A Full-Blown Concept of Lean Manufacturing System in Automotive Industry

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***Abstract*—Lean manufacturing system (LMS) is not a novel concept to manufacturing and the automotive industry, but achieved implementations seen are still not considered industry-wide especially in the Malaysian automotive manufacturing industry. The implementation strategies have not been far reaching and the benefits from the system couldn't be gained by the industry. A total and comprehensive implementation strategy of LMS needs to be outlined in order to achieve more successful implementations. Thus this paper will explain the strategy of LMS implementation in the automotive industry by using the full-blown concept, for enhancing their organizational performances. A questionnaire-survey was administered to gauge the impact of these factors in an implementation process of lean manufacturing system and later analyzing the effect towards their organizational performances. Data from 204 automotive parts manufacturers were gathered and analyzed. The correlation between the 10 influencing factors, 5 lean activities and 6 organizational performances were measured. The results gained, suggest that the integration between the identified influencing factors (Management and Leadership Commitment, Employees Involvement, Empowerment of Employee, Teamwork, Training, Human Resource Management, Customer Relationship Management, Supplier Relationships Management, Organizational Change and Information Technology) will be a valuable key organizational capability impacting organizational performances towards the successful implementation of LMS in the Malaysian automotive industry.**

***Index Terms*—full-blown concept, lean manufacturing system and organizational performances**

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I. Introduction

Lean Manufacturing System (LMS) is not an unfamiliar concept within the domestic automotive industry in Malaysia. This system was initially introduced through the Toyota Production System (just-in-time concept), that focuses upon production of vehicles that has quality. The implementation of LMS in Malaysia was given solid support and positive cooperation by the government. This alliance was aimed towards creating a world class manufacturing level, which would withstand a high degree of competitiveness required in the global automotive market. Thus, the implementation of LMS is considered to be advantageous in the Malaysian automotive context, for the industry itself to improve their operational performances whilst to remain competitive [1].

Although many companies were interested in LMS and tried to implement lean tools, prior studies have shown that the levels of implementation and adoption of lean manufacturing in Malaysia has yet to become comprehensive and is currently being applied in certain stages and known areas only [2] and the main reason of this current state, lies in the improper knowledge disbursement as most do not have, or lacks the technical know-how in having a successful implementation [3]. In reality, some manufacturing outfits adopted a pick-and-choose strategy towards implementing LMS and this has caused deficiencies towards achieving the real value of implementing the LMS. Thus, this paper will explain the strategy of LMS implementation in the automotive industry by using the full-blown concept, for enhancing their organizational performances.

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A. Implementation of LMS in Malaysia – Automotive Manufacturing Industry

After the establishment of AFTA, LMS was given attention and thus interest grew. As policies were refined, an emergence of positivity was underway within the industry, so LMS acted as an enabler for this. The numerous implementations amongst the Malaysian automotive parts' manufacturers, highlights that numerous companies were willing to embrace the concept and were working towards change.

The industry simply needed to conform to demands of the market that is oriented towards competitive pricing, limited time-to-market as well as high quality products. These objectives are only achievable through changes in manufacturing strategy, more aggressive work-culture and one that is based and conforms to lean manufacturing ideology.

Most manufacturing firms will eventually be frustrated with their LMS achievements and some might call an end to their LMS journey, despite the initial enthusiasm. Moreover, some implementers later finding bigger problems that gave a negative impact on their businesses sustainability [4]–[6]. Definitely, the LMS is not a brand new system that was just recently created, but in Malaysia, the level of LMS implementation is still in its infancy [1], [4], [6]–[9].

B. Influencing Factors in LMS Implementation

LMS is not a novel concept to manufacturing and the automotive industry, but achieved implementations seen are still not considered industry-wide. Several contributable factors are known in making LMS having an important role within an implementation process, ultimately achieving a total success to a manufacturing outfit. Numerous studies have been completed to identify these beneficial factors that ushers the LMS implementations towards success [10]–[13]. These factors are Management and Leadership Commitment [14]–[17], Employees Involvement, Empowerment of Employee [18]–[20], Teamwork [21], [22], Training [20], [23], Human Resource Management [13], [20], [22], [24], Customer Relationship Management [11], Supplier Relationships Management [25]–[27], Organizational Change [1], [15], [20], [28], and Information Technology [29]–[33]. These factors are the determinant points to how a system is being accepted and effectively implemented within an organization with some measure of success. Each factors have strong correlations between each other and it is important for an organization to have a strong organizational management and focus in implementing the successful factors of LMS system within the organization.

C. The Dimensions (Activities) of LMS Implementation

LMS comprises activities or tools which when properly segmented could reflect strategic advantages to organizations, which choose to apply LMS as a synergistic and inter-related method purposefully on upgrading their performance parameters. Implementations of LMS have been known to utilize these activities and tools and is widely applied, it is key in achieving the main targets of elimination of wastes, which in principle defines methods in reducing cost by continuing improvements, eventually reducing the cost of products or services, and consequently growing company's profits.

Therefore, applying the right tool at the right time for the right problems is the key in successful implementation of LMS [11], [34], while concurrently increasing the performance parameters of an organization. The related LMS activities are Just-In-Time, Pull system, Total Preventive Maintenance, Quality Management, Continuous Improvement and Design for Customer Needs. Each activity is unique, in that it plays a certain role and solves a certain type of problem or issue. [10], [23], [34]. Perhaps application of these activities is correlated to each other and will provide an impact to organizations and their operations.

D. Organizational Performances

The benefits of LMS implementation can be described through our understanding by viewing organizational performances and their measureable indicators. Items like engineering performances, financial performances, non-financial performances and operational performances are often impacted directly or indirectly by quality improvements brought about by the successful implementation of LMS dimensions. Based on previous literatures, there are 5 types of performances that are usually used as measurable indicators for gauging the effectiveness level of any LMS implementation and its subsequent performance in a manufacturing outfit. Measurable indicators for LMS implementation at an organization are Waste Reduction, Financial Performances, Non-Financial Performances, Marketing Performances and Operational Performances [8], [18], [35]–[37].

LMS adoption in Malaysia or its implementation level domestically started about 12 years ago, as most automotive industry players made attempts toward implementations. LMS is not new, but unfortunately it is still pertinent to point out that the levels achieved are moderate and below satisfactory. Consequently, studies looking into LMS in the Malaysian context is also new and may comprise many existing weaknesses. This is based on available literature review which are less varied, nonetheless, it highlights multiple angles that still can be addressed further into this subject.

This study will focus on the strategic implementation of LMS through full-blown concept for achieving the organizational performances in Malaysian automotive industry players.

II. Methodology

A. Hypothesis Development

Basically, most of the studies are focused on a single aspect of lean and its implication [2], [4], [38]–[40]. Despite studies merely focusing on single-factors within a LMS implementation, there exist the concept of relationship between factors. Benchmarking will then be crucial in measuring LMS activity and performance within the implementation scope, thus to enable a gauging mechanism within this research.

A conceptual model has been proposed based on multiple extensive and comprehensive literature review observed from the many aspects of LMS implementation, with a particular focus on the Malaysian automotive industry. This study focuses on the relationship between LMS factors (10 factors), LMS implementation activities or dimensions (6 dimensions) and also the organizational performances (5 performances). Subsequently eleven (11) hypotheses were developed in order to reflect the mentioned relationships. These hypotheses and comparative support from literature are listed as follows.

a. H1: *Management leadership and commitment has a positive effect on the level of lean implementation*.
b. H2: *Empowerment of employees has a positive effect on the level of lean implementation.*
c. H3: *Employee involvement has a positive effect on the level of lean implementation.*
d. H4: *Employees' training has a positive effect on the level of lean implementation.*
e. H5: *Teamwork has a positive effect on the level of lean implementation.*
f. H6: *Human resource management has a positive effect on the level of lean implementation.*
g. H7: *Customer Relationship Management has a positive effect on the level of LMS implementation.*
h. H8: *Supplier relationship management has a positive effect on the level of lean implementation.*
i. H9: *Organizational change has a positive effect on the level of lean implementation.*
j. H10: *Information technology use has a positive effect on the level of lean implementation.*
k. H11: *Level of lean implementation has a positive effect on the business performance.*

B. *Data Collection Activities – Questionnaire Administration*

Data was collected and consolidated from 350 automotive parts manufacturer companies, as the study is supported by the Malaysia Automotive Institute (MAI) - a government organization that functions as a focal point and coordination center for the development of the Malaysian automotive industry, inclusive of all related matters towards the automotive industry. Mostly, the developed questionnaires were adapted from previous studies conducted [1], [6], [35], [41]. The developed questionnaire was distributed through two types of distribution methods:

1. Distributed directly through seminar series and workshop sessions organized by MAI;
2. Distributed directly through "drop off and collect" mode.

Once the data collection activity was completed, the data was analyzed by utilizing the Structural Equation Modeling (SEM) and SPSS techniques.

III. Results and Analysis

A. *Descriptive Statistics*

The total completed questionnaire was 204, approximately 58.3 percent responses were received for this study. Most of the firms in Malaysia (about 58 percent) have been established for about 10 years and above in their respective products. Therefore, as a state-of-the-art manufacturing system, LMS features are expected to be known to them. Longer times of establishment and larger establishments could probably mean a higher exposure to LMS and its factors, but it is not a definite guarantee. 60 percent were locally-owned and 28 percent had locals as majority shares or owners. Most of the firms introduced about 1-3 new products per year. The total years of involvement with LMS were between 1-3 years (47 percent). It highlights that local automotive parts manufacturing companies mostly had less than 5 years of LMS experience. Through this study, it has revealed that Malaysian automotive industry is still far behind in their LMS implementation whereby 62 percent of respondents divulged of only having little understanding with regards to the LMS concept.

B. *Assessment of the Full Blown Model of Lean Manufacturing System Implementation*

The first CFA performed in this study investigates the correlation of the six dimensions that constitute the LMS implementation, which include JIT, TPM, QM, PS, CI, and DCN. The results of CFA analysis show a very satisfactory overall model fit (RMSEA= 0.029, CMIN/DF= 1.168, RMR= 0.19, SRMR= 0.037, CFI= 0.986, IFI= 4.4 shows that all CR and CA values are higher than the threshold value of 0.7 which indicates the adequate internal consistency [42]. Table I lists the correlation matrix for the measurement model of LMS implementation, with correlations among constructs and the square root of AVE on the diagonal.

TABLE I. Inter-Construct Correlations with Square Root of the AVE on Diagonal

	JIT	TPM	QM	PS	CI	DCN
JIT	**0.706**					
TPM	0.698	**0.807**				
QM	0.694	0.737	**0.801**			
PS	0.589	0.652	0.709	**0.752**		
CI	0.683	0.668	0.701	0.643	**0.801**	
DCN	0.629	0.657	0.634	0.605	0.672	**0.812**

TABLE II. Measurement Model of Lean Manufacturing System Implementation and Results of Second-Order CFA

Constructs	Parameter standardized loading	Composite reliability	Cronbach's alpha	Average variance extracted
LM		0.923	0.889	0.666
JIT	0.809			
TPM	0.841			

QM	0.862
PS	0.784
CI	0.823
DCN	0.775

Fit indices:**RMSEA= 0.027, CMIN/DF= 1.149, RMR= 0.20, SRMR= 0.039, CFI= 0.988, IFI= 0.988, TLI= 0.986, GFI= 0.905, NFI= 0.912, and RFI= 0.901**

The second-order CFA is performed to test whether the lean manufacturing sub-dimensions converge on a single latent factor. The results of CFA was listed in Table II. The results suggest that similar to first-order CFA, the second-order CFA of LMS implementation provides very satisfactory CFA fit (RMSEA= 0.027, CMIN/DF= 1.149, RMR= 0.20, SRMR= 0.039, CFI= 0.988, IFI= 0.988, TLI= 0.986, GFI= 0.905, NFI= 0.912, and RFI= 0.901). The first-order and second-order CFAs for LMS implementation verify the multi-dimensional nature of the LMS implementation, which further proves that researcher's decision to define LMS implementation as a second-order construct is technically valid [43].

C. First and Second-order CFAs of Business Performance

The next CFA performed in this study examines the correlation of the five dimensions that constitute the business performance latent variable, which comprise waste reduction, financial performance, marketing performance, non-financial performance, and operational performance. The results of first-order CFA analysis showed a very satisfying overall model fit in this case as all the fit indices satisfy their cutoff value (RMSEA= 0.028, CMIN/DF= 1.157, RMR= 0.19, SRMR= 0.039, CFI= 0.987, IFI= 0.987, TLI= 0.985, GFI= 0.912, NFI= 0.915, and RFI= 0.900). Table III lists the correlation matrix for the measurement model of business performance, with correlations among constructs and the square root of AVE on the diagonal. Given all square root of AVE for each construct is larger than the correlation of that construct with all other constructs in the model, thus, discriminant validity is satisfied [1].

TABLE III. BUSINESS PERFORMANCE INTER-CONSTRUCT CORRELATIONS WITH SQUARE ROOT OF THE AVE ON DIAGONAL

	WR	FP	MP	NFP	OP
WR	**0.759**				
FP	0.692	**0.770**			
MP	0.624	0.729	**0.784**		
NFP	0.619	0.589	0.679	**0.745**	
OP	0.720	0.605	0.681	0.656	**0.763**

The second-order CFA model for measuring business performance latent variable is listed in Table IV. This table demonstrates the items that are similar to the first-order CFA, the second-order CFA of business performance indeed, provides very satisfactory CFA fit as the analytical values are more affirmative towards the hypothesis (RMSEA= 0.031, CMIN/DF= 1.199, RMR= 0.21, SRMR= 0.044, CFI= 0.983, IFI= 0.984, TLI= 0.981, GFI= 0.908, NFI= 0.909, and RFI= 0.896. The results of the first-order and second-order CFAs for business performance collectively confirm that the business performance is multi-dimensional in nature and the researcher's decision as to define business performance as a second-order construct is technically sound.

TABLE IV. MEASUREMENT MODEL OF BUSINESS PERFORMANCE AND RESULTS OF SECOND-ORDER CFA

Constructs	Parameter standardized loading	Composite reliability	Cronbach's alpha	Average variance extracted
Lean manufacturing		0.906	0.864	0.659
WR	0.815			
FP	0.807			
MP	0.837			
NFP	0.776			
OP	0.824			

*Fit indices:*RMSEA= 0.031, CMIN/DF= 1.199, RMR= 0.21, SRMR= 0.044, CFI= 0.983, IFI= 0.984, TLI= 0.981, GFI= 0.908, NFI= 0.909, and RFI= 0.896

D. Assessment of the Structural Model

The goodness of fit indices of the structure model set the acceptable structural path fitness as all the absolute fit measures completely satisfy their cutoff value (RMSEA= 0.030, CMIN/DF= 1.179, RMR= 0.023, SRMR= 0.049), and all the incremental fit indices reach the respective acceptable threshold values (CFI= 0.967, IFI= 0.968, TLI= 0.968, GFI= 0.800, NFI= 0.822, and RFI= 0.806). Similarly, the structural model is suggestive to the adequate structural fit since ΔX2 (the difference between Chi-Square values) value structural model with its CFA model is very insignificant (ΔX2= 1319.597 - 1302.197 = 17.400). Table V shows the significance of structural relationship among the research variables and the standardized path coefficients in which all except three of the hypotheses are strongly supported. The results obtained are consistent with H1, H2, H4, H5, H7, H9 and H10, each of management leadership, employee empowerment, training, teamwork, customer relationship management, organizational change, and information technology as influencing factors have a significant positive effect of LMS implementation. Among these seven significant influencing factors, organizational change has the most significant effect on LMS implementation (β =0.287, $p<0.001$). Conversely, there is no significant relationship between employee involvement, human resource management, and supplier relationship management as influencing factors with LMS implementation, which further indicate the rejection of H3, H6, and H8. The results show the decisions that are consistent with underlying theory, 10 influencing factors studied as determinant of LMS implementation account for 79.30 percent of the variance in the latent variable of LMS implementation. Finally, Table V reveals that is consistent with H11, LMS implementation has significant positive effect on business performance which accounts for 41.70 percent variance in the latent variable of business performance.

TABLE V. RESULTS OF HYPOTHESES TESTS

Hypothesis	Relationship	β	Support
H1	Management leadership→ Lean manufacturing implementation	0.166*	Yes
H2	Employee empowerment→ Lean manufacturing implementation	0.221**	Yes
H3	Employee involvement →Lean manufacturing implementation	-0.084	No
H4	Training→ Lean manufacturing implementation	0.167*	Yes
H5	Teamwork→ Lean manufacturing implementation	0.159*	Yes
H6	Human resource management→ Lean manufacturing implementation	-0.112	No
H7	Customer relationship management→ Lean Manufacturing implementation	0.168**	Yes
H8	Supplier relationship management→ Lean manufacturing implementation	0.046	No
H9	Organizational change→ Lean manufacturing implementation	0.287***	Yes
H10	Information technology→ Lean manufacturing implementation	0.148*	Yes
H11	Lean manufacturing implementation→ Business performance	0.646***	Yes

* p < .05; ** p < .01; *** p < .001

E. MANOVA Test of Omnibus Lean Manufacturing (OLM)

MANOVA test aims to examine if any increase in the intensity of OLM (average of all dimensions of lean) implementation among Malaysian automotive parts manufacturers results in the improvement of business performance. The first output of MANOVA test for OLM is listed in Table VI which provides the mean and standard deviation for the three different categories of OLM (low implementation, moderate implementation, and full-blown implementation). The Box's test of equality of covariance matrices shows that p<0.001 (p=0.000018), thus, the assumption of homogeneity of covariance is not met and it is not valid to proceed with the rest of MANOVA test. The Levene's test of equality of error variances shows that only scores of FP and OP met the homogeneity of variances as p>0.05 (pJFP= 0.642 and pOP=0.731). Accordingly, tests of Between-Subjects effect are done for FP and OP to see if there are any significant differences in achievement of FP and OP in terms of levels of OLM. Similarly, and for WR, MP, and NFP as the only dimension violating the homogeneity of variances, the robust tests of equality of means is performed to check for differences in level of business performance in terms of levels of OLM. The results of tests of between-subjects effect for FP and OP suggest that OLM has a statistically significant effect on both FP (F (2, 201) = 22.745; P <0.0005) and OP (F (2, 201) = 28.714; P <0.0005). Similarly, the robust tests of equality of means for WR, MP, and NFP suggest that there are statistically significant differences in level of achievement of WR, MP, and NFP in terms of level of OLM as p values for Wlech statistics are less than 0.05 (WlechWR =22.693, p=0.000;WlechMP =58.381, p=0.000;WlechNFP =56.736, p=0.000). In other words, among Malaysian automotive parts manufacturer, moderate implementation of lean manufacturing results in significantly higher WR, FP, MP, NFP, and OP compared to low implementation. Consistently, full-blown implementation of lean manufacturing system brings about significantly higher WR, FP, MP, NFP, and OP compared to moderate implementation. The results of multiple comparison also suggests that although transition from low implementation to moderate implementation will create significant improvement in all dimensions of business performance, however, business performance improvement resulted from migration from low implementation to full-blown implementation is considerably higher than business performance improvement resulted from migration from low implementation to moderate implementation.

TABLE VI. DESCRIPTIVE STATISTICS–OMNIBUS LEAN MANUFACTURING

	OLM	Mean	Std. Deviation	N
AVG.WR	Non implementers	3.0250	.61943	24
	Transitional Implementers	3.5605	.51005	152
	Full Implementers	3.9643	.38893	28
	Total AVG	3.5529	.55986	204
AVG.FP	Non implementers	2.8472	.47119	24
	Transitional Implementers	3.4232	.50014	152
	Full Implementers	3.7857	.55344	28
	Total AVG	3.4052	.55586	204
AVG.MP	Non implementers	2.8125	.41865	24
	Transitional Implementers	3.3931	.48282	152
	Full Implementers	3.9286	.32530	28
	Total AVG	3.3983	.53545	204

AVG.NFP	Non implementers	2.8750	.42040	24
	Transitional Implementers	3.3276	.50980	152
	Full Implementers	3.9357	.32684	28
	Total AVG	3.3578	.54942	204
AVG.OP	Non implementers	2.8229	.54413	24
	Transitional Implementers	3.5016	.55827	152
	Full Implementers	3.9911	.55060	28
	Total AVG	3.4890	.62693	204

IV. Discussion and Recommendation

Ten main factors were initially proposed by the research model of this study and deemed fundamentally critical for the full-blown implementation of LMS among Malaysian automotive part manufactures. Management leadership and commitment toward lean manufacturing forms a key enabler for a full-blown LMS implementation. This finding, in regards to the Malaysian context receives research support from previous studies [1], [11], [15], which suggest the significant positive relationship between management support and commitment towards forming a successful implementation of different LMS dimensions. Being committed to LMS, manufacturers should be able to create a firmer ground for long-term LMS success by reducing costs and improving utilization of resources [20].

The findings of the study also suggest that there is a significant positive relationship between employees' empowerment against a full blown LMS implementation among Malaysian automotive part manufacturers. It explains that by having higher employees' empowerment towards lean manufacturing, Malaysian automotive part manufacturers should be able to reap higher organizational benefits, so an upgrade from the current situation is required, if desiring to achieve a full-blown LMS implementation.

However, the results points out the absence of significant relationship between employees' involvement and full-blown LMS implementation, without being empowered, consequently the rejection of H3. High level of employees' involvement in LMS-related activities did not translate into higher LMS implementation level, amongst the Malaysian automotive part manufacturers. This, challenges the findings of the majority of prior studies [35], [44] signifying the significant positive effect of involvement over LMS implementation.

This has been attributed due to the lack of autonomy given to the employees. This stage could be considered disadvantageous for Malaysian automotive part manufacturers, as it seems that despite the importance of employees' involvement, these businesses did not allow employees an adequate allotment of permissible authority in making effective participation unto diverse lean manufacturing activities.

The results of this study also revealed that training and teamwork are two intra-organizational level factors which are crucial for full-blown implementation of LMS among Malaysian automotive part manufacturers. Consequently, in order to genuinely implement all the dimensions of LMS, employees all over the organization need to receive training and engaging in team activities, using computer and IT tools, carrying out maintenance, performing statistical process control, using quality tools, and finally, basics of materials handling and control.

The results of structural equation modeling further revealed that traditional human resource management practice does not have any significant effect on LMS. This finding is apparently inconsistent with prior studies which have demonstrated that there is a positive link between human resource management and LMS implementation in Japan and the United States automotive industry [20], [22], [24], [45]. Indeed the human resources management styles within those countries might be significantly different and having differing work-culture context. It can be concluded that despite their efforts, Malaysian automotive part manufacturers have not been effective in integrating their human resources practices with lean manufacturing policies, in comparison to other world-class automotive part manufacturers, Malaysian manufactures are at a disadvantage. Hence, human resource management practices needs to be lean-oriented enough to identify, employ, train, and retain the right types of employees. In short Malaysian automotive part manufacturers, should find more effective methods towards integrating their current human resources management with their lean manufacturing policies. Despite this disadvantage, the results however revealed that those automotive part manufacturers that had engaged in customer relationship management practices, have gotten closer to levels of full-blown LMS implementation. This positive significant relationship between customer relationship management and full-blown LMS implementation provides empirical support for prior studies recommending that effective and integrated relationship with customers is crucial to intensify implementation of lean manufacturing dimensions [10], [15], [46].

Another challenge found through this study is the insignificant relationship between supplier relationship management and full-blown LMS implementation, This is found to challenge prior studies arguing that supply chain process integration and effective management of relationship with suppliers adds a considerable facilitation towards leanness and should consequently improve business performance among supply partners [25], [38], [47]. Within the lean manufacturing literature, it is well agreed that management of the supply relationship is crucial to yawning implementation of LMS, particularly in automotive industry [1].

Malaysian automotive part manufacturers need to know that successful implementation of JIT is unachievable unless there exist open communication and a standardization of all things [36]. These may include the status of a production being shared with the supplier, information sharing and integration, acquiring willingness for improvement among suppliers, compliance and collaboration among hub firm and all supply partners. Most importantly, achieving a superior trust levels as a basis for achieving effective and workable collaboration. Given the disadvantage position of Malaysian automotive part manufacturers in integrating their supplier relationship management practices with LMS implementation, these businesses are recommended to commit adequate financial, capital and personnel resources to the development of lean-oriented supplier relationship management. This should well include the ability to convince their suppliers that the best interest of both parties lies in the acceptance of a LMS-orientated direction, with an integrated commitment towards implementing variable types of lean activities.

Findings of the study also demonstrated that organizational change is the most important determinant of a LMS implementation, amongst the investigated influencing factors, There is no doubt that full-blown implementation of LMS necessitates significant changes across the organization. LMS implementation among Japanese manufacturers shows that leanness, has major association with significant changes in organizational structure and operational procedures.

The results also show that information technology has a significant positive effect on full-blown LMS implementation, which indicates the acceptance of H10. This finding supports prior studies from different perspectives, that suggest IT has significantly facilitated effective implementation of JIT [30], [36], [48], maintenance activities, quality management practices [48]–[50] new product development and design for customers' needs [12], and continuous improvement [7], [20], [22].

Finally, the results of this study revealed that there is a significant positive relationship between levels of LMS implementation and business (organizational) performance improvement among Malaysian automotive part manufacturers. This finding empirically supports the existing perspective that effective implementation of lean manufacturing activities will provide the adopting firms with performance improvements and improving different metrics [10], [36], [41]. As argued by [10], improvement in labor productivity and quality, and reduction in customer lead time, cycle time, and manufacturing costs are amongst the most frequently quoted advantages of LMS implementing for manufacturers.

V. Conclusion

This study managed to construct a full-blown conceptual model for LMS implementation in Malaysian automotive industry by consolidating all the major characteristics and factors. Despite this system is not a panacea to solve all problems, indeed, all aspects can be put coherently under a lean manufacturing framework. The uniqueness of LMS lies in its principle of eliminating waste, but increasing quality of product; upgrading knowledge & understanding through training of employees; focusing on mindset change & organizational changes to propel the main agenda; building strength in customer relationship management and supplier relationship management, to form unique synergies that allows flow of expertise and cooperation between different classes within a manufacturing environment-material, technology, logistics, systems, design; usage of IT allows for rapid movements of data and information that enables increase sharing of knowledge between different entities among intra company subjects as well as inter-company.

In this regards, the finding of this study revealed that Malaysian automotive part manufacturers are generally in an advantageous position as they have been successfully able to transform their investments in LMS practices into performance improvements. In fact, data shows that those Malaysian automotive part manufacturers whom are committed to full-blown implementation of LMS have successfully gained performance improvement in all the five dimensions studied, namely waste reduction, marketing performance, financial performance, operational performance, and non-financial performance.

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