Empirical evidence of AMT practices and sustainable environmental initiatives in Malaysian automotive SMEs

Abstract

This paper presents significant empirical evidence on the relationship between Advanced Manufacturing Technology (AMT) practices and sustainable environmental initiatives with the manufacturing capabilities of automotive SMEs in Malaysia. A cross-sectional survey is adopted in this study, which involves 83 Malaysian automotive SMEs. Two hypotheses are proposed in this study, i.e. Hypothesis 1: There are positive effects of AMT practices on the manufacturing capabilities of SMEs and Hypothesis 2: There are positive effects of sustainable environmental initiatives on the manufacturing capabilities of SMEs. The results obtained from the pairwise correlation analysis indicate that both AMT practices and sustainable environmental initiatives have positive effects on manufacturing capabilities, which support both hypotheses. In addition, it is found that 50% of the SMEs implement AMT for flexibility and cost reduction in the past five years. It is also found that more than 80% sustainable practices are adopted in most of the SMEs with the exception of Life Cycle Assessment. Based on the findings, there is a need to move forward into the hybrid approach, which will consider both AMT practices and environmental initiatives to ensure that SMEs remain competitive and become the world player in the automotive industry.
Empirical Evidence of AMT Practices and Sustainable Environmental Initiatives in Malaysian Automotive SMEs

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KEYWORDS: Advanced Manufacturing Technology (AMT), Small and Medium Enterprises (SMEs), Flexible Manufacturing Systems (FMS), sustainable manufacturing

This paper presents significant empirical evidence on the relationship between Advanced Manufacturing Technology (AMT) practices and sustainable environmental initiatives with the manufacturing capabilities of automotive SMEs in Malaysia. A cross-sectional survey is adopted in this study, which involves 33 Malaysian automotive SMEs. Two hypotheses are proposed in this study: 1. Hypothesis 1: There are positive effects of AMT practices on the manufacturing capabilities of SMEs. 2. Hypothesis 2: There are positive effects of sustainable environmental initiatives on the manufacturing capabilities of SMEs. The results obtained from the pairwise correlation analysis indicate that both AMT practices and sustainable environmental initiatives have positive effects on manufacturing capabilities, which support both hypotheses. In addition, it is found that 50% of the SMEs implement AMT for flexibility and cost reduction in the past five years. It is also found that more than 80% of sustainable practices are adopted in most of the SMEs with the exception of Life Cycle Assessment. Based on the findings, there is a need to move forward into the hybrid approach, which will consider both AMT practices and environmental initiatives to ensure that SMEs remain competitive and become the world player in the automotive industry.

1. Introduction

The manufacturing industry has significantly strengthened the economic growth in many countries. It is inevitable that the manufacturing industry plays a crucial role in the global economy since it creates goods and services, and serves as a major employment generator worldwide. Nowadays, developing countries invest heavily in the manufacturing sector with economic restructuring. Many companies and factories are springing up to meet the production needs of the society, especially small and medium enterprises (SMEs), which are a business form consistent with private economies. However, dynamic market conditions as well as the demand for various products based on customer needs result in SMEs having to restructure their production systems in order to respond and adapt to such changes.

Advanced Manufacturing Technology (AMT) plays a major role in improving the quality and flexibility of SMEs. Firms have introduced and implemented AMT since the 1980s in order to gain profits and competitive advantages. Even though the purpose of AMT is to achieve technical capabilities and market profits, the effects of implementing AMT are imperfect.

In Malaysia, SMEs constitute about 84% of manufacturing establishments. In general, SMEs do not only contribute to economic development, but they are also able to sustain themselves as the economy goes through different stages of industrial development. It is believed that SMEs will become even more important as the country develops and will be accorded greater priority in the future. SMEs constantly search for solutions to respond quickly to changes of customers, competitors, and technologies, and flexibility plays a critical role in this struggle for success. Flexibility refers to the SMEs' capacity related to changeability, re-configurability and agility of the manufacturing structure, in which the primary aim is to satisfy an increasing variety of customer requirements and address problems associated with costs, time, and organizational disruption and performance losses.8,9

Many SMEs must respond to the challenges and requirements of producing competitive goods in order to fulfill customer demands such as deadlines, quality, just-in-time and quantity. Manufacturers aim at increasing flexibility, timely delivery, and
product quality and customer service in order to fulfill customer needs. This, in turn, calls for a strategy, which accounts for flexibility, efficiency, quality, reduced production time, increased profits, reduced production costs, increased productivity and regular maintenance services.

One of the systems that is able to respond flexibly is flexible manufacturing systems (FMS). However, the implementation of FMS is an extremely challenging task, which involves a variety of components such as computer numerical controlled (CNC) machines, transportation systems or robots and central computer systems. FMC is considered as the basic component in the development strategies of SMEs and is the key to the survival of the modern manufacturing industry. In recent years, the implementation of flexible manufacturing cells (FMC) is the primary focus of developing countries due to its flexibility and high efficiency up to 90%. However, the implementation and planning of FMC in SMEs play an important role as the key issues need to be addressed in order to increase the utilization of CNC machines and cutting tools.

AMT consists of a potential group of technologies such as computer aided design (CAD), computer aided manufacturing (CAM), computer numerical control (CNC), computer aided process planning (CAPP) and engineering systems, materials resource management, production planning, scheduling, control and integration, material handling systems such as conveyors, automated guided vehicles (AGVs) and robots, FMS/FMC, advanced manufacturing systems such as biology manufacturing systems, facility manufacturing, reconfigurable/ reprogrammable manufacturing systems, sustainable manufacturing systems as well as clean manufacturing systems with electronic data interchange. AMT is a key contributing factor in improving the productivity, flexibility, product quality and green standards (i.e. clean, sustainability and environmental factors) of SMEs. Therefore, SMEs are gaining interest to invest in AMTs in order to attain competitiveness in exporting to potential markets.

However, the decision to invest in AMTs is based on the appropriate support from technical or academic viewpoints as well as from the experience gained by companies that have implemented AMTs. The lessons that can be learnt include the types of AMT, contribution of manufacturing parameters as well as the effects of implementing AMT on the company's performance. Even though profitability is positive, the decision made by SMEs is also dependent on their confidence levels, which is supported by economical parameters such as return on investment.

The increasing human population as well as the need to achieve a high quality of life amplifies the production of goods in the manufacturing industry. Consequently, manufacturing industries need to produce a higher volume of goods to satisfy the market and deliver good quality products within a shorter time, which requires manufacturing flexibility. One of the strategies that can be used to increase flexibility is new advanced technologies.17 Kotha and Swaminathan also stated that AMT promotes flexibility in manufacturing industries.

On the other hand, stringent legislation on environmental conservation has been the focus of manufacturing industries. According to O'Brien,18 manufacturers should produce goods that are within the limits of the earth's carrying capacity. It is obvious that manufacturing activities contribute to enormous waste, high resource exploitation as well as excessive energy consumption. Manufacturing dominates industrial energy consumption, and Schipper19 reported that manufacturing accounts for 84% of energy-related industries' CO2 emissions and 90% of industrial energy consumption. This, in turn, has detrimental environmental impact for future generations. It is apparent that manufacturing activities have a significant contribution on environmental impact and therefore substantial improvements through environmental initiatives must be made.

Knowing the importance of AMT and sustainable environmental initiatives in the manufacturing industry, this study is aimed to explore AMT practices and sustainable environmental initiatives currently implemented in automotive manufacturing SMEs within Malaysia. The correlation between AMT practices and environmental initiatives with respect to the SMEs' manufacturing capabilities as an element of competitiveness is also presented in this paper.

2. Advanced Manufacturing Technology and Environmental Initiative

The implementation of AMT does not only require substantial investment in technology, but also changes in organizational culture and structure. AMT requires careful planning at all levels of the organization to ensure that its implementation will achieve the desired goals. AMT is a complex process in which various factors need to be considered before the full benefits of AMT can be realized.20

It is often stated that the strength of a country lies in the strength of its industrial sector, and progress in an industrial society is accomplished by the development of new technologies. Development is facilitated by the increasing availability of AMT. Small-scale industries (i.e., SMEs) are the backbone of the industrialization process in developing and developed countries and they play a crucial role in increasing the country’s economy. With globalization and free trade agreements, SMEs face increasing pressure to adopt AMTs to ensure their survival and remain competitive in the global market. Policy makers use multiple criteria when analyzing complex problems at all levels of the decision-making processes in organizations.

Several approaches have been proposed to justify investment in AMTs. AMTs can be categorized into three main groups, namely, economic, strategic and analytical approaches.21-24

Even though the economic approach provides ease of data collection and offers an intuitive appeal, this approach only considers a single objective of cash flow and neglects other non-economic benefits such as quality and flexibility. The strategic approach requires less technical data and accounts for the general objectives of the firm. However, it is necessary that strategic approach be coupled with economic or analytic approaches since it is focused on long-term intangible benefits.

The three main elements of AMT are pre-implementation, implementation and post-implementation, which ensures successful implementation of AMT in SMEs. Pre-implementation involves predicting the percentage of the probability of implementation success, selecting robot technologies as well as selecting the suppliers of robot technology. In the implementation phase, managers need to adopt

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References


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