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Challenges in the Implementation of Lean Manufacturing in the Wood & Furniture Industry

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Abstract

Purpose – This study analyses the challenges in implementing lean manufacturing (LM) in the wood & furniture industry. In order to facilitate the smooth implementation of LM practices in this industry, the challenges in terms of its deployment need to be analysed and observed.

Design/methodology/approach – Realising this importance, this study proposes a model, using PLS-SEM, which focuses on dealing with the challenges faced in the implementation of lean in the wood & furniture industry. The model consists of ten challenges that were determined based on a survey involving 46 SMEs companies in Malaysia.

Findings – The findings revealed that the implementation of LM is significantly affected by 3 main issues, namely: knowledge, resources, and, culture and human attitude. Furthermore, the analyses also highlighted four dominant challenges which are related to culture and human attitude issues – lack of employee commitment, lack of senior management's interest and support, difficult to implement, and LM is viewed as "current trend". Overall, the ability to deal with the challenges involving factors of knowledge, and culture and human attitude, determine the success of LM implementation, especially in companies that have limited resources.

Practical Implications – This study would help wood & furniture SMEs, government agencies, professional bodies, and academics to better understand the challenges when implementing LM practices.

Originality – Overall, this study aims at investigating the relationships between the three challenges to better promote LM in the scope under study. Therefore, several activities were proposed to overcome the abovementioned challenges and subsequently contributing to the current body of knowledge.

Keywords: Lean manufacturing, Lean implementation, Challenges, Structural equation modelling (SEM), Knowledge, Resources, Culture and human attitude

Paper type: Research paper

1. Introduction

Lean manufacturing (LM) may be considered as a process, a set of principles, a set of tools and techniques, an approach, a concept, a philosophy, a practice, a system, a program, a manufacturing paradigm, or a model (Bhamu and Singh Sangwan, 2014). The LM concept we know today consists of indispensable activities applied in the current management and production practices such as automotive, aerospace, furniture manufacturing, textile, process industry and service industry (Kumar and Vinodh, 2020). Due to the foreseen importance of LM, many manufacturing organizations are fine-tuning their operations and taking a proactive role in developing cleaner processes through green lean practices (Singh et al., 2020), lean six sigma (Jamil et al., 2020; Swarnakar et al., 2020) and integrating industry 4.0 into lean production (Tortorella et al., 2020; Yadav et al., 2020).

Notwithstanding, various initiatives of LM have widely been adopted in a variety of industries, particularly in developed countries with many successful cases reported in the literature (Pearce et al., 2018). However, there are always emergent challenges to the practitioners that hinder its successful implementation (Abu et al., 2019). Thanki and Thakkar (2014) pointed out that the main challenges in implementing LM are poor training and awareness on LM, lack of statistical applications for process improvement and ambiguity concerning LM tools for deployment. Apart from that, there is also the issue of conducting training for employees by LM experts (Sahoo and Yadav, 2018). In a study by Kumar and Vinodh (2020), lack of top management commitment in understanding and supporting the system, lack of team autonomy and poor selection of improvement teams are found to be affecting the adoption of LM concepts. Most of these previous studies, however, have only focused on a single factor of the challenges in LM implementation. A noteworthy exceptions are the studies by Antony et al. (2012) and Jadhav et al. (2014) on the barriers and challenges related to the implementation of LM and their effects on the success of LM in the industry. On the other hand, some other studies have only categorised the LM implementation issues in general, i.e. lean culture (Angelis et al., 2011; Paro and Gerolamo, 2017) and knowledge (Secchi and Camuffo, 2016). This suggests the existence of a significant knowledge gap in the LM body of knowledge.

To bridge this theoretical gap, this paper focuses on investigating the factors of knowledge (KNW), resources (RES) and culture and human attitude (CUL) in affecting the implementation of LM. Knowledge is viewed as the most influential factor to ensure successful LM implementation (Chaple et al., 2018). Abolhassani et al. (2016) suggested the positive effects of increased knowledge in ensuring the successful implementation of LM. Al-Aomar and Hussain (2018) in their study investigating the challenges of adopting LM practices highlighted the factors corresponding to LM implementation, namely: lack of awareness, training, and skills essential for implementing sustainability practices in general and LM in particular. Moreover, Ramadas and Satish (2018) found that the lack of awareness related to the process/machine item was not supported for building the measurement model in implementing LM. Consequently, to provide deeper knowledge of how KNW pose a challenge in implementing LM, this study attempts to provide empirical evidence for this.

It is evident that the cultural aspect has a great impact on the success of LM implementation (Al-Aomar and Hussain, 2018). Many companies have been identified to be unable to adopt the LM philosophy due to cultural reluctance (Bamford et al., 2015). LM demands cultural change during the transition (Khaba and Bhar, 2018). Lack of a supportive organizational culture (Coetzee et al., 2018) such as top management commitment (Thanki and Thakkar, 2018) is one of the factors hindering the success of LM deployment. A failure to commit, results in lack of attendance in executive meetings and trainings, partial engagement in the whole change process and a visible reluctance to implement the ideas put forward by the members after the completion of projects (Antony et al., 2012). However, Panwar et al. (2015) indicated that most Indian companies view scepticism and culture as insignificant factors to the non-implementation of LM. This indicates that the study on the challenges related to CUL in LM implementation is still scarce and limited.

Besides, lack of resources poses a challenge to the implementation of LM (Abolhassani et al., 2016). Sahoo and Yadav (2018) cited that most companies are concerned about the cost and time involved in implementing LM. Small manufacturers that are new to LM implementation are likely to face financial, and technical struggle and also time constraints (Sahoo and Yadav, 2018). However, sufficient allocation of funds and government support enables companies to successfully deploy the LM practices (Thanki and Thakkar, 2018). Hence, it is deemed important to examine the correlation between RES and challenges.

The aforementioned studies have demonstrated that plenty of researchers have been conducted to study the challenges in LM implementation. However, this current study is the first known study that adopts a PLS-SEM framework to examine the correlation between CUL, KNW, RES and challenges in implementing LM. The framework is proposed to better classify the challenges and understand their importance in facilitating the smooth implementation of LM practices. This study used the data gathered from survey questionnaires in the contexts of the wood & furniture industry. The survey involved 46 Malaysian wood & furniture companies that have participated in the 2018 Lean Management Program sponsored by the Malaysian government.

To this end, this paper outlines a conceptual framework of the most relevant challenges affecting LM implementation in Section 2, the research methodology is presented in Section 3, the analyses and results derived from an empirical study are highlighted in Section 4, an integrative discussion on the findings is elaborated in Section 5. Finally, conclusions and recommendations for future research are discussed in Section 6.

2. Literature review

The literature review is considered the backbone of any research work (Yadav et al., 2020). A systematic literature review was used for the present research work by referring to a collection of work from Abu et al. (2019). These works have demonstrated an adequate understanding of the relevant literature and emphasized the significant challenges in LM implementation. All the LM implementation issues had been investigated and analysed using bibliometric analysis. Furthermore, the study is conducted to support the idea and answer the questions of who, what, why, where, when and how a pilot study is conducted to validate and obtain an in-depth understanding of the issues. Then, all the findings and arguments were compared to better understand the situation. For example, Panwar et al. (2015) indicated that most Indian companies have a high awareness of LM and view scepticism and culture as insignificant factors to the non-implementation of LM which contradict the low respondents' awareness in Malaysia. Based on the literature analyses, the following criteria were listed out.

Gaikwad et al. (2020) stated that it is necessary for SMEs to adopt modern business strategies such as LM to increase their competitive advantages, operations and profits in the regional and global markets. However, the challenges during the implementation are always posed as a normal occurrence in every transformation process (Gaspar and Leal, 2020). Hence, it is crucial to identify the challenges and understand their importance and deployment to facilitate the smooth implementation of LM practices (Grove et al., 2010; Rymaszewska, 2014). This study attempts at making a valuable theoretical and empirical contribution to the scope under study.

There are several empirical pieces of evidence of the variables contributing to the challenges of implementing LM. Most challenges in LM implementation are likely to arise during the early phases of its deployment (Rymaszewska, 2014). In particular, small and medium enterprises (SMEs) encounter various challenges during the initial stages of implementing LM, i.e. negative employee attitude, lack of finances, resistance to change, poor know-how and expertise on LM as well as the non-commitment of higher management (Sahoo and Yadav, 2018). A scrutiny of the available literature reveals that extensive research is undeniably essential to explore the challenges in implementing LM (Table 1).

Previously, Belhadi et al. (2017) categorised LM implementation issues into cultural, knowledge-related, strategic, technical, and market-related based. While prior studies had examined the challenges factors separately, this present study explores three main issues, namely KNW (Abolhassani et al., 2016; Khaba and Bhar, 2018), RES (Panwar et al., 2015; Sahoo and Yadav, 2018) and CUL (Bajjou and Chafi, 2018). Recently, Abu et al. (2019) conducted a pilot study and tested the three LM implementation issues using a sign test on 148 respondents. Five key challenges under CUL and three key challenges under both KNW and

RES were derived from the discussions with LM experts and findings from the previous studies.

This research aims at examining the relationship between CUL, KNW, RES, and challenges (Figure 1). The model constructs and related hypotheses are defined in the following subsections. The general hypothesis is that CUL, KNW and RES pose challenges to the implementation of LM. Accordingly, the proposed conceptual model has three hypotheses to be tested.

H1: Challenges related to CUL affect LM implementation.

H2: Challenges related to KNW affect LM Implementation.

H3: Challenges related to RES affect LM implementation.

2.1. Culture and human attitude challenges

Organizational culture can be defined as the behaviours, attitudes and beliefs that exist within the organization (Khaba and Bhar, 2018). Bajjou and Chafi (2018) classified CUL as any people-related issues such as knowledge, skills, and commitment. LM implementation requires the creation of a continuous improvement in terms of culture and ongoing education, specifically on LM that lead to constant upgrades on how things are done and how problems are solved (Antony et al., 2012). Despite prior evidence of the benefits of LM implementation, there are several barriers to it, e.g. perception, issues with shop floor employees (Melton, 2005) and the lack of a supportive organizational culture to overcome the fear of failure, change, retrenchment, and uphold greater responsibilities (Coetzee et al., 2018). Nevertheless, in some other studies, it was also observed that management resistance to change, perceptions that LM is a gimmick, and LM is unsustainable were not the factors for the failure of LM practices (Abolhassani et al., 2016; Pearce et al., 2018).

In this current study, five key challenges related to CUL were established namely lack of employee commitment (Czabke et al., 2008; Gagnon and Michael, 2003; Hogan, 2007; Ray et al., 2006; Soetara et al., 2018; Vizzotto et al., 2015; Waurzyniak, 2008), lack of interest and support by the senior management (Ray et al., 2006; Waurzyniak, 2008), difficulty to implement LM(Fricke and Buehlmann, 2012; Mo, 2009; Pirraglia et al., 2009; Rymaszewska, 2014), LM is viewed as "current trend" (Antony et al., 2012) and backsliding to old ways of work (Pirraglia et al., 2009; Waurzyniak, 2008).

2.2. Knowledge challenges

The investigation by Pearce et al. (2018) stresses the importance of knowledge management in the early phase of LM implementation, which is in accordance with Chay et al. (2015), who revealed that the lack of technical knowledge among shop floor employees presents the biggest challenge in LM implementation. Abolhassani et al. (2016) has found that the lack of technical knowledge among shop floor employees is an obstacle in LM implementation, believing that 1) adaptation to the new environment is dependent on the management considering that LM 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.

Therefore, lack of technical knowledge (DeLong et al., 2007; Gagnon and Michael, 2003; Guerrero et al., 2017; Mo, 2009; Rymaszewska, 2014), lack of training (DeLong et al., 2007; Fricke and Buehlmann, 2012; Ray et al., 2006; Soetara et al., 2018) and lack of tangible benefits (Czabke et al., 2008; Fricke and Buehlmann, 2012) are the challenges related to KNW issues in implementing LM.

2.3. Resources challenges

Lastly, RES issues may largely comprise: 1) fear of implementation cost and the successive benefits of LM(Bhamu and Singh Sangwan, 2014); 2) 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 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, 4) the lack of financial resources to provide training (Pearce et al., 2018).

Three key challenges related to RES are lack of time (Fricke and Buehlmann, 2012; Pirraglia et al., 2009; Ray et al., 2006; Soetara et al., 2018), lack of financial resources (Guerrero et al., 2017; Ray et al., 2006; Rymaszewska, 2014) and lack of labour resources (Guerrero et al., 2017; Pirraglia et al., 2009).

3. Methodology

The methodology for this current study proceeded in four primary phases.

1- Literature review: In order to contribute to the breadth of knowledge in the field, LM challenges factors were yielded from the systematic literature review of an article prepared by Abu et al. (2019). The proposed model consists of ten challenges.

2- Data collection: Based on the aforementioned research objective, a survey involving 46 SMEs companies in Malaysia was performed.

3-Analysis: The method of validation using structural equation modelling (SEM) is elaborated below in detail. Studies on LM have been identified to benefit the most from using Structural Equation Modelling (SEM) because SEM is at the stage of explorative modelling with the theory under development (Pearce and Pons, 2019). There are two main approaches to SEM: component-based and covariance-based (Bodoff and Ho, 2016). The example of component-based SEM is the partial least square (PLS) method, while AMOS is the most well-known software package supporting the covariance-based SEM (Chin, 1998). The study by Bodoff and Ho (2016) is referred to in choosing component-based SEM as partial least squares structural equation modelling (PLS-SEM). The PLS-SEM aims to explain variance which allows estimating complex cause-effect relationship models with latent variables using SmartPLS(Xue et al., 2011). The model was validated using PLS-SEM as the model contains both reflective and formative constructs and because it infringes upon the multivariate normality assumption (Tehseen et al., 2017). Moreover, the method is capable of handling non-normal data and is flexible enough to scrutinize small samples. Thus, this method was selected because (a) the theoretical model is not well-formed; (b) there is an uneven number of indicators; (c) there are different modes of reflective and formative constructs; (d) the data distributions are not normal and not highly demanding with respect to sample size, and (e) there is flexibility in modelling beyond the first-generation techniques (Chin, 1998).

4- Conclusions and recommendations for further research: This study is part of a government-funded initiative for SME in the wood and furniture industry. The final conclusion and proposed activities can be implemented to overcome the challenges that could make a valuable contribution to society and has adequately bridged the gap between theory and practice.

3.1. Method of validation using PLS-SEM

PLS-SEM requires the computation of construct scores for each latent variable in the path model (Becker et al., 2012). It is used to validate the measurements and test the hypotheses (Xue et al., 2011). Hair et al. (2019) provided guidelines including a rule of thumbs for evaluating the model as well as introduced the crucial options usable in the PLS-SEM. Samuel and Ramayah (2016) recommended a two-stage analytical procedure which entails 1) testing the measurement model to validate the instruments and 2) examining the structural model to test the relationships that were hypothesised.

3.2. Assessing the measurement model

The evaluation of the measurement model was ascertained based on the method introduced by Hair et al. (2014a). Two types of validity which are convergent validity (CV) and discriminant validity (DV) were examined in evaluating the measurement model (Ramayah et al., 2017). With regards to CV examination, the first order construct is a reflective measurement model while the second-order construct is a formative measurement model.

3.2.1. Convergent validity (CV) for reflective first-order constructs

CV is the degree to which multiple items that measure the same concept are in agreement (Amin et al., 2016). The CV evaluates whether or not the items represent one and the same underlying construct (Kashif et al., 2018). Three assessments were used to measure CV namely (1) indicator loadings (outer/factor loading) values, (2) composite reliability (CR) values, and (3) average variance extracted (AVE) values (Hair et al., 2014a).

The first step is to determine the factor loading values. An indicator's outer loading should be above 0.708 (Hair et al., 2014a). Lower loading items were dropped to obtain reliability and discriminant validity (Scholtz et al., 2016). An established rule of thumb is that a latent variable should explain a substantial part of each indicator's variance, usually at least 50% or 0.5 (Hair et al., 2014a). Therefore, the minimum standard of the factor loadings is 0.70 (Chin et al., 2003). The rationale is that the number squared (0.708^2) equalling to 0.50 and 0.70 is considered close enough to 0.708 to be acceptable (Hair et al., 2014a).

The second step is to calculate the internal consistency reliability. There are two common methods used for this purpose which are CR and Cronbach's alpha (Xue et al., 2011). However, CR provides a more appropriate measure of internal consistency reliability compared to the traditional assessment using Cronbach's alpha (Hair et al., 2014b). CR is calculated from (square of the summation of the factor loadings) / [(square of the summation of the factor loadings) + (square of the summation of the error variances)] (Scholtz et al., 2016). The CR varies between 0 and 1 (Hair et al., 2014a). All items with higher values loaded on their latent variable were found to have higher levels of reliability (Scholtz et al., 2016). It is generally interpreted in the same way as Cronbach's alpha (Hair et al., 2014a). Nevertheless, values above 0.90 (and definitely> 0.95) are not desirable because they indicate that all the indicator variables are measuring the same phenomenon and are therefore unlikely to be a valid measure of the construct (Hair et al., 2014a). The reliability scores for all of the principal constructs are considered adequate as they exceeded 0.708 i.e. well above the recommended cut-off of 0.70 (Xue et al., 2011).

The third step is to calculate the AVE values. AVE is the grand mean value of the squared loading equivalent to the commonality of a construct [AVE = (summation of squared factor loadings)/(summation of squared factor loadings) (summation of error variances)] (Scholtz et al., 2016). For AVE values greater than 0.50, the principal constructs should capture a construct-related variance that is higher than the error variance (Xue et al., 2011).

3.2.2. Discriminant validity (DV)

After confirming the CV, we proceed to assess the discriminant validity (DV). DV was verified to indicate that the construct differs from other constructs within the model (items that differentiate the constructs or measure distinct concepts) (Amin et al., 2016; Kashif et al., 2018). Previous researchers suggested the method by Fornell and Larcker (1981) (Amin et al., 2016), which involves two techniques; the first is by comparing the AVE with the squared correlations method (Amin et al., 2016) and the second method is the most commonly used by researchers i.e. comparing the square root of the AVE with the correlations among the constructs (Amin et al., 2016; Kashif et al., 2018). If the AVE's square roots as indicated in the diagonals are larger than those in the rows and columns for the same construct, then the measures can be concluded to be distinct with adequate DV (Amin et al., 2016; Chin, 1998; Xue et al., 2011). The Fornell and Larcker (1981) method which is also known as average variance extracted versus shared variance method (AVE-SV) is a very conservative test of discriminant validity (Voorhees et al., 2016).

However, Ramayah et al. (2017) indicated that there has been a recent criticism on the Fornell-Larcker (1981) method and suggested an alternative approach based on the multitrait-multimethod matrix. Henseler et al. (2015) suggested using the heterotrait-monotrait ratio of correlations (HTMT) because the Fornell-Larcker (1981) method is not reliable in detecting the lack of DV in common research situations. Moreover, Voorhees et al. (2016) emphasized that HTMT should be the standard for publication in marketing journals. Henseler et al. (2015) suggested 0.85 and 0.90 as useful starting points. The constructs are distinct from each other or having discriminant validity if their values are below the suggested cut-off of 0.90 (Xue et al., 2011). According to Hair et al. (2019), aHTMT < 0.90 indicates conceptually identical constructs, whilst a HTMT < 0.85 denotes conceptually dissimilar constructs, and this tests whether the HTMT is considerably below the threshold value. Additionally, the HTMT value's significant difference from 1.00 can be tested using the bootstrapping method (Henseler et al., 2015). Anything close to 1.0 (or exceeds 1.0) would be interpreted as a discriminant validity violation (Voorhees et al., 2016). If very high correlations (r > 0.85) do not cause the analysis to fail or to yield a non-admissible solution, then the extreme collinearity may cause the results to be statistically unstable (Kline, 2011).

3.2.3. Formative second-order constructs

The second-order constructs could be in form of a reflective or formative measurement model. Amin et al. (2016) and Jayasingam et al. (2018) used the reflective measurement model to model the second-order constructs. This study adopts the formative measurement model for the second-order constructs. The variation inflation factor (VIF) was suggested to measure collinearity (Hair et al., 2019; Scholtz et al., 2016) and statistical significance of weight to measure the significance and relevance of the formative second-order construct (Hair et al., 2019; Xue et al., 2011). Thus, the VIF and significance of weight were assessed for the barriers and challenges which are conceptualized as second-order constructs.

As for the reflective-formative type of model, the inner VIF values were chosen to examine the issues of collinearity (Tehseen et al., 2017). Ideally, the value of VIF for all the predictor constructs should be less than 3 (Hair et al., 2019) or less than 5 (Tehseen et al., 2017) to ensure that there is no collinearity issue between the constructs' formative indicators. Multi-collinearity does not pose a problem if the VIF is well below the commonly used threshold of 10 or the more stringent threshold of 3 (Diamantopoulos, 2011). Eliminating indicators, merging indicators into a single index, or creating higher-order constructs are the ways considered to treat collinearity problems (Scholtz et al., 2016).

Subsequently, the indicator weights' significance and relevance can be examined through bootstrapping (Hair et al., 2019; Tehseen et al., 2017). The rule of thumb is that a p-value of < 0.05 or a confidence interval of 95% (determined using the percentile method or the BCa method if the bootstrap distribution is skewed) is not inclusive of zero (Hair et al., 2019). The weights of the indicators should be larger than 0.1 (Duarte and Amaro, 2018; Tehseen et al., 2017).

3.3. Assessing the structural model

The standard assessment criteria for assessing a structural model entail the coefficient of determination (R^2), the blindfolding-based cross-validated redundancy measure (Q^2), the statistical significance and relevance of the path coefficients (Hair et al., 2019). According to Ramayah et al. (2017), it is essential to report the R^2, the significance of path coefficients (β) and the corresponding t-values via a bootstrapping procedure with a resample of 5,000 based on the method suggested by Hair et al. (2017) in their second edition book. However, Amin et al. (2016) indicated that it is enough to use bootstrapping with a resample of 500, path estimates (β) and t-statistics. Moreover, Hair et al. (2019)indicated that the reporting of the f^2 effect size should only be done upon the editors and reviewers' request due to its redundancy with the path coefficients' size. In addition to these basic measures, it was also suggested to report the statistical significance (*p*-value), confidence intervals (Ramayah et al., 2017) and PLS prediction (Hair et al., 2019; Shmueli et al., 2016).

The R^2 was calculated to assess the structural model (Ramayah et al., 2017), to evaluate the structural models' predictive power (Amin et al., 2016), and to present the portions of variance explained (Scholtz et al., 2016). It indicates the amount of variance explained by the exogenous variables (Amin et al., 2016). Thus, by using the repeated indicator approach for the second-order construct, the R^2 values are equal to 1 because the first-order constructs had already explained all the variance of the second-order construct.

3.4. Data collection

A purposeful sampling technique or judgmental sampling technique was used in this study. Samples were collected from wood & furniture agencies/associations as they can provide the most useful company information for assessing LM issues. Three sampling strategies were used in this study, namely: maximal variation sampling, homogeneous sampling, and snowball sampling. The survey was limited to only one respondent (organization was the unit of analysis) that had been in charge of LM implementation. A total of 177 wood & furniture companies participated in this study. However, only 46 companies had implemented LM practices.

4. Results and discussions

4.1. Sample size

Abdul-Rashid et al. (2017) by drawing on the sample size calculation for the application of PLS-SEM by Hair et al. (2014a), recommended a minimum sample size that is ten times the maximum number of arrowheads pointing at the latent variables. As this study uses three latent variables, the sample size is adequate as it surpasses the minimum requirements of 30 respondents. The sample size of this study (46 companies) was more than the minimum requirement.

4.2. Assessment of the measurement models

To assess the measurement model, two types of validity were examined which are CV and DV. The proposed models had an uneven number of indicators for the first-order constructs and used the Mode B repeated indicator approach with a path weighting scheme on the second-order constructs.

First, the CV was assessed using factor loadings (loadings > 0.5), composite reliability (CR > 0.7) and average variance extracted (AVE > 0.5). The results showed that all the reflectively measured constructs were above the threshold of 0.6 after the lower loading items, CCUL5 (0.554) were dropped to obtain better reliability and discriminant validity. Next, all the values for CRs had values above 0.8 and AVEs were higher than the critical value of 0.5.

Second, the DV was assessed using the HTMT method. The HTMT method was used because according to Henseler et al. (2015), the Fornell and Larcker (1981) criterion do not reliably detect the lack of discriminant validity in common research situations. The HTMT values were significantly lower than the cut-off of 0.9, which proved that the constructs were distinct from each other. Bootstrapping determines the significant difference of the HTMT value from 1.00 (Henseler et al., 2015). As shown in Table 2, the measurement model's results and HTMT discriminant validity surpassed the proposed values, hence suggesting adequate convergence validity.

Next, the measurement model of formative second level constructs was confirmed by the VIF and path weight (Table 3). The VIF values presented ideal VIF values (VIF < 3) which indicate that there are no multi-collinearity problems and ensure that there is no collinearity issue between the constructs' formative indicators. The indicators' weights were assessed by bootstrapping showing that all the statistical significances of weights were higher than 0.1, the *p*-value was below 0.01 and the 95% confidence interval (based on the BCa method) did not include zero.

4.3. Assessment of the structural models

To assess the structural model, Hair et al. (2019) suggested examining the coefficient of determination (R^2), the blindfolding-based cross-validated redundancy measure (Q^2), the statistical significance and relevance of the path coefficients. The structural model is presented in Figure 2.

By using the repeated indicator approach, all the variances of the higher-order construct R^2 were equal to 1 (Becker et al., 2012). This is because the R^2 indicated the amount of variance explained by the exogenous variables (Amin et al., 2016). Similarly, the root mean squared error (RMSE) value for the linear regression model is 0, indicating that the model lacks predictive power (because PLS-SEM < linear regression model for none of the indicators) (Shmueli et al., 2019). Thus, it is not appropriate to compare each of the indicator's RMSE value with the linear regression model value and to report the PLS prediction.

The Q^2 for challenges was 0.123, which is greater than 0 thus confirming the predictive relevance ($Q^2 > 0$ indicates adequate predictive relevance for the model (Amin et al., 2016). In addition, the Q^2 predicted value for challenges was 0.764. The Q^2 predicted value results interpretation was similar to the assessment of the Q^2 values obtained using the blindfolding procedure in PLS-SEM (Shmueli et al., 2019). The Q^2 predicted value was greater than 0 indicating that the model is superior to the most naïve benchmark (i.e. the indicator means from the analysis sample). The Q^2 values for challenges were positive thus indicating that the PLS-SEM models offer better predictive performance.

Next, the significance and relevance of the path coefficients were analysed. The results of the bootstrapping procedure with 5000 samples and using the no sign changes option (Shmueli et al., 2019) revealed that all of the structural model relationships were significant. Table 4 shows the structural model analysis. Specifically, significant statistical evidence was obtained for hypothesis H1b (CUL → Challenges, β= 0.484, p<0.01) in line with the outcomes in (AlManei et al., 2018; Khaba and Bhar, 2018). Similarly, strong and statistically significant evidence was found for H2b (KNW → Challenges, β= 0.387, p<0.01). This confirms the findings in previous studies which reported that the aspect of knowledge is the most influential factor for successful LM implementation (Chaple et al., 2018). Moreover, Abolhassani et al. (2016) reported a positive effect of knowledge for lean companies on the factors for failing to implement LM. Additionally, the findings indicated that the issue of resources has a positive effect on the challenges in implementing LM. This study obtained substantial support for hypotheses H3b (β= 0.361, p<0.01). This result is similar to that of Antony et al. (2012) and Khaba and Bhar (2018).

Overall, CUL, KNW and RES have a significant effect on the challenges antecedent constructs. More specifically, CUL has a significant and meaningful effect on companies (CUL; 0.484, p<0.01). The findings indicate that companies need to manage CUL issues to be successful in LM implementation. This is in line with the findings of Khaba and Bhar (2018). The authors indicated that there is a significant difference in CUL (change resistance) between the lean and non-lean firms. Conversely, the RES had the least meaningful effect and was much less pronounced for companies (RES; 0.361). This confirms the report of previous studies that RES has the lowest driving power for successful LM implementation (Chaple et al., 2018).

5. Discussion and recommendations

This research reveals that all the determinants in the CUL, KNW, RES are significant in LM implementation. Tests of CUL, KNW, RES (*H1- H3*) add to prior research in examining and classifying challenges in LM implementation and understand their importance to facilitate the smooth implementation of LM practices. Among all the determinants in the model, culture and human attitude related issues were found as the most influential determinant. The strong relationship is proven by the highest value of the direct effect between CUL and challenges when compared with other determinants. The following sub-sections discuss the results in reference to the relevant issue. Finally, the last paragraph elaborates on how the challenges can be overcome.

5.1. Culture and human attitude challenges

First, hypothesis *H1* relating CUL and challenges is supported; the relationship was found to be positive at the highest level of statistical significance. The significant relationship shows that companies still have a problem with culture reluctance and difficulty in gaining commitment and support to successfully implement LM.

This outcome does not support the findings by Panwar et al. (2015), which indicated that most Indian companies view scepticism and culture as insignificant factors to the non-implementation of LM. The Malaysian wood & furniture industry considered CUL issues as significant challenges in implementing LM. This is supported in literature whereby many companies were identified to be unable to adopt the total philosophy due to practical restrictions and cultural reluctance (Bamford et al., 2015). Adherence to the LM philosophy necessitates leadership commitment in creating a belief in the system towards successful transformation (Abolhassani et al., 2016). This is because LM is environmentally dependent on the culture (Bamford et al., 2015). The primary challenges in implementing LM entail employee attitude, backtracking to inefficient work methods as well as resistance to change (Sahoo and Yadav, 2018). Al-Aomar and Hussain (2018) cited technical and cultural challenges as hindrances to LM implementation in the hotel industry.

To tackle CUL challenges, a company must: (1) obtain commitment from employees, (2) obtain interest and support from the senior management, (3) manage any perceived scepticism, and (4) tackle the perception of difficulty to implement LM. Principally, the managers of LM companies cite employees as the actual barriers to change (Abolhassani et al., 2016). Over a period of time of LM implementation, companies will be confronted with shop floor resistance (Sahoo and Yadav, 2018). Because of that, employees are commonly referred to as the obstruction to successful LM implementation (Abolhassani et al., 2016). Thus, it is important for employees to feel that they are a part of their organization and to understand the significance of LM initiatives (Rymaszewska, 2014).

Next, poor management commitment and support could encourage a negative company-wide attitude, which in turn makes it challenging to nurture a continuous improvement mindset and culture in the organization (Antony et al., 2012). Meeting and event attendance, LM initiative engagements and noticeable implementation of employee ideas are some examples that show the senior management's interest and support. Moreover, employees must be given sufficient time in carrying out LM implementation or transformation projects further to training (Antony et al., 2012). This is because companies' management display a lack of leadership and the employees are still unconcerned with the LM transformation (Abolhassani et al., 2016). The LM transformation will fail because of the absence of key factors to sustain improvements such as leadership, communication, engagement and empowerment (Grove et al., 2010). Thus, solid management commitment and support are significantly crucial. Without the senior management's interest and support, the effort will be futile (Antony et al., 2012).

Difficulty in applying LM techniques is one of the various challenges in implementing LM (Abu et al., 2020; Al-Aomar and Hussain, 2018). From the LM practitioners' perspective, a high level of process variability makes VSM difficult as the employees are unable to converge on a common approach for specific tasks (Grove et al., 2010). Moreover, Abolhassani et al. (2016) highlighted their respondents' agreement about the difficulty of implementing continuous improvement programs. From the academicians' perspective, Bamford et al. (2015) emphasized that it would be too radical to fully implement LM throughout the entire process because of cultural reluctance. The authors presented a figure of the balance between total and partial adoption which is influenced by cultural reluctance, supplier unreliability and operational unreliability.

Therefore, companies will find that LM culture creation is a significant hurdle in implementing LM as it requires substantial organizational learning skills (Rymaszewska, 2014). An LM culture can be propagated through partnership programs and joint training (Al-Aomar and Hussain, 2018). Proper management is needed in adapting to the changing environment; otherwise, the organization will encounter major setbacks in implementing and sustaining the LM culture (Abolhassani et al., 2016). In conclusion, implementing LM requires the full commitment of both employees and management who should be fully aware of what is expected of them throughout the LM journey (Pearce et al., 2018).

5.2. Knowledge challenges

Second, hypothesis *H2,* relating KNW to the challenges is supported. The significant relationship shows that companies have inadequate knowledge of LM practices and lack LM awareness programs for their employees. This finding is in line with that of Sahoo and Yadav (2018) which indicated that there is still a lack of proper LM training, qualified LM experts and LM associations in aiding a fruitful implementation of the concept.

To tackle the challenges related to knowledge, the company must be responsible for increasing the employee and management's technical knowledge by providing training and carrying out awareness programs on the benefits of LM. There is constant misuse of LM practices due to poor knowledge and skills (Abolhassani et al., 2016). This can be attributed to the lack of LM experts (Panwar et al., 2015) particularly for SMEs that are in the initial stages of implementing LM (Sahoo and Yadav, 2018). Moreover, resource limitations in SMEs render the necessity for management knowledge (Pearce et al., 2018).

Training or case studies could be complemented with/implemented by new personal and internal teams with prior experience in LM projects (Pirraglia et al., 2009). This is because attaining the service of LM experts and providing LM training are also significant challenges in this endeavour (Panwar et al., 2015) apart from the employees' learning curve (Al-Aomar and Hussain, 2018). Nevertheless, it has to be done to convince managers and employees about the benefits of implementing LM (Pirraglia et al., 2009).

Consequently, the training and case studies will provide more tangible benefits for the employees such as reduced inventory, better floor-space utilization as well as improved quality and productivity. Thus, it could be inferred from this information that these companies will have to work hard to make their employees believe in the benefits of LM and that there is a better way in carrying out their job (Pirraglia et al., 2009).

5.3. Resources challenges

Third, the relationship between RES and the challenges was found to be positive and significant at a 1% level; thus, *H3* was supported. The significant relationship shows that companies have limited resources to implement LM effectively.

Sahoo and Yadav (2018) differentiated the resource challenges faced by companies in different stages of LM implementation. Small manufacturers that are new to LM implementation are likely to struggle with financial, technical and time constraints (Sahoo and Yadav, 2018) due to the lack of in-house experts to guide them in the LM process (Rymaszewska, 2014). During the transition phase (3-6 years), greater investments and effort are needed to tackle initial resistance and to position initiatives according to the prerequisites of the LM approaches (Sahoo and Yadav, 2018). The lack of LM knowledge and expertise may render the need for hiring LM consultants from external sources thus adding to the cost (Rymaszewska, 2014). Such investment is often rejected by the management due to the exorbitant fees involved (Sahoo and Yadav, 2018).

5.4. Proposed activities

Some researchers have discussed the challenges in implementing LM (Pearce et al., 2018; Sahoo and Yadav, 2018) of which solution requires changes in structure, system, process and employee behavior (AlManei et al., 2018). To overcome the challenges in LM implementation, further recommendations were done through what, how and why rules, which are; what activities must be done, how those activities can be executed, and why such goals should be achieved. The aims are to strengthen the CUL, KNW, RES factors by providing educational support in the form of training sessions, participation, coaching, and case study. Therefore, the plans projected in Table 5 are proposed to achieve these considerations.

5.5. Implications for researchers and practitioners

The present study possesses strong theoretical as well as practical contributions to the industries towards a successful LM implementation. Furthermore, this study is relevant to the current Malaysian government policy. The wood and furniture SMEs were selected because two of the National STIE Niche Areas were aligned with the national aspirations; 10-10 Malaysian Science, Technology, Innovation and Economy (MySTIE) Framework. First, the "Smart supply chain management for sustainable forest products" is aligned with the Agriculture & Forestry Socio-Economic Drivers (10-10 MySTIE). Second, the "Innovative Eco-products from waste" is areas that are aligned with the Environment & Biodiversity Socio-Economic Drivers (10-10 MySTIE).

Furthermore, this study contributes to the Key Economic Growth Activities (KEGA) 12 activity which is Green Economy. Green Economy refers to the creation of a circular economy that can operate without emitting waste. Clearly, the objective for waste elimination techniques implementation in Malaysia SMEs manufacturing industry is to eliminate all eight types of waste; transportation, inventory, motion, waiting, over-processing / extra processing, overproduction, defects and skills underutilized / non-utilized talent.

With the full support from the government, this will lead to a reduction in waste and a change in the attitude of workers and management. This will eventually lead to a higher quality of products and well-trained human resources. Furthermore, the implications of this study for researchers and practitioners are included in the following implications:

- Academic implications - contributing a theoretical and practical knowledge on the correlation between CUL, KNW, RES and challenges in implementing LM. It may strengthen the cutting-edge studies towards developing LM implementation roadmap. Although extensive literature is available on the challenges in implementing LM, fewer prior investigations have been reported to classify and understand the interactions among the determining factors. This research identified and classified key challenges which could make a valuable contribution to supporting the body of knowledge.

- Practical implications – presenting a systematic model for the implementation of LM based on analysis of challenges in CUL, KNW, RES related issues, which is vital for facilitating effective LM implementation. Several activities were proposed to overcome the ten dominant challenges and to facilitate smooth implementation of LM practice. This study would help wood & furniture SMEs, government agencies, professional bodies, and academics to better understand the challenges when implementing LM practices.

6. Conclusions and future research

In the present study, a conceptual framework for the challenges in LM implementation based on CUL, KNW, RES issues is proposed. Various determining factors which are focused on CUL, KNW, RES issues in LM implementation were reviewed. The conceptual framework focuses on classifying the challenges and understanding their importance in facilitating the smooth implementation of LM practices. The next step to this study will be the validation of the framework and executing proposed activities to overcome the challenges.

This study revealed that challenges related to CUL, KNW, RES are significant and have an impact on LM implementation. Ten determinants that are considered challenges under the CUL factor are namely, lack of employee commitment (1), lack of senior management's interest and support (2), difficulty to implement (3), LM is viewed as "current trend" (4); KNW: lack of technical knowledge (5), lack of training (6), lack of tangible benefits (7); and RES: lack of time (8), lack of financial resources (9), lack of labor resources (10). Interestingly, most of the companies disagree that backsliding to old ways of work is the main challenge to implement LM practice. Among all the determinants in the conceptual model, culture and human attitude related issues were found as the most influential determinant.

This study is not without any limitations, which suggest directions for future research. This study helps researchers and practitioners in identifying and understanding the challenges of anticipating SMEs needs. The challenges in LM implementation conceptual framework has been developed with three main LM implementation issues and eleven determining factors based on expert validation from the participation of 46 Malaysian wood & furniture companies in the 2018 Lean Management Program. Further research can address more factors; therefore, the future scope of this study can be widened in the identification of the more essential challenges and issues. Also, the barriers or reasons for not implementing LM also could be investigated because the LM practice has not been widely implemented by SMEs.

Despite extensive interest in researches related to challenges of LM implementation in the manufacturing industry, the view from the perspective of respondents with low awareness and knowledge on LM remains scarce. It is important to understand the challenges confronted by the industry in the Malaysian context to be considered for potential future research directions. Therefore, the present study aims to investigate the challenges of LM in the context of new digital technologies, especially in the post-Covid-19 era.

In formulating a holistic development programme, the main challenge is to analyse the capabilities of the SMEs based on the available and accurate data. A framework could be developed to provide a roadmap for LM implementation that will facilitate Malaysian wood & furniture SMEs to become globally competitive. The framework will help the government to formulate related action plans for the SMEs, especially with the unexpected impact of the Covid-19 pandemic on businesses. It has highly impacted the manufacturing sector and most of the SMEs are in a bleak business situation. Thus, SMEs will be able to reduce unnecessary costs, enhance understanding of the current market situation and customer conditions, prepare for the formulation of corresponding action plans, and look for new business opportunities.

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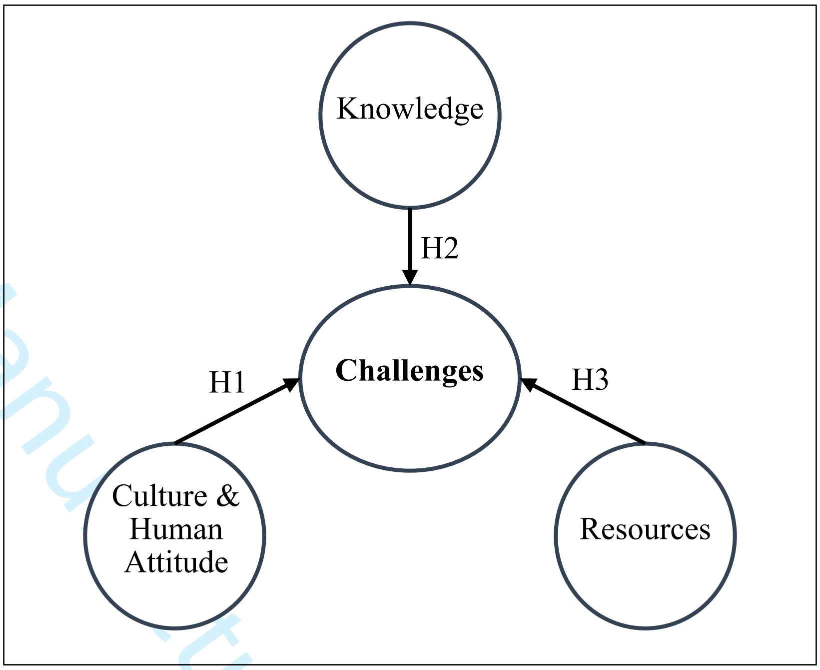
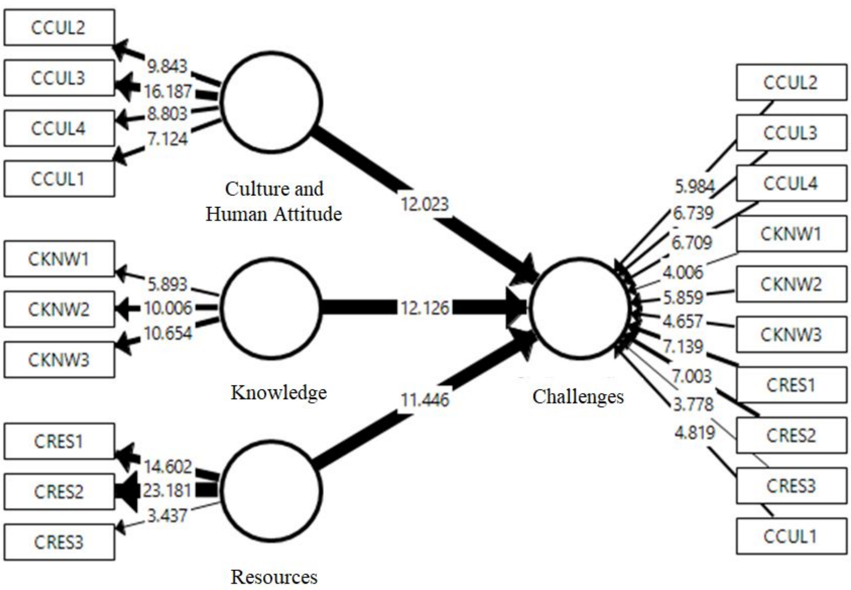


Figure 1: Conceptual model



Note: Hypothesis testing of bootstrapping procedure using 5000 resamples; inner model shows t-values; outer model shows t-values; and highlight path use relative values.

Figure 2: Bootstrapping results

Table 1: Summary of literature on challenges of LM implementation

Items	Sources
Culture and human attitudinal issues	Bajjou and Chafi (2018)
1. Lack of employee commitment	Abolhassani et al. (2016); Czabke et al. (2008); Gagnon and Michael (2003); Hogan (2007); Ray et al. (2006); Soetara et al. (2018); Vizzotto et al. (2015); Waurzyniak (2008)
2. Lack of senior management's interest and support	Antony et al. (2012)
3. Not easy to implement	Pirraglia et al. (2009)
4. Lean is viewed as "current trend"	Antony et al. (2012)
5. Backsliding to old ways of work	Pirraglia et al. (2009), Khaba and Bhar (2018), Sahoo and Yadav (2018); Waurzyniak (2008)
Knowledge	Abolhassani et al. (2016); Khaba and Bhar (2018); Secchi and Camuffo (2016)
6. Lack of technical knowledge	Abolhassani et al. (2016); DeLong et al. (2007); Gagnon and Michael (2003); Guerrero et al. (2017); Mo (2009); Rymaszewska (2014)
7. Lack of training	DeLong et al. (2007); Fricke and Buehlmann (2012); Panwar et al. (2015); Ray et al. (2006); Soetara et al. (2018)
8. Lack of tangible benefits	Abolhassani et al. (2016); Czabke et al. (2008); Fricke and Buehlmann (2012)
Resources	Panwar et al. (2015); Sahoo and Yadav (2018)
9. Lack of time	Pirraglia et al. (2009), Fricke and Buehlmann (2012); Panwar et al. (2015); Pirraglia et al. (2009); Ray et al. (2006); Soetara et al. (2018)
10. Lack of financial resources	Guerrero et al. (2017); Panwar et al. (2015); Ray et al. (2006); Rymaszewska (2014)
11. Lack of labor resources	Guerrero et al. (2017); Pirraglia et al. (2009)

Table 2: Measurement model and HTMT discriminant validity of first-order constructs (reflective)

Constructs	Items / Relation	HTMT	*p*-value	Loadings	CR	AVE
Culture and Human Attitude Issues	CUL					
Lack of employee commitment	CCUL1			0.687	0.844	0.577
Lack of senior management's interest and support	CCUL2			0.761		
Not easy to implement	CCUL3			0.844		
LM is viewed as "current trend"	CCUL4			0.738		
Backsliding to old ways of work	CCUL5			-		
Knowledge Issues	KNW					
Lack of technical knowledge	CKNW1			0.781	0.848	0.651
Lack of training	CKNW2			0.821		
Lack of tangible benefits	CKNW3			0.819		
Resources Issues	RES					
Lack of time	CRES1			0.832	0.836	0.632
Lack of financial resources	CRES2			0.869		
Lack of labor resources	CRES3			0.670		
Discriminant validity						
Knowledge → Culture and Human Attitude	KNW → CUL	0.610	0.001			
Resources → Culture and Human Attitude	RES → CUL	0.684	0.001			
Resources → Knowledge	RES → KNW	0.655	0.001			

Note: AVE = (summation of squared factor loadings) / (summation of squared factor loadings) (summation of error variances); CR = (square of the summation of the factor loadings) / [(square of the summation of the factor loadings) + (square of the summation of the error variances)] (Scholtz et al., 2016); To get better reliability and discriminant validity, lower loadings item CCUL5 (backsliding to old ways of work) were dropped.

Table 3: Measurement model of second-level constructs (formative)

Constructs	Collinearity (Inner VIF)	Statistical sig. of weights	*p*-value	Confidence intervals Lower	Upper
Culture and Human Attitude	1.445	0.484	0.001	0.435	0.566
Knowledge	1.437	0.387	0.001	0.344	0.443
Resources	1.526	0.361	0.001	0.313	0.412

Table 4: Structural model assessment

Hypothesis/Path	Path co-efficient (β)	Standard deviation	*t*-value	*p*-value	BCI Lower	BCI Upper	Support for hypothesis
H1: CUL → Challenges	0.484	0.041	11.770	0.001	0.436	0.568	Yes
H2: KNW → Challenges	0.387	0.031	12.383	0.001	0.350	0.457	Yes
H3: RES → Challenges	0.361	0.031	11.648	0.001	0.324	0.430	Yes

Table 5: Recommendations to overcome the challenges

How those activities can be executed?	Why such goals should be achieved?	What activities must be done?
Training	Training helps the organizational culture to change and guides the project team (Bhat et al., 2016). Sahoo and Yadav (2018) indicated that there is still a lack of proper LM training, qualified LM experts, and lean associations. Providing LM training is also a significant challenge in this endeavour (Panwar et al., 2015) apart from the employees' learning curve (Al-Aomar and Hussain, 2018). Prior to bringing the lean manufacturing concept to the shop floor, LM training programme was conducted for the employee (Kowalchuk, 2006). A LM culture can be propagated through partnership programs and joint training (Al-Aomar and Hussain, 2018).	Seminar Exhibition Workshop In-house lean training Awareness program
Participation	Meeting and event attendance, LM initiative engagements and noticeable implementation of employee ideas are some examples that show the senior management's interest and support (Antony et al., 2012). Dorsett (2006) suggested four learning approaches to enhancing employee productivity by experiment/doing, observing/participating, inquiring/consulting and analyzing/patterning.	Top management meeting On-factory intro Project preparation Project status review Project monitoring
Coaching	Lack of LM knowledge and expertise may render the need for hiring LM consultants from external sources thus adding to the cost (Rymaszewska, 2014). Attaining the service of LM experts is the significant challenges in LM transformation (Panwar et al., 2015) Small manufacturers that are new to LM implementation are likely to struggle with financial, technical and time constraints (Sahoo and Yadav, 2018) due to the lack of in-house experts to guide them in the LM process (Rymaszewska, 2014). Such investment is often rejected by the management due to the exorbitant fees involved (Sahoo and Yadav, 2018).	Guidance sessions Government initiative University collaboration External sponsorship Project consultation
Pilot study	Case studies or training could be complemented with/implemented by new personal and internal teams with prior experience in LM projects (Pirraglia et al., 2009). Employees must be given sufficient time in carrying out LM implementation or transformation projects further to training (Antony et al., 2012). Bamford et al. (2015) emphasized that it would be too radical to fully implement LM throughout the entire process because of cultural reluctance. Adherence to the LM philosophy necessitates leadership commitment in creating a belief in the system (Abolhassani et al., 2016).	Initial visit Initial implementation