International Journal of Business and Society, Vol. 23 No. 1, 2022, 260-278

THE MEDIATING ROLE OF CONTINUOUS IMPROVEMENT ON THE RELATIONSHIP BETWEEN WORKPLACE LEARNING DIMENSIONS AND SUSTAINABLE LEAN MANUFACTURING

Agnes Siang-Siew Lim[♣]
Faculty of Business, Design and Arts, Swinburne University of Technology, Malaysia

Surena Sabil
Faculty of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak, Malaysia

Abang Ekhsan Bin Abang Othman
Faculty of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak, Malaysia

ABSTRACT

The main objective of this paper was to study the mediating role of continuous improvement on the relationship between learning dimensions at the workplace and sustainable Lean implementations. Embedded systems, system connections and support leadership, were the learning dimensions included in this study. The participation in this study of eight Lean manufacturing companies based in Malaysia contributed to 219 survey responses from employees with a background in Lean. The presence of continuous improvement initiatives, as a mediator, was seen to significantly influence the relationship between the dimensions of workplace learning and sustainable Lean manufacturing in Malaysia. The empirical findings from this study can serve as a source of reference, not only for operational specialists but also for human resources practitioners and strategic leaders seeking sustainable Lean benefits. This research provides a synergistic approach between operations management and human resource practices to advance Lean-related interventions for future research or practical implementations.

Keywords: Lean manufacturing, Toyota Production System (TPS), Continuous Improvement, Kaizen, Workplace Learning, Sustainable Management.

Received: 27 June 2020
Accepted: 31 July 2021
https://doi.org/10.33736/ijbs.4612.2022

1. INTRODUCTION

The challenge of sustaining Lean initiatives is a global concern (Kelendar et al., 2020; Zahraee, 2016). There are two ways to conceptualise the term "sustain" in the existing literature regarding Lean implementations; by linking Lean initiatives to the perspective of the "triple bottom line" or maintaining long term stability in achieving successful gains through Lean initiatives (Madsen et al., 2019; Jørgensen et al., 2007). This study concentrated on the latter, which pays attention to the

♣ Corresponding author: Swinburne University of Technology, Jalan Simpang Tiga, 93350 Kuching, Sarawak, Malaysia. Email: aslim@swinburne.edu.my; agneslim0414@gmail.com

concepts of Lean, where continuous work towards perfection is the bottom line to achieve Lean maturity. The operating conditions in each Lean organisation are unlikely to be the same. Practically speaking, it is undeniable that many firms have adopted Lean initiatives to eliminate waste. Some firms have claimed that they have implemented Lean initiatives based on massive cost control and cost reduction practices, as management believed they should effectively and efficiently use their financial and human resources.

However, this study agreed with Comm and Mathaisel's (2005b) argument, which stated that these practices are not based on actual Lean thinking, but rather, such practices are guided merely by short-term, short-sighted savings. Some organisations have introduced Lean initiatives with insufficient sources of reference or guidelines in their operational contexts, and, thus, misunderstandings regarding real Lean principles have occurred. Confusion about true Lean concepts has often been one reason behind employees' resistance towards continuous improvement efforts in Lean firms (Aminuddin, 2018; Bakar et al., 2017; Papadopoulos, 2011; Zahraee, 2016). Angelis and Fernandes (2012) expressed their point of view from a similar perspective that operational decisions needed to achieve state-of-the-art Lean systems still lacked statistically valid guidance.

Not every Lean effort is sustainable (Cadden et al., 2020; Jayaraman et al., 2012, Leksic et al., 2020). Firms practising real Lean thinking must consider waste elimination and long-term value creation to ensure sustainable Lean benefits. Too great a focus on cost-cutting, and a lack of support for employee development, are potential reasons behind the failure of Lean initiatives. Similarly, some firms have not implemented Lean initiatives holistically. For instance, firms that have strictly followed the technical perspective of Lean as their core manufacturing approach, focusing mainly on the shop-floor level, have often forsaken the intellectual facet of human assets in their efforts to achieve operational excellence (Jørgensen et al., 2007; Hines et al., 2004; Yushak et al., 2018). Consequently, implementing Lean initiatives has often been easier than their sustainment (Ali et al., 2013; Bateman, 2005; Jadhav et al., 2014a; Jørgensen et al., 2007; Lindskog et al., 2016; Mohd-Zainal et al., 2011). It is essential to acknowledge that the sustainment of Lean initiatives involves efforts beyond just applying Lean tools and techniques (Jørgensen et al., 2007). Several other authors have supported the notion that human factors, related to employee learning and development, as well as the support of the leaders of Lean teams, have produced positive impacts for firms (Ali et al., 2013; Lindskog et al., 2016; van Dun & Wilderom, 2016; Zahraee, 2016). However, several Lean approaches still lack human integration (Hines et al., 2004; Lam et al., 2015).

Bateman (2005) pointed out a need to explore the theoretical gap between learning and Lean implementations. Moreover, Tan et al. (2019) suggested studying other dimensions related to employee knowledge and continuous improvement that affect Lean sustainment. This study has sought to produce contemporary findings to support Lean practitioners in their decision making. It has also sought to raise awareness and generate responsiveness among human resources practitioners as one of the strategic partners in making Lean implementations a successful journey, acknowledging the presence of such research gaps. Moreover, this study aimed to shed some light by pointing out specific significant predictors that might have been left out, unnoticed, disregarded, overlooked, or ignored in past studies carried out in Lean implementations. Therefore, the purpose of this study was to identify the mediating role of continuous improvement on the relationship

between workplace learning dimensions and sustainable Lean implementations within Lean manufacturing companies in Malaysia.

2. LITERATURE REVIEW

The review of related literature has suggested that most existing research papers have identified the linkage between workplace learning, continuous improvement and Lean implementations from different perspectives. However, it was found that the inter-relationships between workplace learning, continuous improvement and sustainable Lean implementations have not been thoroughly examined. Besides, little study has been carried out on Lean sustainability in the context of Malaysia. Therefore, this paper acknowledged the need to empirically identify the factors for Lean sustainment, as researchers from various disciplines have shown increasing interest in this study area.

2.1. Origin and development of Lean studies

Lean production management is a process of revolutionising the way perfection is conceptualised in human minds to achieve sustainable value creation through continuous waste elimination (Womack et al., 1990). Lean production was initially known as the "Toyota Production System" (TPS) when it was introduced by Eiji Toyoda and Taiichi Ohno in Tokyo, Japan (Raweewan & Kojima, 2020; Womack et al., 1990). Initially, Lean was named the "Respect for Humanity System", while others called it "The Thinking Way" (Jadhav et al., 2014b, p. 132). However, the interpretation of Lean manufacturing was somewhat limited until the book "The Machine that Changed the World" by Womack et al. (1990) was published. The work carried out by Womack et al. (1990) impacted the field of Human Resources (Barney & Clark, 2007).

Further interpretation has revealed that the value of trust and mutual respect has been the foundation for successful continuous improvement efforts in Lean firms (Ali et al., 2013; Angelis & Fernandes, 2012; Bateman, 2005; Hirzel et al., 2017; Raweewan & Kojima, 2020). Unfortunately, most empirical studies on Lean implementations have not paid much attention to the importance of employee learning (Jönsson & Schölin, 2014). Lean practices continue to evolve and extend their influence into different sectors across different regions. Literature regarding Lean practices from Malaysia (Minh et al., 2018; Muraliraj et al., 2019; Yushak et al., 2018) has shown consistent progress over recent years. Although the basic principles of Lean thinking originated from Japan, it is undeniable that active publication concerning Lean practices, from a Western perspective, would have somehow affected the development of global Lean initiatives, including the one in Malaysia. Therefore, this study aimed to verify current Lean practices with empirically supported evidence, as a point of reference or as guidelines, with higher credibility for practitioners and organisations implementing Lean, hoping that further applications would produce more significant chances of garnering positive, consistent, and sustainable results.

2.2. Workplace Learning

Several studies have confirmed that an effective learning culture will facilitate performance improvement under highly complicated and idiosyncratic business environments (Marsick & Watkins, 2003). The foundation underlying the concept of workplace learning in this paper was

derived from the assumption underlying Andragogy (Knowles, 1984). Andragogy, which is commonly known as the theory of adult learning by Knowles (1984), recognises the role of the learning situation rather than focusing solely on the learner's characteristics in the learning process (Merriam, 2001). Based on the learning dimensions proposed by Marsick and Watkins (2003), one crucial dimension of workplace learning for the sustainment of Lean programmes is embedded systems. Tortorella et al. (2020) found that embedded systems were partially correlated with Lean production. Specifically, operational areas involving "pull", "involve employees", and "productive maintenance". Besides setting up embedded systems to sustain Lean implementations at work, strategic partnerships and information sharing through employee's collaborative learning with external stakeholders across the supply chain are believed to enable employees to be more customer-focused and enhance employees' readiness to work with external industry players (Comm & Mathaisel, 2005a; 2005b; Jadhav et al., 2014b; Tortorella et al., 2020). Some recent literature (Gupta et al., 2019; Leksic et al., 2020; Oon et al., 2021) has also suggested that support from leadership is a possible factor for the success of Lean initiatives, which is worthy of further study. This study agreed with prior literature; without learning incorporated into Lean implementations, the sustainment of Lean efforts is nearly impossible, especially when employees are unclear concerning their roles for further engagement in the initiatives. These were the essential findings that motivated the direction of the current study.

2.3. Continuous improvement as a mediator

Imai (1986) conceptualised continuous improvement as 'Kaizen' and an innovative way of thinking. Continuous improvement has been acknowledged in numerous quality-related studies and Project Management Offices (PMO) for process improvement and productivity enhancement, which is imperative to support Industry 4.0. The justification behind developing the comprehensive theoretical insight in this study was grounded on the Resource-based Theory (RBT) by Barney and Clark (2007). The basis underlying the RBT was the work published in Penrose's 1959 book (Pitelis, 2009) on "The Theory of the growth of the Firm". Penrose's basic idea was then extended by Barney (1991) as the framework to clarify the paradox between services or capability and resources, which focuses more on long-term value creation. This framework is consistent with Lean studies, as both principles pursue the same goal, which is to create value for customers. The earliest work built on resource-based logic in Lean manufacturing is evidenced from "The Machine That Changed the World" by Womack et al. (1990). A continuous improvement culture that is successfully nurtured portrays the ideal representation of RBT application in practice. Barney and Clark (2007) proposed the need for further research to examine other sources of sustained competitive advantage that had not been thoroughly examined in their study.

Based on Barney and Clark's (2007) suggestions on extending the RBT through empirical study, this paper pursued the search for empirical evidence to support the role of embedded systems. A well-maintained IT system enhances learning and knowledge management at the workplace and its competitive implications on continuous improvement in Lean organisations. Embedded learning-enabled systems are identified as critical Cyber-Physical Systems (CPS) components that have a high potential to significantly contribute to the current development of smart manufacturing in Industry 4.0 (Sony, 2018). Sony (2018) also mentioned that embedded systems enabled Lean integration under Industry 4.0. Besides, previous literature has indicated that the development of information systems, such as; well-maintained knowledge and visual management systems, were

believed to assist learning, monitoring and encourage a higher level of inputs to support continuous improvement events (Eaidgah et al., 2016; Savolainen & Haikonen, 2007).

Furthermore, successful continuous improvement initiatives eventually lead to positive Lean implementations (Angelis & Fernandes, 2012; Chauhan & Singh, 2012; Tan et al., 2019). Since previous literature has supported the linkage between embedded systems and continuous improvement, while continuous improvement makes the sustainment of Lean implementations possible, it logically follows that continuous improvement mediates the relationship between embedded systems and sustainable Lean implementations. Hence, the following hypothesis was developed:

H_{a1}: Continuous improvement significantly mediates the relationship between embedded systems and sustainable Lean implementations within Lean manufacturing firms in Malaysia.

Similarly, previous research has supported that; creating learning alliances (Love & Gunasekaran, 1999), collaboration through Lean networking (Papadopoulous, 2011) and getting answers across the supply chain (Psomas et al., 2018) have exhibited impacts on successful continuous improvement programmes in Lean manufacturing firms. Inputs captured from learners' active collaborations across the supply chain are hypothesised as the primary source of improvement ideas needed for continuous improvement implementation, which would eventually lead to a significant impact on the sustainment of Lean. These findings strengthened the proposition that continuous improvement plays an essential role as a mediator that influences the relationship between system connections and the sustainment of Lean implementations, and thus, the formulation of the following hypothesis to be tested:

H_{a2}: Continuous improvement significantly mediates the relationship between system connections and sustainable Lean implementations within Lean manufacturing firms in Malaysia.

Consistent support from leaders towards continuous improvement activities has been supported by many researchers (Ali et al., 2013; Angelis & Fernandes, 2012; Bateman, 2005; Flor Vallejo et al., 2020; Hirzel et al., 2017; Unzueta et al., 2020). However, only a few studies have found that support from leadership has indicated a significant influence on increasing the chance of successful Lean implementations (Gupta et al., 2019; Leksic et al., 2020; Tortorella et al., 2020). Surprisingly, some other research papers (Orji & Liu, 2020; Tan et al., 2019) have reported otherwise. Due to the inconsistencies found in previous literature, this study found justifiable reasoning to support the formulation of the following hypothesis:

H_{a3}: Continuous improvement significantly mediates the relationship between support leadership and sustainable Lean implementations within Lean manufacturing firms in Malaysia.

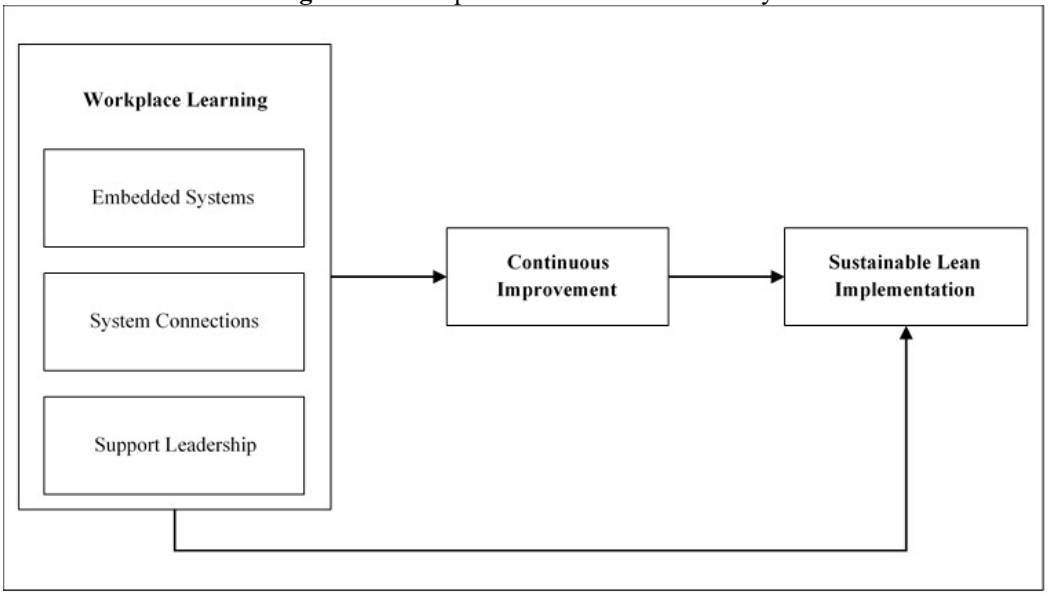
Sustainable Lean implementation enriches the knowledge system of an organisation, creating a flow of information derived from problem-solving experiences during continuous improvement projects. Eventually, the successful sustainment of Lean implementation is believed to enhance employees' learning and create more opportunities for future improvements. According to Barney and Clark's (2007) RBT framework, these capabilities are valuable, rare, and unique due to their specific application, which provides an imperfect imitable experience to employees, and, thus, can

be regarded as a source of sustained competitive advantage when retained within the organisational environment.

2.4. Conceptual Framework

The conceptual framework used in this study was formulated and modified based on the model proposed by Mohd-Zainal et al. (2011). The model proposed by Mohd-Zainal et al. (2011) suggested; the interrelationship between the elements from Marsick and Watkins (2003) Dimensions of Learning Organisation Questionnaire (DLOQ), continuous improvement and problem-solving behaviour as the criterion variables to explain Lean sustainability. Based on the earlier discussion concerning past literature, this study extended the role of continuous improvement as a mediator (see Figure 1). The dimensions adopted from the DLOQ (embedded systems, system connections and support leadership) were depicted as independent variables representing a single component, workplace learning, and sustainable Lean implementation was represented as the dependent variable of this study. The reasoning behind the rationale of this study which looked into the potential effect of continuous improvement as a mediating variable, was as a result of several previous studies (Ali et al., 2013; Angelis & Fernandes, 2012; Bateman, 2005), which proposed that active engagement in workplace learning had significantly led to continuous improvement. Furthermore, continuous improvement has also been proven to significantly impact Lean implementation (Angelis & Fernandes, 2012; Chauhan & Singh, 2012). Thus, there is reason to believe that there is a possibility that continuous improvement could explain the relationship between workplace learning and the sustainability of Lean implementations.

Figure 1: Conceptual Framework of the Study



Source: Mohd-Zainal et al. (2011); Marsick and Watkins (2003)

3. METHODOLOGY

3.1. Research design

This cross-sectional study aimed to identify the linkages between learning dimensions, continuous improvement and Lean sustainability within Lean manufacturing firms in Malaysia. A quantitative survey method was used to achieve the research objectives of this study. Surveying is an efficient and accurate (Zikmund et al., 2013) deductive approach (Saunders et al., 2009), which allows for the speedy collection of vast amounts of data to be carried out economically (Hair et al., 2011). A research questionnaire was administered to employees from eight Lean manufacturing firms registered with the Malaysia Productivity Corporation (MPC) for the data collection purposes of this study.

3.2. Instrument

A self-reporting survey questionnaire was conducted, which allowed a considerable amount of impartial information to be obtained while minimising bias (Psomas et al., 2018) and strengthening the representation of the research findings (Muijs, 2004). The questionnaire design was in the form of close-ended statements intended to offer respondents greater convenience when responding during their working hours, requiring minimal writing. The response format for the research questionnaire was in the form of a Five-Point "Likert-style rating scale", which required the respondents to indicate their degree of agreement (i.e., 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree) with a statement representing the variables that were tested in this study (Saunders et al., 2009). The questionnaire consisted of two parts. The first part consisted of 8 items on the respondents' demographic characteristics. In addition, as a control measure to collect meaningful data for this study, three close-ended items were included in the first part of the questionnaire to confirm the respondent's background in Lean. Among the questions asked to verify the respondent's Lean background included; (1) "Have you attended Lean Training"; (2) "Years of Lean experience or exposure at the workplace"; (3) "Continuous improvement (Kaizen) projects involvement".

The second part of the questionnaire covered the five variables examined under the scope of this study. The items representing dimensions of workplace learning used in the instrument of this study were adopted from Marsick and Watkins' (2003) DLOQ. This instrument was used in Jönsson and Schölin's (2014) study on workplace learning in an organisation adopting TPS, as well as other research related to learning at the workplace with an established level of reliability, and validated across various business and management contexts (Awasthy & Gupta, 2012; Yang et al., 2004). Continuous improvement is dynamic, and most practitioners have focused on different aspects of continuous improvement based on different organisational needs. Therefore, continuous improvement items for this study were adopted from several sources (see Table 1) based on the criteria proposed by the original author, Imai (1986). Lean sustainability items for constructing a research instrument in this study were adopted from Bhasin (2012; 2015) Lean assessment tool for "Lean Sustainability Audit" that set a standard for Lean organisations to measure their Lean maturity.

Table 1: Summary for the Questionnaire Source of References

Variables	Number of Item	Source of References
Embedded systems (ES)	8	Marsick & Watkins (2003)
System Connections (SC)	6	Marsick & Watkins (2003)
Support Leadership (SL)	9	Marsick & Watkins (2003)
Continuous Improvement (CI)	15	Sun et al. (2008) Bhasin (2011) Chauhan & Singh (2012) Ingelsson & Mårtensson (2014)
Sustainable Lean Implementation (SLI)	16	Bhasin (2012) Bhasin (2015)

Thirty sets of questionnaires were distributed during a pilot study to test the reliability of the questionnaire. The respondents involved in the pilot study were not included in the actual study. The pilot study results showed that all items achieved the minimum reliability requirements with a Cronbach alpha's value of 0.7 (Coakes et al., 2010; Muijs, 2004).

3.3. Data Collection

This study targeted a population of employees with a Lean background, currently working with Lean manufacturing firms in Malaysia. Data collection commenced by contacting the Human Resources Managers of prospective Lean manufacturing companies to obtain permission to carry out this study. A total of eight Lean manufacturing firms agreed to participate in this study. An estimated number of employees engaging in Lean was obtained from the respective organisations. According to Krejcie and Morgan (1970), the required sample size to represent the perceptions of the estimated population size, N=680, is n=248. Before the questionnaire was distributed, a brief description concerning the data collection procedures was communicated to the person-in-charge appointed to administer and assist the data collection process at the respective organisations. As a result, this study distributed 400 sets of the research questionnaire, which were voluntarily accepted by the respective organisations, as per their estimation of employees engaging in Lean. The researcher's contact information was included in the questionnaire. Follow-up calls to the person-in-charge of the questionnaire administration were made before the due date as a reminder to return the completed questionnaires. Returned questionnaires were screened. Out of 400 distributed questionnaires, 219 usable responses (response rate=54.75%) were analysed for hypothesis testing.

3.4. Data Analysis

The overall reliability statistics showed that the alpha coefficient values of the variables were higher than 0.70 (see Table 2), which signified that the variables in the questionnaires were reliable (Coakes et al., 2010; Muijs, 2004). Furthermore, the results of the factor analysis showed that all of the retained items exceeded the minimum standard for validity (see Table 2 and Table 3), which was set at 0.4 (Habtoor, 2016; Hair et al., 1995) and the Eigenvalues surpassed 1.0 (Zikmund et al., 2013). In addition, all of the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy values exceeded the absolute minimum of 0.6, and Bartlett's Test of Sphericity was statistically significant at $p \leq 0.05$ (Zikmund et al., 2013).

Table 2: Goodness of Data

Variables	Factor Loading	KMO	Bartlett's Test of Sphericity	Eigen Value	Variance Explained	Cronbach's Alpha
SLI	0.625-0.892	0.904	3171.036 (p=0.000)	8.958	74.468	0.947
CI	0.579–0.890	0.902	2103.125 (p=0.000)	7.755	68.169	0.932
ES	0.685–0.858	0.877	1234.814 (p=0.000)	5.224	65.297	0.923
SC	0.760–0.867	0.894	721.099 (p=0.000)	3.986	66.432	0.897
SL	0.803–0.885	0.921	1776.363 (p=0.000)	6.446	71.618	0.950

Table 3: Item Validity

Variables	Indicator	Factor loading
Sustainable Lean Implementations (SLI)	SLI 1	0.892
	SLI 2	0.884
	SLI 3	0.881
	SLI 4	0.852
	SLI 7	0.724
	SLI 8	0.783
	SLI 9	0.765
	SLI 11	0.625
	SLI 12	0.658
	SLI 13	0.645
	SLI 14	0.715
	SLI 19	0.824
	SLI 20	0.862
	SLI 21	0.726
	SLI 22	0.737
	SLI 23	0.732
Continuous Improvement (CI)	CI 1	0.780
	CI 2	0.890
	CI 3	0.805
	CI 4	0.579
	CI 6	0.746
	CI 7	0.800
	CI 8	0.788
	CI 15	0.648
	CI 17	0.761
	CI 18	0.797
	CI 19	0.768
	CI 20	0.727
	CI 21	0.665
	CI 25	0.615
	CI 27	0.640
Embedded Systems (ES)	ES 1	0.685
	ES 2	0.858
	ES 3	0.842
	ES 4	0.820

	ES 5	0.827
	ES 6	0.796
	ES 7	0.822
	ES 8	0.803
System Connections (SC)	SC 1	0.777
	SC 2	0.822
	SC 3	0.855
	SC 4	0.804
	SC 5	0.867
	SC 6	0.760
Support Leadership (SL)	SL 1	0.835
	SL 2	0.885
	SL 3	0.847
	SL 4	0.832
	SL 5	0.803
	SL 6	0.866
	SL 7	0.850
	SL 8	0.835
	SL 9	0.861

Notes: Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Regression analysis is one of the common approaches researchers use (Jönsson & Schölin, 2014; Tan et al., 2019; Zahraee, 2016) for hypothesis testing involving mediation (Lam et al., 2015; van Dun & Wilderom, 2016). Hypothesis testing of the mediation effect of CI on the relationship between the predictor and outcome variables in this study was carried out, based on the Baron and Kenny (1986) criteria:

1. The predictor variable must affect the mediator variable;
2. The predictor variable must affect the outcome variable;
3. The mediator variable must affect the outcome variable.

If the criteria mentioned above are met, then the effect of the predictor variable on the outcome variable in the direct model must be higher than in the mediation model. In addition, complete mediation is assumed, provided that the predictor variable does not affect the outcome variable when the mediator is controlled (Baron & Kenny, 1986). This study followed the Hayes (2013) bootstrapping method and the Sobel Test to test if the mediation was significant. This study's statistical inference for indirect effects was based on the normal theory-based Sobel Test, generated through the SPSS PROCESS analysis tool (Hayes, 2013). The SPSS PROCESS generates the indirect effect size, along with a 95% bias-corrected bootstrap confidence interval by default (Hayes, 2013).

4. RESULTS

Based on the findings of the hypotheses testing, ES (β=0.720, p=0.000), SC (β=0.653, p=0.000) and SL (β=0.660, p=0.000) were found to be significant predictors of CI, respectively (see Table 4). The empirical evidence from this study supported several existing studies which claimed that the dimensions that sustained employee learning at work, such as; investment in learning

technology and information systems (Savolainen & Haikonen, 2007), besides developing learning alliances (Love & Gunasekaran, 1999) through SC and SL (Habtoor, 2016; Lam et al., 2015; Unzueta et al., 2020) somehow positively affected CI in Lean firms. Therefore, the first condition proposed by Baron and Kenny (1986) was met.

Table 4: Regression analysis for the dimensions of workplace learning and CI

	CI		
Dimensions	**Unstandardised Coefficient, β**	**SE**	**Standardised Coefficient, Beta**
ES	0.720**	0.034	0.822**
SC	0.653**	0.040	0.745**
SL	0.660**	0.035	0.789**

Notes: **p<0.01.

Further analysis found that ES (β=0.628, p=0.000), SC (β=0.575, p=0.000), SL (β=0.565, p=0.000) and CI (β=0.831, p=0.000) significantly predicted SLI (see Table 5). The statistical findings of this study suggested that human factors (Zahraee et al., 2016), such as the development of employee learning, substantially contributed towards a sustainable Lean culture (Jørgensen et al., 2007). This study extended that CI was a significant predictor of Lean sustainment, parallel with previous findings (Angelis & Fernandes, 2012; Chauhan & Singh, 2012; Tan et al., 2019). Following Baron and Kenny (1986), the second and third conditions to establish the presence of a mediator were fulfilled.

Table 5: Regression analysis for the dimensions of workplace learning, CI and SLI

	SLI		
Dimensions	**Unstandardised Coefficient, β**	**SE**	**Standardised Coefficient, Beta**
ES	0.628**	0.042	0.716**
SC	0.575**	0.045	0.655**
SL	0.565**	0.042	0.674**
CI	0.831**	0.038	0.830**

Notes: **p<0.01.

Based on the statistical evidence of the hypothesis testing, the significant relationship between ES and SLI in the direct model (β=0.628, p=0.000) was no longer significant (β=0.091, p=0.120) with the presence of CI in the mediation model (see Table 6). Thus, the statistical findings derived that CI fully mediated the relationship between ES and SLI. In terms of explanatory power, CI in the mediation model explained 69.2% of the SLI's variance.

Table 6: Mediation test for CI on the relationship between ES and SLI

Dimensions	**Unstandardised Coefficient, β**
Direct Model (R^2=0.512)	
ES → SLI	0.628**
Mediation Model (R^2=0.692)	
ES → SLI	0.091
ES → CI	0.720**
CI → SLI	0.746**

Notes: **p<0.01.

Similarly, it was evident that the significant relationship between SC and SLI in the direct model (β=0.575, p=0.000) became insignificant (β=0.072, p=0.148) upon the inclusion of CI in the mediation model (see Table 7). Therefore, this study found sufficient evidence to support the statistical inference that the inclusion of CI as a mediator perfectly mediated the relationship between SC and SLI. As for explanatory power, CI in the mediation model explained 69.2% of the SLI's variance.

Table 7: Mediation test for CI on the relationship between SC and SLI

Dimensions	Unstandardised Coefficient, β
Direct Model (R^2=0.429)	
SC → SLI	0.575**
Mediation Model (R^2=0.692)	
SC → SLI	0.072
SC → CI	0.653**
CI → SLI	0.770**

Notes: **p<0.01.

Based on the results of further hypothesis testing, the significant relationship between SL and SLI in the direct model (β=0.565, p=0.000) appeared insignificant (β=0.043, p=0.401) upon the inclusion of CI in the mediation model (see Table 8). Therefore, sufficient empirical evidence supports that CI perfectly mediated the relationship between SL and SLI. In terms of explanatory power, CI in the mediation model explained 69.0% of the SLI's variance.

Table 8: Mediation test for CI on the relationship between SL and SLI

Dimensions	Unstandardised Coefficient, β
Direct Model (R^2=0.455)	
SL → SLI	0.565**
Mediation Model (R^2=0.690)	
SL → SLI	0.043
SL → CI	0.660**
CI → SLI	0.790**

Notes: **p<0.01.

As a result, this study found sufficient empirical support that CI mediated the relationship between the dimensions of workplace learning and SLI. To back hypotheses; H_{a1}, H_{a2} and H_{a3} with statistical evidence, this study proceeded with a bootstrapping analysis and the Sobel Test. Based on the results of the bootstrapping analysis, zero laid outside of the 95% confidence bootstrap intervals, which signified that the mediation was significant (see Table 9). Furthermore, the Sobel Test results supported the statistical inferences that CI significantly mediated the relationship between all dimensions of workplace learning and SLI (p<0.05). Therefore, this study found sufficient empirical evidence to support hypotheses; H_{a1}, H_{a2} and H_{a3}. In summary, this study achieved its primary objective with the support of empirical evidence, which showed that the probability of achieving successful implementations of Lean intervention was higher with the existence of CI together with the establishment of positive learning environments at work.

Table 9: Sobel Test for the Indirect Effects between the dimensions of workplace learning, CI and SLI

Dimensions	Indirect Effect	SE	95% CI Bootstrap		Sobel Test, p
			LB	UB	
ES	0.5371	0.0787	0.3815	0.6845	0.0000
SC	0.5024	0.0680	0.3734	0.6354	0.0000
SL	0.5212	0.0585	0.4156	0.6447	0.0000

5. DISCUSSION

Hypothesis H_{a1} was supported. The results of the hypothesis testing supported that CI significantly mediated the relationship between ES and SLI within Lean manufacturing firms in Malaysia. The current research findings were consistent with Savolainen and Haikonen's (2007) proposition that the development of ES was crucial for CI. Consequentially, CI significantly contributed to Lean sustainment (Angelis & Fernandes, 2012; Chauhan & Singh, 2012; Tan et al., 2019). A variety of information can be managed effectively using well-developed ES in Lean organisations. This aspect is crucial for CI integration into smart Lean manufacturing under Industry 4.0. Well-maintained visual management systems, made available to all employees through ES, are powerful Lean tools that assist learning, monitoring, and accountability, supporting CI events (Eaidgah et al., 2016). They contribute to operational performance and organisational performance in Lean manufacturing firms (Jayaraman et al., 2012). A well-maintained information system reassures transparency in reporting and allows Lean practitioners to keep track of CI progress in real-time, increasing the chance of Lean success. Therefore, from the RBT viewpoint, the statistical evidence from this finding supported that the integration of ES with CI initiatives was a source of competitive advantage that contributed towards the sustainment of Lean.

Hypothesis H_{a2} was supported. SC enabled employees to think holistically (Marsick & Watkins, 2003) and become more market-oriented, positively impacting Lean success (Cadden et al., 2020). Employees' involvement in CI develops their scientific mindset and resourcefulness in searching for solutions to get their work done. The empirical findings of this study supported Psomas et al. (2018) 's suggestion which encouraged employees to explore additional improvement ideas from the external environment for a sustainable Lean journey. Employees with system thinking were more innovative in idea generation and their learning approaches, proven to benefit CI (Papadopoulos, 2011). The author also recommended establishing a "Lean-favouring network", which creates a channel for Lean practitioners to effectively focus their improvement on the entire value chain to significantly impact the sustainment of Lean initiatives. This study agreed with Love and Gunasekaran (1999) that developing long-lasting learning alliances enables a climate of mutual trust and respect, consistent with the actual practice of Lean principles. Hence, the findings of this study empirically supported the development of SC alongside CI as a means to sustain Lean gains.

Hypothesis H_{a3} was supported. The empirical findings from the series of hypothesis testing cleared doubts that arose from previous inconsistencies reported in some literature. The findings of this study supported that leaders' commitment to developing learning at work was a significant enabler of CI (Unzueta et al., 2020; Flor Vallejo et al., 2020) and consequently contributed to successful Lean implementations. As a result, this study opposed other reported findings (Orji & Liu, 2020; Tan et al. 2019) with the justification for support from leaders to establish a controlled condition,

with calculated risk, encouraging a "blame-free" environment which is a significant aspect in developing a sustainable CI culture (Comm & Mathaisel, 2005a; 2005b; Gupta et al., 2019; Jadhav et al., 2014b; Jayaraman et al., 2012; Leksic et al., 2020). The support of leaders, which is employee-oriented, brings about a positive impact on the performance of CI projects and, thus, contributes towards the sustainment of Lean journeys. Overall, the empirical results of this study defended the claims (Habtoor, 2016; Jönsson & Schölin, 2014; Mohd-Zainal et al., 2011) that the probability of achieving successful implementation of Lean interventions was higher with the existence of a CI culture together with the establishment of a positive learning environment at work. Thus, the main objective of this study was met.

6. CONCLUDING REMARKS AND FUTURE WORKS

In summary, the empirical findings of this study supported the conceptual framework formulated earlier, which illustrated the overall motivation of this study. The research framework enlightened the role of human resource development in the sustainment of Lean implementation as a core competency that is rare and unavailable to rivals, besides being difficult to imitate. There are several significant findings from this study worth highlighting. Firstly, the findings of the Sobel Test provided empirical evidence that was sufficient to verify that CI played a significant role as a mediator that facilitated the relationship between workplace learning dimensions and SLI. Barney and Clark (2007) claimed that empirical tests were the most apparent extensions of the RBT. The empirical results in this study have contributed to the theoretical development of the RBT by providing significant evidence. They showed that the presence of CI as a mediator successfully nurtured from effective workplace learning practices, such as; ES, SC, and SL, depicted the ideal representation of RBT application in practice for Lean sustainment, as claimed by Jadhav et al. (2014a).

The results of the data analysis suggested that CI was a powerful Lean tool that could create a productive working culture if embraced successfully. Therefore, Lean practitioners seeking sustainable improvement should implement CI alongside developing employee learning, such as; investing in ES, promoting SC across the supply chain, and prioritising the SL towards directions that encourage learning and innovation at work. Lean leaders should embrace an authentic Lean culture that is more humanistic to develop long-term value creation, rather than practising the misrepresentation of Lean, as mean production (Aminuddin, 2018; Legge, 1998; Sisson, 1994), or merely a short-term cost-saving initiative (Hines et al., 2004).

These research findings can be an essential source for Lean manufacturers to develop effective learning cultures for long-term operational benefits. This study also revealed the significant impact of ES in Lean manufacturing firms operating under Industry 4.0. The integration of ES, which is learning-enabled, will benefit Lean manufacturing firms to enhance operational efficiency through successful Lean payoffs. This valuable finding accurately represents the technological influence that affects every production area in Lean manufacturing. From the empirical findings of this study, Lean firms should seriously consider integrating and upgrading their information systems to enhance their production capacity as a competitive strategy to survive the Industrial Revolution 4.0.

Besides, Lean leaders can extend their support to assist employees in collaborative learning by establishing channels to form learning alliances and network for sustainable CI efforts across the supply chain. The empirical findings generated through hypothesis testing in the current research have contributed to establishing an interconnectedness between the different schools of thought. They have assisted in formulating a synergistic strategy, incorporating operations management and human resource practices to pursue further advancement under Lean interventions. Consequently, this study has served its' purpose as a source of reference for operational specialists and human resources practitioners in developing their assessment frameworks when revisiting their audit criteria, be it for Lean maturity monitoring or keeping track of employees' learning capabilities under Lean initiatives. Overall, the objectives of this study were met, leading to further understanding of Lean applications and contributing to the empirical literature, from the context of Malaysia.

6.1. Limitations and Future Studies

The majority of academic research is constrained by its scope (Psomas et al., 2018; Habtoor, 2016; Lam et al., 2015); the current study is no exception. The sample of this study was selected from manufacturing firms implementing Lean practices in Malaysia. Therefore, the findings of this study may not be sufficient to be generalisable to the entire population of businesses operating under different sectors. Future research could consider pursuing similar studies to keep track of the progress of Lean implementations in other sectors, such as; healthcare (Lindskog et al., 2016) and financial services (Hirzel et al., 2017) operating in developing economies.

As Lean sustainability recognises the involvement of employees from various hierarchical levels, quantitative survey research was adopted to meet the purpose of this study. Although this research method enabled a considerable amount of data to be collected, restrictions regarding the depth of information gathered were unavoidable. Future research could replicate the current study by considering qualitative research methods to reveal more in-depth deliberations and obtain further insights into this study area.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to the reviewers for their constructive feedback to improve this paper.

REFERENCES

Ali, A. J., Islam, M. A., & Lim, P. H. (2013). A study of sustainability of continuous improvement in the manufacturing industries in Malaysia: Organisational self-assessment as a mediator. *Management of Environmental Quality: An International Journal, 24*(3), 408-426.

Aminuddin, M. (2018). *Human Resource Management: Principles and Practices* (4th ed.). Malaysia: Oxford Fajar Sdn. Bhd.

Angelis, J., & Fernandes, B. (2012). Innovative lean: Work practices and product and process improvements. *International Journal of Lean Six Sigma, 3*(1), 74-84.

Awasthy, R., & Gupta, R. K. (2012). Dimensions of the learning organization in an Indian context. *International Journal of Emerging Markets, 7*(3), 222-244.

Bakar, N. A. A., Mat, T. Z. T., Fahmi, F. M., & Urus, S. T. (2017). Lean management practices and its effect in Malaysian local government performance. *Asia-Pacific Management Accounting Journal*, *12*(2), 79-104.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99-120.

Barney, J. B., & Clark, D. N. (2007). *Resource-Based Theory: Creating and Sustaining Competitive Advantage*. New York: Oxford University Press.

Baron, R. M. & Kenny, D. A. (1986). The moderator mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psycology, 51*(6), 1173-1182.

Bateman, N. (2005). Sustainability: The elusive element of process improvement. *International Journal of Operations & Production Management, 25*(3), 261-276.

Bhasin, S. (2011). Measuring the leanness of an organisation. *International Journal of Lean Six Sigma*, 2(1), 55-74.

Bhasin, S. (2012). An appropriate change strategy for lean success. *Management Decision, 50*(3), 439-458.

Bhasin, S. (2015). *Lean Management Beyond Manufacturing: A Holistic Approach*. Switzerland: Springer International Publishing.

Cadden, T., Millar, K., Treacy, R., & Humphreys, P. (2020). The mediating influence of organisational cultural practices in successful lean management implementation. *International Journal of Production Economics, 229*, 1-12.

Chauhan, G., & Singh, T. P. (2012). Measuring parameters of lean manufacturing realization. *Measuring Business Excellence, 16*(3), 57-71.

Coakes, S. J., Steed, L., & Ong, C. (2010). *SPSS Version 17.0 for Windows: Analysis without Anguish*. Milton Qld 4064: John Wiley & Sons Australia, Ltd.

Comm, C. L., & Mathaisel, D. F. X. (2005a). A case study in applying lean sustainability concepts to universities. *International Journal of Sustainability in Higher Education, 6*(2), 134-146.

Comm, C. L., & Mathaisel, D. F. X. (2005b). An exploration study of best lean sustainability practices in higher education. *Quality Assurance in Education, 13*(3), 227-240.

Eaidgah, Y., Maki, A. A., Kurczewski, K., & Abdekhodaee, A. (2016). Visual management, performance management and continuous improvement: A lean manufacturing approach. *International Journal of Lean Six Sigma, 7*(2), 187-210.

Flor Vallejo, V., Antony, J., Douglas, J. A., Alexander, P., & Sony, M. (2020). Development of a road map for lean six sigma implementation and sustainability in a Scottish packaging company. *The TQM Journal*, *32*(6), 1263-1284.

Gupta, S., Modgil, S., & Gunasekaran, A. (2019). Big data in lean six sigma: A review and further research directions. *International Journal of Production Research, 58*(3), 947-969.

Habtoor, N. (2016). Influence of human factors on organisational performance: Quality improvement practices as mediator variable. *International Journal of Productivity and Performance Management, 65*(4), 406-484.

Hair, J. F. Jr., Anderson, R. E., Tatham, R. L., & Black, W. C. (1995). *Multivariate Data Analysis with Readings* (4th ed.). New Jersey: Prentice-Hall, Inc.

Hair, J. F. Jr., Celsi, M. W., Money, A. H., Samouel, P., & Page, M. (2011). *Essentials of Business Research Methods (2nd ed.)*. NY10017: Taylor & Francis.

Hayes, A. F. (2013). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. NY: The Guilford Press.

Hines, P., Holweg, M., & Rich, N. (2004). Learning to evolve: A review of contemporary lean thinking. *International Journal of Operations & Production Management*, *24*(10), 994-1011.

Hirzel, A., Leyer, M. & Moormann, J. (2017). The role of employee empowerment in the implementation of continuous improvement: Evidence from a case study of a financial service provider. *International Journal of Operations & Production Management, 37*(10), 1563-1579.

Imai, M. (1986). *Kaizen: (Ky'zen), The Key to Japan's Competitive Success*. US: McGraw-Hill Publishing Company.

Ingelsson, P. & Mårtensson, A. (2014). Measuring the importance and practices of lean values. *The TQM Journal, 26*(5), 463-474.

Jadhav, J. R., Mantha, S. S., & Rane, S. B. (2014a). Development of framework for sustainable lean implementation: An ISM approach. *Journal of Industrial Engineering International, 10*(3), 1-27.

Jadhav, J. R., Mantha, S. S. & Rane, S. B. (2014b). Exploring barriers in lean implementation. *International Journal of Lean Six Sigma, 5*(2), 122-148.

Jayaraman, K., Teo, L. K., & Keng, L. S. (2012). The perceptions and perspectives of Lean Six Sigma (LSS) practitioners: An empirical study in Malaysia. *The TQM Journal, 24*(5), 433-446.

Jönsson, S. & Schölin, T. (2014). Potentials facilitators of workplace learning in a TPS based company. *Journal of Management Development, 33*(10), 1004-1018.

Jørgensen, F., Mathiessen, R., Nielson, J., & Johansen, J. (2007). Lean maturity, lean sustainability. In J. Olhager and F. Persson (Ed.s), *IFIP International Federation for Information Processing: Vol. 246. Advances in Production Management Systems* (pp. 371-378).

Kelendar, H., Faisal, M., & Mohammed, M. A. (2020). The need for lean thinking in the Kuwaiti healthcare system. *Health Science Journal, 14*(2), 1-6.

Knowles, M. S., & Associates. (1984). *Andragogy in Action: Applying Modern Principles of Adult Learning*. London: Jossey-Bass Publishers.

Krejcie, R. V., & Morgan, D. W. (1970). Determining Sample Size for Research Activities. *Education and Psychological Measurement, 30*, 607-610.

Lam, M., O'Donnell, M., & Obertson, D. (2015). Achieving employee commitment for continuous improvement initiatives. *International Journal of Operations & Production Management, 35*(2), 201-215.

Legge, K. (1998). Is HRM ethical? Can HRM be ethical?. In M. Parker (Ed.), *Ethics and Organisations* (pp. 150-172). Sage, London.

Leksic, I., Stefanic, N., & Veza, I. (2020). The impact of using different lean manufacturing tools on waste reduction. *Advances in Production Engineering & Management, 15*(1), 81-92.

Lindskog, P., Vänje, A., Törnkvist, Å., & Eklund, J. (2016). Sustainable lean in psychiatry? assessment through socio-technical principles. *International Journal of Quality and Service Sciences, 8*(1), 53-71.

Love, P. E. D., & Gunasekaran, A. (1999). Learning alliances: A customer-supplier focus for continuous improvement in manufacturing. *Industrial and Commercial Training, 31*(3), 88-96.

Madsen, D. Ø., Berg, T., Stenheim, T., Moum, J. V., Bordewich, I. O., & Storsveen, M. (2019). The long-term sustainability of lean as a management practice: Survey evidence on diffusion and use of the concept in Norway in the period 2015-2017. *Sustainability 2019, 11*(11), 1-18.

Marsick, V. J., & Watkins, K. E. (2003). Demonstrating the value of an organisation's learning culture: The dimensions of the learning organisation questionnaire. *Advances in Developing Human Resources, 5*(2), 132-151.

Merriam, S. B. (2001), Andragogy and self-directed learning: Pillars of adult learning theory. *New Direction for Adult and Continuing Education, 2001*(89), 3-13.

Minh, K. S., Zailani, S., Iranmanesh, M., & Heidari, S. (2018). Do lean manufacturing practices have negative impact on job satisfaction?. *International Journal of Lean Six Sigma, 10*(1), 257-274.

Mohd-Zainal, A., Goodyer, J., & Grigg, N. (2011). *Organizational Learning to Sustain Lean Implementation in New Zealand Manufacturing Companies*. Paper presented at the 3rd International Conference on Information and Financial Engineering, Singapore. Retrieved from http://www.ipedr.com/vol12/27-C029.pdf

Muijs, D. (2004). *Doing quantitative research in education with SPSS*. London: SAGE Publications Ltd.

Muraliraj, J., Kuppusamy, S., Suhaiza Zailani, Santha, C. (2019). Lean, six sigma and its influence on potential and realized absorptive capacity. *International Journal of Lean Six Sigma, 11*(1), 84-124.

Oon, F. Y., Aziati, A. H. N. & Abu, A. S. E. (2021). Business Excellence, Leadership and Lean: A Systematic Literature Review. *International Journal of Business and Society, 22*(1), 332-345.

Orji, I. J. & Liu, S. (2020). A dynamic perspective on the key drivers of innovation-led lean approaches to achieve sustainability in manufacturing supply chain. *International Journal of Production Economics, 219*, 480-496.

Papadopoulos, T. (2011). Continuous improvement and dynamic actor associations: A study on lean thinking implementation in the UK National Health Service. *Leadership in Health Services, 24*(3), 207-227.

Penrose, E. (2009). *The Theory of The Growth of The Firm*. In C. Pitelis (Ed.). New York: Oxford University Press Inc. (Original work published 1959).

Psomas, E. Antony, J. & Bouranta, N. (2018). Assessing lean adoption in food SMEs: Evidence from Greece. *International Journal of Quality & Reliability Management, 35*(1), 64-81.

Raweewan, M. & Kojima, F. (2020). Digital lean manufacturing – collaborative University-industry education in systems design for lean transformation. *Procedia Manufacturing, 45*, 183-188.

Saunders, M., Lewis, P. & Thornhill, A. (2009). *Research methods for Business Students* (5th ed.). England: Pearson Education Limited.

Savolainen, T. & Haikonen, A. (2007). Dynamics of organisational learning and continuous improvement in six sigma implementation. *The TQM Magazine, 19*(1), 6-17.

Sisson, K. (1994). Personnel management: Paradigms, practice and prospects. In Sisson, K. (Ed.), *Personnel Management: A Comprehensive Guide to Theory and Practice in Britain* (pp. 3-50). Oxford OX4 1JF, UK: Blackwell Publishers.

Sony, M. (2018). Industry 4.0 and lean management: A proposed integration model and research propositions. *Production & Manufacturing Research, 6*(1), 416-432.

Sun, H., Ho, K. & Ni, W. (2008). The empirical relationship among organisational learning, continuous improvement and performance improvement. *International Journal of Learning and Change, 3*(1), 110-124.

Tan, O. K., Lim, K. Y., Ong, C. H., Goh, C. F., & Choi, S. L. (2019). Lean six sigma implementation: Does success means sustainability?. *International Journal of Academic Research in Business and Social Sciences, 9*(6), 907-914.

Tortorella, G. L., Fettermann, D., Miguel, P. A. C., & Sawhney, R. (2020). Learning organisation and lean production: An empirical research on their relationship. *International Journal of Production Research, 58*(12), 3650-3666.

Unzueta, G., Esnola, A., & Eguren, J. A. (2020). Continuous improvement framework to develop cultural change: Case study, capital goods company. *The TQM Journal*, *32*(6), 1327-1348.

van Dun, D. H., & Wilderom, C. P. M. (2016). Lean-team effectiveness through leader values and members' informing. *International Journal of Operations & Production Management, 36*(11), 1530-1550.

Womack, J. P., Jones, D. T. & Roos, D. (1990). *The Machine That Changed the World*. New York: Macmillan Publishing Company.

Yang, B., Watkins, K. E., & Marsick, V. J. (2004). The construct of the learning organisation; dimensions, measurement, and validation. *Human Resource Development Quarterly, 15*(1), 31-55.

Yushak, M. S., Dolah, R. & Bakar, N. A. (2018). Lean Principles Reduces Resistance to Change in Transforming A Shipyard Operations. *International Journal of Business and Society, 19*(2), 274-286.

Zahraee, S. M. (2016). A survey on lean manufacturing implementation in a selected manufacturing industry in Iran. *International Journal of Lean Six Sigma, 7*(2), 136-148.

Zikmund, W. G., Babin, B. J., Carr, J, C., & Griffin, M. (2013). *Business Research Methods (9th ed.).* USA: Cengage Learning.