The relationship between sustainable manufacturing practices, lean improvement and performance

Nurul Fadly Habidin*

Department of Management and Leadership,
Faculty of Management and Economics,
Universiti Pendidikan Sultan Idris,
35900 Tanjung Malim, Perak, Malaysia
Email: fadly@fpe.upsi.edu.my
*Corresponding author

Anis Fadzlin Mohd Zubir and
Nursyazwani Mohd Fuzi

Department of Accounting and Finance,
Faculty of Management and Economics,
Universiti Pendidikan Sultan Idris,
35900 Tanjung Malim, Perak, Malaysia
Email: anysfadzlyn@gmail.com
Email: nursyazwanimohdfuzi@yahoo.com

Mad Ithnin Salleh

Department of Management and Leadership,
Faculty of Management and Economics,
Universiti Pendidikan Sultan Idris,
35900 Tanjung Malim, Perak, Malaysia
Email: mad.ithnin@fpe.upsi.edu.my

Abstract: The purpose of this study is to examine the relationship between sustainable manufacturing practices, lean improvement, and performance in Malaysian automotive industry by using structural equation modelling technique. Survey questionnaires were used among 227 managers in Malaysian automotive industry. SEM technique was used to test the statistical analysis of the data required in the study. Based on the results, sustaining lean improvement is part of a mediating relationship between sustainable manufacturing practices and performance which is positive results. For this purpose, it assists academicians and researchers for sustainable manufacturing practices implementation in order to assist the automotive industry to increase lean improvement and performance.

Keywords: sustainable manufacturing practices; lean improvement; performance; manufacturing process; environmental management; social responsibility; continuous improvement; reliability; structural equation modelling; automotive industry.

Reference to this paper should be made as follows: Habidin, N.F., Zubir, A.F.M., Fuzi, N.M. and Salleh, M.I. (2020) 'The relationship between sustainable manufacturing practices, lean improvement and performance', *World Review of Entrepreneurship, Management and Sustainable Development*, Vol. 16, No. 1, pp.92–107.

Biographical notes: Nurul Fadly Habidin is a Senior Lecturer at Universiti Pendidikan Sultan Idris, where he teaches industrial management and business. His main research interests are lean, six sigma, quality/business engineering, and environmental management accounting.

Anis Fadzlin Mohd Zubir is a Master student of Management Accounting at Universiti Pendidikan Sultan Idris. Her main research interest is sustainable manufacturing practices and lean in automotive industry..

Nursyazwani Mohd Fuzi is a PhD student of Management Accounting at Universiti Pendidikan Sultan Idris. Her main research interest is environmental management accounting in manufacturing industry.

Mad Ithnin Salleh Vol. 16, No. 1,is a Senior Lecturer at Universiti Pendidikan Sultan Idris, where he teaches strategic management. His main research interests are productivity studies.

1 Introduction

The development of entrepreneurship, in terms of concept and activity, has been growing in Malaysia. Dana (1999) stated that the importance of entrepreneurship and business, especially in the industry. This is due to entrepreneurship is an activity, process and concept that involve business activities. In Malaysia, small business and entrepreneurship is important for industrial policies. Besides, small business and entrepreneurship is important to increase poverty and restructure, particularly in the environment through government policies (Dana, 1987a). In addition, the entrepreneurial may affect the continued or existence of the organisation. Some researcher has indicated the effect of entrepreneurial environments on entrepreneurship and venture creation (Dana, 1987b; Ahmad and Xavier, 2012; Dana, 2014). It shows that the entrepreneurship is important for venture creation.

According to Abdullah and Muhammad (2008), entrepreneurship activities are important, especially with the government policies and government-supported in the automotive industry. Automotive industry plays an important role in assisting the development of the local automotive industry. In order to achieve one of the National Automotive Policy (NAP) objectives, this study is to encourage a sustainable domestic automotive industry, particularly in the local automotive industry. Thus, the automotive industry is seen as the main sectors to improve the growth.

Thus, sustainable manufacturing practices (SMPs) can be implemented in Malaysian automotive industry in order to improve the performance. The purpose of this study is to examine the relationship between SMPs and sustainable performance (SP) for Malaysian automotive industry through the acting of sustaining lean improvement (SLI) in order to assist the organisation both locally and internationally to sustain the performance. Each

element should be used to develop a research model on the quality initiatives of SMPs, SLI, and SP criteria and sub-criteria in Malaysian automotive industry. With this quality model, it can assist the organisation to obtain a better understanding in managing change for successful quality initiative's implementation, where the improvement should have been made and provide structured guidelines in vendor evaluation.

Research by Dues et al. (2013) environmental aspects focused on sustainable development and to reduce ecological impact of industrial activities through elimination of waste and pollution. Environmental aspects can reduce the environmental risks and improve the ecological efficiency. SMPs related to environmental sustainability in order to improve the performance (Kara et al., 2014; Garza-Reyes, 2015; Aly and Mansour, 2017; Ohkita, 2017). SMPs have important implications for industrial, which can develop the knowledge on sustainable for improving the environment sustainability (Goyal et al., 2015).

Having described SMPs concept and philosophy, techniques and performance measurement, the next issue which needs to be described is SLI and its concept. Generally, lean is the automobile manufacturing technique of the Toyota Motor Corporation which has achieved outstanding success rates for more than 40 years (Beck and Britzelmaier, 2013; Sisson and Elshennawy, 2015). Despite the wide knowledge and available resources, Taj (2008) noted that lean means manufacturing without waste including a minimum amount of equipment, resources, parts, and working time that are necessary to production (Arumugam et al., 2012; Thanki and Thakkar, 2014). Schlichting (2009) and Ali et al. (2013) provided the key elements to sustain lean improvements namely standard work, employee involvement, and continuous improvement included basic tools which are linked to the individual aspects in attempt to ensure the sustainability of these improvements. Moreover, the elements set by Sajan et al. (2017) was agreed upon and supported as a comprehensive element of SLI.

In this view, SP measurement can be considered as one of the most important element in the SMPs and SLI implementation. Hence, it would enable organisations to provide the performance, particularly for SP (Bai et al., 2012; Gadenne et al., 2012; Fuzi et al., 2013; Habidin et al., 2013; Abdul-Rashid et al., 2017). Overall, this change would ultimately assist firms to improve their financial performance.

Finally, in order to increase the understanding of this subject area, this research concentrates on studying the relationship between SMPs, SLI, and SP in Malaysian automotive industry. Therefore, the aim of this study is to examine the relationship between SMPs, SLI, and SP in Malaysian automotive industry.

2 Literature review

2.1 Research hypotheses

To understand the relationship between SMPs, SLI, and SP in Malaysian automotive industry, the research hypotheses are based on H1 to H4 using SEM techniques.

Most of the authors show the relationship between SMPs and SP. Rusinko (2007) mentioned that the relationship between SMPs and SP in the US. The results show that SMPs has positively with environmental performance. According to Rosen and Kishawary (2012) and Zubir et al. (2012), SMPs can improve sustainability, profitability,

productivity in order to increase company's goals, particularly for Malaysian automotive industry.

Kaebernick et al. (2003) noted that SMPs implementation is a tool of product development. The implementation of SMPs can assists to the new market especially for Malaysian automotive industry. This is supported by Gunasekaran and Spalanzani (2011) pointed out SMPs provides a competitive advantage and new market in order to improve SP. In relation to that, SMPs and SP are more important for improving the performance. This hypothesis is discussed as follow:

H1 There is a positive relationship between SMPs and SP in Malaysian automotive industry.

The relationship between SMPs and SLI has increased debates in the research. Laosirihongthong and Dangayach (2005) stated that by implementing SMPs, the companies can achieve effectively in sustainable development. A company should continuous improvement in order to improve sustainable development (Thomas et al., 2012; Ratnayake and Chaudry, 2017). Besides, SMPs and SLI should accompany for improving the performance in Malaysian automotive industry.

Herron and Braiden (2006) developed a model to describe a positive relationship between SMPs in Nissan Motor Manufacturing UK. The finding shows a positive relationship between SMPs and SLI. Furthermore, the automotive industry demonstrated a good performance with operations, processes, and sustainable management. This is supported by Pakdil and Leonard (2015) who stated that SLI implementation is to enhance efficiency, effectiveness, and productivity. Therefore, this discussion formulated to this hypothesis:

H2 There is a positive relationship between SMPs and SLI in Malaysian automotive industry.

The relationship between SLI and SP is important to improve the performance in Malaysian automotive industry. From the implementation of SP, Hofer et al. (2012) stated the relationship between SLI implementation and SP. The impact of SLI is to be partially mediated on SP. Furthermore, there is a positive relationship between SLI and SP (Piercy and Rich, 2015). SP as indicated by Groen et al. (2012) has shown that the performance can enhance cost savings, quality improvement, market share, employee involvement, and customer satisfaction (Tang and Tang, 2015; Ho et al., 2017). It shows that the positive relationship between SP can improve with the SLI. Hence, the SLI benefits can affect to environmental performance (Piercy and Rich, 2015). Another study by Habidin et al. (2014) found that social performance is also positive relationship related to lean improvement in order to enhance the SLI.

Therefore, the relationship between SLI and SP in Malaysian automotive industry can be examined for this study. The following hypothesis is formulated:

H3 There is a positive relationship between SLI and SP in Malaysian automotive industry.

Previous studies highlight SMPs and SLI focused on sustainable development, sustainable management, and environmental management (Comoglio and Botta, 2012; D'Agostini et al., 2017), lean management and quality management (Karim and

Arif-Uz-Zaman, 2013; Abdullah et al., 2017) and sustainable manufacturing and improvement activities (Abdul-Rashid et al., 2017; Randhawa and Ahuja, 2017).

Adebanjo et al. (2016) studied SMPs are one of the significant environmental management taken by manufacturing industry to improve the environment and the quality management while performing SP. However, there is a lack of studies focused on the relationship between SMPs, SLI, and SP in Malaysian automotive industry (Abdul-Rashid et al., 2017). For this study, SP is positive relationship between SMPs and SLI, particularly in Malaysian automotive industry. Therefore, the following hypothesis is proposed:

H4 There is an indirect positive relationship between SMPs, SLI, and SP in Malaysian automotive industry.

3 Methodology

In this study, the population is automotive industry in Malaysia and samples were selected from the Proton and Perodua. Besides, the researcher visited the vendor in PROTON's Tanjung Malim plant (PROTON Annual Report, 2016). This venue is located two kilometres from the new campus, Universiti Pendidikan Sultan Idris (UPSI).

This study is using structural equation modelling (SEM) method. The sample sizes between 100 to 200, but not more than 400, due to the large number of estimates (Habidin et al., 2013; Fuzi et al., 2017). Survey questionnaires were used to examine the relationship between SMPs, SLI, and SP among 227 managers in Malaysian automotive companies. Therefore, the sample is suitable for SEM method.

4 Results and discussion

In this study, EFA consists of three variables (SMPs constructs, SLI constructs, and SP measures). EFA for 17 items of SMPs, EFA for 11 items of SLI, and EFA with 14 items from SP which is (n = 227) of Malaysian automotive industry.

Kaiser-Meyer-Olkin (KMO) measurement showed the sampling adequacy as 0.891 (SMPs), 0.866 (SLI), 0.916 (SP). According to Habidin and Yusof (2012), the accepting values > 0.5. Similarly, Bartlett's test of sphericity was significant at ($p < 0.001$), showing sufficient correlation among items to proceed with the analysis. Table 1 presents the results of KMO and Bartlett's test of sphericity.

Table 1 Results of KMO and Bartlett's test of sphericity

KMO		*SLI 0.866*	*SMPs 0.891*	*SP 0.916*
Bartlett's test of sphericity	Approx. chi-square	2,328.828	1,974.965	2,283.385
	df	55	136	91
	Sig.	0.000	0.000	0.000

Initial solution results for all factors contributed 67.866% (SMPs), 85.702% (SLI), and 75.033% (SP) from the total variance which is sufficient for further analysis which requires at least 50% (Zakuan, 2009).

At least 0.5 loads for each item on respective factor are considered sufficient for the factor (Habidin and Yusof, 2013). This result helps the researcher to identify the items which correlate the highest to the lowest remaining factor. In this study, four SMPs constructs (MP, SCM, SR, EM), three SLI constructs (SW, EI, CI), and three SP measures (EN, EC, CSR).

For this study, Cronbach's Alpha Coefficient was used to test reliability for each construct. According to Cronbach (1951), the value of greater alpha was 0.6 for all constructs. Table 2 shows the all items for EFA and reliability analysis for SMPs, SLI, and SP.

Table 2 EFA and reliability analysis for SMPs, SLI, and SP

	EFA			*Reliability analysis*		
Factors	*No. of items*	*KMO and Bartlett's test of sphericity*	*% of variance explained*	*Alpha values*	*Item for deletion*	*Alpha if item is deleted*
SMPs		0.891 ($p < 0.001$)	67.866			
MP	7			0.902	None	0.902
SCM	3			0.811	None	0.811
SR	3			0.753	None	0.753
EM	4			0.833	None	0.833
SLI		0.866 ($p < 0.001$)	85.702			
SW	4			0.948	None	0.948
EI	3			0.932	None	0.932
CI	4			0.930	None	0.930
SP		0.916 ($p < 0.001$)	75.033			
EN	5			0.939	None	0.939
EC	4			0.889	None	0.889
CSR	5			0.881	None	0.881

Notes: MP = manufacturing process, SCM = supply chain management, SR = social responsibility, EM = environmental management, SW = standard work, EI = employee involvement, CI = continuous improvement, EN = environmental performance, EP = economic performance and CSR = SR performance.

Before conducting the structure analysis, it was required that the variables of overall test satisfy the assumption of normality. To test the normality, skewness and kurtosis were referred as shown in Table 3. The skewness value was less than 1.00; therefore the symmetry of the individual values could be estimated. Moreover, the value of kurtosis was close to 0. Skewness and kurtosis were referred as shown in Table 3.

Table 3 Assessment of normality

	Skewness	*Kurtosis*
SMPs	0.243	–0.424
SLI	–0.079	–0.171
SP	0.324	–0.090

The subsequent level in analysis is to test the measurement model, SMPs constructs, SLI constructs, and SP measures were tested in confirmatory factor analysis (CFA). In this stage, SMPs, SLI, and SP as an adequate fit outcome, as shown in Figure 1, Figure 2, and Figure 3. CFA for SMPs with four factors (χ^2/df = .63, GFI = 0.92, AGFI = 0.88, CFI = 0.97, TLI = 0.96 and RMSEA = 0.05), CFA for SLI with three factors (χ^2/df = 1.63, GFI = 0.93, AGFI = 0.88, CFI = 0.97, TLI = 0.96 and RMSEA = 0.08) and SP with three factors (χ^2/df = 1.82, GFI = 0.92, AGFI = 0.89, CFI = 0.97, TLI = 0.97 and RMSEA = 0.06) was acceptable and a good fit data.

With regards to factor loading, the value for SMPs (0.690), SLI (0.73), and SP (0.54) as shown in Figure 1, Figure 2 and Figure 3.

Figure 1 Modified SMPS model: the output path diagram with four factors

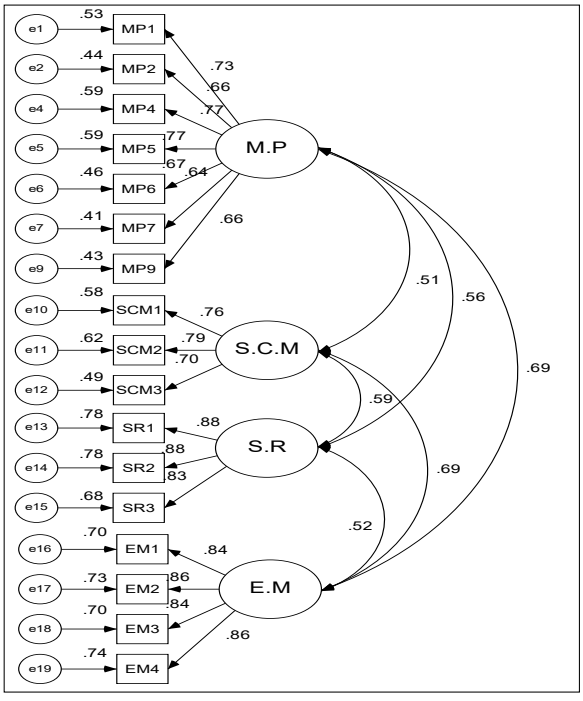

Figure 2 Modified SLI model: the output path diagram with three factors

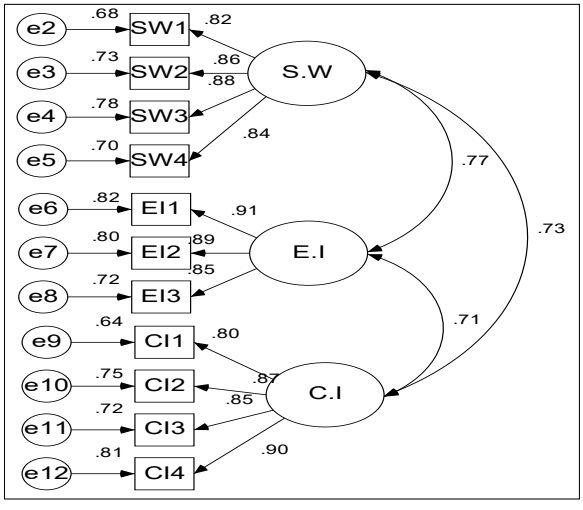

Figure 3 Modified SP model: the output path diagram with three factors

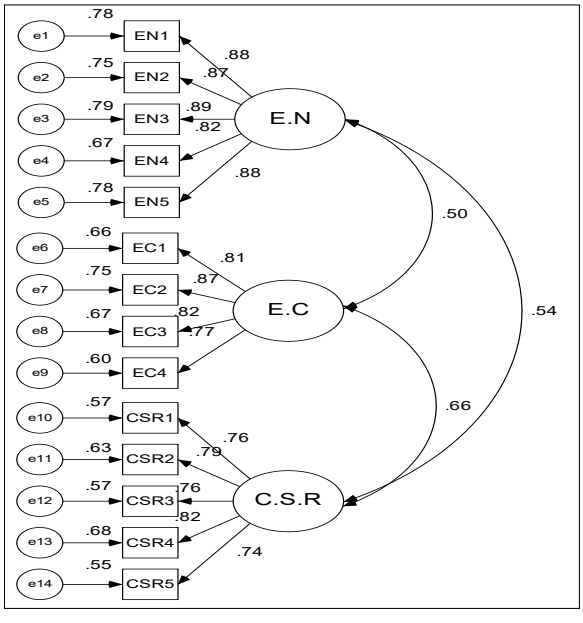

Figure 4 Relationship between SMPS, SLI, and SP in Malaysian automotive industry

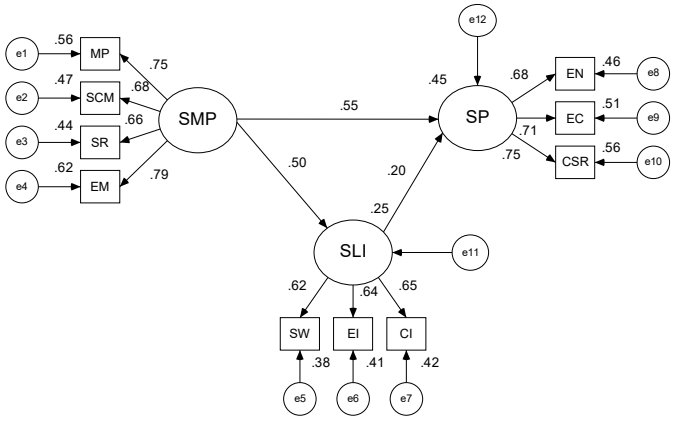

Figure 4 indicates the relationship between SMPS, SLI and SP, based on the model for Malaysian automotive industry (n = 227.)

The goodness-of-fit indices for structural model (χ^2/df = 2.230, GFI = 0.944, AGFI = 0.903, CFI = 0.943, TLI = 0.920 and RMSEA = 0.074) was good within the general acceptable limit, thus exhibiting a good fit data.

In order to evaluate the hypothesis of structural relationship in structure model was adopted in this Malaysian automotive study. The relationship between SMPs and SP for Malaysian automotive industry was found positive and significant, which confirmed that SMPs implementation had a strong positive direct impact towards SP.

To test whether SLI is would be the key mediator for SMPs with SP, the following rule of thumb (Hair et al., 2011).

1 IE < 0.074 = > non mediator

2 IE > 0.074 and IE ≈ DE = > partial mediator (SMPs - > SP relationship, p < 0.05)

3 IE > 0.074 and IE >> DE => total mediator (SMPs - > SP relationship, p > 0.05)

Table 4 revealed that standard indirect effect (IE) from SMPs for SP was 0.100 which is more than 0.074. Thus, SLI is SMPs mediator and SP. Since p-value for direct effect (DE) between SMPs and SP was less than 0.05, therefore, SLI effort could be considered a partial mediator. In brief, this finding supported hypothesis H4 whereby the effect of SMPs implementation towards SP was increased through the mediating of SLI.

Table 4 Direct effect (DE) and indirect effect (IE) analysis in Malaysian automotive industry

Factor		*Total effect*			*Direct effect*		*Indirect effect*		
	SMP	*SLI*	*SP*	*SMP*	*SLI*	*SP*	*SMP*	*SLI*	*SP*
SLI	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
SP	0.6	0.2	0.0	0.5	0.2	0.0	0.1	0.0	0.0

Note: Standard total effect = DE + IE.

5 Discussion

In order to evaluate the hypothesis of mediating effect, structural relationship in structure model was adopted in this Malaysian automotive study. The relationship between SMPs and SP for Malaysian automotive industry was found to be positive and statically significant, which confirmed that SMPs implementation had a strong positive direct impact towards SP.

Through these results, it is surprising that SLI did not give strong and direct impact on SP. This may be one of the causes why the automotive supplier in Malaysia seems to be less interested and aware about the role of SLI. However, this finding is different with the previous research finding which discovered a positive relationship between SLI and firm performance in the automotive supplier industry (Loureiro and Kaufmann, 2014).

Based on the relationship between SMPs, SLI, and SP, the relationship between SMPs implementation and SP, H1 was positive (0.55). According to H1, the findings show that there is a positive and direct significant relationship between SMPs and SP in Malaysian automotive industry. This result is in line with Fairfield et al. (2011) who concluded that a company adopting SMPs are positively associated with competitive outcomes. Positive impact on economic performance is also regarded as a strong driver in implementing SMPs. Gimenez et al. (2012) and Gadenne et al. (2012) suggested that SMPs implementation are able to achieve increased product quality, increased market-share and increased profits.

The standardised weight for this relationship was positive (0.50) and significant $p < 0.001$, confirming that H2: SMPs gives a strong positive impact to SLI level. According to H2, the finding shows that there is a positive and direct significant relationship between SMPs and SLI in Malaysian automotive industry. Moldan et al. (2012) showed that there is a positive relationship between the SMP and SLI. A study of manufacturers by Soosay et al. (2016) explained that all the manufacturers continually improve their product quality, even though there are lower product yields and higher customer return rates. In fact, their adoption of advanced quality and manufacturing practices helped them to manage continuous improvement.

The standardised weight for direct relationship of SLI and SP was found positive (0.20) and was not significant with p-value of 0.156 greater than 0.05. The result did not support H3: SLI had a strong and direct effect on SP. According to H3, the findings show that there is a positive and were not significant relationship between SLI and SP in Malaysian automotive supplier. Empirical evidence of the positive link between SLI and SP has been found in previous literature (Rajenthirakumar et al., 2011; Nasab et al., 2012).

The finding of the H4 verified that SP could give indirect effect (0.100) on SMPs implementation through SLI. This provides strong evidence of SLI partially mediating the relationship between SMPs and SP with p value less than 0.05. This subsequently showed that SMPs should be combined with SLI to ensure that SP can be upgraded. Hence, SLI is part of a mediating relationship between SMPs and SP which is generally positive and significant. Therefore, the objectives of this study are focused on the relationship between SMPs, SLI, and SP in Malaysian automotive industry. According to H4, the findings show that there is a positive and direct significant relationship between SMPs and SP in Malaysian automotive industry through the acting of SLI.

6 Conclusions

By using the SEM technique, four SMPs constructs, three for SLI, and three SP measures were developed and verified. Based on the results, SMPs implementation through SLI provides strong evidence of SLI partially mediating the relationship between SMPs and SP. For this purpose, it assists academicians and researchers to increase the knowledge and SMPs implementation to the automotive industry in order to improve SP, empirical results of SLI in the practice of SMPs that can improved the SP, and the final result of this research is reliable in terms of decision making process in supplier evaluation through the implementation of SMPs and SLI on SP for Malaysian automotive industry. This study is only focus on automotive industry in Malaysia. For future research, it is suggested that future researchers must be able to prepare themselves with various supports before conducting the final research. Given the prominent role that SMPs and SLI play in quality improvement in contemporary business and industry, there is a definite need for a more scientific research on enhancing SMPs and SLI methodologies by studying other factors in the SMPs collaboration within SLI initiative in order to obtain much better elements relevant for the current scenario in the automotive industry.

Acknowledgements

The researchers would like to acknowledge the Ministry of Higher Education (MOHE) for the financial funding of this research and Research Management and Innovation Centre (RMIC), Universiti Pendidikan Sultan Idris (UPSI) for Research University Grant (RUG).

References

Abdullah, I., Mahmood, W.H.W., Fauadi, H.F.M., Rahman, M.N.A. and Mohamed, S.B. (2017) 'Sustainable manufacturing practices in Malaysian palm oil mills: priority and current performance', *Journal of Manufacturing Technology Management*, Vol. 28, No. 3, pp.278–298.

Abdullah, S. and Muhammad, A. (2008) 'The development of entrepreneurship in Malaysia: State-led initiatives', *Asian Journal of Technology Innovation*, Vol. 16, No. 1, pp.101–116.

Abdul-Rashid, S.H., Sakundarini, N., Ghazilla, R.A.R. and Thurasamy, R. (2017) 'The impact of sustainable manufacturing practices on sustainability performance: empirical evidence from Malaysia', *International Journal of Operations and Production Management*, Vol. 37, No. 2, pp.182–204.

Adebanjo, D., Teh, P. and Ahmed, P.K. (2016) 'The impact of external pressure and sustainable management practices on manufacturing performance and environmental outcomes', *International Journal of Operations and Production Management*, Vol. 36, No. 9, pp.995–1013.

Ahmad, S.Z. and Xavier, S.R. (2012) 'Entrepreneurial environments and growth: evidence from Malaysia GEM data', *Journal of Chinese Entrepreneurship*, Vol. 4, No. 1, pp.50–69.

Ali, A.J., Islam, M.A. and Howe, L.P. (2013) 'A study of sustainability of continuous improvement in the manufacturing industries in Malaysia: organizational self-assessment as a mediator', *Management of Environmental Quality: An International Journal*, Vol. 24, No. 3, pp.408–426.

Aly, A.H. and Mansour, M.E. (2017) 'Evaluating the sustainable performance of corporate boards: the balanced scorecard approach', *Managerial Auditing Journal*, Vol. 32, No. 2, pp.167–195.

Arumugam, V., Antony, J. and Douglas, A. (2012) 'Observation: a lean tool for improving the effectiveness of lean six sigma', *The TQM Journal*, Vol. 24, No. 3, pp.275–287.

Bai, C., Sarkis, J., Wei, X. and Koh, L. (2012) 'Evaluating ecological sustainable performance measures for supply chain management', *Supply Chain Management: An International Journal*, Vol. 17 No. 1, pp.78–92.

Beck, V. and Britzelmaier, B. (2013) 'A value-based management perspective for the automotive industry', *World Review of Entrepreneurship, Management and Sustainable Development*, Vol. 9, No. 2, pp.136–151.

Comoglio, C. and Botta, S. (2012) 'The use of indicators and the role of environmental management systems for environmental performances improvement: a survey on ISO 14001 certified companies in the automotive sector', *Journal of Cleaner Production*, Vol. 20, No. 1, pp.92–102.

Cronbach, L.J. (1951) 'Coefficient alpha and the internal structure of tests', *Psychometrika*, Vol. 16, No. 3, pp.297–334.

D'Agostini, M., Tondolo, V.A.G., Camargo, M.E., Dullius, A.I.D.S., Tondolo, R.D.R.P. and Russo, S.L. (2017) 'Relationship between sustainable operations practices and performance: a meta-analysis', *International Journal of Productivity and Performance Management*, Vol. 66, No. 8, pp.1020–1042.

Dana, L.P. (1987a) 'Industrial development efforts in Malaysia and Singapore', *Journal of Small Business Management*, Vol. 25, No. 3, pp.74–76.

Dana, L.P. (1987b) 'Entrepreneurship and venture creation: an international comparison of five commonwealth nations', *Journal Frontiers of Entrepreneurship Research*, Vol. 7, No. 4, pp.573–583.

Dana, L.P. (1999) *Entrepreneurship in Pacific Asia: Past, Present and Future*, World Scientific, Singapore.

Dana, L.P. (2014) *Asian Models of Entrepreneurship: from the Indian Union and the Kingdom of Nepal to the Japanese Archipelago: Context, Policy and Practice*, 2nd ed., World Scientific, Singapore.

Dues, C.M., Tan, K.H. and Lim, M. (2013) 'Green as the new lean: how to use lean practices as a catalyst to greening your supply chain', *Journal of Cleaner Production*, Vol. 40, No. 2, pp.93–100.

Fairfield, K., Harmon, J. and Behson, S. (2011) 'Influences of the organizational implementation of sustainability: an integrative model', *Organization Management Journal*, Vol. 8, No. 1, pp.1541–6518.

Fuzi, N.M., Habidin, N.F., Desa, A.F.N.C., Zamri, F.I.M. and Hibadullah, S.N. (2013) 'Corporate social responsibility practices, ISO 26000 efforts and CSR performance in Malaysian automotive industry', *International Journal of Managerial and Financial Accounting*, Vol. 5, No. 3, pp.277–293.

Fuzi, N.M., Habidin, N.F., Hibadullah, S.N. and Ong, S.Y.Y. (2017) 'CSR practices, ISO 26000 and performance among Malaysian automotive suppliers', *Social Responsibility Journal*, Vol. 13, No. 1, pp.203–220.

Gadenne, D., Mia, L., Sands, J., Winata, L. and Hooi, G. (2012) 'The influence of sustainability performance management practices on organisational sustainability performance', *Journal of Accounting and Organizational Change*, Vol. 8 No. 2, pp.210–235.

Garza-Reyes, J.A. (2015) 'Lean and green – a systematic review of the state of the art literature', *Journal of Cleaner Production*, Vol. 102, No. 1, pp.18–29.

Gimenez, C., Sierra, V. and Rodon, J. (2012) 'Sustainable operation: their impact on the triple bottom line', *International Journal Production Economics*, Vol. 140, No. 1, pp.149–159.

Goyal, P., Rahman, Z. and Kazmi, A.A. (2015) 'Identification and prioritization of corporate sustainability practices using analytical hierarchy process', *Journal of Modelling in Management*, Vol. 10, No. 1, pp.23–49.

Groen, B.A.C., Wouter, M.J.F. and Wilderom, C.P.M. (2012) 'Why do employees take more initiatives to improve their performance after co-developing performance measures? A field study', *Management Accounting Research*, Vol. 23, No. 2, pp.120–141.

Gunasekaran, A. and Spalanzani, A. (2011) 'Sustainability of manufacturing and services: investigation for research and applications', *International Journal Production Economics*, Vol. 140, No. 1, pp.35–47.

Habidin, N.F. and Yusof, S.M. (2012) 'Relationship between lean six sigma, environmental management system, and organizational performance in Malaysian automotive industry', *International Journal of Automotive Technology*, Vol. 13, No. 7, pp.1119–1125.

Habidin, N.F. and Yusof, S.M. (2013) 'Critical success factors of lean six sigma for Malaysian automotive industry', *International Journal of Lean Six Sigma*, Vol.4, No. 1, pp.60–82.

Habidin, N.F., Fuzi, N.M., Desa, A.F.N.C., Hibadullah, S.N. and Zamri, F.I.M. (2014) 'ISO 26000 efforts and corporate social responsibility performance in Malaysian automotive industry', *International Journal of Business Excellence*, Vol. 7, No. 4, pp.515–529.

Habidin, N.F., Zubir, A.F.M., Conding, J., Jaya, N.A.S.L. and Hashim, S. (2013) 'Sustainable manufacturing practices, sustaining lean improvements and sustainable performance in Malaysian automotive industry', *World Review of Entrepreneurship, Management and Sustainable Development*, Vol. 9, No. 4, pp.444–459.

Hair, J.F., Ringle, C.M. and Sarstedt, M. (2011) 'PLS-SEM: indeed a silver bullet', *Journal of Marketing Theory and Practice*, Vol. 19, No. 2, pp.139–151.

Herron, C. and Braiden, P.M.A. (2006) 'Methodology for developing sustainable quantifiable productivity improvement in manufacturing companies', *International Journal Production Economics*, Vol. 104, No. 1, pp.143–153.

Ho, C., Ding, M. and Lii, Y. (2017) 'The impact of consumer and environmental CSR on consumer behavioural intention', *World Review of Entrepreneurship, Management and Sustainable Development*, Vol. 13, No. 1, pp.10–26.

Hofer, C., Eroglu, C. and Hofer, A.R. (2012) 'The effect of lean production on financial performance: the mediating role of inventory leanness', *International Journal Production Economics*, Vol. 138, No. 2, pp.242–253.

Kaebernick, H., Kara, S. and Sun, M. (2003) 'Sustainable product development and manufacturing by considering environmental requirements', *Robot Computer Integration Manufacturing*, Vol. 19, No. 16, pp.461–468.

Kara, S., Ibbotson, S. and Kayis, B. (2014) 'Sustainable product development in practice: an international survey', *Journal of Manufacturing Technology Management*, Vol. 25, No. 6, pp.848–872.

Karim, A. and Arif-Uz-Zaman, K. (2013) 'A methodology for effective implementation of lean strategies and its performance evaluation in manufacturing organizations', *Business Process Management Journal*, Vol. 19, No. 1, pp.169–196.

Laosirihongthong, T. and Dangayach, G.S.A. (2005) 'Comparative study of implementation of manufacturing strategies in Thailand and Indian automotive manufacturing companies', *Journal of Manufacturing Systems*, Vol. 24, No. 2, pp.131–143.

Loureiro, S.M.C. and Kaufmann, H.R. (2014) 'Intentions towards the sustainability of young adults: a cross-cultural comparison', *World Review of Entrepreneurship, Management and Sustainable Development*, Vol. 10, No. 2/3, pp.247–266.

Moldan, B., Janouskova, S. and Hak T. (2012) 'How to understand and measure environmental sustainability: indicators and targets', *Ecological Indicators*, Vol. 17, No. 1, pp.4–13.

Nasab, H.H., Bioki, T.A. and Zare, H.K. (2012) 'Finding a probabilistic approach to analyze lean manufacturing', *Journal of Cleaner Production*, Vol. 29 No. 1, pp.73–81.

Ohkita, K. (2017) 'A shift in inter-firm relationships towards sustainability in the Japanese video game industry', *World Review of Entrepreneurship, Management and Sustainable Development*, Vol. 13, No. 4, pp.441–449.

Pakdil, F. and Leonard, K.M. (2015) 'The effect of organizational culture on implementing and sustaining lean processes', *Journal of Manufacturing Technology Management*, Vol. 26, No. 5, pp.725–743.

Piercy, N. and Rich, N. (2015) 'The relationship between lean operations and sustainable operations', *International Journal of Operations and Production Management*, Vol. 35, No. 2, pp.282–315.

PROTON Annual Report (2016) *PROTON Annual Report* [online] http://ir.chartnexus.com/proton/flash/ar_2016/index.html (accessed 29 September 2017).

Rajenthirakumar, D., Mohanram, P.V. and Harikarthik, S.G. (2011) 'Process cycle efficiency improvement through lean: a case study', *International Journal of Lean Thinking*, Vol. 2, No.1, pp.1–10.

Randhawa, J.S. and Ahuja, I.S. (2017) '5S – a quality improvement tool for sustainable performance: literature review and directions', *International Journal of Quality and Reliability Management*, Vol. 34, No. 3, pp.334–361.

Ratnayake, R.M.C. and Chaudry, O. (2017) 'Maintaining sustainable performance in operating petroleum assets via a lean-six-sigma approach: a case study from engineering support services', *International Journal of Lean Six Sigma*, Vol. 8, No. 1, pp.33–52.

Rosen, M.A. and Kishawary, H.A. (2012) 'Sustainable manufacturing and design: concepts, practices and needs', *Sustainability*, Vol. 4, No. 2, pp.154–174.

Rusinko, C.A. (2007) 'Green manufacturing: an evaluation of environmentally sustainable manufacturing practices and their impact on competitive outcomes', *Engineering Management, IEEE Transactions on Engineering Management*, Vol. 54, No. 3, pp.445–454.

Sajan, M.P., Shalij, P.R., Ramesh, A. and Biju, A.P. (2017) 'Lean manufacturing practices in Indian manufacturing SMEs and their effect on sustainability performance', *Journal of Manufacturing Technology Management*, Vol. 28, No. 6, pp.772–793.

Schlichting, C. (2009) *Sustaining Lean* [online] https://www.wpi.edu (accessed 28 September 2017).

Sisson, J. and Elshennawy, A. (2015) 'Achieving success with lean: an analysis of key factors in lean transformation at Toyota and beyond', *International Journal of Lean Six Sigma*, Vol. 6, No. 3, pp.263–280.

Soosay, C., Nunes, B., Bennett, D.J., Sohal, A., Jabar, J. and Winroth, M. (2016) 'Strategies for sustaining manufacturing competitiveness: comparative case studies in Australia and Sweden', *Journal of Manufacturing Technology Management*, Vol. 27, No. 1, pp.6–37.

Taj, S. (2008) 'Lean manufacturing performance in China: assessment of 65 manufacturing plants', *Journal of Manufacturing Technology Management*, Vol. 19, No. 2, pp.217–234.

Tang; Z. and Tang, J. (2015) 'The influence of stakeholder-firm power difference on corporate social responsibility of Chinese small and medium-sized enterprises', *World Review of Entrepreneurship, Management and Sustainable Development*, Vol. 11, No. 4, pp.414–428.

Thanki, S.J. and Thakkar, J. (2014) 'Status of lean manufacturing practices in Indian industries and government initiatives: a pilot study', *Journal of Manufacturing Technology Management*, Vol. 25, No. 5, pp.655–675.

Thomas, A., Francis, M., John, E. and Davies, A. (2012) 'Identifying the characteristics for achieving sustainable manufacturing companies', *Journal of Manufacturing Technology Management*, Vol. 23, No. 4, pp.426–440.

Zakuan, N.M. (2009) *Structural Analysis of Total Quality Management, ISO/TS 16949 and Organizational Performance in Malaysian and Thailand Automotive Industry*, Doctoral dissertation, Universiti Teknologi Malaysia.

Zubir, A.F.M., Habidin, N.F., Conding, J., Jaya, N.A.S.L. and Hashim, S. (2012) 'The development of sustainable manufacturing practices and sustainable performance in Malaysian automotive industry', *Journal of Economics and Sustainable Development*, Vol. 3, No. 7, pp.130–138.

Appendix

A1 Sustainable manufacturing practices (17 items)

- extent to which water-based paints is used
- extent to which recycled material is used
- extent to which air emissions is minimised
- extent to which hazardous and non-hazardous waste creation are minimised
- extent to which reusable parts are designed
- extent to which accessible parts are designed
- extent to which greenhouse gas emissions is reduced
- extent of forming partnership with suppliers to promote sustainable manufacturing
- extent of encouraging suppliers to use recycled materials
- extent of sources from environmentally friendly suppliers
- extent of promoting good relationship with the staff and union
- extent of using documented code of ethnic to guide the behaviour of the firm
- extent of using social responsibly as a strategy for creating brand loyalty
- extent of reducing pollution and toxic chemical use and their effects on our employees, customers and the communities in which we operate
- extent of securing needed raw materials over the long term for our employees, suppliers, customers and the communities in which we operate
- extent of reducing and/or managing the risks and impacts of climate change on our employees, customers and the communities in which we operate
- extent of ensuring an adequate supply of water for our employees, suppliers, customers and the communities in which we operate.

A2 Sustaining lean improvement (11 items)

- extent to which we use uniform methods of manufacturing
- extent to which we use uniform methods for assessing first-line supervisor/manager productivity
- extent to which we use uniform measures of product quality
- extent to which we use uniform methods for assessing first-line supervisor/manager work quality
- extent to which we attempt to improve our processes even there are no pressing problems
- extent to which employees are constantly eliminating activities that do not add value

- extent to which employees frequently make small process improvement at their workstations
- extent of regular reviews and improvement are made in the training system to accommodate changing requirements
- extent of providing work area employees with freedom to make changes to work area
- extent of rewarding or recognising kaizen team members for their contributions
- extent of work area management encouraging work area employees to apply kaizen knowledge and skill.

A3 Sustainable performance (14 items)

Environmental sustainability

- reduction of air emissions
- reduction of effluent waste
- reduction of solid wastes
- reduced in consumption for hazardous/harmful/toxic materials
- reduced in frequency for environmental accidents

Economic sustainability

- reduced in cost of materials purchasing
- reduced in cost for energy consumption
- reduced in fee for waste treatment
- reduced in fine for environmental accidents.

CSR sustainability

- improved responsibility towards human right
- improved responsibility towards safety
- improved personal desires of employees to do what is right
- improved social programs that our customers have in place
- increased awareness of social issues among our customers.