, 2015). However, it was observed that SMEs often have poor financial arrangements which act as a major barrier in the adoption of lean (Achanga *et al.*, 2006; Zhou, 2016; Dora *et al.*, 2013; Chaplin *et al.*, 2016). Lean transformation also requires clear communication between all the partners in a value stream (Timans *et al.*, 2012; Hu *et al.*, 2015).

A majority of articles in literature on the LIBs are in the context of large enterprises; while a few have discussed LIBs for SMEs. For instance, Achanga *et al.* (2006) conducted ten case studies of UK-based SMEs and identified four critical success factors (leadership and management, financial capabilities, skill and expertise and organisational culture) for lean implementation. Bhasin (2012) performed a survey of 68 UK-based manufacturing organisations and identified barriers for large enterprises as well as SMEs. Further, Dora *et al.* (2016) explored determining factors and their impacts on lean implementation in SMEs operating in the food processing sector using a multiple case study research approach. It is observed from the literature that a few studies are discussing LIBs in SMEs and generalised LIBs for SMEs cannot be extracted from extant studies. Therefore, we aimed at identification and modelling of LIBs in the SME context and the research methodology is discussed in the next section.

3. Research methodology

The objective of the study is to identify the LIBs in context of SMEs and to develop a hierarchical model that can explain the relationship among them. The research methodology adopted for this study is presented in Figure 1. As discussed in the previous section, most of

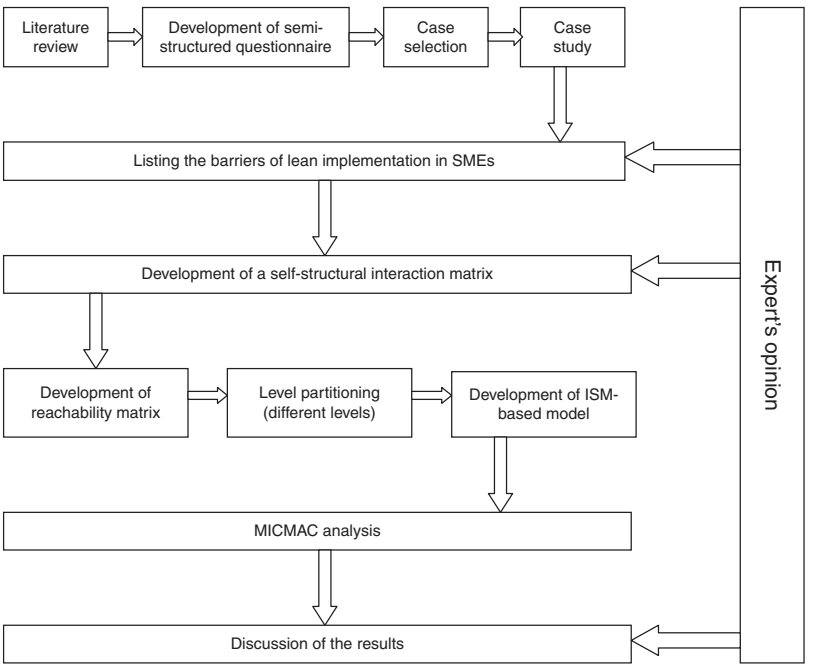

Figure 1.
Research methodology

the studies for LIBs focus on large enterprises which are not apt for SMEs. Thus, the generalised LIBs for SMEs cannot be extracted from the literature. Case study method has been used to extract the LIBs in SMEs. Three SMEs which had implemented lean thinking were considered for the study. The extracted LIBs are prioritised using the ISM method.

If the research is exploratory in nature, then the use of statistical inference to generalise from a sample to a larger population could be an appropriate method. However, qualitative research relies on logical inference whereby "case studies are generalisable to theoretical propositions and not populations" (Yin, 1989). Our study mainly focusses on theory development which is primarily exploratory in nature. There are two reasons of selecting the case study research design: first is "there is little theory regarding the LIBs in SMEs" and another is "to explore the unforeseen LIBs in most natural context of SMEs". As our research was not aimed to a specific industry, multiple case studies were conducted and this increases the external validity (Voss *et al.*, 2002). The cases were chosen from multiple sources (web pages, directory of Ministry of MSME India and database of the Confederation of Indian Industries).

The case studies were tested for construct validity and internal validity. Construct validity is the extent to which we establish correct operational measures for the concepts being studied. To ensure construct validity, the authors looked for multiple sources of evidence such as interviews with consultants, managers and employees for each of the important elements in the propositions. The interview protocol is dynamically adjusted to maximise insights into the themes that emerged during the interviews (Eisenhardt, 1989). Use of multiple informants and use of archival data helped authors to cross-check pertinent information and to verify the reliability of the collected data. A brief description of research aim and expected outcomes were shared with target respondents and confidentiality of sensitive data was ensured. The data were collected through three visits to case sites and unstructured interviews with consultants, managers/owner and workers of the company. Relevant company records and interviews with company consultants were used to collect additional information. To demonstrate the internal validity, the authors recorded evidence of other factors that might be alternative explanations for the observed patterns. Internal validity is the extent to which we can establish a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships (Yin, 1989).

Data analysis, findings and interpretation have been mainly qualitative in a cross-case method. The finding consisted of critical LIBs for SMEs. These cases are discussed in the next section. To maintain the confidentiality, cases are named A, B and C. Further, ISM was used to establish the relationship among LIBs. It is considered as a powerful tool to develop the structural model for the attributes. An expert team was formed consisting of four academicians (two professors, one associate professor and one lecturer) having PhD in the lean domain and three practitioners (owners of the SMEs). This team critically analysed the various extracted LIBs in SMEs in context to lean implementation. Subsequently, the relationships among the LIBs were established. These relationships helped in forming structural self-interaction matrix and to carry out further analysis. The steps involved in the ISM method are explained in the following:

- List the barriers extracted from the literature and the cases.
- Define the contextual relationship between barriers from the extensive discussion with the expert team.
- Develop the SSI matrix for barriers with the help of contextual relationship between barriers. In SSI matrix, pair-wise contextual relationships are expressed in the form of V, A, X and O ($V =$ barrier I will lead to j, $A =$ barrier j will lead to i, $X =$ barrier i and j will lead to each other and $O =$ barriers i and j are not related).

- Develop the initial reachability matrix (RM) from SSI matrix by converting information in cells into a binary form.
- Develop the final RM by considering the transitivity in initial RM.
- Develop the level partitioning table consisting of the reachability set and the antecedent set.
- Draw a directed graph (called ISM model) based on the above relationship and remove the transitivity links.
- Finally, review the ISM model for inconsistency and modifications through the expert team.

4. Case studies

Case company A, an ISO 9001 certified company with approximately 100 employees, manufactures surgical disposable needles and syringes. This is a family-owned SME which was established in 1981 and located in western Rajasthan, India. In the 1990s, it enjoyed 15 per cent of market share in India. However, due to the opening of the Indian economy in 1991 the company faced competition from global manufacturers resulting a significant decrease in market share. To retain their market share, the company decided to adopt lean and hired a consultant. Some basic lean practices were implemented in the production process. A lean training programme was organised for the employees at all levels. It was followed by the adoption of 5 S, visual control, SMED, lot size reduction, statistical process control, quality management programme and production levelling. In total, 18 months of lean implementation resulted in decreased cycle time, reduced inventory and improved productivity. Now, the company is not only able to attract domestic but also international customers.

The case provided some interesting observations regarding barriers in lean implementation. For instance, the owner (also the manager) of the organisation accepted that he was not actively involved in implementation project because he was ignorant of the benefits of lean. Further, he complained about the lack of time due to his involvement in all functional areas. The organisation also realised that lack of communication system was a major barrier to lean implementation. The company adopted a piecemeal approach for lean implementation citing not having enough money for training, consultancy and purchase of new equipment. Further, employees were hesitant about participating in lean initiatives, but training and motivation by consultant and owner, they started involving in quality circles and brainstorming. Additionally, lack of skilled manpower and tendency to backsliding to old methods were pointed out as other important barriers.

Case company B deals with products for water treatment and purification like industrial water treatment plant, industrial water purification plant, water filters and industrial sewage treatment plant. It is an ISO 9001:2008 company with annual turnover USD310k–775k. Initially, the company enjoyed monopoly but could not retain its position due to new entrants in the trade. The company adopted lean to reduce the delivery lead time and to improve productivity. Significant improvements were recorded in the second year of lean implementation, and the firm became more competitive.

Contrary to Case A, the top management was actively involved in the lean initiative. Frequent meetings with the employees were held to improve employees' involvement. Two training programs were conducted for skill development and to enhance the knowledge of lean tools. The consultant wanted to conduct few more training and skill development programs in the organisation, but due to the resource limitations, the management did not support this suggestion. Initially, employees showed resistance to change due to new work

classification system, remuneration system and the job insecurity but with persuasion, they complied. On the similar grounds, the middle management also did not feel motivated to support the initiative. The problem of employees shifting to their old ways was also faced by the company. After the successful lean implementation on the shop floor, the company decided to adopt just-in-time concept in their supply chain, but due to the lack of involvement of suppliers, this initiative was not successful. Similar to Case A, lack of communication was found to be one of the important barriers.

Case company C produces balls and rollers for different kind of bearings. This ISO 9002-certified SME was established in 1985. Due to global and local competition, the company had to reduce prices jeopardising its profitability, and the company decided to adopt lean in the organisation. After 18 months of lean implementation, significant improvements were observed in downtime, rework, setup-time and productivity.

The company hired a consultant for lean implementation. The consultant suggested some new machines and automation in the production line. Additionally, they recommended a generator system to avoid the problems of frequent power interruption from the grid. However, due to the lack of financial resources, the management did not procure. As per the consultant's suggestions changes in the work, the system was made. This was followed for some time, but later on most of the workers stepped back to the old system.

The owner interested in implementing lean but due to his very busy schedule, most of the times he passed on the responsibility for lean implementation to the supervisors. There was lack of communication between supervisors and workers and also the workers were not taken into confidence resulting in resistance for lean initiatives. They were not satisfied with the work classification system and also they sought additional financial benefits for the extra efforts. The company, however, did not accept. During the interviews, it was revealed that the employees were never asked for suggestions or problems regarding the production process. All this resulted in less involvement of workers in lean implementation.

4.1 Barriers to lean implementation

This section describes the barriers to the implementation of lean in SMEs identified through the exploration of literature on large enterprises and the three case studies mentioned in this study. These barriers are summarised in Table II. For convenience, LIBs are coded as B1, B2, …, B10. The symbol "✓" denotes the presence of the barrier in the case and symbol "_" indicates the absence of the barrier in the case. It is noted that out of these ten barriers seven- B2, B3, B4, B6, B7, B8 and B9 are present in all the cases. The LIBs are discussed next.

4.1.1 Lack of management commitment and leadership. Management commitment is a key ingredient for the success of any new initiative. Lack of management commitment leads to a swarm of other problems, like restricted access to resources, delays in decision-making

	LIBs	Case A	Case B	Case C
B1	Lack of management commitment and leadership	✓	–	✓
B2	Organisational culture	✓	✓	✓
B3	Lack of communication	✓	✓	✓
B4	Lack of resources	✓	✓	✓
B5	Resistant to change	–	✓	✓
B6	Lack of employees' involvement	✓	✓	✓
B7	Lack of training and skills	✓	✓	✓
B8	Lack of understanding lean benefits (measuring benefits)	✓	✓	✓
B9	Backsliding to old methods	✓	✓	✓
B10	Lack of supplier involvement	✓	✓	–

Table II. LIBs identified from cases

processes and improper communication (Scherrer-Rathje *et al.*, 2009). Lean implementation strictly requires consistent involvement, encouragement and supervision of the top management (Panizzolo *et al.*, 2012; Hu *et al.*, 2015; Abolhassani *et al.*, 2016). Top management has to set vision, strategy, goals and a direction to keep the project (Jadhav *et al.*, 2014). Especially in the SMEs context, this factor is highly relevant due to the direct involvement of top management in regular operations, direct supervision and deliveries. Owner (having responsibilities of HR, marketing and production) one of the case companies said:

> In the initial phase of implementation, I was doubtful about the benefits of lean and the success of this project. For this reason, I was not actively involved in this.

4.1.2 Organisational culture. The culture of an organisation may be defined as rule and behaviours which cover trust, hierarchy, working environment and fellow-feeling (Dora *et al.*, 2016). The organisational culture of an SME reflects the personality or attitude of top executives. According to Achanga *et al.* (2006) and Dora *et al.* (2016), organisational culture is crucial for lean implementation. Supportive organisational culture act like an encouraging platform for the lean implementation (Achanga *et al.*, 2006). On the other hand, if the trust, working environment and fellow-feeling are deficient in the organisation then organisational culture becomes a major LIB. All the three cases revealed the importance of organisational culture in the success of lean initiatives.

4.1.3 Lack of communication. Effective communication between all levels of organisational hierarchy as well as between internal and external stockholders is mandatory for any management initiatives including lean. It works as cement between bricks. A proper communication within the organisation and between its stakeholders is the key success factor for lean implementation (Scherrer-Rathje *et al.*, 2009; Timans *et al.*, 2012). During the interview, the supervisor of the case company expressed that:

> There was a lot of communication gap between top management, middle management, and workers. The management transferred the information related to production to the shop floor level. They did not, however, communicate any information related to lean implementation; only the consultant did.

4.1.4 Lack of resources. Lack of financial, technical and human resources is considered as a prominent barrier in lean implantation. According to Eswaramoorthi *et al.* (2011), lack of time, workforce and funds have been attributed for the meagre adoption of lean in SMEs. An adequate amount of resources are required for the successful implementation of lean (Chaplin *et al.*, 2016; Achanga *et al.*, 2006). The consultant for lean implementation in the case SMEs expressed the need for resources as:

> Case SMEs had more capabilities than they achieved from lean implementation but the big constraint was lack of resources. Due to this reason, the company missed many opportunities for improvements.

4.1.5 Resistant to change. The sudden introduction of new methods makes employees uncomfortable because they are more comfortable with the traditional methods. The middle management and shop floor workers provide a "resistance to change" during lean implementation (Marodin and Saurin, 2015; Jadhav *et al.*, 2014; Bhasin, 2012). The reasons for resistance to change, however, may be different for managers and workers. Fear of failure was found to be of concern among managers while workers were more apprehensive about their jobs (Jadhav *et al.*, 2014). Similar observations were made in all the case SMEs. Lack of knowledge about lean may also create a negative mindset of employees.

4.1.6 Lack of employees' involvement. Successful lean transformation requires direct involvement of employees in setting organisational vision, goals and values. Participation of employees increases the flow of knowledge and information and contributes to problem-solving as well. Involvement of employees and management acts as cement

in the wall. Lack of employees' involvement make lean implementation process tedious and unfruitful (Panizzolo *et al.*, 2012; Wong and Wong, 2011; Cudney and Elrod, 2010).

4.1.7 Lack of training and skills. Trained and skilled employees are considered as an asset to the industry. For the successful lean implementation, training of managers and workers is strictly required to enhance the basic knowledge of lean (Dora *et al.*, 2016; Hu *et al.*, 2015). In case of SMEs, lack of training and skills was considered to be one of the reasons for a low degree of lean implementation. The case SMEs avoided some training programmes due to the financial and time constraints.

4.1.8 Lack of understanding of lean benefits. It is argued that if the benefits of any new initiatives are clear to the stakeholders, they become motivated towards the adoption of the initiative. Additionally, measurement of improvements also motivates the stakeholders (Bhasin, 2012). Executives of case companies accepted that they did not have enough knowledge about the benefits of lean implementation. It was also revealed in the cases that motivation was low in the starting phase of lean implementation, but it improved once improvements were observed. A consultant mentioned that:

> In the first phase of implementation, the involvement of management and employees were very low. But once we measured the improvements and showed to the top executives; motivation level went up considerably.

4.1.9 Backsliding to old methods. One of the barriers to lean implementation is backsliding to old methods in anticipation that the improvement in the productivity results in unemployment (Wong and Wong, 2011; Emiliani and Stec, 2005). According to Wong *et al.* (2009), the major problem in lean implementation is the propensity to revert to traditional practices when difficulties were encountered. In our case studies also, it was revealed that the supervisors and workers stuck to their old methods and they did not follow the new methods suggested by the consultants.

4.1.10 Lack of supplier involvement. To survive and grow in today's competitive environment, suppliers should act as a seamless extension of the organisation (Dey *et al.*, 2015; Yadav, Sharma, and Singh, 2018; Yadav and Sharma, 2015a, b). It is necessary to extend the lean implementation to their supply chain partners, but according to Abdul-Nour *et al.* (1998), it is difficult for SMEs to develop a lean supply chain. SMEs suffer from a lack of cooperation with their suppliers (Salaheldin, 2005). Two out of three case studies revealed that the suppliers were not actively involved in the lean implementation.

5. ISM model for LIBs

After the identification of lean implementation barrier in SMEs, the next step was to develop the relationship between them. The team of experts studied the cases and validated the various LIBs. They provided the relationship between barriers which helped in developing the structural self-interaction matrix (SSIM). The SSIM is presented in Table III. Further, the SSIM was converted into a binary form which is called the initial RM. The conversion into a binary form was performed by the following rules:

- If the entry (i, j) is V in SSIM, then the corresponding entry in (i, j) will be 1 and entry in (j, i) will be 0.
- If the entry (i, j) is A in SSIM, then the corresponding entry in (i, j) will be 0 and entry in (j, i) will be 1.
- If the entry (i, j) is X in SSIM, then the corresponding entry in (i, j) will be 1 and entry in (j, i) will be 1.
- If the entry (i, j) is O in SSIM, then the corresponding entry in (i, j) will be 0 and entry in (j, i) will be 0.

Table III.
Structural self-interaction matrix

	B10	B9	B8	B7	B6	B5	B4	B3	B2
B1	V	V	X	V	V	V	V	X	V
B2	O	V	O	A	A	V	O	O	
B3	O	V	V	A	X	V	O		
B4	O	O	O	V	O	O			
B5	O	V	X	X	X				
B6	O	V	O	X					
B7	O	O	V						
B8	O	V							
B9	O								
B10									

Following the above convention, the initial RM was prepared (Table IV). The final RM was developed by considering the transitivity and the again discussion with the experts. Transitivity states that if barrier *a* is related to *b* and *b* is related to *c*, then *a* is necessarily related to *c*. Final matrix was further checked and corrected by the expert team. Then final RM was obtained and presented in Table V. To further develop the levels of the barrier in the hierarchy model, the level partitioning was performed. The reachability sets and antecedents sets for each barrier were identified. The reachability sets consist of the barrier itself and the barrier which it may help to achieve. The antecedents sets consist the barrier itself and the barrier which may help to achieve it. Then the intersection set was drawn for each barrier. The barriers for which the reachability set and intersection set had the same values were given the top-level variable in the model. These top-level barriers in

Table IV.
Initial reachability matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
B1	1	1	1	1	1	1	1	1	1	1
B2	0	1	0	0	1	0	0	0	1	0
B3	1	0	1	0	1	1	0	1	1	0
B4	0	0	0	1	0	0	1	0	0	0
B5	0	0	0	0	1	1	1	1	1	0
B6	0	1	1	0	1	1	1	0	1	0
B7	0	1	1	0	1	1	1	1	0	0
B8	1	0	0	0	1	0	0	1	1	0
B9	0	0	0	0	0	0	0	0	1	0
B10	0	0	0	0	0	0	0	0	0	1

Table V.
Final reachability matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
B1	1	1	1	1	1	1	1	1	1	1
B2	0	1	0	0	1	1*	1*	0	1	0
B3	1	0	1	0	1	1	1*	1	1	1*
B4	0	0	1*	1	0	0	1	0	0	0
B5	0	1*	1*	0	1	1	1	1	1	0
B6	0	1	1	0	1	1	1	0	1	0
B7	1*	1	1	0	1	1	1	1	1*	1*
B8	1	1*	0	0	1	1*	1*	1	1	1*
B9	0	0	0	0	0	0	0	0	1	0
B10	0	0	0	0	0	0	0	0	0	1

Note: 1* indicates indirect relationship through transitive property

the model would not help in achieving other barriers. These barriers were then removed from the list of barriers, and the process was repeated until all barriers were assigned their level. It can be seen from Table VI that there are total six levels for ten barriers. Once the levels of barrier are found, the next step is building the final structural model. The final ISM was obtained by removing all transitivity links as shown in Figure 2.

Figure 2 shows that "lack of management commitment and leadership", "lack of resources" and "lack of communication" are placed at sixth, fifth and fourth levels, respectively. Thus, these three barriers are key LIBs in SMEs. It is noted that "lack of management commitment and leadership" and "lack of communication" are key LIBs for large enterprises also (Jadhav *et al.*, 2014; Bhasin, 2012). It is further noted that "lack of resources" is found to be an important barrier in SMEs unlike in large enterprises. As per ISM, "backsliding to old methods" and "lack of supplier involvement" are found to be less

	Reachability set	Antecedent set	Intersection	Level
B1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	1, 3, 7, 8	1, 3, 7, 8	VI
B2	2, 5, 6, 7, 9	1, 2, 5, 6, 7, 8	2, 5, 6, 7	II
B3	1, 3, 5, 6, 7, 8, 9, 10	1, 3, 4, 5, 6, 7	1, 3, 5, 6, 7	IV
B4	3, 4, 7	1, 4	4	V
B5	2, 3, 5, 6, 7, 8, 9	1, 2, 3, 5, 6, 7, 8	2, 3, 5, 6, 7, 8	II
B6	2, 3, 5, 6, 7, 9	1, 2, 3, 5, 6, 7, 8	2, 3, 5, 6, 7	II
B7	1, 2, 3, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8	1, 2, 3, 5, 6, 7, 8	II
B8	1, 2, 5, 6, 7, 8, 9, 10	1, 3, 5, 7, 8	1, 5, 7, 8	III
B9	9	1, 2, 3, 5, 6, 7, 8, 9	9	I
B10	10	1, 3, 7, 8, 10	10	I

Table VI.
Level partitioning

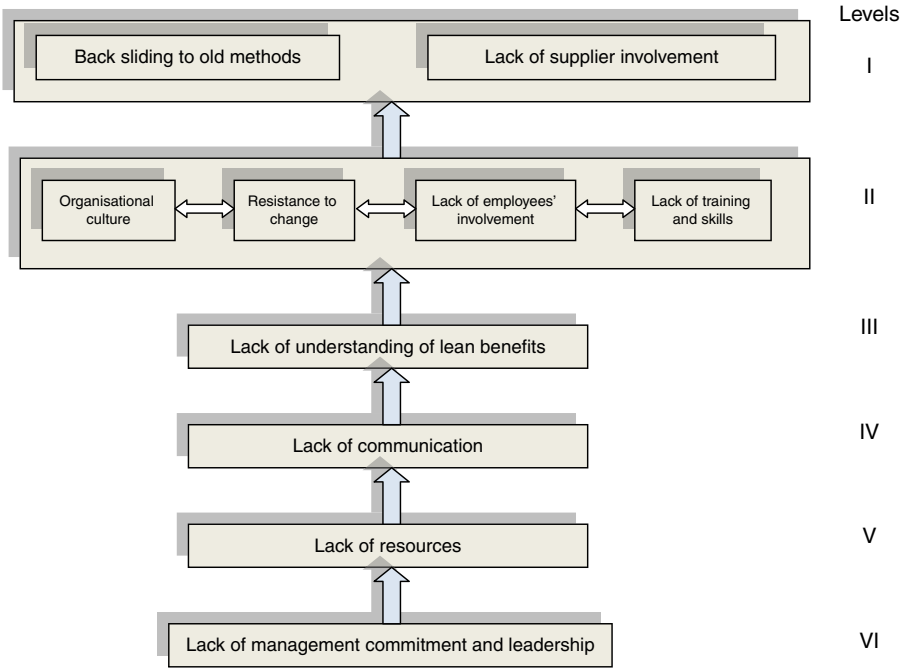

Figure 2.
ISM based model for LIBs

important barriers in SMEs. The barriers "lack of understanding of lean benefits", "organisational culture", "resistance to change", "lack of employees' involvement" and "lack of training and skills" are of the intermediate level showing medium importance. To further know the degree of relationships (driving power and dependence power), MICMAC analysis was performed.

5.1 MICMAC analysis

Using the MICMAC analysis, the barriers were classified into four groups on the basis of their driving and dependence powers. These categories are named as autonomous, dependent, driver or independent and linkage barriers. The dependence and driving power of barriers were calculated from the final RM and shown in Table VII. The driver-dependence diagram for MICMAC analysis was drawn and shown in Figure 3.

It was noted that a lack of management commitment and leadership has high driving power which signifies that the level of management commitment affects the other LIBs in SMEs. It was also noted that "lack of training and skills" has high driving as well as high dependence power. The ISM model also suggests that management commitment, communication level and availability of resources affect training and skills which in turn affect other barriers, namely, "backsliding to old methods", "employees' involvement",

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	Driving power
B1	1	1	1	1	1	1	1	1	1	1	10
B2	0	1	0	0	1	1*	1*	0	1	0	5
B3	1	0	1	0	1	1	1*	1	1	1*	8
B4	0	0	1*	1	0	0	1	0	0	0	3
B5	0	1*	1*	0	1	1	1	1	1	0	7
B6	0	1	1	0	1	1	1	0	1	0	6
B7	1*	1	1	0	1	1	1	1	1*	1*	9
B8	1	1*	0	0	1	1*	1*	1	1	1*	8
B9	0	0	0	0	0	0	0	0	1	0	1
B10	0	0	0	0	0	0	0	0	0	1	1
Dependence power	4	6	6	2	7	7	8	5	8	5	58

Note: 1* indicates indirect relationship through transitive property

Table VII.
Dependence and driving power matrix

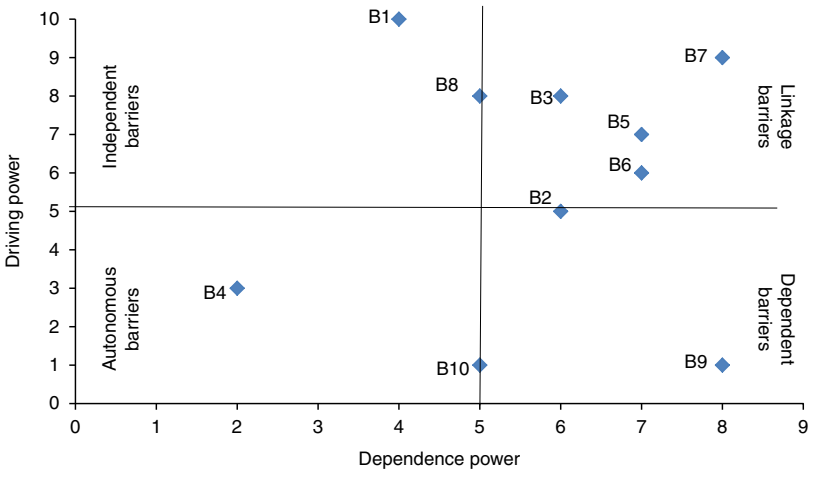

Figure 3.
Driver-dependence diagram for MICMAC analysis

"organisational culture" and "resistance to change". Similarly, "lack of communication", "resistance to change" and "employees' involvement" are linkage barriers but with relatively lesser driving and driven power. Backsliding to old methods has high dependence which suggests that other barriers may affect this while it does not affect other barriers.

6. Theoretical and managerial implications

The results suggested that "lack of management commitment and leadership" is of utmost importance as it lies at the lowest level. This finding is consistent with other studies like Netland (2015) and Zhang *et al.* (2017). Being the most crucial barrier, "lack of management commitment and leadership" also impacts on other LIBs. Thus, for successful lean implementation in SMEs, a proper commitment of management and owner is mandatory, and training should be provided to the managers to improve their leadership and other managerial skills. In addition to this, "lack of resources, communication, and understanding of lean benefits" also the major barriers in lean adoptions and they have an impact on other barriers. These barriers have more importance in the context of SMEs because of the characteristics of this sector, while these are largely ignored by most of the scholars focussing on large enterprises. Achanga *et al.* (2006) also stated that resource inadequacy is the major hindrance to implement lean in SMEs. Our model helps academicians in improving understandings regarding LIBs with their comparative importance and the interdependencies among these barriers.

From the practitioner's perspective, the finding of this research helps in understanding the LIBs and their interdependence. On the basis of our model, one can prioritise the barriers and focus on them accordingly. Before starting the lean implementation, the firm must ensure that the management is committed and have the leadership skills to pursue the employees for lean. Further, lack of resource is one of the major hindrances for lean implementation in SMEs, but it is suggested that SMEs can start lean adoption with small funding (Bhasin, 2012) or may think for mobilising additional resources to gain the immense benefits of lean implementation. Like many other management initiatives, lean also requires effective communication between all levels of the organisation. The improved communication would lead to a greater understanding of the probable benefits among the stakeholders, employees' involvement, training and skills, organisational culture and supplier involvement.

According to Wong *et al.* (2009), the major problem in lean implementation is the propensity to revert to traditional practices when difficulties are encountered. Hence, proper supervision and motivation are required during the transformation phase. Apart from these internal issues, it is necessary to extend the lean implementation to the supply chain partners.

7. Conclusions

A majority of studies have explored the LIBs for large enterprises, but very few have concentrated on SMEs. Considering the importance of SMEs in the global economy and their distinct characteristics, it is imperative to investigate the barriers of lean in SMEs. In this paper, we have identified the barriers of lean implementation in SMEs in India and prioritised them. The findings provide specific suggestions to the practitioners for successful implementation of lean in SMEs.

The results showed that "lack of management commitment and leadership", "lack of communication" and "lack of resources" are the most critical barriers hence these should be considered as the foundation of any lean implementation project in SMEs. The study also suggested that fundamental knowledge of lean as well as its benefits should be known to the employees at an early stage for their active involvement. Furthermore, lack of resources was found to be a dominating factor in SMEs. The management may look for alternative sources of money to fund the lean initiatives.

This study should be observed in the light of some limitations. As this analysis and findings are based only on three case studies of the Indian manufacturing SMEs, one should be cautious in generalising the findings for developed countries and other sectors of the economy. Moreover, the foundation of this research is personal interviews and expert discussions which may have a possibility that the opinion of the interviewees and expert may be limited and biased. Given these limitations, this study suggests potential areas of future research. For the generalisation of results, this study may be extended to some more cases and in more countries. Further, an empirical study may be conducted for the generalisation of findings.

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