

Green Lean TQM Practices in Malaysian Automotive Companies

Noor Azlina Mohd Salleh, Salmiah Kasolang and Ahmed Jaffar

Abstract—Green Lean Total Quality Management (TQM) System is a system comprises of Environmental Management System (EMS) practices which is integrated to TQM with Lean Manufacturing (LM) principles. The ultimate goal of this system is to focus on achieving total customer satisfaction and environmental care by removing eight wastes available in any process in an organization. A survey questionnaire was developed and distributed to 30 highly active automotive vendors in Malaysia and analyzed by SPSS v.17. It was found out that some vendors have been practicing TQM and LM while some have started to implement EMS. This study is only focusing on highly active companies that have been involved in MAJAICO Program and Proton Vendor Development Program. This is the first study conducted to know the current status of TQM, LM and EMS practices in highly active automotive companies in Malaysia. It was found out that EMS has been practiced by 16 companies out of 30. Within these 16 companies the approach is more holistic and green. This is a preliminary study that combined 4 awards practices, ISO/TS16949, Toyota Production System SAEJ4000, MAJAICO Lean Production System and EMS.

Keywords—Automotive Industry, Lean Manufacturing, Operational Engineering Management, Total Quality Management, Environmental Management System.

I. INTRODUCTION

MALAYSIAN automotive industry has been more than 30 years in the fierce competition of fulfilling demanding customers that seek not only high quality and service products but at the lowest price. [1] – [2]. In order to survive, the companies need to be a world class manufacturer [3]. Toyota Production System has been able to be a world class manufacturer by using their own Lean Manufacturing System which is Toyota Production System. Besides that, world class manufacturers are now not only looking on systems that can improve their operations effectiveness and efficiency but at same time sustaining the environmental by having Environmental Management System in their organization. Due to this, a Lean TQM Factory Model System that has been established in 2011 from a study on highly performance automotive companies in Malaysia [2] can be more comprehensive with the addition of ISO14001 - Environmental Management System (EMS). This new

N.A.Mohd.Salleh was with the Quality Management Section Hicom-Honda Manufacturing Sdn. Bhd and Research and Development Department PROTON Berhad. She is now a Ph.D student in Faculty of Mechanical Engineering, Universiti Teknologi MARA Malaysia (phone: 603-55105090; fax: 603-55435160; e-mail: azlina_salleh@yahoo.com).

S. Kasolang is now an Associate Professor and Deputy Dean (Research and Industrial Linkage) of Faculty of Mechanical Engineering Universiti Teknologi MARA Malaysia (e-mail: salmiahk@salam.uitm.edu.my).

A. Jaffar is now a Professor and Dean of Faculty of Mechanical Engineering Universiti Teknologi MARA Malaysia (e-mail: ahmedjaffar@salam.uitm.edu.my).

framework model that integrated TQM with LM [2] and EMS will be beneficial for companies going for operations improvements through waste elimination and sustainable environment. This Green Lean TQM framework model is inline with the current focus of Malaysia Automotive Institute (MAI) that is moving towards implementing and producing greener technology products [3].

The Green Lean TQM model established in this study is based on adaptation of Malaysian Prime Minister Award Model, Malcolm Baldrige National Quality Award, European Quality Foundation Award, Toyota Production System, ISO16949, SAEJ4001 and MAJAICO Lean Production System. The framework of the model allows a company not only improves its competitiveness but also open for more opportunity for global and environmental recognition. This paper serves as the initial study to gain more understanding on the status of TQM, LM and EMS practices and established an integrated framework model.

This paper will start with the research methodology comprises of the design and development of the questionnaire survey and followed with the findings of the five practices. The five practices are in Leadership, Supplier, Organization and Customers Management practices, Information Management, Human Resource Management and lastly Operational Control Management. The detail framework model will be given in Table II after conclusion section. Discussion on Table II is included in Section II (B).

II. METHODOLOGY – DESIGN AND DEVELOPMENT OF QUESTIONNAIRE

In this study, the main tool used to collect descriptive data is through questionnaires developed based on ISO14001:2004 Environmental Management System, four awards which are Malaysia Quality Award, Deming Prize Award, Malcolm Baldrige National Quality Award, European Award, ISO/TS16949, MAJAICO Lean Production System, Toyota Production System and SAEJ4001: Implementation of Lean Operation User Manual which has been issued in November 1999 by The Engineering Society for Advancing Mobility Land, Sea, Air and Space. The questionnaire has been reviewed by six academicians and four practitioners. The reliability of the questionnaires was analysed using Social Sciences Package v.17 Software SPSS. The results showed that the entire variable is reliable as the overall Cronbach Alpha is 0.915. In previous studies a reliability coefficient Cronbach Alpha value of more than “0.60” sufficient to signify the validity of the variables used in the questionnaires [4].

The study consists of 30 highly performing and active automotive vendors to a common master company. The vendors are evaluated by the master company being highly committed and high performance vendors. These vendors also serve as the benchmark for other vendors. The respondents of the survey are personnel's from Quality, Factory, Operations, Production Engineers, Executives, Managers, Top Management divisions and Environment Officers. The questionnaire was directed to them to ensure that the terms and structures used are meaningful and understood by them. In order to ensure understanding of the questionnaire, all the participating vendors were visited to attend any queries by the respondents as they went the questions.

III. RESULTS AND DISCUSSION

A. Current Status of TQM, LM and EMS in Malaysian Automotive Industry

The response rate obtained is "100%" in one month time for 30 vendors. This group of 30 vendors represents 12.3% of the total automotive vendors in Malaysia [5]. The average response rate for a questionnaire typed survey is reported to be between 11.5% to 12.6% [6], [7] and [8]. Hence, the response rate obtained in this study is considered acceptable and reasonable.

Table I displays the results on implementation percentage, starting year and reasons for implementation of TQM, LM and EMS. The results suggest that the most practiced initiative is LM (66.7%) followed with EMS (53.3%) and TQM (36.7%). Even though TQM has started much earlier in 1996 however, the popularity of this initiative seems to decrease. This could be because companies are now implementing the TQM in the form of ISO/TS16949 which is more acceptable to most manufacturers. The data shows LM has been practiced since 2001 while EMS since 2002. However, LM is accepted more due to the relevance of the initiative to the automotive industry as it is originated and proven its success from Toyota Production System. Besides that, another factor that causes the acceptance of LM is through MAJAICO program which is a Malaysian government vendor development program that has been actively promoting Lean Production System through Malaysia Automotive Institute. EMS initiatives that have been practiced as early as 2002 is used more than TQM. In this study, it is found out that customer requirements on EMS certification is the highest reason why the companies implement EMS practices in their organization. This study has also found out that the highest reasons for a company implementing TQM and LM is voluntarily besides customers and parents company requirements. This shows that the Malaysian automotive companies really want to improve their effectiveness and dare to change for better. Table I displays the information on implementation percentage, started year and reasons for implementation.

TABLE I
IMPLEMENTATION PERCENTAGE, STARTED YEAR AND REASONS FOR IMPLEMENTATION

Initiatives	Implementation %	Starting Year in Malaysia	Reasons for Implementation
LM	66.7%	2001	Volunteer, Customers and Parents Company Requirements
TQM	36.7%	1996	
EMS	53.3%	2002	Customer requirements on EMS certification

B. Integrated TQM with LM and EMS Practices in Malaysia Automotive Companies

In this study, there are five main practices that are used to measure the level of implementation percentage by Malaysian automotive companies which are Leadership, Human Resource Management, Information Management, Suppliers, Organization and Customers Management and Operational Control Management. The implementation percentage is obtained by using the mean results from descriptive analysis by SPSS v.17. Fig. 1 illustrates the implementation percentage of Lean TQM System and EMS. The results show that EMS has higher implementation than Lean TQM system in terms of Leadership, Human Resource Management, Information Management and Operational Control Management. The reasons could be because EMS has legislation requirements which have to be followed in order to be certified as EMS certified companies. However, Suppliers, Organization and Customers Management are so much higher in Lean TQM System with 82.4% compared to EMS with 65.5%. This indicates that the companies which are using TQM, LM and EMS in their operations still have some issues in managing outside parties like suppliers and customers. Lean TQM system has higher implementation percentage due to the fact that this initiative has been highly promoted by government through Malaysia Automotive Institute MAJAICO Lean Production System.

Table II illustrates overall Green Lean TQM framework model with foundation practices and the three levels required for their implementation in automotive companies. The foundation practices are those practices that need to be initially implemented if a company has the interest in implementing the integrated practices. Other practices are described in Level I, II and III.

The foundation practices are determined based on the "90.5 – 96.5%" implementation response from the surveys conducted. It is found out that all the vendors have agreed and most of them have been highly implementing the practices compared to other practices. Thus, these practices are considered as the key practices in the integrated Lean TQM System. After successfully implementing the foundation practices, a company can proceed with practices from Level I, II and lastly Level III which are in the range of "85 – 89.9%, 80 – 84.9% and 70 – 79.9%" respectively.

TABLE II
FRAMEWORK MODEL GUIDELINE ON INTEGRATED GREEN LTQM PRACTICES PROPOSED FOR AN AUTOMOTIVE COMPANY

LEVEL III		<p><i>Implementation Percentage: "75.7 – 78%"</i></p> <p>Long term agreement for financial benefits.</p> <p>Financial benefits for performance in quality improvement</p> <p>Supplier improvements through partnership, training, supplier selection.</p> <p><u>GREEN CUSTOMERS AND SUPPLIERS MANAGEMENT PRACTICES</u></p> <p>Environmental criteria's are included in the selection of suppliers.</p> <p>Suppliers are urged or encouraged to implement environmental actions.</p> <p>There is a contract with extensive agreement with customers related to environmental issues.</p> <p>There is a logistical integration with customers.</p>	<p><i>Implementation Percentage: "78 – 78.5%"</i></p> <p>Open access of information, knowledge, operating and financial data for continuous improvement.</p>	<p><i>Implementation Percentage: "76.2%"</i></p> <p>Career plan or development path for employees are available.</p> <p><u>GREEN HUMAN RESOURCE MANAGEMENT PRACTICES</u></p> <p>The company has adequate resources of infrastructures and technology to establish, implement and maintain the EMS</p> <p>All people performing activities are competent for environmental technologies on certain level of education, training or experience and are recorded and review for its effectiveness.</p>	<p><i>Implementation Percentage: "75 – 79.8%"</i></p> <p>Integrated logistics is in place.</p> <p>Statistical tool is used to control and reduce process variability.</p> <p>Any process is stopped when there is quality problem (jidoka – in station quality).</p> <p>Production activities are controlled by visible/audible indicators in order to ensure no problems are hidden (andon).</p> <p>Problem solving method is used in the Preventive Maintenance activities.</p> <p><u>GREEN OPERATIONAL CONTROL</u></p> <p>Processes are optimized to reduce waste.</p> <p>There are purchasing criteria that avoid the use of hazardous materials and to develop an environment – oriented selection of material /environmental friendly raw materials</p>
-----------	--	---	--	--	--

LEVEL II	<p><i>Implementation Percentage: "80.3 – 84%"</i></p> <p>Non-blaming performance oriented process driven organization.</p> <p>Identify and reviewed impact of new technologies to the organization.</p> <p>Everyone contribute to the improvement programs.</p> <p>Reviewed – environmental noncompliance.</p> <p><u>GREEN LEADERSHIP PRACTICES</u></p> <p>The environmental policy is available to public.</p> <p>There are corporate responsibilities in identification of social commitment and contribution towards sustainable world.</p> <p>More customers acceptability of the new environmental friendly product</p> <p>The programs are defined and designate responsibilities at each relevant function and level</p>	<p><i>Implementation Percentage: "81.5 – 84.5%"</i></p> <p>Continuously improved on material and services.</p> <p>Follow-up on customer requirements and customer satisfaction and communicated to all employees.</p> <p>Customers is no.1 priority to all support department.</p>	<p><i>Implementation Percentage: "82.2 – 82.7%"</i></p> <p>Data analysis are conducted and are used for determining trends, reviewing performance of key areas of control, planning for policy development, improvement activities, training and development of human resources.</p> <p><u>GREEN INFORMATION MANAGEMENT PRACTICES</u></p> <p>Procedures are available for internal communication and exchanges of information between various levels and functions.</p> <p>Procedures are available for external communication and exchanges of information in order to receive, document and responds and decide whether to communicate the significant aspects and documents its decisions.</p>	<p><i>Implementation Percentage: "80.3 – 84%"</i></p> <p>Employee Morale Indicate exists.</p> <p>Appropriate education, skill, training and experience for all staff.</p> <p>Complete training in Lean Manufacturing System to all staff.</p> <p>Reviewed & monitored all training effectiveness.</p> <p>Effective top down communication by transmitting information to all via two way communication methods.</p> <p>All continuous improvement teams are empowered with authority and it is written, understood and followed.</p> <p>All staff and team agree on target and continuously review performance.</p> <p>Objectives of individuals and teams are negotiated, people are appraised fairly and are rewarded with sufficient incentives and financial packages.</p> <p>Employees are empowered, motivated to be innovative, creative and do continuous improvements</p> <p>Company provides health, safety, morale and spiritual needs of employees-physical and recreational facilities and other activities such as counseling, self improvement programs etc.</p> <p><u>GREEN HUMAN RESOURCE MANAGEMENT PRACTICES</u></p> <p>Training needs of environmental aspects and EMS are recorded</p> <p>The company has sufficient human resources and specialized skills to establish, implement and maintain the EMS</p>	<p><i>Implementation Percentage: "80.3 – 84.5%"</i></p> <p>Bills of Materials are accurately catalogued and standard operations are accurately routed, timed and have been value engineered.</p> <p>The processes are managed by process ownership.</p> <p>All the nonconformance findings from Preventive Maintenance activities are recorded and documented.</p> <p>Effective management on raw material sources and supplies, material inventories are optimized, material waste is minimized and fixed assets are utilized to obtain optimum effect.</p> <p>Error-proofing device or system is in place in order to obtain in-process quality (poka-yoke).</p> <p>An effective planned Preventive Maintenance System is in its place.</p> <p>Procedures are in placed and consistently followed that result in shortens changeover times and smaller lot size.</p> <p>Changeover histories are recorded.</p>

<p style="writing-mode: vertical-rl; transform: rotate(180deg);">LEVEL I</p>	<p><i>Implementation Percentage: "85.2 – 89.9%"</i></p> <p>Value Stream Mapping</p> <p>Financial Cash Flow and Balance Sheet.</p> <p>Appointment of Customer Representative, Management Representative and Lean Kaizen Leader.</p> <p><u>GREEN LEADERSHIP PRACTICES</u></p> <p>Management review is by top management at planned interval</p> <p>Corporate image is improved resulting in an improved position of the company in the market</p> <p>Financial resources have been allocated to establish, implement and maintain EMS</p> <p>There are environmental programs available with SMART objectives and targets</p>	<p><i>Implementation Percentage: "86.3 - 89.3%"</i></p> <p>Effectively analyzed, documented and promptly feedback on customer feedback and complaint.</p> <p>Involvement at the earliest stage in development and reviews.</p> <p>Properly represented.</p>	<p><i>Implementation Percentage: "85.7%"</i></p> <p>Operating data are recorded, collected and used by person in charge.</p> <p><u>GREEN INFORMATION MANAGEMENT PRACTICES</u></p> <p>There is procedure to identify, storage, protect, retrieve, retention and disposal records.</p>	<p><i>Implementation Percentage: "86.3 – 88.2%"</i></p> <p>Recorded information on trainings, education and experience.</p> <p>Training budget is allocated.</p> <p><u>GREEN HUMAN RESOURCE MANAGEMENT PRACTICES</u></p> <p>Procedure available for everyone to be aware of their roles and responsibilities in conformance with EMS requirements.</p> <p>Procedure is available for everyone to be aware of significant environmental aspect/impact and benefits of improvements</p> <p>Roles, responsibilities and authorities are defined, in written and communicated to all people that involved in the organization</p>	<p><i>Implementation Percentage: "85.2 – 87.5%"</i></p> <p>All processes are continuously improved.</p> <p>5 Why Analysis</p> <p>Product Segregation.</p> <p>5S Audit.</p> <p>Factory layout is updated from VSM activities. Travelling distance is continuously reduced and periodically reviews for continuous improvements as per BOM and standard operations in use.</p> <p>Any process changes are communicated to all, staffs are trained prior to the implementation and process changes are audited to ensure predicted results are achieved.</p> <p>Person Machine Separation.</p> <p>The work methods are documented and followed which resulted in balanced work loads (standardized task).</p> <p>Production commences after receipt of shipment order.</p> <p>Pull System</p> <p>One piece Flow</p> <p><u>PRODUCT</u></p> <p><i>Implementation Percentage: "81 – 84%"</i></p> <p>All stakeholders agreed on cost, performance and attribute for product and processes based on Design For Manufacture/Assembly and lean principle.</p> <p>All staff has product and process knowledge</p> <p>Continuously shortened product lead times.</p> <p>Robust product and process design.</p> <p><u>GREEN OPERATIONAL CONTROL</u></p> <p>Retain records of calibration and verification</p> <p>Procedures are available to identify potential emergencies and accidents.</p> <p>Emergency plan/procedures are periodically tested.</p> <p>Emergency Preparedness and Response Procedure are reviewed and revised especially after occurrence of accidents or emergency situations.</p> <p>Procedures are available on how to respond to actual emergency situations and accidents and prevent or mitigate impacts.</p> <p>The environmental aspects and impacts are documented and updated to relate all activities, products and services.</p> <p>There are complete and effective procedures on performing activities for dealing with nonconformity, corrective and preventive issues.</p> <p>There are processes or activities that identify and plan operations and procedures available to monitor deviations from policy, objectives and targets.</p>
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">MANAGEMENT PRACTICES</p>	<p>LEADERSHIP</p>	<p>SUPPLIER, ORGANIZATION AND CUSTOMER</p>	<p>INFORMATION</p>	<p>HUMAN RESOURCE</p>	<p>OPERATIONAL CONTROL</p>

FOUNDATION PRACTICES

Implementation Percentage: "90.5 – 96.5%"

LEAN TOM SYSTEM

- Set S-M-A-R-T policies and objectives for Quality, Environment and Lean.
 - Set vision and mission statement.
 - Owned commitment to customer, statutory, regulatory, environment and safety.
 - Review company performance status from customer feedback, cost of quality and audit results.
- Everyone in the company must have mind setting that these practices are for gaining LONG TERM BENEFITS.

GREEN LEADERSHIP

- Top Management commitment to meet the environment and safety requirements.
- Established environment policy includes commitment to comply with legal requirements and other related requirements such as trade barriers and relates to the key products, services and activities
- Documented environment policy has been developed, updated for any changes and communicated effectively to all persons working in the company.
 - Records of Management Review are maintained.
- Established environment policy includes commitment to continual improvement on prevention of pollution and relates to the key products, services and activities.
 - Results of periodic evaluation of legal requirements compliance are recorded.

GREEN HUMAN RESOURCE MANAGEMENT

- The Environmental Management Representative report to top management for review and improvement.
- There is an environmental management representative that has clear roles, responsibility and authority for effective EMS.
 - Procedure is available for everyone to be aware of conformance to policy, procedures and requirements of EMS.
 - Procedure available for everyone to be aware of their roles and responsibilities in conformance with EMS requirements.

GREEN INFORMATION MANAGEMENT

- All documents must establish, implement and maintain a procedure to ensure all documents are updated, approved, controlled and remains legible and identifiable prior to usage.

GREEN OPERATIONAL CONTROL MANAGEMENT

- Environmental Audit Results are reported to management.
- Procedure is available to evaluate compliance with legal requirements and other requirements. Monitoring and measuring equipment are calibrated and verified.
 - Environmental Audit Programs are at planned interval.
 - Retain records of calibration and verification.
- There is a procedure to identify and evaluate environmental aspect and its impact whether it is significant to all activities, products and services.

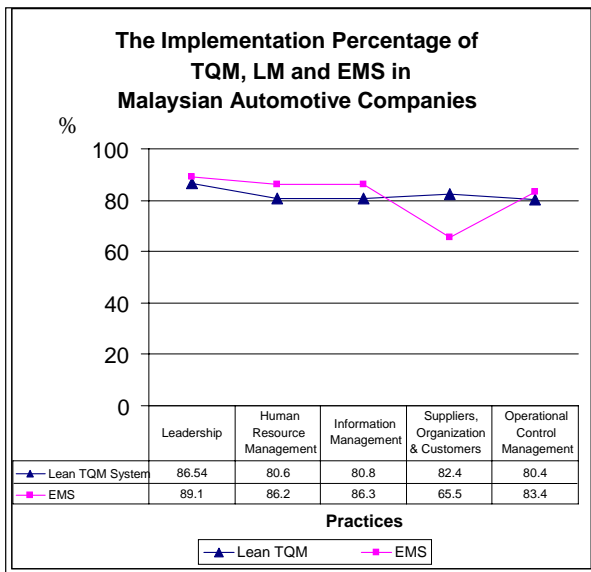


Fig. 1 Implementation percentage of Lean TQM System and EMS in Malaysian automotive companies

IV. CONCLUSION

EMS practices have been practiced commonly compared to LM and TQM for a company that has the three initiatives. This is a good indicator for current automotive manufacturers whereby they are now moving towards sustainable environment instead of just focusing on financial profit. However, an organization with the three initiatives still has not been able to merge all the initiatives into a uniform company organization and develop their vendors to implement EMS. The EMS practices is highly implemented internally in the organization but weakly practiced by their suppliers. Thus, the framework established from this study hopefully will aid an automotive company specifically or other industries generally in integrating TQM, LM and EMS. Besides that, support from government through Malaysia Automotive Institute in promoting comprehensive environmental care and awareness will fasten the progress of more EMS certified

companies that will have more potential in producing green technology products.

ACKNOWLEDGMENT

This contribution was developed from PhD Research Study funded by UiTM Excellence Fund (600-RMI/ST/ DANA 5/3/Dst 206/2009) and FRGS Fund (600-RMI/ST/FRGS 5/3/Fst (126/2010). Special thanks to CEO of Malaysia Automotive Institute and his teams En.Mohamad Madani Sahari, En.Mohd.Nazmi Mohd.Noor, PROTON Holdings Berhad Y.Bhg. Dato'Syed Zainal Abidin Syed Mohamed Tahir, Vendor Management Group lead by Encik Mohd. Taufik Kamarudin, Encik Amir Shah Mohd. Ariff, Cik Ernie Fadzlina, all participated vendors and Dean of Faculty of Mechanical Engineering UiTM Shah Alam for their full support.

REFERENCES

- [1] S.Taj, "Lean manufacturing performance in China: assessment of 65 manufacturing plants," *Journal of Manufacturing Technology Management*, vol.19, pp 217-234, 2, 2008.
- [2] N.A.M.Salleh, S.Kasolang and A.Jaffar "Lean TQM Automotive Factory Model System," *World Academy of Science, Engineering and Technology*, vol. 79, pp 627-633, 2011.
- [3] National Automotive Policy, "Malaysia Automotive Institute," [online]2012. <http://www.mai.org.my> – national automotive policy (Accessed: 5 May 2012).
- [4] S.F.Lim, "Empirical study on the perception of lean manufacturing practices in Penang manufacturing companies," MBA dissertation, Universiti SainsMalaysia,Malaysia,2000,unpublished.
- [5] Vendor Development Unit, "List of Vendors," Report Vendor Development Unit, PROTON BERHAD, 2009, unpublished.
- [6] Y.C. Wong, , K.Y. Wong, A. Ali, "A study on lean manufacturing implementation in the Malaysian electrical and electronics industry.," *European Journal of Scientific Research*, vol. . 38, pp. 521 – 535, 4 2009.
- [7] R. Jusoh, D. N. Ibrahim, and Y. Zainuddin, ."The performance consequence of multiple performance measures usage: evidence from the Malaysian manufacturers," *International Journal of Productivity and Performance Management*, vol. 57, pp. 119-136, 2008.
- [8] S. Ahmed, and M. Hassan, "Survey and case investigation on application of quality management tools and techniques in SMIs," *International Journal of Quality and Reliability Management*, vol. 20, pp. 795-826, 2003.