

**MEDIATING EFFECT OF MANUFACTURING TECHNOLOGY ON ENVIRONMENTAL
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mhalim@uum.edu.my**ABSTRACT**

The purpose of this study is to explore how the implementation of manufacturing technology could facilitate successful lean implementation in achieving superior operational performance. The paper is based on a survey research done on lean manufacturers in Malaysia and their adoption of manufacturing technology to couple the implemented lean system. The challenges faced by lean manufacturing firms in many developing countries includes adopting the right technology, using it efficiently and continuously reviewing production technology in order to gain maximum output. Many organizations believe that implementation of lean manufacturing involved large amount of capital, capacity, infrastructures and technology investment to support the system, which might proof to be a financial burden to these manufacturers. This perception is not help by the scarcity of related research on manufacturing technology impact and adoption among lean manufacturers in Malaysia and globally. Model from this empirical study is expected to contribute towards the enhancement of theory on technology adoption and its effect on performance. At theoretical level, the study results showed the impact of manufacturing technology on the manufacturing performance of lean implementers.

Field of Research: *Operational, production and technology management.*

1. INTRODUCTION

In Malaysia, the manufacturing sector is the second largest contributor to GDP at 26.2%, it is the main source of employment with total employment rate of 28.4%, and it remains as the main sector for contributing toward the Malaysian economic growth (MPC, 2011; FMM, 2010; Islam & Karim, 2010). These facts show how pertinent the manufacturing sector is to the overall economic health of Malaysia. This sector continues to propel the economy forward through synergistic relationships with others such as trading, financial, transportation, and services. Therefore it is without any doubt that the manufacturing sector is one of the most important drivers of the growth of the Malaysian economy, which to date employs more than one million workers nationwide (Annual Manufacturing Report, 2010). The aim of this study is to determine the impact of manufacturing technology on environmental factors and operational performance of Malaysia lean manufacturers.

2. LITERATURE REVIEW

Manufacturing Performance

However due to globalisation and the increased demand for better products by customers, manufacturers nowadays face intense multifaceted pressure to perform. Influx of foreign products, new product introduction by competitors, shorter product lifecycle, rapid technology updates, and changes in customer demand have forced manufacturers to re-examine their current strategy and achievements (De Toni & Tonchia, 2001; Anand & Ward, 2004; Verdu-Jover et al., 2006). With such a dynamic environment in Malaysia, manufacturers also face a high level of uncertainty caused by these on-going changes. The electronics industry which had been shown earlier as Malaysia's chief export earner since 1974 and the leading contributor of employment had experienced performance downturn since 1997.

Environmental Factor

Heavy dependence on exported performance meant that any changes in global economy will have a more focal and significant impact on the local manufacturers. The downside of manufacturing performance in Malaysia is in tandem with the decline in global market shares of exports. In 2009 alone, the Productivity Report posted a massive dropped of 8.6 % in terms of total manufacturing productivity due to deterioration of electrical and electronic product cluster, which contracted a share of about 22.8%. Since manufacturing constitutes the largest single component of Malaysia's economy, sluggish manufacturing performance without doubt would affect the nation's overall economy as well.

Manufacturing technology (MT)

Technology has a broad meaning to manufacturers. Today's competitive environment has caused manufacturers to re-evaluate their technology strategies and practices. One aspect that manufacturers focus on is the ability of the current manufacturing technology on hand to meet these challenges in the turbulent environment (Sonntag, 2003). From a strategic perspective, manufacturing technology acts as

a tool used by firms to adapt and react to the increasingly volatile and complex business environment (Orr & Sohal, 1999). In the context of this research, manufacturing technology is defined as advance manufacturing technologies which consists of a group of computer based technologies that includes computer aided design, computer aided manufacturing, manufacturing resource planning, robotics, group technology, flexible system, automated material handling system, computer numerically control machine tools, bar coding or other automated identification techniques as well as any additional or advance technology when compared to previous manufacturing technologies (Lewis & Boyer, 2002; Stock & McDermott, 2001; Abd Rahman & Bennet, 2009). Manufacturing technology is a generic term for a group of manufacturing technologies which combines both scope and scale capabilities in a manufacturing environment. As a result, manufacturing technology can play a crucial role in making it possible for firms to compete on “traditionally” contradictory competitive priorities simultaneously. This study will look into manufacturing technology adoption by lean implementers. 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.

3. RESEARCH FRAMEWORK

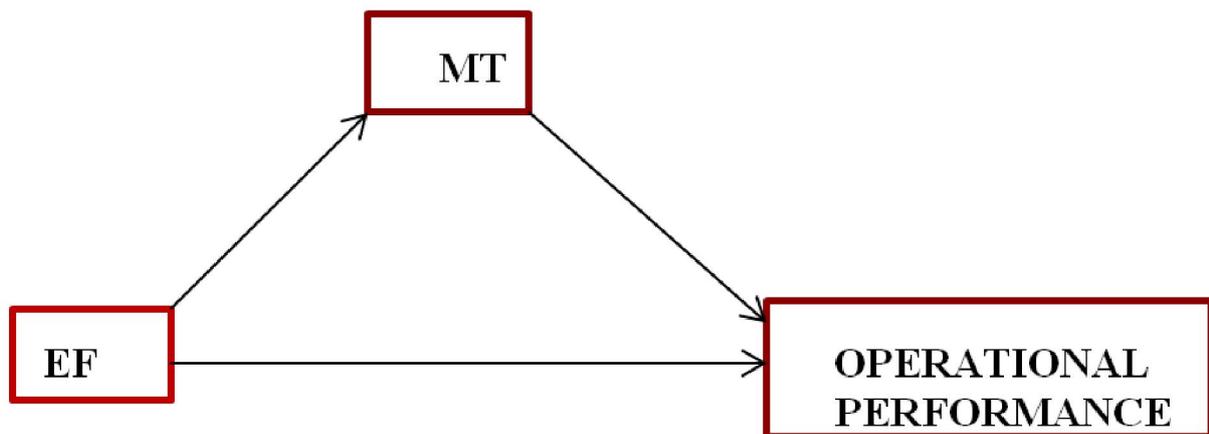


Figure 1.0

The hypotheses is that manufacturing technology(MT) mediate the relationship between environmental factor and operational performance

4. Methodology

Due to unregistered list of choice respondents, a total of 1246 electric and electronic, automobiles and aerospace manufacturers listed in FMM 2010 Directory were contacted by phone. This exercise was

carried out to determine the number of lean manufacturers within the initial population. Upon completion, a total of 226 companies were identified as lean manufacturers. However due to the low respond rate among Malaysian manufacturers, as exhibited in previous study (Jusoh, 2007; Wong et. al, 2009), a total of 226 questionnaires were sent out. Five more follow ups were then done via email and phone calls on a weekly basis. Out of the 226 respondents, 112 respondents completed the questionnaire, leaving the response rate at 49.6%. However out of 112 received questionnaires, only 85 were answered by the intended respondents while another 27 were answered by the Human Resource (HR) department. Therefore only 85 questionnaires were coded and analyzed.

5. RESULTS AND DISCUSSION

Demographics

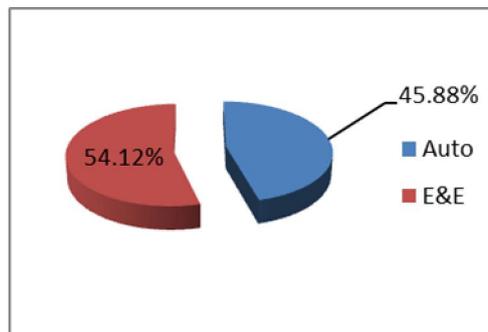


Figure 2.0 Respondents industry type profile

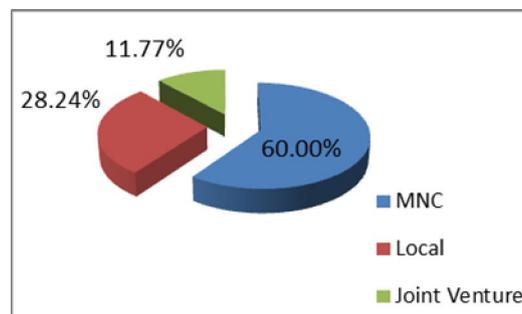


Figure 3.0 Ownerships type of analyzed manufacturers

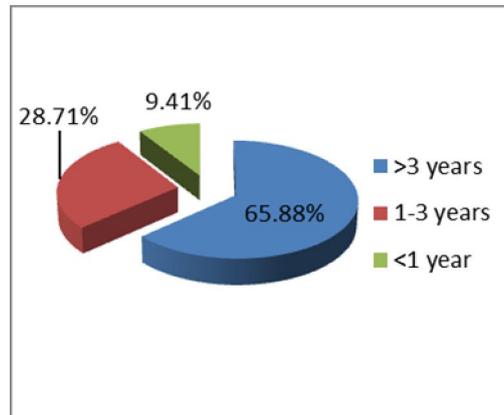


Figure 4.0 Lean implementation history of respondents.

Data Analysis

Data for this study was analyzed using one of structural equation modeling (SEM) method, which is partial least squares (PLS). The first step in PLS path modeling is to analyze the measurement model used in the research. This initial step is to determine how well the indicators (specific questions) load on the theoretically defined constructs.

Table 1.0

	AVE	Composite Reliability	Cronbachs Alpha
EF	0.7495	0.8000	0.7784
MT	0.6029	0.8832	0.8357
OP	0.8005	0.8891	0.7536

Results showed that the measurement model is valid with AVE more than 0.5 , composite reliability more than 0.7 and Cronbach alpha more than the recommended 0.7. As for factor loading , every construct in the measurement model are maintained if the loadings are more than 0.7. Chin & Henseler (2010) suggested using 0.7 for loadings as this value makes the measurement models touch conventional acceptance thresholds of reliability and validity (Chin & Henseler,2010). This conclude that the measurement model used in this study is valid.

Mediation effect of MT

PLS is best used with the casual steps approach that relies on regression analysis. The path coefficients generated by PLS provide an indication of relationships and can be used similarly to the traditional regression coefficients (Gefen et al., 2000). First, a direct link must be established between the independent and dependent variable to ensure there is a relationship to be mediated. This is established in Figure 2.0

Figure 5.0 First model analysis

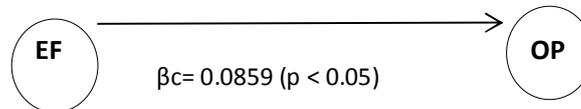
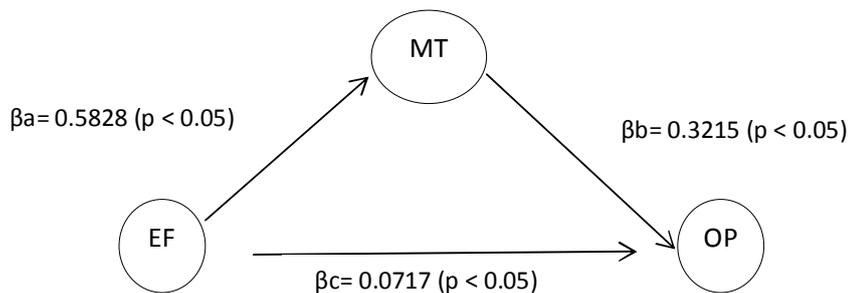


Figure 6.0 Second model analysis

In the second model, manufacturing technology (MT) was introduced as the mediator between external environment and operational performance.



Based on the calculated VAF, 72.37% of total effect for this model is explained by the indirect effect.

6. DISCUSSION

This showed strong mediating impact of MT in the relationship between EF and OP. Results showed that 2/3 of the relationship is explained by the indirect effect. The introduction of path 'a' and 'b' clearly affected the relationship between EF and OP. So as an initial finding this model showed that the implementation of manufacturing technology by lean manufacturers significantly increases their operational performance. This finding supported earlier suggestion by technology researchers (Orr & Sohal, 1999; Sonntag, 2003). However MT itself consist of several type and classification, it is the intention of this study to further investigate the effect of different types of MT on OP. Investment in MT always require a large amount of capital therefor the more precise the choice of MT that will effect OP, the better it will be for the manufacturers financially.

7. CONCLUSION AND SUGGESTION

Based on early data analysis, manufacturing technology mediate the relationship between environmental factor and operational performance. Further analysis need to be done in order to differentiate the effect of different types of technology on operational performance.

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