

MANUFACTURING TECHNOLOGY ADOPTION AMONG LEAN MANUFACTURERS: AN INITIAL STUDY

WeeH.S.and Risyawati M.I.
School of Technology Management and Logistic,
College of Business, Universiti Utara Malaysia,
06010 Sintok, Kedah, Malaysia

Abstract:

Lean manufacturing is a technique that allows work to be performed without bottlenecks or delays while eliminating wasteful activities by linking and balancing equal amounts of work steps together, enabling products to be consumed directly into the next step, one piece at a time until completed. The aim of this research is to analyse the level of implementation of manufacturing technology among lean practitioners in Malaysia. It highlights on the types of technologies applied in the lean practice and to what extend the level of technologies being used. A questionnaire survey was used to identify the different manufacturing technologies being used and the level of applications among lean manufacturers in Malaysia. From the questionnaire results, it shows that there are 3 groups of manufacturing technology used by manufacturers, mainly the direct, indirect and administrative technology. Meanwhile, according to the results the level of technologies used by lean manufacturers in Malaysia is considered as within medium level. This might be due to the cost of applying such technologies or the lack of information regarding each manufacturing technologies.

Keywords: Manufacturing technology, lean

1.0 INTRODUCTION

As a developing country, Malaysia is currently striving to transform its manufacturing industry into being a resilient, broad based and internationally competitive. Such focus is due to the importance of Malaysian manufacturing sector impact on its economic growth and gross domestic product (GDP) (Jabaret *et al.*, 2011). According to Central Bank of Malaysia (2012), the manufacturing sector has contributed RM56, 823 million of GDP growth for the year 2011. In an increasingly competitive and globalized 21st century markets, demand for higher quality products with shorter lead time and lower cost are increasing (Sachpreet&Janpreet, 2008). Therefore various manufacturing strategies were explored to meet such requirement one of them being lean manufacturing system. To uphold competitiveness especially internationally, companies began to adopt lean concept due to broader market but at the same time the pressure from serious competition, cost increase and the diversity of demands is becoming heavier and heavier (Li *et al.*, 2009). Lean manufacturing is defined as a technique that allows work to be performed without bottlenecks or delays while eliminating wasteful activities by linking and balancing equal amounts of work steps together, enabling products to be consumed directly into the next step, one piece at a time until completed (Bon & Rahman, 2009). Through years of research by academicians and industrialists on the implementation and success of lean however, they came to a mutual conclusion that the system is still lack of information, guideline or implementing handbook especially on whether technology is a crucial part in implementing the concept (Li *et al.*, 2009; Papadopoulou&Ozbayrak, 2005). A contingent area which is least explored is the implementation of manufacturing technology. The right technology will enable firms to respond to changing customer and market demands, thus ensuring their survival (Joseph, 1999; Sonntag, 2001; Hayes & Pisano, 1996). As for Malaysia, the country's manufacturing demand for the latest technologies was valued at RM20 billion every year (Business Times, 2006, p.45). Earlier suggestion by technology researchers (Orr & Sohal, 1999; Sonntag, 2003) indicated that lean manufacturers did implement manufacturing as part of their strategies in improving operational performance however these researchers did not indicate the level of implementation or the type of implemented technology. Basically, the goal of this study is to conduct initial research on the importance of technology to lean

manufacturers and identify the type and level of manufacturing technologies implemented by lean companies.

2.0 LITERATURE REVIEW

Manufacturing Technology

White and Bruton (2007) defined technology as the practical implementation of learning and knowledge by individuals and organizations to aid human endeavour. Technology is the knowledge, products, processes, tools and systems used in the creation of goods or in the provision of services. For the purpose of this research, technology is divided into three groups of technology which are (i) high technology, (ii) medium technology and (iii) low technology (Nouman *et al.*, 2011). All three type of the technology differ at the levels of research and development expenses, technological innovation and changing rate of technology within the company (White & Bruton, 2007). Manufacturing technology (MT) is a field of study focused on the improvement of manufacturing processes, techniques, or equipment in order to reduce costs, increase efficiency, enhance reliability, or to incorporate safety and anti-pollution measures which turn the raw materials into products (Dai, 2006). MT is also related to various activities like research and development (R&D), product development, procurement and factory operations (Seino *et al.*, 2011). Manufacturing technologies have been the focus of interest for researchers for some time now. It is an issue that is quite separate from the decision to adopt or not adopt a new technology, the latter being examined extensively in the technology diffusion literature. Advanced Manufacturing Technology (AMT) represents a wide variety of computer -based or numerical-based system (software and hardware) which designed to accomplish, improve or support manufacturing operations and enhancing decision making in production lines (Dangayach *et al.*, 2006; Gunawardana, 2006). AMT is also a comprehensive collection of technologies for enhancing the efficiency and flexibility of manufacturing systems which consist of a wide variety of modern technologies devoted to improve operational efficiency and the competitiveness of manufacturing firms (Small, 2006; 2007). AMT also can be explained as the application of the latest scientific or engineering discoveries to the design of operations and production processes (Idris *et al.*, 2008). According to Dangayach and Deshmukh (2005), AMT can be classified into direct, indirect and administrative. In this study MT and AMT carried the very same scope.

Lean manufacturing

Lean manufacturing (LM) is a technique that allows work to be performed without bottlenecks or delays. This method will eliminate wasteful activities by linking and balancing equal amounts of work steps together, enabling products to be consumed directly into the next step, one piece at a time until completed (Bon & Rahman, 2009; Abdulmalek & Rajgopal, 2007; Bhuiyan & Baghel, 2005; Hallam *et al.*, 2009; Nordin *et al.*, 2011; Papadopoulou & Ozbayrak, 2005). The ultimate goals of lean manufacturing are to increase productivity, reduce lead time and cost and improve quality (Sanchez & Perez, 2010) through practicing lean manufacturing principles, conducting Kaizen events, and removing unnecessary activities and variations through continuous improvement keep businesses competitive (Peter *et al.*, 2011). In addition, lean also focus on reducing cost by eliminating waste (Abdulmalek & Rajgopal, 2007; Papadopoulou & Ozbayrak, 2005). Waste is anything other than minimum amount of equipment, materials, parts and working time that are absolutely essential in production (Taj & Morosan, 2010).

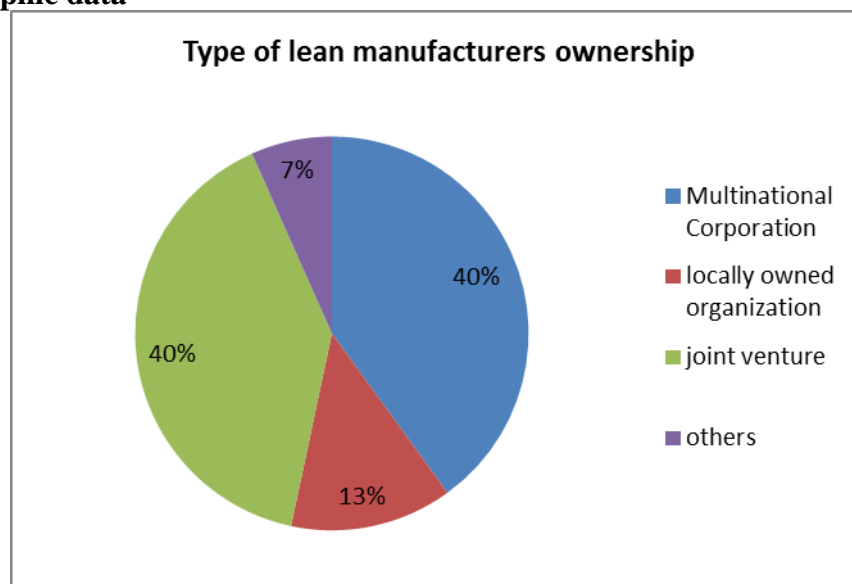
3.0 METHODOLOGY

The method that is used to collect data is by sending questionnaire through paper-pencil-questionnaire and web based questionnaire. This method seems to be the best way to collect primary data for this study since it included larger amount of data (Wong *et al.*, 2009). In this research framework, the independent variables involved only one manufacturing practices which is the lean implementation in

the manufacturing production. The dependable variable is manufacturing technology types used by the manufacturers. The respondents for this research were obtained from FMM-MATRADE Industry Directory 2011 consisting of electrical and electronics (E&E). Companies were chosen from E&E which implemented lean in their production, located in Kedah, Penang and Perlis. The reason for choosing on this group of manufacturers are (1) lean implementer focused on waste removal to increase efficiency in their operation therefor any implemented tool such as manufacturing technology is aimed to harness maximum operating efficiency without overly investing on the tools (2) lean manufacturers such as Toyota and Intel were recognised worldwide as high performers, therefor their manufacturing performance serve as the best benchmark for the manufacturing sector. Questionnaires were distributed to the top or middle management of the department since they are considered as those who truly understand the adoption of technology in the companies. The questionnaire survey was divided into three parts. The first part of the questionnaire asked about assessment of lean manufacturing practices in the company. The second part of the questionnaire survey asked about assessment of MT used in the company. The third and last part of the questionnaire survey which is about the demographic information of the manufacturer and the respondent. The questionnaires are structured using the interval scale which needed the respondent to determine the level of the technology implemented within their organizations. The choices represent the respondent degree of agreement on that particular questions or statements. The questionnaires was sent to the respective companies and they were given a week to complete the questionnaires. 40 questionnaires were sent out, however only 15 (37.5%) companies were able to provide feedbacks for the questionnaires. Most of the companies refused to share any information. Follow up call was then done to check on the completion of the questionnaires. Alternatively the questionnaires were also sent through electronic mail (e-mail).

4.0 RESULTS

4.1 Demographic data



Most of the respondents in this study is from multinational corporation. 7% of the respondent have been implementing lean for 1 year, 46% between 1 to 3 years and 47% have been lean for more than 3 years. Respondents from this survey were also asked on the types of different processes use in their organization. Most of them used more than 1 process in their company with batch production as the preferred manufacturing process.

4.2 Adoption level of direct MT

Computer for control on the factory floor is highest item of direct MT adopted by LM, which its mean is 4.00; follow by the computers for production scheduling with 3.93. Both of these items are classified as high level of MT adoption. Besides that, the type of MT with medium level of adoption are NC / CNC with mean of 3.47 and FMC / FMS. However, robots and 'Pick and Place' robots are lowest in adoption level with mean of 2.13 and 2.0.

4.3 Adoption level of indirect MT

Based on this study only one indirect MT is highly adopted by lean practitioners, namely CAD with mean of 4.0. Besides that, medium level of indirect adoption were identified i.e. CAD/CAM(3.6), CAE(3.7), computer aided inspection (3.33), computer aided quality control(3.33) and MRP I(3.4)&MRP II (3.4) systems.

4.4 Adoption level of administrative MT

Only one MT in administrative category was shown to be highly adopted, which is LAN(4.2) for lean factories. There are 5 MT that is at medium level of application. They are LAN for technical data (3.86), EDI (3.13), intercompany networks (3.33), automated drafting technologies (3.53) and programmable controllers (3.36). As for NC/CNC, based on the result it is classified at lower level application with mean of 2.43.

5.0 DISCUSSION

Based on the analysed data, MT practices among LM in Malaysia is still on the average level. This was properly due to the high cost of installing and operating MT. However due to small sample size generalization could not be made and further evidence need to be provided in the future. However, lack of studies in MT and lack of awareness among manufacturing practices in E&E companies often resulted in lower and medium level of MT (Nordin *et al.*, 2010; Wong & Wong, 2011). From the analysis, direct and administrative manufacturing practices among manufacturers are on a medium level of implementation. Indirect manufacturing practice in LM is also on the middle level. The data analysis shows that only few manufacturers implemented high level of MT in LM by using computer for control on Factory Floor, CAD, LAN for factory and Computers for Production Scheduling.

In this new era, heightening challenges and global competitive market have prompted many manufacturing firms to adopt new manufacturing management strategies in order to enhance the firms' efficiency and competitiveness. MT has been viewed as strategic weapon to gain competitive advantage by manufacturing firms. It is because by implementing MT, it will not only improve firm's productivity and performance but also improve the flexibility of production. It also can improve products and services and even reduce time of product needed into the market by the enterprises and manufacturing enterprises. There were nineteen types of MT adoption in Malaysia manufactures examined in this research. Higher level of MT adoption in E&E companies represents a more efficient and effective manufacturer. Nowadays, MT plays an important role in manufacturing industries especially in E&E manufacturing. MT plays a major role in quality and flexibility improvements in process sector companies. Numerous studies have emphasized the potential strategic benefits of flexibility, responsiveness, improve quality and improve productivity through purposeful investment in MT (Hall & Nakane, 1990; Gerwin, 1993). Moreover, previous studies showed that the benefits of MTs are both tangible and intangible and hinge on the type of MTs and its applications (Jonsson, 2000, Sohalet *et al.*, 2001; Dangayach & Deshmukh, 2005). They found that MT adoption brought many benefits to manufacturing firms in aiding the increase of throughput, better management control, overcoming skill deficiencies, reduction of set-up time, accurate materials planning, enhancing company image, obtaining competitive advantage, reduction in costs, expanding product / process flexibility, a decrease in lead-time; reducing "time to market," better working relationships, improvement in factory utilization, improvement of product quality and improvement in productivity.

6.0 LIMITATION

Several problems were faced when collecting the information for this study. One of the major difficulties is searching and sending the questionnaire to the responsible respondent. 40 questionnaires had been sent to the companies. However, only 15 (37.5%) companies were able to provide feedbacks for the questionnaires. Most of the companies refused to share any information.

In addition, some respondents did not answer the entire questionnaires that had been given. Besides that, the main limitation comes from time constraints.

7.0 RECOMMENDATION

The implementation of lean production relating too many tools and technologies, but there is no exact guideline or implementing handbook, so in the process of implementation of MT, the companies have no knowledge about the importance of respective lean tools and under this situation the experts become the only norm (Qi & Cheng, 2005; Sachpreet&Janpreet, 2008, Seino *et al.*, 2011). This research only shows the level of technologies being implemented within the companies. but it did not answer certain questions as to the reason of certain technologies having low implementation as compared to other types of MT.

In order to overcome this gap, there should be a further detailed research on the impacts of MT in LM among manufacturers in Malaysia to show the importance of LM. Besides that, research on why certain technologies were applied in lower than others should be carried out in the near future. With more data and information provided through research, this could promote the understanding of linkage between lean concept and MT among manufacturers.

8.0 CONCLUSION

This research had been carried out to identify the types and level of MT adoption by E&E companies in Malaysia. There are several MT tools that had been adopted by the companies in order to support and enhance productivity. For instance, CAD, CNC machines, DNC machines, RO, FMS, AS / RS, AMHS, AGV), Bar Coding BC, RP, MRP, SPC, MRP II, ERP, ABC and OA (Gunawardana, 2006; Dangayach *et al.*, 2005). From the results, level of MT adoption in Malaysia manufactures still in the early stage and still lacks of awareness and studies in MT (Nordin *et al.*, 2010; Wong & Wong, 2011). The result shows that lean manufacturers adopt several types of MT in their operation but only to the extent of medium level technologies.

References:

- Abdulmalek, F. A., & Rajgopal, J. (2007). Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. *International Journal of Production Economics*, 107(1), 223-236.
- Bank Negara Malaysia. (2012, March 30). *Economic and financial data for malaysia*. Retrieved from <http://www.bnm.gov.my/index.php?ch=111>
- Bhuiyan, N., & Baghel, A. (2005). Defining the foundation of lean manufacturing in the context of its origins (Japan). *An overview of continuous improvement: from past to present. Management Decision*, 43(5).
- Bon, A.T.; Rahman, N.A. (2009). Quality measurement in lean manufacturing. *Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME), 2009 International Conference on*, vol., no., pp.1-7, 23-25 Nov. 2009
- Business Times (2006), "Kuala Lumpur", *Business Times*, 24 April
- Chen, H., & Lindeke, R. R. (2010). Lean automated manufacturing: avoiding the pitfalls to embrace the opportunities. *Assembly Automation*, 30(2), 117-123.
- Dai, Q.H. (2006). ON relation of manufacturing system, manufacturing mode and manufacturing technology. *Advanced Manufacturing Technology*, 889-893.
- Dangayach, G.S. *et al.*, (2006). Advanced manufacturing technology: a way of improving technological competitiveness. *International Journal of Global Business and Competitiveness*, 2(1), 1-8.

- Gerwin, D. (1993). Manufacturing flexibility: A strategic perspective. *Management Science*, 39 (4), pp. 395-410.
- Gunawardana, K.D. (2006). Introduction of advanced manufacturing technology. *Sabaragamuwa University Journal*, 6(1), 116-134.
- Hallam, C.R.A. *et al.*, (2010). Comparative analysis of work force management techniques between lean and traditional manufacturing companies: a quantitative decision tool for choosing between layoffs and continual improvement. *IEEE*, 1-11.
- Hall, R.W. and Nakane, J., (1991). Holonic manufacturing: Flexibility-the competitive battle in the 1990s. *Production Planning & Control*, 2(1), pp. 2-13.
- Hayes, R.H., and Pisano, G.P. (1996). Manufacturing strategy: At the intersection of two paradigm shifts. *Production and Operations Management*, 5, pp. 25-41.
- Jabar, J. *et al.*, (2011). Organisational learning as an antecedent of technology transfer and new product development: a study of manufacturing firms in Malaysia. *Journal of Manufacturing Technology*, 22(1), 25-45
- Jonsson, P. (2000). An empirical taxonomy of advanced manufacturing technology. *Journal of Operations & Production Management*, 20(12), 1446-74.
- Li, J.Q. *et al.*, (2009). Design on method of Statistical Process Control (SPC) based on RFID technology. *Management Science & Engineering*, 207.
- Li Shaobo; Wu Chunhua; Zhang Hongliang; , "Key technology analysis of implementing lean production," *Industrial Engineering and Engineering Management*, 2009. *IE&EM '09. 16th International Conference on*, vol., no., pp.1993-1996, 21-23 Oct. 2009
- Nordin, N. *et al.*, (2010). A survey on lean manufacturing implementation in Malaysian automotive industry. *International Journal of Innovation, Management and Technology*, 1(4), 374-380.
- Nordin, N. (2011). Lean manufacturing implementation in Malaysian automotive industry: an exploratory study. *Operations and Supply Management*, 4(1), 21-30.
- Nordin, N., Deros, B. M., Wahab, D. A., & Rahman, M. N. A. (2011). A framework for managing change in lean manufacturing implementation.
- Nouman, M.; Warren, L.; Thomas, S.R. (2011). Researching the 'forgotten sector': Low and medium tech (LMT) innovation - present light on future trends. *Technology Management Conference (ITMC), 2011 IEEE International*, vol., no., pp.103-113, 27-30 June 2011
- Official Website of Malaysian Industrial Development Authority (MIDA). (2008). Retrieved March 13, 2012 from www.mida.gov.my/
- Orr, S., and Sohal, A.S. (1999). Technology and global manufacturing: Some German Experiences. *Management Decision*, 374, pp. 356-362.
- Papadopolou, T. C., & Ozbayrak, M. (2005). *Journal of Manufacturing Technology Management*, 16(7), 784-807.
- Peter, G.J., Shinn, K. and Fleener, F., (2011). Lean manufacturing practices: Issues created when two companies are integrated and quality management standards are imposed. *Technology Management in the Energy Smart World (PICMET), 2011 Proceedings of PICMET '11*: , vol., no., pp.1-7, July 31 2011-Aug. 4 2011
- Sachpreet, S. A., & Janpreet, S. G. (2008). Lean manufacturing- a practitioner's perspective. *IEEE, IEEM*.
- Sanchez, A.M. and Perez, M.P. (2010). Lean indicators and manufacturing strategies. *Journal of Operations & Production Management*, 21(1), 1433-1451.
- Seino, T., Kyomasu, N., Nomura, T. , (2011). Proposal of manufacturing technology management as a new research framework in technology management. *Technology Management in the Energy Smart World (PICMET), 2011 Proceedings of PICMET '11*: , vol., no., pp.1-6, July 31 2011-Aug. 4 2011
- Small, M.H. (2006). Justifying investment in advanced manufacturing technology: a portfolio analysis. *Industrial Management & Data Systems*, 106(4), 485-508.
- Small, M.H. (2007). Planning, justifying and installing advanced manufacturing technology: a managerial framework. *Journal of Manufacturing Technology*, 18(5), 518-537.
- Sohal, A. *et al.* (2001). Adoption of AMT by South African manufacturers. *Integrated Manufacturing Systems*, 12(1), 15-34.

- Taj, S., &Morosan, C. (2011). The impact of lean operations on the chinese manufacturing performance. *Journal of Manufacturing Technology Management*, 22(2), 223-240.
- White, M. A., &Bruton, G. D. (2007). *The management of technology and innovation: A strategic approach*. (2nd ed.). USA: South-Western Cengage Learning.
- Wong, Y.C. and Wong K.Y. (2011).A lean manufacturing framework for the Malaysian electrical and electronics industry. *IPEDR*, 12, 30-34.