Examining the Impact of Lean Manufacturing on Soft TQM Practices and Sustainable Performance: Evidence from Malaysian Industries

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Abstract

Sustainable Performance (SP) is a common goal for any manufacturing organization. In this regard a conceptual model is developed in this paper to investigate the impact of Lean Manufacturing (LM) on Soft TQM (STQM) practices and Malaysian industries SP. Little empirical studies are conducted in the developing economy of Malaysia to examine the interrelationships among these three (3) key Operations Management (OM) practices. The primary data which gathered from 329 Malaysian industries through a structured questionnaire were analyzed using techniques from Structural Equation Modeling (SEM). Findings from AMOS 22 program implied that two (2) hypotheses are supported which indicated that these are complementary practices. These are associated with LM and STQM and LM and SP. On the other hand, hypothesis related to STQM and SP relationship is not supported which implied that future researchers have to focus more on TQM tools and techniques.

Keywords: Lean, Soft TQM, Sustainable, AMOS, Malaysia

1. Introduction

Nowadays, numerous enterprises are trying to be lean and most of the industries are implementing Lean Manufacturing (LM) different tools and techniques, so they are known as lean enterprises [18]. Additionally, the new economic model developed by Alias et al. [1] comprised of three parts and sustainability is one of these. Generally, Operations Management (OM) contemporary literature reported perceived benefits from successful implementation of these practices. However, OM literature is filled with criticism regarding these three (3) initiatives. For instance, implementing TQM is not without difficulties and achieving its promised benefits is not an easy task [16]. Scholars are questioning if both LM and STQM are complementary or contradictory? And whether these practices can be integrated together in the same environment or not [2]. These practices are world class strategies which applied separately in the manufacturing industry. This paper tries to eliminate mentioned gap. Though, it contributes to OM literature by two folds; theoretically, by proposing the comprehensive conceptual model that links these practices and empirically by investigating this model through focusing on large sample in measured manufacturing sectors in Malaysia.

The next sections in this paper review the literature concerned with LM, STQM and SP. It describes the relevant findings of previous studies focusing on these initiatives. This is followed by developing the model and the design of this paper. Besides, results and hypotheses testing were introduced. The paper ends with showing the conclusion, future directions and recommendations.

2. Literature review

Literature in this paper is divided into different sub-sections. These are related to previous studies and criticism on three key OM practices namely LM, STQM, and SP. Specifically it focused on explanation the linkages and relevant studies among (i) LM and SP, (II) LM and STQM and (iii) STQM and SP. Next it shows the model developed and hypotheses based on these practices.

2.1 LM and SP linkage

Different scholars studied the relationship among both LM and SP. Currently; studies that investigated this linkage are growing rapidly [21]. For instance, Piercy and Rich [18] explored the broader sustainability benefits of LM operations and proposed that both are interlinked. Researchers [3] considered how LM fits with SP in terms of environmental or waste impacts and investigate corruption, supplier screening (including governance/labor standards), and local supply issues. They reported that there is no rigorous academic study investigating these practices together in the same model. Additionally, OM literature is filled with numerous misconceptions regarding LM and SP. For instance, the scholars (e.g. [8]) considered LM as only has an effect on waste reduction only. Others investigated LM as only JIT or QM initiatives [24]. Both strategic and operational approaches of LM and SP are available in the OM literature [11]. Researchers [9] discussed numerous LM and SP models; and examined the impact of LM and sustainable manufacturing to improve SP and show that there are potential benefits among these initiatives.

2.2 LM and STQM linkage

According to [19], the main reason for lacking of LM and TQM implementation is due to the absence of a uniform framework model that is appropriate for Malaysian environment. Researchers [4] considered that LM and TQM are driving variables and considered that Lean behavior drives TQM. In addition, they considered that Lean behavior is one of the tools that can be deployed to achieve TQM. They concluded that both are important areas which have attracted an immense interest among researchers and practitioners over last two decades. Aoun and Hasnan [2] investigated empirically the relationship between LM and TQM and found that lean practices have a significant and positive influence on soft TQM through standardization. They argued that lean production eliminates all non-value adding activities, supported by TQM standardization methods, in order to improve performance and drive organizations to innovation. In addition, they discussed that LM practices are essential to eliminate wastes and advance the quality of healthcare services through the standardization and continuous improvement strategies of TQM. In addition, a number of scholars have provided evidence that the combination of LM and TQM application was one of the more effective quality approaches in improving quality, cost, delivery [12] and revenue [13].

2.3 STQM and SP linkage

Researchers have examined the effects of TQM on organizational SP. Douglas [5] considered the importance of STQM for enterprises to utilize the human resources, and to create final products and services, though meeting customers' expectations and achieving sustainability. He considered that sustainability as a win-win-win situation. This means that company, staff, and economy can all win when practicing sustainability in proper manner. Zairi (2002) [23] that sustainability is a mean for an organization to maintain its competitiveness. Though, no sustainability is expected if there is no competitive advantage among enterprises. Idris [14] investigated the relationship between TQM and SP in Malaysian firms and used exploratory factor analysis and multiple regression in their analysis and extracted six factors for TQM and one factor for SP. Furthermore, Tan et al. [22] raised this question in their literature: "Can TQM improve the sustainability of family owned business?". Several studies have indicated a positive effect ([15]; [7]). Researchers [9] in their study in the eastern China reach the conclusion that the "soft" TQM elements contribute to overall performance. The integrated LM TQM model developed by [13] is investigated in HKSAR, China and Japan, thus he recommended that future research is needed to further show the model validity for global sustainability.

2.4 Model development and hypotheses

It proposed that LM is the driver for STQM and that STQM is the driver for SP in Malaysian Industries ([2]; [4]). The sequence (LM – STQM- SP) indicates the direct influence of LM effectiveness on SP aspects and the indirect effect of LM on SP through its direct effect on Soft TQM elements. The developed model proposed that this relationship among both LM and SP can be changed upon entering STQM. This model aids in the formulation and empirical analysis of previous issues, and also aims to guide the understanding of the concept in the area of quality management especially in the context of Malaysian manufacturing industries. LM is considered as the exogenous variable in terms of Structural Equation Modeling (SEM) concepts. The observed variable will be treated as the dependent variable in this paper which is the sustainable performance (SP). In other words, it is the criterion, the effects or result variable. In terms of SEM, it is called as the endogenous variable. In managing the direction of the analysis, and to clarify the debatable explanations on these practices, three (3) hypotheses are postulated from the developed model. The aim is to try to add a new confirmation to the knowledge on this topic when the SP dimensions were investigated. The developed model is depicted in Figure 1.

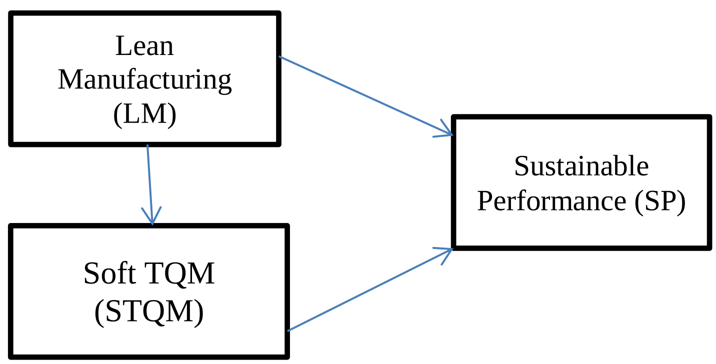

Figure1: Developed model

Referring to the developed model, the Postulated hypotheses are as follows:

H1: LM has positive relationship with SP practices in Malaysian industries
H2: LM has positive relationship with STQM in Malaysian industries.
H3: STQM Practices have positive relationship with SP in Malaysian industries.

3. Methodology

3.1 Design and sample selection

A structured closed questionnaire with five point's common Likert scale is used to measure the practices. Before designing the questionnaire, interviews with some respondents were carried out to examine if the model is applicable in Malaysian industries. The target population including all industry sectors is shown in Table 1. These companies were clustered based on Federation of Malaysian Manufacturers directory (FMM, 2015) [6] and SIRIM website (www. malaysiancertified.com.my)

In this paper, the designed questionnaire was sent to 900 respondents' managers as authors do not expect to receive 100 % response rate. Among these, 370 were returned. After removing the unsuitable missing questionnaires and outliers cases, 329 questionnaires were considered sufficient for analysis. Though, the resulting response rate is 36.5 % which is considered higher than the response rate for study implemented by Shah and Hussain [20] which is 30.4 %.

Table 1: Industries certified to ISO 9001

Stratum (Industry Type)	No.
manufacture of plastic products	**208**
manufacture of rubber products	**105**
manufacture of other nonmetallic mineral products	**196**
manufacture of electrical machinery and apparatus	**147**
manufacture of chemicals and chemical products	**272**
manufacture of basic metals and fabricated metal products	**384**
manufacture of food products and beverages	**157**
manufacture of machinery -automotive	**9**
manufacture of wood and wood products	**36**
manufacture of furniture	**31**
manufacture of paper and paper products	**85**
manufacture of printing, publishing, and reproduction of recorded media	**29**
manufacture of motor vehicles, trailers and semi- trailers	**29**
manufacture of machinery and equipment	**117**
manufacture of other transport equipment	**12**
manufacture of coke, refined petroleum products and nuclear fuel	**19**
manufacture of medical, precision and optical instruments, watches and clocks	**23**
manufacture of wearing apparel, tanning and leather	**19**
manufacture of textiles	**23**
manufacture of radio, television and communication equipment and apparatus	**52**
manufacture of Tobacco products	**3**
manufacture of office, accounting and computer machinery	**10**
Recycling	**3**
other manufacturing activities not elsewhere classified	**22**
Total	**1991**

3.2 Structural Equation Modeling (SEM)

Authors used Co variance based SEM (CB-SEM) Analysis of Moment Structure (AMOS 22) program for hypotheses testing in this paper as it is most relevant for the nature of this empirical study considering the large sample size affecting all measured manufacturing sectors in the different industry type in Malaysia. Besides, as the purpose here is to confirm the theories supporting the model, Confirmatory factor analysis (CFA) is used and reflected in terms of the measurement model for each latent construct separately. After finalizing the measurement model, the structural model is established and a hypothesis testing is conducted.

4. Results

Results in this paper include testing the three formulated hypotheses as per the developed model. Techniques from SEM were utilized for this purpose.

4.1 Measurement model for LM

LM construct (original 64 items) has been factored into seven components as a result of PCA. In this paper, authors analyzed the measurement model for LM through using CFA to assess the meaningfulness of items in measuring LM construct. LM initial CFA model consists of 26 items entered to AMOS program to confirm factor analysis. Results show that the fitness indices are not achieved as normed chi square equals 12.936, CFI equals 0.424 and RMSEA= 0.191. This indicates that initial CFA model to be updated and refined to get better model fit. Researcher checked that factor loadings are less than 0.5 for the followings LM items: LM 30, LM28, LM27, LM26, LM 24, LM 21, LM 20, LM19, LM 17, LM14, and LM1. These items were discarded from further analysis as they are not related to LM construct. After deleting items with low factor loadings, still the model fit is not achieved and there are five items namely LM2, LM3, LM4, LM 12 and LM 13 have low factor loadings estimated with 0.39, 0.40, 0.40, 0.37 and 0.39 respectively for these five items(Figure 2a).

Additionally, authors examined MI from AMOS output, and noticed that still factor loadings are low for items LM 58, LM57 and LM56. These were removed from analysis. Based on MI results the following correlations were done to try get better results; item LM58 (error 1) and item LM57 (error 2); item LM58 (error 1) and item LM56 (error 3); item LM57 (error 2) and item LM56(error 3); item LM 55 (error 4) and item LM 39(error 5); item LM39 (error 5) and item LM38 (error 6); item LM 37 (error 7) and item LM 36(error 8) ; item LM 33(error 9) and item LM31(error 10). This is depicted in Figure 2a. The final revised CFA for LM shows an acceptable fit indices as normed chi square = 3.212, CFI = 0.989, RMSEA = 0.08. In addition, factor loadings are acceptable which satisfy the uni-dimensionality of the measurement model for LM (Zainudin [23]). Final refined CFA for LM is depicted in Figure 2b.

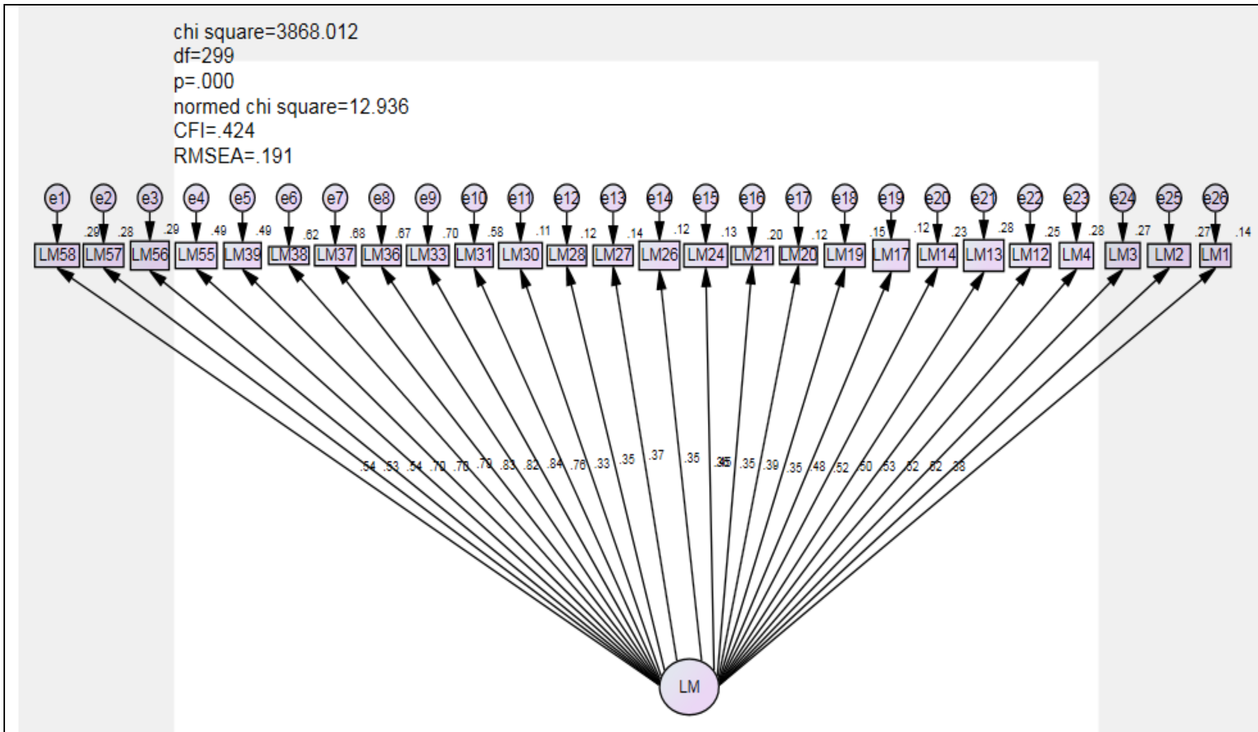

Figure 2a : Hypothesized initial CFA for LM

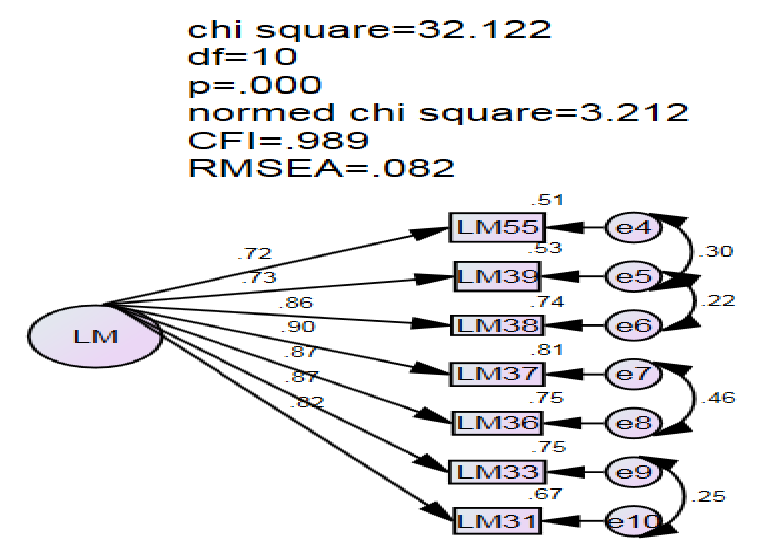

Figure 2b : Final refined CFA for LM

4.2 Measurement model for STQM

STQM construct (original 20 items) has been factored into three components as a result of PCA. The initial hypothesized CFA for STQM model as it depicted in Figure 3a shows that fitness indices are not achieved as normed chi square = 14.453, CFI= 0.715, and RMSEA= 0.203. This needs improvement of the model to obtain an acceptable values and better model fit. Instead of writing STQM for each item in CFA and to simplify analysis process, researcher coded items as ST1 to represent item STQM1, ST2 to represent item STQM2 and so on for the remaining items. Authors examined that three items namely ST17, ST18 and ST19 have low factor loadings, and these were discarded from further analysis.

However, the revised CFA model after deletion of the three items shows that both normed chi square and RMSEA values did not achieve the threshold values. These have values of 8.838 and 0.1555 respectively. CFI achieve the fit indices which has value of 0.915. In addition, to improve the model fit, researcher examined MI and the followings were correlated; item ST8 (error 5) and item ST9 (error 6), item ST3 (error3) and item ST4 (error4), ST1 (error1) and ST2 (error 2). The revised model shows that fitness indices were achieved as values of normed chi square, CFI and RMSEA are acceptable. In addition, factor loadings are achieved, though seven items for STQM were retained for further analysis. Final revised CFA for STQM is depicted in Figure 3b.

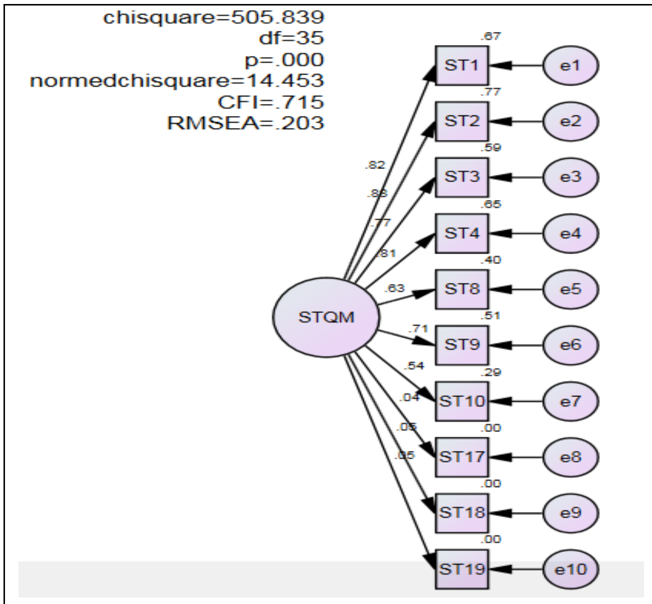

Figure 3a: Initial hypothesized CFA- STQM

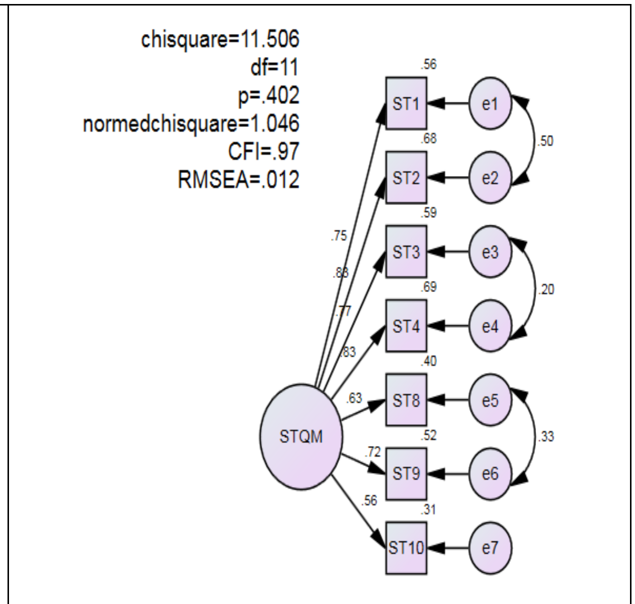

Figure 3b: Final revised CFA- STQM

4.3 Measurement model for SP

SP latent construct (original 22 items) has been factored into three components as a result of PCA. Thirteen (13) items were entered in AMOS program to examine CFA for SP. The initial hypothesized CFA model as it depicted in Figure (4a) showed that fitness indices were not achieved as Normed chi square value equals 10.58 and RMSEA equals 0.17. However, CFI = 0.97 performs good result. Additionally, the initial CFA shows that factor loadings are low for the following items: SP1, SP2, SP8, SP10, SP21, and SP22. Researcher decided that these items to be discarded from analysis in order to try to improve goodness of fit indices.

However, the revised model also shows that normed chi square = 12.194 does not achieve the threshold value, CFI =0.97 and RMSEA= 0.185. In addition, factor loading for both SP9 =0.40 and SP20 =0.46 is low. These were discarded from further analysis to improve the model fit. Authors checked modification MI and the followings were correlated; item SP3 (error 3) and item SP4 (error 4), item SP17 (error 9) and item SP18 (error10), item SP3 (error3) and item SP18 (error10). After doing these steps, final refined model achieved fitness indices. However, factor loading for item SP 18 = 0.48 is deleted as it is below 0.5. The final measurement model for SP which contains four items having acceptable factor loadings is depicted in Figure (4b)

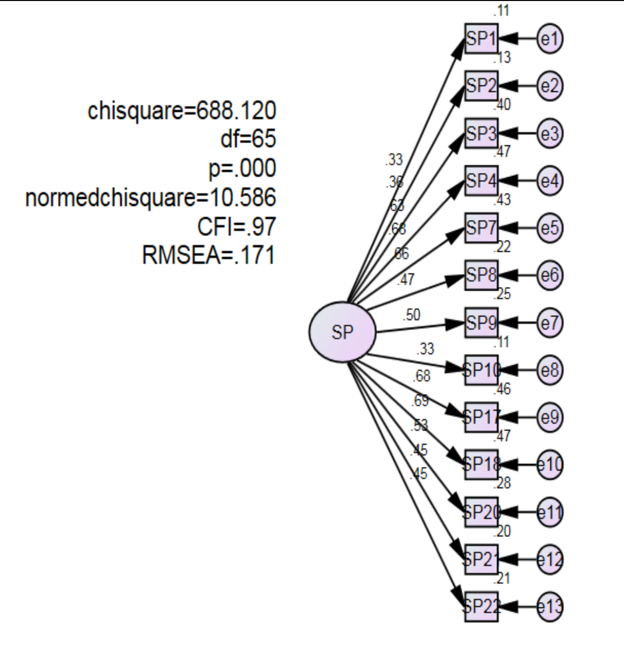

Figure 4a: Initial CFA- SP

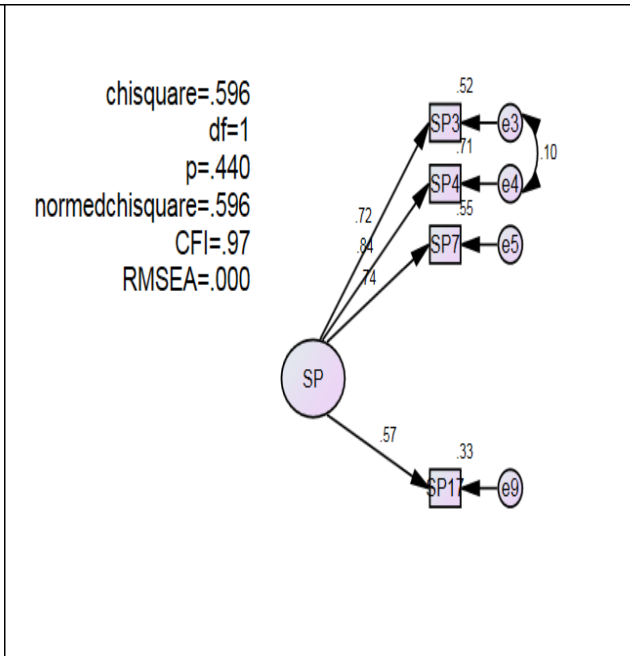

Figure 4b: Revised final CFA – SP

4.4 Structural model and hypothesis testing

The final revised full- fledged structural model shows that all normed chi square, CFI and RMSEA have achieved the threshold levels. These have values of 1.551, 0.968 and 0.041 respectively. Additionally, factor loadings for all items are acceptable. Thus, it is validated model. Results of hypotheses testing are shown in Table 2.

Table 2: hypotheses testing (direct effects)

Hypothesis	construct		construct	β standardized	Estimate	S.E.	C.R	P-Value	Result
H1	LM	→	SP	0.35	0.30	.077	3.89	.032	significant
H2	LM	→	STQM	0.2	.231	.056	4.125	***	significant
H3	STQM	→	SP	0.032	.017	.093	.181	.856	Not significant

Note: Significant Relationship = Supported hypothesis , Not Significant relationship = Not supported hypothesis
C.R= Critical Ratio = Z value; S.E= standard error; P-value = probability level.

5. Conclusion and recommendations

The developed model is empirically examined in the Malaysian industries. As results indicated, two hypotheses were statistically and practically significant, hence, both are accepted. These are: Hypothesis 1 for the linkage between LM and SP, and Hypothesis 2 for the linkage between LM and STQM. The third hypothesis regarding the association among both STQM and SP is not supported in this paper. This could be due to fact that there are other factors which are necessary to be implemented and considered by manufacturers concerned with the technical side of TQM; in other words, it is hard aspects of TQM. This paper proved and showed that both LM and STQM are complementary to each other, and their integration can enhance the sustainability initiatives in the Malaysian environment. This is vital as the country needs to be an industrialized nation and improves its financial sustainability and economy. Besides, taken into consideration the other components of SP namely the environmental and social aspects. Authors recommend that future research can be done on investigation hard TQM aspects in terms of the developed model. As one of the limitations of this study is focusing only on the manufacturing sector, other scholars can conduct this study on the services companies to examine the model applicability.

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