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The implementation of lean manufacturing in the furniture industry: A review and analysis on the motives, barriers, challenges, and the applications

Falah Abu [a, b], Hamed Gholami [a, *], Muhamad Zameri Mat Saman [a], Norhayati Zakuan [c], Dalia Streimikiene [d]

[a] Department of Manufacturing & Industrial Engineering, School of Mechanical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia (UTM), Johor 81310, Malaysia
[b] Faculty of Applied Sciences, Universiti Teknologi MARA (UiTM), 40450 Shah Alam, Malaysia
[c] Department of Business Administration, Azman Hashim International Business School, Universiti Teknologi Malaysia (UTM), Johor 81310, Malaysia
[d] Lithuanian Energy Institute, Breslaujos 3, Kaunas, LT-44403, Lithuania

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ABSTRACT

Although research on the adoption of lean manufacturing in the furniture industry in emerging economies is slowly progressing, its implementation has been emphasized by researchers and practitioners. Research on this scope is therefore limited, particularly when compared to the vast amount of scholarly studies contributed to successful implementation of lean in the developed countries. To support the narrow body of knowledge on this under-researched scope, this paper presents the current shortfalls of implementing the lean manufacturing in terms of motives, barriers, challenges, and applications. To address these issues, a methodological approach was implemented in two tiers. Firstly, a comprehensive review of state-of-the-art literature on the issues was performed followed by an analytic approach using a survey on 148 companies in Malaysia to finalize the research. Upon validation of the analyses, the results revealed that most of the lean companies agreed that the reasons for lean implementation are to increase efficiency, to clean up and organize the workplace, and to increase utilization of space. Non-lean companies believe that issues related to knowledge are the reasons for not undertaking lean implementation. However, lean companies believe that the obstacles are more about employee-related issues including lack of labor resources, lack of implementation know-how, and employee resistance to change. Lean companies also face challenges in the form of technical knowledge, training, and financial resources during the early phase of lean implementation. In addition, only three applications – 5S, employee training, and quality control – were found to be useable in the Malaysian wood and furniture industry. These findings present a critical view of the current shortfalls of lean implementation in the wood and furniture industry throughout Malaysia and other emerging economies.

1. Introduction

After the publication of the ground-breaking work "The Machine that Changed the World" (Womack et al., 1990), lean underwent a significant and unprecedented evolution over the years, subsequently being unanimously accepted as a highly beneficial practice (Bhamu and Singh Sangwan, 2014). Over the course of time, a number of prominent researchers have explored the various range of tools for lean manufacturing (LM), since it has successfully proved in a large variety of industries with many successful cases recorded in the literature (Pearce et al., 2018a).

An increasing number of literature studies have found that LM has significantly contributed to the success of companies in developed countries (e.g. Japan, the US, the UK, Germany, and Italy). Until now this methodology has only been applied to developed countries, and there is little effort taken to investigate LM implementation in developing countries (Amoako-Gyampah and Gargeya, 2001; Nawanir et al., 2013). On the other hand, the influences of lean manufacturing in the furniture industry is not

* Corresponding author.
E-mail address: ghamed@utm.my (H. Gholami).

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Abbreviations:

CTCS	Certified Timber and Credible Suppliers Global Sdn. Bhd
CIP	Continuous improvement process
CITC	Corrected item to total correlation
GMP	Good manufacturing practices
JIT	Just in time
JITF	Just-in-time flow
KPIs	Key performance indicators
KLSFIA	Kuala Lumpur and Selangor Furniture Industry Association
LM	Lean manufacturing
MF3	Malaysian Furniture and Furnishing Fair
MFC	Malaysian Furniture Council
MFPC	Malaysian Furniture Promotion Council
MTIB	Malaysian Timber Industry Board
OEE	Overall equipment effectiveness
QM	Quality management
SMED	Single minute exchange of dies
SMEs	Small and medium enterprises
SOPs	Standard operation procedure
TPM	Total productive maintenance
TQC	Total quality control
TQM	Total quality management
VSM	Value stream mapping

promising. An evidence indicates there is no respondents from wood and furniture company has implemented lean practices in China (Huo et al., 2019). The forest based (Finnish SMEs) companies were at a very early stage of development and may not have matured sufficiently within company thinking (D'Amato et al., 2018). Yet, LM is a new manufacturing paradigm especially for the furniture industry in Malaysia. This condition brings out a fundamental question: "*What are the motives for the lean manufacturing adoption*?"

Regrettably, a majority of small and medium enterprises (SMEs) have rejected the idea of adopting LM (Bhamu and Singh Sangwan, 2014). Despite prior evidence of the benefits of lean implementation, there are several barriers to it as well including perception, lack of tangible benefits, and issues with shop floor employees (Melton, 2005). This may largely be due to: 1) the fear of implementation cost and the successive benefits of lean (Bhamu and Singh Sangwan, 2014); 2) the lack of job security among employees and the risk of losing their job if it is non-value added (Khaba and Bhar, 2018); 3) the lack of a supportive organizational culture to overcome the fear of failure, change, retrenchment, and uphold greater responsibilities (Coetzee et al., 2018); 4) the lack of governmental support which emerged as one of the significant factors to the success of lean implementation in SMEs (Thanki and Thakkar, 2018), and, most importantly, 5) the lack of knowledge or training (Pearce et al., 2018a). Regarding the status of these two companies (lean and non-lean companies), expectedly the important questions rise: *"To what extent do views of barriers to lean implementation differ between lean and non-lean companies?"*

The investigation by Pearce et al. (2018a) stresses the importance of knowledge management in the early phase of lean implementation, which is in accord with Chay et al. (2015) who revealed that the lack of technical knowledge among shop floor employees present the biggest challenge in lean implementation. It has been noted that the existing lean implementation has failed in the aspects of leading and supervising workers because it is prone to practicing a top-down approach (Chay et al., 2015). It was verified that companies have failed to associate employees with lean practice due to lack of knowledge management in the implementation phase (Chay et al., 2015; Pearce et al., 2018a). Similarly, Abolhassani et al. (2016) also found the lack of technical knowledge among shop floor employees as an obstacle in lean implementation, believing that 1) adaptation to the new environment is dependent on the management considering that lean is a sustainable philosophy, and 2) since the business philosophy of LM is not a gimmick, technical knowledge and management commitment are crucial in ensuring its full implementation. It was also observed that 'management resistance to change', 'lean is gimmick', and 'lean is unsustainable' were not the factors for the failure of lean practices (Abolhassani et al., 2016; Pearce et al., 2018a). With such constraints to lean implementation, a fundamental question is accordingly highlighted: "*What are the challenges faced by the wood and furniture companies in the early phase of lean implementation?*"

Shah and Ward (2003) claimed that LM is a multiphase concept (bundles), i.e. it is not solely dependent on single principles. This claim was further supported by Nawanir et al. (2013), who revealed/concluded that the implementation of LM must not be carried out as separate practices or in limited subsets. Thereafter, Longoni and Cagliano (2015) and Gelei et al. (2015) employed the LM bundles proposed by Shah and Ward (2003) for their investigations. Till date, several studies have introduced their own lean clusters that are suited respective to their own fields of research (Nawanir et al., 2013; Shah and Ward, 2007). However, a key problem with much of the literature is that the application of lean implementation in the furniture industry are limited; majority are predominantly practiced in the automotive industry. This is starkly evident in the investigation by Henao et al. (2019) out of the 679 articles, 3% of the literature indicated being related to the furniture, machinery, foundry, and logistic industry. This condition – a need for in-depth research on the practices in the wood and furniture industries – thereby draws our last fundamental question: "*What are the applications of lean implementation practiced by the wood and furniture companies?*"

Despite the numerous anecdotal and empirical evidences about the benefits of LM for the manufacturing industry, not many theoretical and methodological studies have been carried out about this matter in the context of wood and furniture companies particularly in emerging economies. The lack of research on the recognition of barriers and challenges in SMEs, particularly, in the wood and furniture companies, is indeed apparent, due to the fact research on the abovementioned matter still be considered limited. To complement and support the narrow body of knowledge on the under-researched scope, this paper contributes to the prevailing lean implementation literature by revealing the current shortfalls of lean implementation in terms of motives, barriers, challenges, and applications. More specifically, this study is undertaken to clarify the aforementioned questions, which were fundamentally formulated to propagate the research purpose.

To achieve these considerations, this paper is organized as follows: Section 2 provides insight into specified domains through a literature review; Section 3 addresses the research methodology; Section 4 presents the comprehensive results and discussion on the data analysis; and Section 5 outlines conclusions, limitations, and recommendations for future research.

2. Literature review

To address the research purpose, this study reviewed the literature that investigates the lean implementation in terms of motives, barriers, challenges, and applications. This review offers an understanding of the lean issues through the scenarios performed in developing countries (e.g. the Indian scenarios). In this regard, firstly, this section presents a background of lean manufacturing in the context. Following, it provides an inclusive factor that drive Malaysian wood and furniture companies to implement/not implement lean in order to investigate the motives and barriers that keep companies from practicing lean. Next, a comprehensive overview of the challenges to understand the situation faced by wood and furniture companies in the early phases of lean implementation is presented. Finally, the applications of lean implementation as practiced in the wood and furniture industries are described. The outcomes of this appraisal, which are discussed below, are systematically presented in Tables 1 and 2.

2.1. Background of lean manufacturing

Lean is extensively used in interdisciplinary sector and have various definitions among researchers who have diverse perspectives of idea, and different point of views, plans, thoughts, and suggestions (Bhamu and Singh Sangwan, 2014). In general, lean means manufacturing without waste (Vamsi Krishna Jasti and Kodali (2014). Most researchers have highlighted lean as an approach to eliminate waste. On the other hand, Shah and Ward (2003) defined lean as a method to deliver the upmost value to customers by removing waste through process and human design elements. Some definitions focused on minimal buffering costs (Hopp and Spearman, 2004), eliminating waste throughout a product's value stream (Shah and Ward, 2007), and waste identification and elimination in value stream of supply chain (Karim and Arif-Uz-Zaman, 2013).

Lean can also be defined based on benefits or reason of implementation (Melton, 2005). For instance, Hallgren et al. (2009) defined lean as an approach with the main aims of increasing efficiency of operations, identifying both value and waste, developing knowledge, and creating a working culture of continuous improvement to promote sustainability in process operations and business management. Hence, reduction in rework, which inherently uses more materials and energy than necessary will help raise employee awareness of sustainability (Erdil et al., 2018).

Other researchers have defined lean based on philosophy of lean tools. For instance, lean is characterised as a people-oriented production system (Chay et al., 2015). Besides that, lean manufacturing extends the scope of Toyota's production philosophy (Holweg, 2007). Not only that, lean is a multi-dimensional approach consisting of production with minimum amount of waste (JIT), continuous and uninterrupted flow (cellular layout), well-maintained equipment (TPM), well-established quality system (TQM), and well-trained and empowered work force (HRM) that positively impacts operations/competitive performance (Rahani and Al-Ashraf, 2012; Taj and Morosan, 2011).

Nevertheless, Samuel et al. (2015) indicated that many researchers do not agree with any one concrete definition for lean. Their debates have eventually led to the evolvement of lean definition. Even though it lacks in certain areas, this deficiency has provided an opportunity for researchers to explore for a better lean ideology. Therefore, lean can be an approach with the main aims to obtained benefits from the lean tools by eliminating waste, developing knowledge and working culture.

However, the benefits of lean have been publicized for over three decades (Pearce et al., 2018a). Khanchanapong et al. (2014) proposed that lean practices have a positive relationship with the four dimensions of operational performance, i.e. quality, lead time performance, flexibility performance, and cost performance. Nawanir et al. (2013) pointed out that lean is an effective method in enhancing operations performance via improvements in its quality, minimization of inventory, delivery, productivity, and minimization of cost. Marodin et al. (2016) investigate on the different patterns of lean practices implementation and operational performance and found that high lean practices adopters had better performance on the lead time, inventory, and turnover metrics, but not in quality and on-time delivery. Lean manufacturing is also considered as a powerful technique in enhancing business performance via improvements in profitability, sales and customer satisfaction (Nawanir et al., 2013; Yang et al., 2011), social performance (Cherrafi et al., 2016; Henao et al., 2019), green supply chain performance (Cherrafi et al., 2018), and sustainable performance (Huo et al., 2019; Nayha, 2019). Moreover, Jabbour et al. (2013) studied the influence of environmental management on the operational performance of 75 companies in Brazil and verified that lean practices have a positive correlation with environmental management. Caldera et al. (2017) and Dieste et al. (2019) conducted the systematic literature review on how the implementation of lean influenced business organization to improve their environmental performance.

2.2. Motives for adopting lean practices

The growing need for wood-based raw material will have various impacts, both positive and negative as well as social, environmental and economic (Mustalahti, 2018). The main motivation behind lean implementation is the internal desires stemming from the organization's objectives (Bamford et al., 2015). From the comprehensive review on literature, most lean practitioners agreed that the reasons for lean implementation are to increase customer satisfaction (Panwar et al., 2015; Pirraglia et al., 2009), to reduce the amount of time it takes to deliver products to the market (Pirraglia et al., 2009; Tammela et al., 2013), and to improve quality (Bajjou and Chafi, 2018; Panwar et al., 2015; Pirraglia et al., 2009). However, there are contradictions found on some factors. Panwar et al. (2015) who investigated the status of lean manufacturing in Indian processing industries highlighted that decreased cost is a significant factor for lean adoption. However, the survey done by Bajjou and Chafi (2018) on the benefits of LM implementation in the Moroccan industry showed that reduced cost is ranked as the least significant factor. Moreover, there are conflicting results on the factors of increased efficiency and housekeeping capabilities which are listed as the most important reasons for lean adoption by Vilkas et al. (2015), yet Panwar et al. (2015) found that there is no significant reason to increase utilization of space and supply chain efficiency.

2.3. Barriers in lean implementation

Numerous barriers to lean implementation have been discussed in the literature; however, the respondents had been limited to include only employees of companies that are practicing lean. Panwar et al. (2015) highlighted that one item (unfamiliarity with lean) under reasons for not implementing lean was deleted to increase the value of alpha (α) because it is obvious from the answers given that most of the respondents are familiar with lean manufacturing. Abolhassani et al. (2016) and Khaba and Bhar (2018) carried out a study on the perception of lean barriers among lean and non-lean companies. There is a significant difference in the perception of four lean barriers between non-lean and lean companies namely lack of lean understanding, resistance to

Table 1
Contemporary literature on the lean issues – motives, barriers, challenges, and applications.

References	Findings	Imply
Panwar et al. (2015)	The significant motives are to increase customer satisfaction, waste elimination, decrease production cost, to improve quality and increase demand management efficiency. In contrast, to increase space utilization and increase supply chain efficiency were insignificant motives.	Motives
Vilkas et al. (2015)	To enhance efficiency and improve capacities related to problem-solving and housekeeping.	Motives
Bamford et al. (2015)	To assist in the achievement of strategic objectives, to enhance efficiency (internal factor) and to maintain marketplace competitiveness (external factor). Management drive, organizational restructuring, capital investment and piecemeal success are the factors of successful adoption of lean.	Motives
Tammela et al. (2013)	There is a correlation between time-based competition strategies and cultural variables from furniture companies located in different countries.	Motives
Pirraglia et al. (2009)	Wood industry are working towards enhancing the quality of their products, improving customer satisfaction and minimizing lead times (reducing the amount of time it takes to deliver products to the market).	Motives
Bajjou and Chafi (2018)	Better project quality is ranked highest while reducing construction cost is ranked lowest.	Motives
Marodin et al. (2018)	Authors argue that there is a limitation in exploring the potential benefits of LM implementation because it is restricted solely to the factory floor by many companies, rather than on the product development processes	Motives
Panwar et al. (2015)	Significant reason to not opt for implementing lean are large batch production is necessary for capacity utilization and lack of education and expertise on lean. Lack of time and lack of financial resources are not the reasons for not adopting lean. The “unfamiliarity with lean” was deleted because most respondents answered that they were familiar with lean manufacturing.	Barriers
Abolhassani et al. (2016)	Lean companies believed lack of technical knowledge regarding lean methods and employees being resistant to changes are the barriers. Management being resistant to change, lean is gimmick and lean is unsustainable were not factors for failing in implementing lean. Non-lean companies believed lack of technical knowledge and lack of understanding of the benefits are the barriers. Both lean and non-lean companies agree that LM is not a gimmick business philosophy while insufficient knowledge still remains as a prominent issue in lean adoption.	Barriers
Thanki and Thakkar (2014)	Insufficient training on lean, inadequate employee awareness programs on lean, under-utilization of process improvement statistical tools, and ambiguity about suitable lean tools for use are the barriers. Employees unwilling to eliminate or manage the said barriers, even though employees are well-aware of it.	Barriers
Bajjou and Chafi (2018)	Lack of knowledge about lean construction practices, unskilled human resources and insufficient financial resources are the barriers. Approximately half of the respondents believed that culture and human attitudinal issues, lack of government support and resistance to change were the obstacles.	Barriers
Chaple et al. (2018)	The *knowledge* and *management* areas indicated the highest driving power and lowest dependence such as inadequate management time as well as deficiencies in supervisory and senior management skills. The *resource* areas were found to have low driving power (e.g. cost investment, internal and external funding)	Barriers
Coetzee et al. (2018)	Employee barriers examples: lack of well-trained and experienced staff, knowledge about existing specialists, management commitment, coaching, communication, support, employee development and job security, as well as cultural resistance to change and undervalued employees. There is greater focus on lean tools at the expense of the human side of lean management which has prevented an effective lean implementation.	Barriers
Escuder et al. (2018)	The major barriers are the dearth of KPIs, inadequate multi-level management support and absence of a leader in guiding the improvement process. Based on the factor analysis, these barriers were further classified into four groups: *internal* (B4– KPI, B5- commitment and support of top managers, B2- facilitator), *stakeholders* (B6- resistance to change, B11- motivation, B15- limited time), *improvement management* (B9- organizational silos, B7- culture of improvement, B3- training, B12- communication, B16- managerial skills) and *resources* (B8- stakeholders' requirements, B10- hierarchical structure, B13- health-care regulations, B1- resources, B14-unions).	Barriers
Khaba and Bhar (2018)	Cultural difference at workplace are the main barrier for both lean and non-lean mines. There are significant differences in the perception between lean and non-lean mines on lack of lean understanding, resistance to change, financial constraints and shortage of lean consultants and trainers.	Barriers
Ramadas and Satish (2018)	12 critical barriers were identified. Six variables are from *high rejection rate* (inadequate training programs, insufficient regular maintenance, inferior quality materials provided by suppliers, lowly inspection of vendors, deteriorating machines, problematic supervisor-worker communication); two were from *employee absenteeism* (un-maintained employee–employer relationship, workplace boredom); and four were from *frequent breakdown factors* (overworked machines, workplace negligence, non-replacement of impaired machine parts and disregard of warning signals given out by the machines).	Barriers
AlManei et al. (2018)	The major challenge of lean implementation is in thoroughly managing the change journey throughout the implementation plan. The change entails the structure, system, processes and employee behaviour.	Barriers/Challenges
Grove et al. (2010)	6 key challenges were high process variability, a lack of understanding of lean, poor communication and leadership, target focused, problems in defining waste, and difficulty in determining who is the customer and what exactly do they value?	Challenges/Barriers
Sahoo and Yadav (2018)	Authors proposed a cluster analysis to cluster respondents into three groups which are “lean” firms (48 firms), “lean beginners” firms (n = 37) and in-transition lean” firms (n = 36). Lean beginner's firms ranked attitude of workman, inadequate knowledge and lean experts and the lack of budget as the main challenges during the early three years of lean implementation. Poor training, the need of integration with business associates and the lack of clarity across functional groups were ranked last. The challenges towards attitude of workman; inadequate knowledge and lean experts and lack of budgets were consistently ranked the highest after three to five years of lean adoption. In-transition firms also included signs of internal resistance appearing during this period. Both poor training and the need for integration with business associates remains unchanged at the bottom two of the ranking. After five years of lean implementation, lean firms encountered problems on the attitude of workmen, backsliding to old ways of working and internal resistance. Matured lean firms have no problem with the inability to quantify benefits, risk of operation disruption and poor training	Challenges/Barriers

(*continued on next page*)

Table 1 (*continued*)

References	Findings	Imply
Panwar et al. (2015)	The major challenges are to facilitate small batch production, lack of training and to arrange lean implementation experts. Companies do not have problems with skepticism/cultural barriers and short lead times.	Challenges
Al-Aomar and Hussain (2018)	The technical challenges are lack of "know-how" and management support in adopting sustainability practices. The cultural challenges was due to the lack of management understanding and support for sustainability practices, learning curve of workers and employees, culture of workers and guests, difficulty of applying lean technique to service operations and the lack of specialists in applying sustainability practices.	Challenges
Henao et al. (2019)	The major challenges of LM and sustainability integration are failure to properly identify, prove, and address the implications on long-term sustainability.	Challenges
Kurilova-Palisaitiene et al. (2018)	Ten challenges identified were lack of material requirements planning system, poor core information, a lack of core material, poor spare parts information, a lack of spare parts material, insufficient quality management practices, large inventories, stochastic remanufacturing processes, a lack of supply-demand balance, and insufficient automation.	Challenges
Pearce et al. (2018a)	Highlight the main issues in managing staff and their resistance to change. The downfall towards achieving lean success did not lie in management commitment but rather on management knowledge during the implementation phase.	Challenges
Seifullina et al. (2018)	The formation of a lean team requires the involvement of the mining company's employees as well as academics/consultants that represent the experts on lean.	Challenges
Ufua et al. (2018)	Exposed employee-related issues whereby shop floor workers said that no one listened to their ideas despite having good ones by using eye-catching illustrative pictorial diagrams.	Challenges
Rymaszewska (2014)	Introduced 5 approaches to address the challenges which include long-term orientation, learning organization, levelling out workflow, supplier-buyer relations and employee empowerment and standardization of work procedures.	Challenges
Antony et al. (2012)	12 challenges highlighted are problem with terminologies, designed in isolation, lack of awareness of the benefits, lack of commitment and support from senior executive, viewed as something of a temporary fix, absence of process thinking and process ownership, inadequate visionary leadership, culture, lack of understanding customer needs, lack of communication, lack of resources (time, budget), lack of skills, knowledge expertise, and flavour-of-the-month.	Challenges
Sassanelli et al. (2015)	Four challenges identified were to define what is waste, what is value, what are the constraints and how to support design process in a lean-oriented way.	Challenges
Spagnol et al. (2013)	The challenges were to overcome these barriers; (1) *the first impression: initial approach, where* organization can show quick visible results by eliminating the false idea that lean management results in staff reduction, (2) *implementation process*, (meeting schedule) and (3) *lean thinking maintenance*.	Challenges
Yu et al. (2017)	Furniture companies are lacking IT talents or sufficient capital for the development of information system	Challenges
Kurilova-Palisaitiene et al. (2018)	Seven suggestions to tackle challenges for lean improvement tools and lean measurements are implementing standard operations, instructions or/and check-lists, implementing continuous flow, emploting the Kanban ordering system, improving teamwork, organizing employee cross-training and learning through problem solving, designing factory layout for continuous flow and developing supplier partnership.	Challenges
Thanki and Thakkar (2018)	Three factors of successful deployment of lean-green initiatives were government support, top management commitment and sufficient allocation of funds while employee motivation and reward system was ranked last.	Success factors
Panwar et al. (2015)	The higher lean tools implemented were 5S, visual control, work standardization, and quality management program. VSM, takt time, pull production and Kanban were not used or seldom used.	Applications
Vilkas et al. (2015)	The most frequently used lean practices are: employee training on lean principles and practices, integration of quality control into work processes, work standardization, Gemba and 5S.	Applications
Mayr et al. (2018)	Industry 4.0 and lean can coexist and complement each other. Lean tools used to support Industry 4.0 are JIT, heijunka (levelling the workload), Kanban, VSM, TPM, SMED, poka yoke and visual management-5S/zoning/andon.	Applications
Coetzee et al. (2018)	The focus on lean tools at the expense of the human side of lean management have prevented effective lean implementation from taking place.	Applications
Sahoo and Yadav (2018)	"Lean beginners" ranked TPM, 5S (workplace organization) and visual control as the most used lean tools within the first 3 years. On the other hand, Jidoka (automation), heijunka (levelling the workload), Poka Yoke (mistake proofing) and VSM were not commonly used. In the following two years, "In-transition lean" firms ranked 5S, TPM and Kaizen (continuous improvement) as the most adopted lean tools. Heijunka, continuous flow and quality function deployment was not commonly adopted. "Lean" firms that have implemented lean for more than 5 years rank 5S practice as their top priorities. It was then followed by TPM, SMED (setup time reduction) and Kaizen. Heijunka, Kanban (pull system), continuous flow and standardized work/process were not commonly implemented.	Applications
Kurilova-Palisaitiene et al. (2018)	Standard operations, continuous flow, Kanban, teamwork, employee cross-training, layout for continuous flow, and supplier partnership were suggested for optimizing lead time	Applications
Khaba and Bhar (2018)	The most implemented lean tools were 5S, TPM, VSM, work standardization and KPIs.	Applications

change, financial constraints and shortage of lean consultants and trainers (Khaba and Bhar, 2018). However, the study reveals that the main barrier in both non-lean and lean companies is cultural difference in the workplace. Furthermore, lack of technical knowledge about lean methods and lack of understanding about its benefits are also obstacles in the implementation of lean for both non-lean and lean companies (Abolhassani et al., 2016). Based on opinions from experts, there is still a lack of awareness and LM implementation in the Malaysian wood and furniture industry due to the fact that LM had just started in 2014 as initiated by MTIB (MTIB, 2017). Therefore, there is a need to study the barriers to lean implementation among lean and non-lean companies.

2.4. Challenges while implementing lean

The challenge in lean implementation is in guiding the change journey (AlManei et al., 2018) and overcoming the barriers (Spagnol et al., 2013). Hence, this study reviewed the prevailing challenges of

Table 2
The summary of published studies on the lean issues.

Issues	Items/applications	Sources/References
1. Motives for adopting lean practices	**To increase customer satisfaction**	Panwar et al. (2015)
	Satisfaction of customers	Vilkas et al. (2015)
	Improving customer satisfaction	Pirraglia et al. (2009)
	To eliminate wastes	Vilkas et al. (2015)
	Eliminations of wastes	Panwar et al. (2015)
	To reduce production costs	Panwar et al. (2015)
	Profit	Vilkas et al. (2015)
	Reducing the planning and design cost	Bamford et al. (2015)
	Cost reduction	Pirraglia et al. (2009), Freitas et al. (2017)
	Lower costs and faster turnover	Bajjou and Chafi (2018)
	To improve quality	Panwar et al. (2015)
	Improvement of organization	Vilkas et al. (2015)
	Product development and time to market	Pirraglia et al. (2009)
	Improving service quality	Pirraglia et al. (2009)
	Quality of products/services	Vilkas et al. (2015)
	Improving the quality	Bajjou and Chafi (2018)
	Product development processes	Marodin et al. (2018)
	New product development	Lermen et al. (2018)
	To increase efficiency	Abolhassani et al. (2016)
	To increase supply chain efficiency	Panwar et al. (2015)
	To increase management efficiency	Panwar et al. (2015)
	Efficiency	Vilkas et al. (2015)
	To improve efficiency	Bamford et al. (2015)
	To solve problem	Vilkas et al. (2015)
	Identification and prevention of problems	Vilkas et al. (2015)
	To cleaned up and organized workplace	Piercy and Rich (2015)
	Housekeeping level	Vilkas et al. (2015)
	To increase utilization of space	Panwar et al. (2015)
	To improve communication of information (to reduce miscommunication)	Bamford et al. (2015)
	Restructuring the information flow	Bamford et al. (2015)
	Process management/understanding of processes of organization	Vilkas et al. (2015)
	To facilitate just in time (JIT) production	Panwar et al. (2015)
	Reducing lead times/cycle times	Pirraglia et al. (2009)
	To reduce the time (total cycle time)	Tammela et al. (2013)
	Improving the process cycle time	Bamford et al. (2015)
	Reducing the total project duration	Bajjou and Chafi (2018)
2. Barriers in lean implementation	**Middle management resistance to change**	Pirraglia et al. (2009)
	Lack of senior management's interest and support	Panwar et al. (2015)
	Lack of management commitment	Abolhassani et al. (2016), Coetzee et al. (2018)
	Management resistance to change	Abolhassani et al. (2016)
	Management drive	Bamford et al. (2015)
	Lack of commitment from top management;	Bajjou and Chafi (2018)
	Commitment and support from top managers	Escuder et al. (2018)
	Lack of top management commitment and support	Khaba and Bhar (2018)
	Support	Coetzee et al. (2018)
	Lack of senior management commitment	Sahoo and Yadav (2018)
	Employee resistance to change	Abolhassani et al. (2016), Bajjou and Chafi (2018), Escuder et al. (2018), Khaba and Bhar (2018)
	Employee resistance	Pirraglia et al. (2009)
	Commitment of employees to seek objectives of organization	Vilkas et al. (2015)
	Employees' reluctant to eliminate the barriers	Thanki and Thakkar (2014)
	Unwillingness to learn and see	Chaple et al. (2018)
	Employee attitude/resistance to change	Chaple et al. (2018)
	Non-lean behaviour	Chaple et al. (2018)
	Human aspects	Chaple et al. (2018)
	Lack of empowerment of employees	Chaple et al. (2018)
	Employees that do not feel valued	Coetzee et al. (2018)
	Shop floor workers complaining about not being listened to	Ufua et al. (2018)
	Attitude of workmen	Sahoo and Yadav (2018)
	Lack of implementation on know-how (insufficient practical knowledge to implement lean)	Pirraglia et al. (2009), Chaple et al. (2018)
	Lack of technical knowledge	Abolhassani et al. (2016)
	Lack of technical capabilities of organization	Khaba and Bhar (2018)
	Competence of employees	Vilkas et al. (2015)
	Knowledge on implementation lean techniques	Bamford et al. (2015)

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Table 2 (*continued*)

Issues	Items/applications	Sources/References
	Insufficient supervisory skills to implement lean	Chaple et al. (2018)
	Insufficient senior management skills to implement lean	Chaple et al. (2018)
	Insufficient workforce skills to implement lean	Chaple et al. (2018)
	Lack of well-trained and experienced staff	Coetzee et al. (2018)
	Poor managerial skills	Escuder et al. (2018)
	Lack of knowledge or skill of employees	Ramadas and Satish (2018)
	Lack of awareness about the process/machine	Ramadas and Satish (2018)
	Lack of expertise on lean	Panwar et al. (2015)
	Knowledge about existing specialists	Coetzee et al. (2018)
	Lack of understanding about lean	Chaple et al. (2018), Khaba and Bhar (2018)
	Lack of methodology	Chaple et al. (2018)
	Coaching	Coetzee et al. (2018)
	Leader to guide the process	Escuder et al. (2018)
	Shortage of lean consultants and trainers	Khaba and Bhar (2018)
	Inadequate knowledge and lean expertise	Sahoo and Yadav (2018)
	Lean is difficult to implement	
	Lean is complex to implement	Panwar et al. (2015)
	Not easy to implement	Pirraglia et al. (2009)
	Lack of understanding benefits (not being able to understand profit gained from lean)	Abolhassani et al. (2016)
	Insufficient understanding of the potential benefits	Chaple et al. (2018)
	Financial benefits not recognized	Chaple et al. (2018)
	No direct financial advantage	Chaple et al. (2018)
	Inability to quantify benefits	Sahoo and Yadav (2018)
	Lack of time	Pirraglia et al. (2009), Panwar et al. (2015), Chaple et al. (2018)
	Time and commercial pressure	Bajjou and Chafi (2018)
	Insufficient management time	Chaple et al. (2018)
	Insufficient time allocated for improvement program	Escuder et al. (2018)
	Lack of capital fund	Pirraglia et al. (2009)
	Lack of financial resources	Panwar et al. (2015)
	High cost of investment	Abolhassani et al. (2016)
	Capital investment	Bamford et al. (2015)
	Insufficient financial resources	Bajjou and Chafi (2018)
	Insufficient internal funding	Chaple et al. (2018)
	Insufficient investment cost	Chaple et al. (2018)
	Insufficient external funding	Chaple et al. (2018)
	High cost of advanced technology	Chaple et al. (2018)
	Lack of resources	Escuder et al. (2018)
	Financial constraint	Khaba and Bhar (2018)
	Lack of resources	Sahoo and Yadav (2018)
	Lack of budget,	Sahoo and Yadav (2018)
	Lack of labor resources (insufficient time due to being too busy with their 'day jobs')	Pirraglia et al. (2009), Chaple et al. (2018)
	Perception of additional work load	Thanki and Thakkar (2014)
	Unskilled human resources	Bajjou and Chafi (2018)
	Change in employee behaviour	AlManei et al. (2018)
	Fear of committing mistakes and losing the job	Thanki and Thakkar (2014)
	Employee development and job security	Coetzee et al. (2018)
	Lean is gimmick (implementation of lean has no value)	Abolhassani et al. (2016)
	Lean is viewed as "flavor of the month"	Pirraglia et al. (2009), Chaple et al. (2018)
	Perception (belief that already have continuous production)	Panwar et al. (2015)
	Lean is unsustainable	Abolhassani et al. (2016)
	Lean does not fit culture (lean unsuitable with employee attitudes in performing their jobs)	Abolhassani et al. (2016)
	Culture and human attitudinal issues	Bajjou and Chafi (2018)
	Cultural barriers (resistance to change)	Panwar et al. (2015)
	Cultural reluctance	Bamford et al. (2015)
	Cultural issues	Chaple et al. (2018)
	Social factor	Chaple et al. (2018)
	Cultural resistance to change	Coetzee et al. (2018)
	Lack of an improvement culture	Escuder et al. (2018)
	Cultural difference in work place,	Khaba and Bhar (2018)
	Organizational culture	Sahoo and Yadav (2018)
	Internal resistance	Sahoo and Yadav (2018)
3. Challenges while implementing lean	**Lack of employee commitment**	Abolhassani et al. (2016)
	Attitude of workmen	Sahoo and Yadav (2018)
	Change in employee behaviour	AlManei et al. (2018)
	Staff resistance to change	Pearce et al. (2018a)
	Employee relations	Rymaszewska (2014)

Table 2 (*continued*)

Issues	Items/applications	Sources/References
	Lack of senior management's interest and support	Antony et al. (2012)
	Lack of lean awareness programs for employees	Thanki and Thakkar (2014)
	Lack of management commitment	Abolhassani et al. (2016)
	Lack of senior management commitment	Sahoo and Yadav (2018)
	Lack of management support	Al-Aomar and Hussain (2018)
	Lack of management understanding	Al-Aomar and Hussain (2018)
	Management commitment	Pearce et al. (2018a)
	Philosophy	Rymaszewska (2014)
	Poor communication and leadership	Grove et al. (2010)
	Lack of technical knowledge	Abolhassani et al. (2016)
	To arrange lean implementation experts	Panwar et al. (2015)
	Uncertainty regarding the appropriate tools	Thanki and Thakkar (2014)
	Inadequate knowledge and lean expertise,	Sahoo and Yadav (2018)
	Lack of "know-how"	Al-Aomar and Hussain (2018), Rymaszewska (2014)
	Lack of specialists in applying sustainability practices	Al-Aomar and Hussain (2018)
	Lack of skills, knowledge and expertise	Antony et al. (2012)
	Lack of understanding of lean	Grove et al. (2010)
	Lack of training	Panwar et al. (2015)
	Inadequate lean training	Thanki and Thakkar (2014)
	Poor training	Sahoo and Yadav (2018)
	Organizational learning	Rymaszewska (2014)
	Not easy to implement	Pirraglia et al. (2009)
	Supplier unreliability	Bamford et al. (2015)
	Improper information exchange across supply chain	Bamford et al. (2015)
	Difficulty of applying lean technique	Al-Aomar and Hussain (2018)
	High process variability	Grove et al. (2010)
	Lack of tangible benefits (e.g. Reduced cost, reduced inventory, improve quality, improve productivity, better floor-space utilization)	Abolhassani et al. (2016)
	Inability to quantify benefits	Sahoo and Yadav (2018)
	Lack of awareness of the benefits	Antony et al. (2012)
	Show quick visible results	Spagnol et al. (2013)
	Lack of time	Pirraglia et al. (2009), Panwar et al. (2015)
	Operational unreliability	Bamford et al. (2015)
	Short lead time	Panwar et al. (2015)
	Lack of resources (time, budget etc)	Antony et al. (2012)
	Implies time investment	Spagnol et al. (2013)
	Lack of financial resources	Panwar et al. (2015)
	High cost of investment	Abolhassani et al. (2016)
	Lack of budget	Sahoo and Yadav (2018)
	Financing	Rymaszewska (2014)
	Lack of resources (time, budget, etc)	Antony et al. (2012)
	Lack of enough capital	Yu et al. (2017)
	Lack of labor resources (lack of availability of time because too busy with the 'day job')	Pirraglia et al. (2009)
	Operational unreliability	Bamford et al. (2015)
	Lack of resources	Sahoo and Yadav (2018)
	Lack of talents employee	Yu et al. (2017)
	Lean is viewed as "current trend"	Antony et al. (2012)
	Cultural reluctance	Bamford et al. (2015)
	Skepticism/cultural barriers	Panwar et al. (2015)
	Lean is gimmick	Abolhassani et al. (2016)
	Backsliding to old ways of work (return to the old inefficient ways of working)	Pirraglia et al. (2009), Khaba and Bhar (2018), Sahoo and Yadav (2018)
	Backsliding/lack of perseverance	Chaple et al. (2018)
	Previous failures of lean	Abolhassani et al. (2016)
	Past experience	Chaple et al. (2018)
4. Application of lean implementation	**5S -** Five (5S) Method (Workplace organization)/5S (sort, straighten, sweep, standardize, and self-discipline)/5S S' (sort, set in order, shine, standardize and sustain)	Abdulmalek and Rajgopal (2007); Abolhassani et al. (2016); Ayeni et al. (2016); Bhamu and Singh Sangwan (2014); Browning and Heath (2009); Hadid et al. (2016); Jabbour et al. (2013); Jasti and Kodali (2014); Karim and Arif-Uz-Zaman (2013); Kumar Br et al. (2015); Maalouf and Gammelgaard (2016); Melton (2005); Panwar et al. (2015); Piercy and Rich (2015); S. Sharma and Shah (2016); Tayyab and Sarkar (2016); Thanki and Thakkar (2014); Vilkas et al. (2015); Wong and Wong (2014), Sahoo and Yadav (2018)
	Five S (Seiri, Seiton, Seiso, Seiketsu and Shitsuke)	Boscari et al. (2016),
	Workplace organization (5'S)	Pirraglia et al. (2009)
	Workplace management	Boscari et al. (2016)

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Issues	Items/applications	Sources/References
	Process mapping	Chaurasia et al. (2016); Pirraglia et al. (2009); Rybicka et al. (2015)
	Process flow mapping	Kumar Br et al. (2015); Melton (2005),
	Waste identification and elimination	Pirraglia et al. (2009),
	Waste reduction	Anholon and Sano (2016); Piercy and Rich (2015),
	Waste, inventory and variability reduction	Browning and Heath (2009),
	Visual management	Chaurasia et al. (2016); de Kogel and Becker (2016); Hosseini Nasab et al. (2012); Maalouf and Gammelgaard (2016); Marodin et al. (2016); Pirraglia et al. (2009),
	Visual factory	Jasti and Kodali (2014),
	Visual tools (tool shadow boards, color coding and tags)	Boscari et al. (2016),
	Visual workplace	Chaurasia et al. (2016); Piercy and Rich (2015)
	Visualization	Hadid et al. (2016),
	Total quality and visual management [Practice bundle]	Birkie (2016),
	Kaizen/Continuous improvement	Ball (2015), Secchi and Camuffo (2016), Browning and Heath (2009), de Kogel and Becker (2016), Sahoo and Yadav (2018)
	Continuous Improvement Programme/Continuous Improvement Process (CIP)	Anholon and Sano (2016); Ball (2015); Bamford et al. (2015); Bhamu and Singh Sangwan (2014); Hadid et al. (2016); Jabbour et al. (2013); Panwar et al. (2015); Schnellbach and Reinhart (2015); Shah and Ward (2003, 2007); Welo et al. (2013),
	Continuous improvement	Ball (2015); Browning and Heath (2009); de Kogel and Becker (2016); Secchi and Camuffo (2016),
	Continuous process improvement	Shokri et al. (2016),
	Continuous improvements and workforce involvement	Ciccullo et al. (2018)
	Improvement circles/kaizen circles	Jabbour et al. (2013),
	Kaizen blitz	Hadid et al. (2016),
	Kaizen	Bhamu and Singh Sangwan (2014); Chaurasia et al. (2016); de Kogel and Becker (2016); Jasti and Kodali (2014); Kumar Br et al. (2015); Melton (2005); Mund et al. (2015); Pakdil and Leonard (2015); Pirraglia et al. (2009); P. Sharma and Kulkarni (2016); S. Sharma and Shah (2016); Vilkas et al. (2015),
	Just in Time (JIT)/Continuous flow production	Abdulmalek and Rajgopal (2007); Ayeni et al. (2016); Ball (2015); Bhamu and Singh Sangwan (2014); Chaurasia et al. (2016); de Kogel and Becker (2016); Gelei et al. (2015); Hadid et al. (2016); Jabbour et al. (2013); Jasti and Kodali (2014); Khanchanapong et al. (2014); Kumar Br et al. (2015); Longoni and Cagliano (2015); Pakdil and Leonard (2015); Prajogo et al. (2016); Rahani and Al-Ashraf (2012); Sagnak and Kazancoglu (2016); Schnellbach and Reinhart (2015); Shah and Ward (2003, 2007); Thanki and Thakkar (2014); Wickramasinghe and Wickramasinghe (2016)
	JIT delivery by supplier	Nawanir et al. (2013); Shah and Ward (2007),
	JIT links with customers	Shah and Ward (2007),
	Just-in-time (JIT) manufacturing and delivery	Browning and Heath (2009),
	Just-in-Time Flow (JITF)	Yang et al. (2011),
	Just-in-Time/Flow (JIT) [Practice bundle]	Birkie (2016); Shah and Ward (2003).
	Continuous flow	Abolhassani et al. (2016); Boscari et al. (2016); Browning and Heath (2009); Ghirann (2012); Jasti and Kodali (2014); Pakdil and Leonard (2015); Shah and Ward (2007),
	Work standardization	Pirraglia et al. (2009); Vilkas et al. (2015),
	Standardized work/Work standardization/Standard work/Standardization of work	Bhamu and Singh Sangwan (2014); Boscari et al. (2016); Browning and Heath (2009); de Kogel and Becker (2016); Hosseini Nasab et al. (2012); Jasti and Kodali (2014); Marodin et al. (2016); Panwar et al. (2015); Piercy and Rich (2015); S. Sharma and Shah (2016),
	Operating standard	Maalouf and Gammelgaard (2016),
	Standard Operation Procedure (SOPs)	Thanki and Thakkar (2014),
	Standardization	Chaurasia et al. (2016); Hadid et al. (2016); Welo et al. (2013),
	Work standardization	Pirraglia et al. (2009); Vilkas et al. (2015),
	Value Stream Mapping (VSM)/Value stream map	Belayutham et al. (2016); Bhamu and Singh Sangwan (2014); Bhat et al. (2016); Boscari et al. (2016); Browning and Heath (2009); Chaurasia et al. (2016); de Kogel and Becker (2016); Hadid et al. (2016); Jasti and Kodali (2014); Lindskog et al. (2016); Maalouf and Gammelgaard (2016); Matt (2014); Mund et al. (2015); Pakdil and Leonard (2015); Panwar et al. (2015); Pirraglia et al. (2009); Secchi and Camuffo (2016); S. Sharma and Shah (2016); Thanki and Thakkar (2014); Wong and Wong (2014), Helleno et al. (2017) Stadnicka and Litwin (2019) Verma and Sharma (2016)
	Environmental Value Stream Mapping (E-VSM)	Garza-Reyes et al. (2018)
	One piece flow	Chaurasia et al. (2016); de Kogel and Becker (2016),
	One piece flow/Continuous flow	Marodin et al. (2016),
	Total Productive Maintenance (TPM)	Abdulmalek and Rajgopal (2007); Bhamu and Singh Sangwan (2014); Chaurasia et al. (2016); de Kogel and Becker (2016); Gelei

Table 2 (*continued*)

Issues	Items/applications	Sources/References
		et al. (2015); Hosseini Nasab et al. (2012); Jabbour et al. (2013); Jasti and Kodali (2014); Karim and Arif-Uz-Zaman (2013); Kumar Br et al. (2015); Longoni and Cagliano (2015); Marodin and Saurin (2015); Nawanir et al. (2013); Pakdil and Leonard (2015); Panwar et al. (2015); Piercy and Rich (2015); Rahani and Al-Ashraf (2012); Sagnak and Kazancoglu (2016); Thanki and Thakkar (2014); Yang et al. (2011)
	Preventive maintenance	Abolhassani et al. (2016); Nawanir et al. (2013); Shah and Ward (2003, 2007),
	Total preventive maintenance	Browning and Heath (2009); Hadid et al. (2016); Pirraglia et al. (2009),
	Total Preventive Maintenance (TPM)	Chaurasia et al. (2016),
	Total Productive Maintenance (TPM) [Practice bundle]	Birkie (2016); Shah and Ward (2003),
	Overall Equipment Effectiveness (OEE)	Pirraglia et al. (2009).
	Error proofing (Poka yoke)	Anholon and Sano (2016); Pirraglia et al. (2009)
	Mistake-proofing	Browning and Heath (2009); Hadid et al. (2016); Panwar et al. (2015), Baysan et al. (2019)
	Poka Yoke (mistake proofing)	Sahoo and Yadav (2018)
	Poka Yoke	Abolhassani et al. (2016); Bhamu and Singh Sangwan (2014); Bhat et al. (2016); Chaurasia et al. (2016); de Kogel and Becker (2016); Kumar Br et al. (2015); Melton (2005); S. Sharma and Shah (2016); Tayyab and Sarkar (2016),
	Jidoka/Poka-yoke	Marodin et al. (2016),
	Jidoka	de Kogel and Becker (2016), Sartal et al. (2018)
	Jidoka/Automation	Pirraglia et al. (2009); Schnellbach and Reinhart (2015), Sahoo and Yadav (2018)
	Automation	Bhamu and Singh Sangwan (2014); Hadid et al. (2016); Karim and Arif-Uz-Zaman (2013); Kumar Br et al. (2015); S. Sharma and Shah (2016),
	Takt time	Aguado et al. (2013); Ali and Deif (2014); Ayeni et al. (2016); de Kogel and Becker (2016); Hadid et al. (2016); Jasti and Kodali (2014); Kumar Br et al. (2015); Panwar et al. (2015); Pirraglia et al. (2009),
	Pacing by takt time/the rate of customer demand	Browning and Heath (2009),
	Employee training	Vilkas et al. (2015),
	Training	Bhat et al. (2016); Boscari et al. (2016); Chaplin et al. (2016); Hadid et al. (2016); S. Sharma and Shah (2016); Shokri et al. (2016); Wong and Wong (2014); Yang et al. (2011); Yasukawa et al. (2014)
	Training and cross functional teams	Shah and Ward (2007).
	Cross functional training	S. Sharma and Shah (2016),
	Human resource training and involvement	Browning and Heath (2009).
	Operator training	Piercy and Rich (2015),
	Quality control	Piercy and Rich (2015); Prajogo et al. (2016)
	Integration of quality control into work processes	Vilkas et al. (2015),
	Process and product quality control	Nawanir et al. (2013),
	Zero defects quality control	Hosseini Nasab et al. (2012)
	Quality at the source	Nawanir et al. (2013),
	Quality circles	Nawanir et al. (2013); Yang et al. (2011),
	Quality Function Deployment (QFM)	Bamford et al. (2015); Hadid et al. (2016); Pirraglia et al. (2009),
	Quality improvement and control	Yang et al. (2011),
	Quality improvement and quality at the source	Browning and Heath (2009),
	Quality logistic partner	de Kogel and Becker (2016),
	Quality Management (QM)/Quality management programme	Panwar et al. (2015); Shah and Ward (2003, 2007); Yang et al. (2011),
	Seven quality tools	Chaurasia et al. (2016),
	Supplier (quality) level	Shah and Ward (2007),
	Total quality and visual management [Practice bundle]	Birkie (2016),
	Total Quality Control (TQC)	Piercy and Rich (2015); Prajogo et al. (2016),
	Total Quality Management (TQM)	Abdulmalek and Rajgopal (2007); Bhamu and Singh Sangwan (2014); Browning and Heath (2009); Chaurasia et al. (2016); Gelei et al. (2015); Jasti and Kodali (2014); Karim and Arif-Uz-Zaman (2013); Khanchanapong et al. (2014); Longoni and Cagliano (2015); Piercy and Rich (2015); Sagnak and Kazancoglu (2016); Shah and Ward (2003); S. Sharma and Shah (2016); Shokri et al. (2016); Wickramasinghe and Wickramasinghe (2016); Yang et al. (2011); Zu et al. (2008),
	Total Quality Management (TQM) [Practice bundle]	Shah and Ward (2003),
	Kanban	Abdulmalek and Rajgopal (2007); Abolhassani et al. (2016); Anholon and Sano (2016); Ayeni et al. (2016); Ball (2015); Bamford et al. (2015); Bhat et al. (2016); Boscari et al. (2016); Chaurasia et al. (2016); Hadid et al. (2016); Jabbour et al. (2013); Jasti and Kodali

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Issues	Items/applications	Sources/References
		(2014); Melton (2005); Panwar et al. (2015); Shah and Ward (2003); Tayyab and Sarkar (2016); Thanki and Thakkar (2014); Wiengarten et al. (2015); Yang et al. (2011)
	e-Kanban	Powell (2013),
	In-process kanban	Kumar Br et al. (2015),
	Kanban cards	de Kogel and Becker (2016),
	Kanban production control	Bhamu and Singh Sangwan (2014); Browning and Heath (2009),
	Kanban/Pull production	Shah and Ward (2007),
	Pull systems/Kanban	Nawanir et al. (2013), Sahoo and Yadav (2018)
	Pull production/Pull-based production	Abolhassani et al. (2016); Anholon and Sano (2016); Bhamu and Singh Sangwan (2014); Browning and Heath (2009); Hosseini Nasab et al. (2012); Jasti and Kodali (2014); Marodin and Saurin (2015); Panwar et al. (2015); Yang et al. (2011),
	Pull system/support	Aguado et al. (2013); Bhamu and Singh Sangwan (2014); Boscari et al. (2016); de Kogel and Becker (2016); Hadid et al. (2016:Kumar Br et al., 2015 #140); Jasti and Kodali (2014); Pakdil and Leonard (2015); Pirraglia et al. (2009); Shah and Ward (2003, 2007); S. Sharma and Shah (2016)

Note: Bolded items indicate the validated items.

lean implementation, so that the key observations and insights could be summarized to guide Malaysian wood and furniture companies towards lean transformation. AlManei et al. (2018) proposed a new lean framework which was established from the drivers and barriers to lean implementation. Shortcomings need to be identified earlier so that furniture companies can take cognizance of their abilities, be better equipped for the implementation of lean and be unswervingly consistent process-wise (Rymaszewska, 2014). Furthermore, lean deployment requires changes in structure, system, process and employee behaviour in accordance to the transformation plan (AlManei et al., 2018).

It was found that the most important success factors to have successfully implemented lean manufacturing are employee involvement and culture change (Alhuraish et al., 2017). Top management commitment is one of the most important drivers for the implementation of lean manufacturing (Gandhi et al., 2018). Pearce et al. (2018a) conducted case studies on two first-time implementations of lean in SMEs. The authors highlighted that the key issues were handling staff and their resistance to change. Moreover, the problem towards achieving lean success was not related to management commitment but rather on management knowledge especially during the implementation phase. Sahoo and Yadav (2018) examined LM implementation practices and identified several major lean implementation challenges encountered by the lean beginners group, in-transition lean group, and lean group.

2.5. Applications of lean implementation

There are almost 100 tools for lean practices and with time, there are going to be more and extensive collections of lean practices as suggested by various researchers (Antony et al., 2016). The selection of lean practices should be made wisely to guarantee a successful implementation (Anholon and Sano, 2016). Chay et al. (2015) identified failure to engage with shop floor employee, poor supervision skills (lead workers) and lack of knowledge (Abolhassani et al., 2016) as the obstacles in lean transformation. Karim and Arif-Uz-Zaman (2013) suggested that three objectives should be taken into account before considering and selecting the right lean tools which are: to avoid waste, to reduce additional costs and to prevent additional production time. According to Bamford et al. (2015), the selection of lean practices should be made based on the nature of the process or works. It is important that a manufacturer has enough knowledge on lean practices, so that they understand the workings of lean implementation. Farias et al. (2019) has developed lean assessment framework that linking lean practices to operational and environmental performance. Furthermore, organizations can choose which tool can be effectively accessed by their staff, which depends on the company's production and operations background (Antony et al., 2016).

3. Methods

This research has been oriented to be an applied research, investigating the lean issues status quo of those companies that are operating in a variety of wood and furniture products through directly reaching out to them. It begins with the leading-edge literature study consisting of a review of keywords/issues – 'motives' for adopting the lean practices, 'barriers' in lean implementation, 'challenges' while implementing lean, and 'applications' of lean implementation. To move towards exploring these lean issues more fully, an analytic approach was accordingly carried out using a survey, which is from the exploratory objective point of view – descriptive and analytic, and single cross-sectional – on 148 Malaysian wood and furniture companies in pursuit of the investigations of Prasad et al. (2016), Panwar et al. (2015), Thanki and Thakkar (2014), and Shah and Ward (2007). Fig. 1 outlines the steps adhered to this approach, as explained in more detail below.

3.1. Identifying the data collection method

There are a variety of methods to collect data in the survey research; questionnaires are considered to be the main method as widely employed in the available literature (e.g. Prasad et al., 2016; Thanki and Thakkar, 2014; Shah and Ward, 2007). It may be due to: they can be completed at the respondent's convenience and prepared to give an authoritative impression; they can ensure anonymity and reduce interviewer bias; and there are no time constraints therein. To this end, Prasad et al. (2016) used survey questionnaire method to collect data for a pilot survey of 27 foundry industry in India, which covers different regions and a variety of products. Thanki and Thakkar (2014) carried out a questionnaire-based survey to address the current level of lean implementation, the status of awareness of lean practices, and the barriers to lean implementation. Shah and Ward (2007) followed up with a questionnaire-based survey during a pilot study to conduct exploratory data analysis. These investigations have successfully demonstrated the adaptation of aforementioned method to further their research purposes. Therefore, this study has taken into account survey questionnaire method to collect data in the under-researched scope.

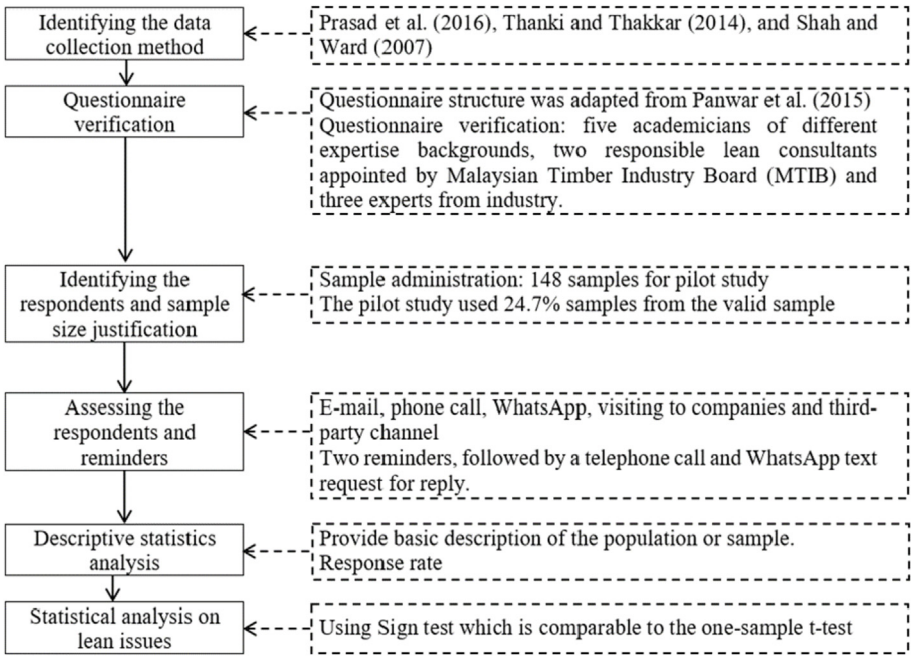

Fig. 1. Research analytic framework.

3.2. Questionnaire verification

The structure of the questionnaire survey is consisted of three sections; general information of company, awareness about lean manufacturing, and lean implementation issues. The questionnaire was redesigned and verified to reach out directly to companies that were operating in Malaysian furniture industry and wood-based products. The questionnaire was divided to those companies that are implementing (lean companies) and not implementing the lean practices (non-lean companies) according to Panwar et al. (2015), who selected both types of respondents from lean and non-lean companies.

The questionnaire was performed through the revision based on the viewpoints of five academicians from different expertise background regarding lean manufacturing, wood and furniture technology and expert from Centre of Statistical and Decision Science Studies, Universiti Teknologi MARA, Malaysia. In addition, the questionnaire was validated by two responsible lean consultants appointed by Malaysian Timber Industry Board (MTIB) for the lean program and three experts from industry. Both survey and interview validation rubric were used by the expert panel to examine the questionnaire.

Moreover, an interview conducted with Chief of Operating Officer (COO) from Kuala Lumpur and Selangor Furniture Industry Association (KLSFIA) and two consultant companies that was appointed by MTIB for the lean program verifies that the lean manufacturing is a new manufacturing paradigm for the furniture industries. Mostly, they are Small Medium Enterprise (SMEs) company and there are not many of them has implemented lean practices.

3.3. Identifying the respondents and sample size justification

Out of the 1362 companies from the Malaysian Timber Industry Board (MTIB), Malaysian Furniture Promotion Council (MFPC) and Malaysian Furniture Council (MFC) databases, 125 samples were screened and eliminated due to duplicate records in different sources, duplicate records in joining the different lean initiative programs and duplicate records from product categories arrangement. The directories of the 1237 remaining companies were taken and 148 companies located in Kuala Lumpur and Selangor were selected for the pilot study. Due to the low number of sample size, additional face-to-face interviews and third-party channels on unregistered companies were included to increase the number of respondents, which is in accord with the recommendation by Panwar et al. (2015).

In this regard, Shah and Ward (2007) used 28.7% samples from the total of 2616 companies for the exploratory phase. Prasad et al. (2016) employed only 27 companies (7.3% samples) for the pilot study from a total of 368 companies to investigate the applicability of lean practices in the foundry industry in India. Moreover, Thanki and Thakkar (2014) confirmed that it is adequate to use 53 responses to conduct a pilot study as suggested by Shah and Ward (2007). Similar results from a pilot study survey conducted by Abolhassani et al. (2016) indicated that only 34 lean companies and 8 non-lean companies had responded to their survey. The current study uses 24.7% valid samples (148 companies), which is acceptable in comparison to the other investigations (Table 3).

3.4. Assessing the respondents and reminders

Kuala Lumpur (KL) and Selangor are the hub of wood and furniture production for Malaysia. In these states, there is a furniture association called Kuala Lumpur and Selangor Furniture Industry Association (KLSFIA); which represent the furniture producers to liaise with the government to explore more opportunities and potential development for Malaysia's furniture industry, including importing and exporting. Ironically, KLSFIA is an establishment of a constructive association for KL and Selangor furniture businesses with the largest registered companies in Malaysia (refer to Table 4). Therefore, KL and Selangor are appropriately considered to be selected for the exploratory phase due to the location and association connection that can help to constitute more understanding on lean issues among furniture companies.

In accordance with the literature, a letter introducing the research together with the questionnaire's web access was sent by

Table 3
Comparison of sample records for the pilot study taken from the literature.

References	Pilot study	Large scale study	Exploratory sample (%)	Response rate (%)
Shah and Ward (2007)	750	2616	28.7	63 responses (9%)
Prasad et al. (2016)	27	368	7.3	27 responses
Thanki and Thakkar (2014)	59	–	–	59 responses
Abolhassani et al. (2016)	327	–	–	51 responses (15%) 34 lean and 8 non-lean companies
Current Study	148	599	24.7	21 responses (14%) 16 non-lean and 5 lean companies

Table 4
Refining wood and furniture companies.

Source	Population	Without contact	Valid sample	Pilot study
1- Malaysian Timber Industry Board (MTIB)				
Lean Manufacturing and Good Manufacturing Practices" (5S) programs	104	0	104	23
Certified Timber and Credible Suppliers (CTCS) Global Sdn. Bhd.	26	0	26	0
Wood and Lifestyle (2018) event in 7 states	78	0	78	0
2- Malaysian Furniture Promotion Council (MFPC)				
Malaysian Furniture Promotion Council (MFPC)	206	4	202	77
3- Malaysian Furniture Council (MFC)				
Persatuan Pengusaha Kayu-kayan Bumiputera Malaysia (PEKA)	127	45	82	38
Kuala Lumpur and Selangor Furniture Industry Association (KLSFIA)	589	589	0	0
Malaysian Furniture and Furnishing Fair (MF3)	97	0	97	0
13 states of furniture association	0	0	0	0
4- Unregistered				
Face to face interviews and third party channels	10	0	10	10
TOTAL	1237	638	599	148

e-mail to the selected wood and furniture companies, as shown in Table 4. Distribution of the survey instrument was conducted via email to each of the selected companies (depending on accessibility of the contact information). A request letter was also sent to the KLSFIA to distribute the survey to individuals who do not have any contact info among the KLSFIA members. In addition, we have considered giving out a second reminder to increase the response rate by contacting and texting (via WhatsApp) the respondents. Visiting unregistered companies through third-party channels and face-to-face interviews were also taken into consideration to obtain responses. This process has been illustrated in Fig. 2.

3.5. Descriptive statistics analysis

To begin with, the data produced were analysed using descriptive analysis and missing item analysis. Descriptive statistic results are used to describe the characteristics of the sample. There are three types of descriptive statistic, namely: measures of central tendency (mean, median, and mode), measure of variability/dispersion (range, variance, standard deviation, minimum, and maximum), and measure of kurtosis and skewness. Thenceforth, the data collected has been subjected to assessment by using a standard research analysis software, known as Statistical Package for Social Sciences 25.0 (SPSS).

3.6. Statistical analysis on lean issues using sign test

Thanki and Thakkar (2014) and Panwar et al. (2015) ranked the lean issues based on the results of mean. Panwar et al. (2015) conducted one sample *t*-test and ranked the lean practices, reasons and challenges of implementing lean based on the mean scores. Yet, both studies did not conduct a normality test. They assumed the result obtained were normal. A normal distribution has a symmetric distribution, which is determined by the mean (measure of central value or average) and standard deviation (spread).

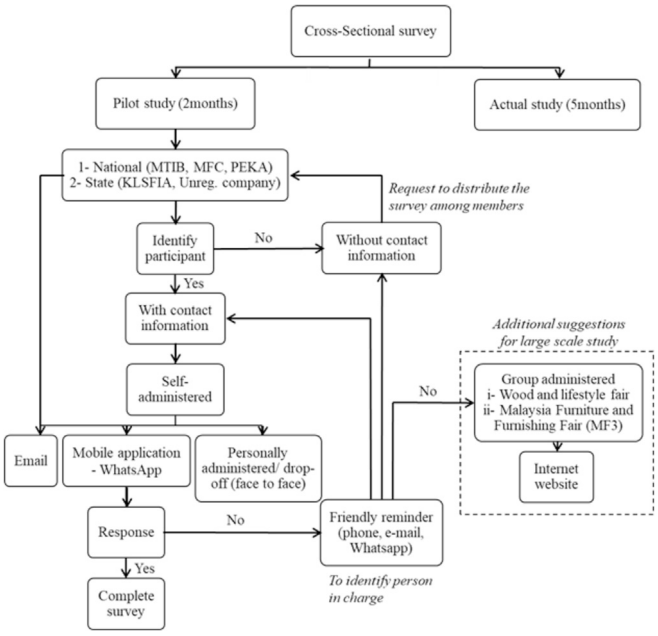

Fig. 2. Process flow for data collection.

However, according to Abolhassani et al. (2016), using the Likert scale for the questions produces data that are ordinal and therefore non-parametric. Non-parametric data cannot use parametric parameters such as mean, variance, and standard deviation to represent its central tendency (Abolhassani et al., 2016). Non-parametric statistics do not follow a normal frequency distribution. Therefore, median was used for ordinal variables and numeric variables with skewed distribution. Mann-Whitney U is a non-parametric test used to compare the average value (median) of a quantitative variable in two conditions: 1) when the distribution of

the variable is not normal, or 2) when the sample size is too small. Abolhassani et al. (2016) computed a one-sample sign test which is comparable to the one-sample *t*-test because the data is ordinal and non-parametric (which is not following a normal frequency distribution).

Therefore, sign test was carried out for two different groups, i.e. facilities that practice lean and those that do not. Assumptions were not made by the one-sample sign test with regards to the population distribution because the data can be non-symmetric. Whether or not the population's median is different than that of the hypothetical median is determined by the sign test (Abolhassani et al., 2016). Questions were asked to lean and non-lean companies to assess the status of lean implementation in the Malaysian wood and furniture industry. Participants were requested to give responses on the reasons, barriers, challenges and types of lean tools implemented. A five-point Likert scale was used to measure the reasons, barriers and challenges with ratings of "strongly disagree", "disagree", "neutral", "agree" and "strongly agree". A category scales was used to measure the type of lean tools practice ratings which are "not used", "seldom used", "sometimes", "often used" and "always used".

By refer to Abolhassani et al. (2016) method, the first step to set up the sign test is to determines if the responses differs from "neutral" response where no agreement or disagreement is provided. The hypothetical population median ($\tilde{\mu}$) for the sign test was set to 3, which represents a neutral response. If the median of the population ($\tilde{\mu}$) of a sample size (n) does not significantly differ from the neutral response, for a level of confidence (α), then the conclusion drawn will indicate that the participants do not provide a significant level of agreement or disagreement with the reason provided. Secondly, count the number of above (+) and below (−) of the responses. Thirdly, add up the number of above and below responses and subtract with the neutral (test value is 3) responses.

Finally, used the binomial calculator or binomial distribution table to calculate the p-value (Berman, 2019). Enter value for probability of success on a single trial with p = ½ (0.5); number of trials (n = sample size) and number of successes (x = number of "+" responses). The calculator will compute binomial and cumulative probability. If the "+" responses is much larger than "-" responses, used the cumulative probability $P(X \geq x)$ and if the "-" is larger than "+" responses, than used the cumulative probability $P(X \leq x)$ result.

According to Walpole et al. (2011), the null hypothesis (H_0) is rejected in favour of H_1 when the proportion of plus signs is significantly less than or greater than ½. This, of course, is equivalent to population (x) being sufficiently small or sufficiently large.

4. Results and discussion

The results of this research are categorized into two tiers in order to address the research questions, as previously highlighted in Section 1. In the first tier, a comprehensive review of the state-of-the-art literature on the lean issues was performed. Then, an analytic approach using a survey on the wood and furniture industries in Malaysia was used to finalize the research.

4.1. Results of the literature review

A comprehensive literature review was conducted to investigate the current shortfalls of implementing the lean manufacturing in emerging economies. The results of this review have been presented in Tables 1 and 2, where the contemporary studies imply the lean issues − motives, barriers, challenges, and applications − to implement lean manufacturing. Table 1 describes the finding(s) of each analysed study. Forty articles could be classified according to the following issues: (a) 'motives' for adopting the lean practices, considered by 7 articles; (b) 'barriers' in lean implementation, considered by 9 articles; (c) 'challenges' while implementing lean, considered by 17 articles; and (d) 'applications' of lean implementation, considered by 7 articles. As shown in Table 2, the findings revealed the importance of 59 sub-issues (items), which were applied as starting points to develop our survey. In this regard, the investigations of Abolhassani et al. (2016), Prasad et al. (2016), Panwar et al. (2015), Thanki and Thakkar (2014), and Shah and Ward (2007), as discussed in the relevant sections, were found noteworthy among others, helping the authors to develop the methodological analytic approach in the under-researched scope.

4.2. Results of the analytic approach

Out of 148 wood and furniture companies in Kuala Lumpur and Selangor, we received 21 responses. Eight respondents were from the Lean Manufacturing and Good Manufacturing Practices (5S) programmes while the other responses were collected from different sources. The effective response rate was 14% and considered adequate for conducting a pilot study. It is noteworthy that in Malaysia, lean practices have been implemented by very few furniture companies as indicated by MTIB, furniture associations and field experts/consultants. A similar response rate was achieved for the current pilot study, with that of other small sample-sized studies. In the study by Panwar et al. (2015) and Abolhassani et al. (2016), a response rate of 20% and 16% was attained respectively; meanwhile, Thanki and Thakkar (2014) had gathered data from 32 different industries in India.

The questionnaire was administered using an online survey method. Initially, even with frequent reminders, the response rate was observed to be low. Therefore, to increase the response rate, the respondents were contacted directly via phone as well as face-to-face interviews or drop-offs. Resultantly, the response rate improved whereby 48% of the responses were collected using the drop-off method, 38% by email and 14% by the mobile application, WhatsApp. The pilot study's data collection methods were found to be disadvantageous whereby the survey questionnaire did not reach the intended persons-in-charge. Hence, further measures had to be taken, i.e. by contacting the selected companies to request for the targeted individuals' contact information. Despite that, some of the companies gave out phone numbers or e-mail addresses that were no longer valid. In view of these drawbacks, it was recommended that for the actual study, the selection of the basic research method must be incorporated with the group administered methods (Fig. 2). To gain more respondents, wide-reaching events such as the Wood and Lifestyle Fair and the Malaysia Furniture and Furnishing Fair were recommended.

A sign test was carried out to examine the lean issues − motives, barriers, challenges, and applications from two different groups; the companies that practice lean and those that do not. Below is an example calculation on a barrier in non-lean companies, i.e. "Lack of implementation know-how". Using the sign test to test the hypothesis, at the 0.05 level of significance, that the test value or neutral agreement (median) is 3. Therefore;

$$H_0: \ \tilde{\mu} = 3$$

$$H_1: \ \tilde{\mu} \neq 3$$

$$\alpha = 0.05$$

Next, calculate and replaced each response by the symbol "+" if it above 3 (agree and strongly agree) and by the symbol "-" if it is below 3 (disagree and strongly disagree) and discarding the equal

(neutral) measurement. Hence, the result obtained is n = 14 and x = 12. Then used binomial calculator to calculate the P-value.

$$P = 2P(X \geq 12 \text{ when } p = ½)$$

$$P = 2\sum_{x=0}^{12} b((x; 14, ½)$$

$$P = 2(0.006469)$$

$$P = 0.0129$$

So the null hypothesis $\tilde{\mu} = \tilde{\mu}_0$ can certainly be rejected at the 0.05 level of significance.

4.2.1. Findings and discussion on 'motives' for adopting lean practices

The sign test was carried out for the companies who practiced lean. One sample sign test (test value of 3) was carried out to identify the significant motives for adopting lean (Table 5). Lean companies believe that all the factors listed were the reasons they implemented lean practices. It was found that lean implementation motivation exceeded the median of the neutral agreement level. Surprisingly, the results showed that there is no significant reason to all the factors. The companies strongly agreed that the most significant reasons for implementing lean in the wood and furniture industry in Malaysia are "to increase efficiency", "to increase utilization of space" and "to clean up and organize the workplace".

The survey results suggested that the companies were having trouble with their factory or workshop space. All respondents agree that they implemented lean to increase the housekeeping level through utilization of space and to cleaned up and organized workplace. Both furniture companies and the government are aware that the industry is branded as 3D (dirty, dangerous and difficult) hence justifying the initiative GMP-5S program conducted by MTIB. However, based on the survey administration result, only a few companies that had joined the GMP 5S program had undertaken the lean program in the following years. Out of 112, only 8 companies had upgraded their manufacturing system from GMP to lean. Three companies involved with the GMP 2015 programs had participated in the LEAN programs in 2016. Meanwhile, 5 more companies that participated in the GMP 2016 had also taken part in the LEAN 2017 program. These outcomes were in direct contradiction with the reasons why the companies agreed to implement lean practices. Once they had embarked on the 5S program, they were expected to take part in the lean manufacturing program. The companies could have been facing tough challenges while practising lean that had forced them to turn down the opportunities to continue implementing it.

4.2.2. Findings and discussion on 'barriers' in lean implementation

Barriers on lean implementation are obstacles that keep furniture companies from practicing lean. Out of the 21 companies, 16 have not implemented lean. The ratio of companies that have not implemented lean is more than those that have. This is contradicting the research done by Abolhassani et al. (2016) where 8 of the facilities did not practice lean as compared to 34 facilities which have implemented lean. However, both research studies did have a small size number of respondents that have not implemented lean. One sample sign test with a test value of 3 (neutral) was carried out to identify the barriers in lean implementation. The results determined whether the median of the responses differed from the hypothetical median of the neutral agreement level. Tables 6 and 7 show the median scores of barriers in lean implementation from non-lean companies and lean companies respectively.

First, one sample sign test (test value of 3) was carried out to identify the significant reasons for non-lean companies refused to implement lean. There are significant results that lack of implementation know-how ($p < 0.05$) and lack of expertise on lean ($p < 0.05$) were ranked as top reasons of companies for not implementing lean. Likewise, the level of agreement for lack of understanding benefits is above the neutral (agree), but it did not indicate significant outcome as one of the important barriers to implement lean. Respondents agreed that barriers in lean implementation were associated to all items from the knowledge issues and one items from the resources issues, which is lack of capital fund. However, the result for resources issues is contradicting to research done by Panwar et al. (2015). They disagree that lack of time and lack of financial resources were the main barriers to lean implementation by ranking both items to the lowest reason for not implementing lean. Therefore, the survey results suggested that knowledge on lean is the major factor for companies to decline the implementation of lean from the viewpoint of Malaysian wood and furniture industry.

Furthermore, it is interesting to find out that companies rejected all the items from culture and human attitudinal issue. The companies are aware on the support needed and changes in culture when implementing the lean practices. Remarkably, the outcomes for all items are well below from the hypothetical median of the neutral agreement level. Respondents are significantly do not believed that lean is a gimmick ($p < 0.05$). In the context of Malaysian wood and furniture industry, there were no significant agreement ($p > 0.05$) on the both culture reluctant factors (middle management and employee resistance to change) and perception factors (lean is difficult to implement, and lean does not fit culture).

Second, one sample sign test with a test value of 3 (neutral) was carried out to identify the barriers in lean implementation from the lean company's perspective. The present study revealed that lack of understanding benefits (knowledge issue) and lean is a gimmick (culture and human attitudinal issue) were not the barriers in lean implementation. Lean companies agreed on four barriers to lean

Table 5
Motives for adopting lean practices (Test Value = 3).

Items	*n*	Below	Equal	Above	*p*	Median
To increase efficiency	5	0	0	5	0.0625	5
To increase utilization of space	5	0	0	5	0.0625	5
To cleaned up and organized workplace	5	0	1	4	0.1250	5
To reduce production costs	5	0	0	5	0.0625	4
To improve quality	5	0	0	5	0.0625	4
To facilitate just in time (JIT) production	5	0	0	5	0.0625	4
To eliminate wastes	5	0	1	4	0.1250	4
To improve communication of information	5	0	1	4	0.1250	4
To increase customer satisfaction	5	0	1	3	0.2500	4
To solve problem	5	1	0	4	0.3750	4

Table 6
Barriers in lean implementation (non-lean companies) (Test Value = 3).

Items	*n*	Below	Equal	Above	*p*	Median
Culture and human attitudinal issue						
Middle management resistance to change	16	8	5	3	0.2266	2.5
Employee resistance to change	16	9	4	3	1.4600	2
Lean is difficult to implement	16	8	3	5	0.5811	2.5
Lean is a gimmick	16	10	4	2	0.0386	2
Lean does not fit culture	16	9	4	3	0.1460	2
Knowledge issue						
Lack of implementation know-how	16	2	2	12	0.0129	4
Lack of expertise on lean	16	2	2	12	0.0129	4
Lack of understanding benefits	16	5	2	9	0.4240	4
Resource issue						
Lack of time	16	6	3	7	1.0000	3
Lack of capital fund	16	3	5	8	0.2266	3.5
Lack of labor resources	16	6	3	7	1.0000	3

Table 7
Barriers in lean implementation (lean companies) (Test Value = 3).

Items	*n*	Below	Equal	Above	*p*	Median
Culture and human attitudinal issue						
Middle management resistance to change	5	2	2	1	1.0000	3
Employee resistance to change	5	1	1	3	0.6250	4
Lean is difficult to implement	5	1	3	1	1.0000	3
Lean is a gimmick	5	3	2	0	0.2500	2
Lean does not fit culture	5	2	1	2	0.7500	3
Knowledge issue						
Lack of implementation know-how	5	0	1	4	0.1250	4
Lack of expertise on lean	5	1	1	3	0.6250	4
Lack of understanding benefits	5	3	1	1	0.6250	2
Resource issue						
Lack of time	5	1	2	2	1.0000	3
Lack of capital fund	5	1	3	1	1.0000	3
Lack of labor resources	5	0	2	3	0.2500	4

implementation, namely: lack of labour resources (resources issue), employee resistance to change (culture and human attitudinal issue), lack of implementation know-how and lack of expertise on lean (both knowledge issue). However, there is no significant agreement ($p > 0.05$) agreed from all the barriers items.

To provide a clear structure for the discussion, this section discussed the barriers in lean implementation based on the research objectives: To what extent do views of barriers to lean implementation differ between lean and non-lean companies?

Both lean and non-lean companies agreed that lean is not a gimmick. There is definitely no perception issue which viewed lean as a flavour of the month due to great promotion from the lean management program, tour and workshop initiated by MTIB.

In general, both lean and non-lean companies agreed that lack of implementation know-how and lack of expertise on lean are the barriers to lean implementation. The result established to an agreement that there is insufficient practical knowledge to nurture competence and well-trained employees for lean implementation in Malaysian wood and furniture industry. Similar findings from Panwar et al. (2015) shows that lack of education and expertise on lean was the main reason for not implementing lean. Companies were also agreed that lack of technical knowledge on lean as one of the reason for not implementing lean (Abolhassani et al., 2016). Therefore, a lean implementation framework that consist of training sessions, site visits, workshops, and counselling were proposed to introduce the companies to the benefits and risks of the lean implementation (Barth and Melin, 2018).

Ironically, the absence of sufficient number of expertise in lean makes it difficult for companies to develop supervisory skills, management skills and workforce skills among the employees. It seems to be quite obvious that most of the respondents are unenlightened about lean manufacturing. Because, the more enlightened employers offer better practice for the lean implementation. Moreover, the findings show that some companies with limited knowledge on lean choose to implement it while others refuse. It is believed non-lean company are confronting with financial constraint (median for lack of capital fund is 3.5) compared to lean companies. This will be restricted the companies to appoint lean expertise or to allowed employees enrolled for lean training or workshop. Thus, the current situation obligates companies to hire lean consultant and trainers to guide the lean transformation, and hence stimulate the understanding on lean techniques.

Nevertheless, both lean and non-lean companies have a different view point on the culture reluctant issue. Non-lean companies disagree with the factor of employee resistance to change, whilst lean companies agree that employee is resistance to change is the obstacle that keep furniture companies from practicing lean. Instead of resistance, the employees could actually feel burdened with their daily job after they were asked to practice with lean tools. For that reason, they are probably reluctant to change to the lean system and hence return to the old inefficient ways of working. The findings is contradict to both study done by Abolhassani et al. (2016) and Panwar et al. (2015). Both lean and non-practitioners believed that employee is resistance to change as one of the barriers to lean implementation (Abolhassani et al., 2016). In different circumstances, the cultural barriers (resistance to change) was ranked at the bottom of the reasons for not implement lean practice (Panwar et al., 2015).

Lastly, both lean and non-lean companies have a different agreement on the lack of understanding benefits. Non-lean

companies agree that they did not implemented lean because of not being able to understand profit gained from lean (median = 4). However, lean companies disagree and denied that they do not understand profit gained from lean and implementation of lean has no value. Lean companies are able to prove the tangible benefit to the employees after implementing lean. Even though lean companies encountered insufficient practical knowledge to implement lean and lack of expertise on lean, still they understand the potential benefits and profit gained from lean implementation.

4.2.3. Findings and discussion on 'challenges' while implementing lean

The challenge of lean implementation is a situation faced by a company that needs to put in great effort and determination in order to successfully implement lean. One sample sign test with a test value of 3 (neutral) was carried out to identify the challenges while implementing lean (Table 8). The median value of the factor is above 3 if the participants agreed with the challenges factors, while the median value is below 3 if the respondents disagreed with the challenges factor. Notably, none of the factors listed has a median value of below 3. The respondents agree that they might face challenges while implementing lean and none of the factors listed were denied.

Our study revealed six major challenges while implementing lean, namely; 1) all items in resources issue (time, financial and labor), 2) all items in knowledge issue except for neutral agreement in lack of tangible benefits and 3) one item from culture and human attitudinal issue which is related to backsliding to old ways of work. Our study re-confirms the prominent conflicts with SME's company found by Caldera et al. (2019) which are lack of financial resources, lack of time, lack of knowledge, and existing organizational cultures that impede sustainable business practice. Nunes et al. (2019) proposed company to consider organization values, policies, and available resources overcoming internal barriers in SMEs. Moreover, Pearce et al. (2018b) highlights the importance of knowledge in driving sustainable performance through the application of lean practices.

Due to lack of time, financial and labor resource, the companies experience restrictions in conducting more training on lean and providing sufficient knowledge to the employees. According to Spagnol et al. (2013), organizations must prepare for the establishment of a new management culture, which consequently implies the need for time investment and workload adaptation to new and greater responsibilities. Due to work constraints organizations do not usually allocate the necessary time required for lean activities. Furthermore, the employees are too busy with their 'day job'. They do not have time to practice lean tools due to the lack of labour. This will inadvertently lead to staff frustration in the face of poor results. This factor restricts the companies from moving forward as most of the wood and furniture companies are small to micro-sized companies with less than 5 workers. Therefore, the employees have the tendency to backsliding to old ways of work.

Ironically, previous section shows that the barriers to lean implementation is employee resistance to change. Even though the result shows there is neutral responses on culture and human attitudinal issue which is related to culture reluctant/scepticism (not easy to implement and lean is viewed as current trend), the challenges faced while implementing lean is associated with the issue where employees refused to changes and return to the old inefficient ways of working. Instead of resistance, the employees could actually feel burdened with their daily job after they were asked to practice with lean tools. It is because, lean companies face challenges in terms of time, financial resource and labor resources. For that reason, they are probably reluctant to commit and hesitant to change to the lean system.

4.2.4. Findings and discussion on the 'applications' of lean implementation

Table 9 shows the results of the sign test that identified the most significantly used lean tools in the Malaysian wood and furniture industry. According to one sample sign test (test value of 3), 5S and employee training are the most often used lean tools. Quality control is occasionally used while another 13 lean tools are not used at all in the Malaysian wood and furniture industry. The number of significantly used lean tool is lower compared to Panwar et al. (2015) study (five lean tools) and the contemporary literature. It was verified that lean manufacturing is not well implemented in Malaysian wood and furniture industry. Ramos et al. (2018) found that 88% of companies which had an average time of six years' official lean implementation program, still had a medium level of lean implementation. Therefore, the result of the survey suggests that there is hardly any furniture company that is practicing lean tools in their manufacturing process.

4.3. Integrative discussion

We carried out present study exclusively for Malaysian wood

Table 9
Applications of lean implementation (Test Value = 3).

Lean tools	*n*	Median	*t*	*p*
5S	5	4.00	2.45	0.070
Employee training	5	4.00	−0.27	0.799
Quality control	5	3.00	−0.59	0.587

Table 8
Challenges while implementing lean (Test Value = 3).

Items	*n*	Below	Equal	Above	*p*	Median
Culture and Human Attitudinal Issue						
Lack of employee commitment	5	1	2	2	1.0000	3
Lack of senior management's interest and support	5	1	3	1	1.0000	3
Not easy to implement	5	0	3	2	0.5000	3
Lean is viewed as "current trend"	5	2	3	0	0.5000	3
Backsliding to old ways of work	5	0	2	3	0.2500	4
Knowledge Issue						
Lack of technical knowledge	5	0	1	4	0.1250	4
Lack of training	5	0	1	4	0.1250	4
Lack of tangible benefits	5	1	2	2	1.0000	3
Resource Issue						
Lack of time	5	1	1	3	0.6250	4
Lack of financial resources	5	0	2	3	0.2500	4
Lack of labor resources	5	0	1	4	0.1250	4

and furniture industry. For companies who might be considering implementing lean manufacturing but are uncertain about the potential outcomes, this study reveals the potential benefits that might occur from the wood and furniture company's perspective. Applications of lean manufacturing have been less common in the Malaysian wood and furniture industry, in part because of implementation difficulties that this sector is lack of knowledge-related issues, and in part because of the challenges during lean transformation; this was caused from the knowledge and resources-related issues to commit to the improvement program. Out of all items, only three items from the lean issues were found to have a significant result ($p < 0.05$). The non-lean companies believed that lean is not a gimmick and agreed that lack of implementation know-how and lack of expertise are the barriers to lean implementation. Furthermore, the findings show that culture and human attitudinal related issues does not have a significant effect on the barriers and challenges to lean implementation, and it is in fact that companies were quite feasible to cautiously adapt lean techniques. We demonstrate this with a pilot-study approach to address the lean techniques which can be suitably adapted. The availability of the information provided from survey in Kuala Lumpur and Selangor found that there are inadequate numbers of lean practices implemented by companies (5S, employee training and quality control).

5. Conclusions and future research directions

The research is among the very limited number of studies, which have investigated the current shortfalls of implementing the lean manufacturing in the furniture industry in terms of motives, barriers, challenges, and applications. The following is a summary of the conclusions, which can contribute to support the narrow body of knowledge on the under-researched scope.

- This study has found that generally the motives for adopting lean practices are to increase efficiency, utilization of space and to cleaned up and organized workplace. The findings are particularly associated to the programs initiated by the MTIB. Most of the lean companies were found adopting 5S tools which is a basis lean practice used to increase utilization of space by cleaning up and organizing the workplace. The result shows that the companies believe in the benefits of lean practice and are willing to change for the sustainability of the business. The evidence of the study can encourage companies and MTIB in the process of understanding how lean principles can be practically applied and promoted in the wood and furniture industry.
- Evidence from the study suggests that implementing lean in Malaysian wood and furniture industry is by no means an easy task, as it is heavily burdened by knowledge and resource-related barriers. The most obvious finding to emerge from this study is that both lean and non-lean companies believed that the knowledge is the prominent issue. Lack of implementation know-how and lack of expertise on lean had prevented the companies from applying the lean approach. With the concern of insufficient knowledge to implement lean and lack of capital fund (non-lean companies) to hire lean consultants, MTIB has taken the initiative to increase lean awareness by granting selected furniture companies access to participate in GMP (5S) and lean manufacturing programs for a period of six months.
- In addition to the identification of the barriers which comparable for both lean and non-lean companies, the paper also investigated the dissimilar agreement between lean and non-lean companies. Our finding revealed that companies do not implement lean because they are not able to understand the profit gained from practicing lean (lack of understanding benefit). One unanticipated finding was that 76 percent of furniture companies located in the Klang Valley area have not implemented lean. In contrast, lean companies do not agree that lack of understanding benefits was a barrier to practicing lean tools as the result showed a negative level of agreement. Lean companies believe that employee resistance to change was one of the barriers to lean implementation, but not to non-lean companies. The finding uncovered the fact that the lean programs endorsed by MTIB had successfully educated the participants. Further evidence needs to be provided through case studies from the MTIB lean program on how effectively lean practices are being adopted and implemented, particularly in the case of transferring the knowledge (lean transformation) and dealing with employee attitude.
- Throughout the study, it was emphasized that the relevance of the challenges is clearly supported by the motives and barriers to lean implementation. Lack of technical knowledge and lack of training had emerged as the major challenges during lean implementation. Lack of skill, technical knowledge and training on lean practices will cause misapplication, as a result it will fail to deliver expected results and benefits. Moreover, lean companies agree that company faced difficulties in arranging time, financial and labor resources to ensure the successfulness of lean implementation. With the limited number of resources, the companies are facing the perceived issue of additional work load when implementing lean. The employees are busy with their day job and tends to return to the old inefficient ways of working. The result provides an understanding for the potential companies that lean manufacturing implementation requires time, money, energy and full company commitment. Shortcomings that are identified in advanced will allow furniture companies to become well-aware of their own capabilities and ensure that they are better prepared and more consistent in their progress for lean implementation.
- These findings had enhanced our understanding concerning the lack of lean implementation in the wood and furniture industry in Malaysia. Due to limited resources, it is found to be possible for the furniture companies to apply all lean tools and techniques at one time. Securing the full benefits of lean manufacturing requires the companies to concentrate on the specific project and lean comprehensive tools, wherever applicable and necessary. The use of rigorous 5S and employee training appears to be the only widespread practice among Malaysian wood and furniture industry. The following lessons from this finding indicate that only a few wood and furniture companies were driven to improve their manufacturing practices.

Despite its exploratory nature, this study offers some insight into lean implementation comprehension while identifying knowledge areas of strength and deficiencies. The results of the study will help government, furniture association and wood and furniture companies to make more mature and careful decisions regarding the lean issues or critical success factors. More information on lean implementation from Malaysian wood and furniture companies would help us to establish lean implementation framework towards the successful implementation of lean. Therefore, in the pre-implementation stage, furniture companies can identify how their capabilities and resources can be utilized to accomplish the lean issues or critical success factors for the implementation of lean manufacturing. Moreover, government will be able to provide adequate assistance to the furniture companies so as to prepare them for the challenges ahead and accelerate the process towards full lean adoption.

However, this study involves some limitations, which suggest

directions for future research. The survey was limited to the furniture companies situated in the Kuala Lumpur and Selangor region of Malaysia. Only registered companies with government and furniture association were allowed to participate with the survey. Comprehensively, companies that were permitted are, home furniture, office furniture, kitchen furniture mattress and bedding, home appliances, soft furnishings, wood or bio-composite flooring, door and window, and others. Any products such as electrical equipment use for dining, water filtration, air purifier, carpet, fire prevention, household cleaning services, security, insect screen, and kitchen appliances (hood/hob) were impermissible. The questionnaire responses for each company were limited to only one respondent.

In the present study, the sample size is not very large. Ironically, the lean awareness and level of lean implementation in Malaysian wood and furniture industry is not so encouraging. Thus, in the perspective of Malaysian wood and furniture industry, the organization context such as plant age, plant size and level of lean implementation was not taken into consideration. Moreover, the reason for implementing lean are focus only on operation performance. The approach of this survey was to distribute questionnaire that could be completed efficiently by companies even though without a knowledge on lean practices.

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