THE IMPACT OF INVESTMENTS IN MANUFACTURING PRACTICES ON ORGANIZATIONAL PERFORMANCE

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ABSTRACT

This study examines the effects of investments in manufacturing practices on operational and quality performance through process efficiency, based on data from the 4th round of the Global Manufacturing Research Group (GMRG) survey. In addition, the study investigates the difference between investments in manufacturing practices and process efficiency, based on the level of economic countries. A research model is proposed, which describes the impact of investments in manufacturing practices on organizational performance. The proposed research model and hypotheses will be tested using structural equation modeling.

Keywords: Investments in manufacturing practices, process efficiency, economic countries, GMRG survey.

INTRODUCTION

The fierce global competitions among manufacturing companies require increasing the efficiency of processes and investment in manufacturing practices (e.g., facilities, equipment, system, etc.) under an uncertain market situation (Murugesan et al, 2012). Consequently, in an open market with advanced information technology, an organization needs to improve the efficiency and effectiveness of processes, which are significant contributors to a successful company by for example, reducing the set up time, manufacturing throughput time, increasing the utilization rate of plant/equipment, and investment rate of manufacturing facilities. To improve the efficiency and effectiveness of processes, leaders or managers of manufacturing industries try to invest in their existed practices/systems for both employees and the company.

In recent research of manufacturing practices using Global Manufacturing Research Group (GMRG) data sets, Wiengarten et al. (2011) showed that investments in manufacturing practices are significant effects on organizational performance. Results of the study also provided moderating effect of investments in manufacturing practices on operational performance according to the type of national culture. On the other hand, Davies and Kochhar (2002) suggested that implementation of practices is either successful or not successful in certain
situations. Previous studies proposed differences in manufacturing practices depending on the countries to improve organizational performance (Kadipasaoglu et al., 1999; Whybark & Vastag, 1993; Wiengarten et al., 2011).

Process efficiency is also one of the largest concerns in the industry today because improving the efficiency of a process is a great way to reduce overhead and to maximize optimization. In addition, organizations need innovation and/or development in manufacturing practices because they depend on “the accurate, timely description of process and conditions” (Nemeth & Cook, 2007). Therefore, organizations develop manufacturing practices to enhance process efficiency through existing systems as to improve performance based on international manufacturing practices or on the environment because of the currently heightened level of competitions both in the domestic and international markets. In addition, organizations need to compete effectively in manufacturing practices for opportunities to exploit their strategic abilities and improve performance through process efficiency, including understanding of international manufacturing practices.

There are only a few studies on the relationship between investments in manufacturing practices and process efficiency. Also, there has been a paucity of studies on differences among multi-country economies in manufacturing practices that maximize the efficiency of processes. Therefore, the purpose of this study is to empirically test the effects of investments in manufacturing practices on process efficiency and organizational performance. In addition, the study compares the difference of investments in manufacturing practices based on multi-countries. The research question of the paper is to explore how companies which invest in manufacturing practices are gaining a competitive advantage by focusing on process efficiency for operational and quality performance. A research model is proposed based on previous studies.

The study employs data from the 4th round of the Global Manufacturing Research Group (GMRG) survey and examines the proposed model through structural equation modeling. The rest of this paper is organized as follows: Section 2 provides a review of previous studies and relevant concepts; Section 3 proposes the research model and hypotheses; Section 4 describes the research methodology; Section 5 presents the expected results.

**LITERATURE REVIEW**

In the challenging era, companies understand how to reduce waste, improve the efficiency of their operations, and adopt sustainability to be more competitive in the global market. Organizations have competitive priorities (e.g., customer satisfaction, operational flexibility, the order cycle time, delivery speed, and product quality to achieve their goals through their capabilities, such as plant and equipment, system, and/or quality (Dangayach & Deshmukh, 2000; Kathuria et al., 2010). To have these competitive advantages, most companies try to
develop, invest, or benchmark in an effort to improve their existing system or program from well-known manufacturing practices, which are used by a successful leading international company.

**Manufacturing Practices**

Practices refer to a well-known model adopted by a company to achieve successful business for its environment in the manufacturing industry (e.g., Laugen et al, 2005; Whybark & Vastag, 1993; Wiengarten et al, 2011). The manufacturing practices commonly introduced are plant and equipment, system/program, quality, new product development (Kadipasaoglu et al, 1999; Laugen et al, 2005; Voss et al, 1995).

Well-known manufacturing practices have been examined and adopted to improve process efficiency and/or performance in the manufacturing industry (Kadipasaoglu et al, 1999; Rho & Yu, 1998; Voss et al, 1995). According to the research which examined differences between manufacturing practices and performances using multi-country (i.e., Rungtusanatham et al, 2005; Wiengarten et al, 2011; Voss et al, 1995; Wiengarten et al, 2011), manufacturing practices might be adopted or invested based on the situation of each country or economy because it implies cultural differences (Rungtusanatham et al, 2005; Wiengarten et al, 2011). However, some researchers presented national culture influences on operational management (i.e., Hope & Muehlemann, 2001).

Previous studies suggested quality implementations to reduce defect, prevent errors, and improve the quality of products and services (Laugen et al, 2005). A study of Rungtusanatham et al. (2005) presented a difference between implementation of quality practices and organizational performance in a multi-country. Also, Dangayach and Deshmukh (2000) and Kathuria et al. (2010) showed that manufacturing quality is generally considered as one of the most important competitive priorities.

Previous studies suggested investments in environmental practices, such as ISO 14000 certification (e.g., Lee et al, 2011; Schoenherr, 2012), pollution prevention (e.g., Klassen & Whybark, 1999), recycling of resources (e.g., Murugesan et al, 2012; Schoenherr, 2012), and waste reduction actives (e.g., Shah & Ward, 2007), which positively impact competitive advantage and organizational performance. Schoenherr’s study (2012) showed the importance of environmental investments in manufacturing industry. Ichim (2007) addressed that “existing processes must minimize flows and loads wherever possible, and nontoxic substances must be substituted for toxic substances wherever possible.” Although in the dynamic environment, it is very difficult and complicated to invest, as the strategy and tool to successfully operate, however, the manufacturing environment should be considered as one of the manufacturing practices.
For the best manufacturing practices in the study we selected commonly used practices based on previous studies, and included the manufacturing environment because of the importance of investment in manufacturing environment in recently. In the study, investments in manufacturing practices are used from the study of Flynn et al. (1995), Schoenherr (2012), and Wiengarten et al. (2011) - namely, manufacturing plant and equipment, system, quality, and environment.

**Process Efficiency**

Highly efficient organization can quickly respond in order to provide the needed products, which are requested by consumers, or to deal with problems when a rapid surge in demand occurs through operational processes (Jacobs & Chase, 2010). Goals of the operational efficiency and lean manufacturing are waste elimination and time reduction. This means finding out where any company spend resources (e.g., time, money, people, effort, etc.) on activities that do not add value through the operational process. As operational efficiency can help increase efficiency, reduce costs, and streamline processes, the efficiency of operations can be achieved by process efficiency because it involves all employees in improving the plant's administrative and operational processes. Also, manufacturing companies can improve data quality and reduce processing errors; increase efficiency and simplify workflows; promote security, privacy, and compliance; and shorten development time and reduce the total production and operating costs.

Improved processes provide performance-based outcome, such as improving productivity, eliminating waste and reducing cost, to manufacturers (Jacobs & Chase, 2010; Rho & Yu, 1998). Day (1995) and Roby (1995) presented that process efficiency leads to increasing productivity and quality, and Roby’s study (1995) especially showed an increasing rate of 250% in productivity and 50% in quality.

Process efficiency that optimizes operational and quality performance in terms of organizational performance is more important to keep consistent with high quality in a rapidly changing competitive global market. In other words, process efficiency plays a vital role in improving speed and performance, eliminating waste, and developing efficient information networks with suppliers, including reduced lead time, new operational strategies, and consistent quality (Lee et al, 2011). Also, as process efficiency sustains internal consistency through manufacturing practices, it can influence quality to reduce process variance and prevent rework and errors (Lee et al, 2011). For example, manufacturing quality programs, such as total quality management (TQM), Six Sigma, and Statistical quality control (SPC), are effective within the existing cultural boundaries to improve organizational processes. The Iida Factory, one of Japan's leading facilities for ventilator production, makes competitive products by factory automation. It combines several technologies to build automated, high-efficiency, high-precision production lines for improving process efficiency. Thus, the process efficiency is derived by the operational process for strong competitive advantage, increased productivity, improved quality, and reduced setup and response time.
Consequently, process efficiency in the study refers to the process activities to reduce cost and setup time, increase efficiency, and streamlining processes in the acquisition process for gaining competitive advantages. In the study, measurement items of process efficiency are used as follows: manufacturing throughput time reduction, setup time reduction, new product design time reduction, and increasing utilization rate of manufacturing plant and equipment.

**Organizational Performance**

Organizational performance is defined as an outcome of organizational goals achieved through the effectiveness of strategies or techniques; it was then measured based on the type of industry and the concept of the research model. Firms typically measure financial and nonfinancial performance outcomes related to certain aspects of strategies and operations in the context of organizational goals. Manufacturing firms may achieve their organizational goals for competitive priorities by manufacturing practices to reduce defects, save cost, and improve operational efficiency. For quality performance, we used several constructs as - namely, a reduction in the defect rate for materials, processes, and inspections, and the customer return rate - based on the study of Kadipasaoglu et al. (1999), Laugen et al. (2005), and Wiengarten et al. Therefore, in this study organizational performance is measured as the quality and operational performance. Also measurement items of operational performance are based on the study of Kadipasaoglu et al. (1999) and Wiengarten et al. (2011) to measure manufacturing cost, product performance and quality, order fulfillment speed, and flexibility to change product mix.

**RESEARCH MODEL AND HYPOTHESES**

According to previous research, manufacturing practices, such as practices of manufacturing quality and/or system, lead to reducing process variance. Variance reduction by process efficiency is available to safety stock inventory reduction, setup time reduction, manufacturing throughput time reduction, and defect reduction (Flynn et al, 1995). For instance, practices of manufacturing quality (i.e., six-sigma, TQM, ISO 9000) can allow reducing defect and preventing errors through process efficiency in operational processes. Accordingly, organizations strive for process efficiency in their existing work process (Lee et al, 2011). Thus, it is important to analyze the effects of investments in manufacturing practices on operational performance through process efficiency for competitive advantage.

Figure 1 shows the proposed research model describing how investments in manufacturing practices would affect process efficiency, which in turn affects organizational performance. Investments in manufacturing practices play a key role in developing work process to provide better products/service, complete tasks successfully by employees, and improve process efficiency. Thus, investments in manufacturing practices such as manufacturing plant and
equipment, manufacturing system, manufacturing quality, and manufacturing environment can have an impact on process efficiency by increasing the utilization rate of manufacturing plant and equipment as well as the investing rate of new manufacturing equipment, and reducing setup time and manufacturing throughput time (Rho & Yu, 1998; Rungtusanathama et al, 2005).

For instance, TQM, as one of the manufacturing practices, improves the overall areas of a company's operational processes as follows: improved customer satisfaction and product quality, increased productivity, reduced operating costs, and decreased scrap and rework defects. Also, manufacturing environment by manufacturers is an important implication for sustainability conditions of the natural environment (Ichim, 2007). Process efficiency can be achieved by a choice of several resources, such as pollution prevention system (e.g., ISO 14000) and recycling of materials or resources practices, as well as to reduce the negative aspects of manufacturing environment on organizational performance (Schoenherr, 2012; Yang et al, 2011). Schoenherr (2012) proposed a positive relationship between manufacturing environment and organizational performance. Young et al. (1997) suggested that reduction of manufacturing processes in the industry will improve the efficiency of processes and reduce the negative influence on environmental conditions. Thus, investments in manufacturing practices will have a positive relationship with process efficiency. Therefore, the following hypotheses are proposed:

H1. Manufacturing plant and equipment will positively affect process efficiency
H2. Manufacturing system will positively affect process efficiency  
H3. Manufacturing quality will positively affect process efficiency  
H4. Manufacturing environment will positively affect process efficiency  

The increased interaction between manufacturing practices and organizational performance, particularly operational and quality performance, is influenced by processes to improve the efficiency (Wiengarten et al, 2011). This interaction implies more investments in manufacturing practices, which involves innovation or developments in the existing system, and plays a critical role in improving the process efficiency. As a result, process efficiency improves operational and quality performance and competitive advantages (White & Mohdzain, 2009). Consequently, process efficiency will have a positive relationship with operational and quality performance. Thus, the following hypotheses are proposed:  

H5. Process efficiency will positively affect operational performance  
H6. Process efficiency will positively affect quality performance  

Many previous studies of manufacturing industry have investigated the differences among countries based on characteristics of operating and/or manufacturing practices. The results of these previous researches commonly presented that each company has to develop or adopt practices based on the organization's management style in terms of cultural differences (e.g., Kadipasaoglu et al, 1999; Rungtusanatham et al, 2005; Whybark & Vastag, 1993; Wiengarten et al, 2011). With increased knowledge and technology of manufacturing practices, the level of investments in manufacturing practices can drive the efficiency and effectiveness of processes in existing systems for competitive advantages. Therefore, investments in manufacturing practices may differently affect the process efficiency based on the degree of economic countries. Thus, the following hypotheses are proposed:  

H7. The impact of manufacturing plant and equipment will be different on process efficiency depending on the degree of economic countries  
H8. The impact of manufacturing system will be different on process efficiency depending on the degree of economic countries  
H9. The impact of manufacturing quality will be different on process efficiency depending on the degree of economic countries  
H10. The impact of manufacturing environment will be different on process efficiency depending on the degree of economic countries  

**RESEARCH METHODOLOGY**

**Data Collection**

We will utilize data from the 4th round of the Global Manufacturing Research Group (GMRG) survey, a survey conducted by a multinational community of researchers dedicated to the study of manufacturing practices. The first GMRG 1.0 survey focused on textile and machine tool
industries in 10 countries for the 1986-1989 periods. As the revision of GMRG 1.0 to GMRG 2.0 (1991-1997), GMRG 2nd survey involved 22 countries in the manufacturing industry. In the GMRG 3.0 (1998-2003) survey, only 5 countries participated, while among these, the manufacturing executives refused (Samson, 2009).

As for the GMRG 4.0 (2007-2009), more than 22 countries (e.g., Austria, China, Finland, Germany, Hungary, Italy, Korea, Nigeria, Poland, Switzerland, and the U.S.) were involved, whose survey is designed to be used by researchers throughout the world. The 4th round of the GMRG survey, collected between 2007 and 2009, available on the GMRG homepage (http://cibs.tamu.edu/gmrg), uses a standard questionnaire that is translated and back-translated by academics in each country. The GMRG centralizes survey data and shares them with all data gatherers. However, the GMRG does not employ randomly selected samples, and thus, GMRG data are not considered to be representative of each country.

**Measurement Items for Constructs**

The GMRG survey measured several constructs using a seven-point Likert-type scale. Table 1 summarizes the measurement variables: investments in manufacturing practices as manufacturing plant and equipment, manufacturing system, manufacturing quality, and manufacturing environment: process efficiency: and organizational performance as operational and quality performance.
Table 1: Measurement variables

<table>
<thead>
<tr>
<th>Factor</th>
<th>Variable</th>
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<tbody>
<tr>
<td>Manufacturing plant &amp; equipment</td>
<td>Extent of invested resources - cellular manufacturing (MP1)</td>
</tr>
<tr>
<td>(MP&amp;E)</td>
<td>Extent of invested resources - factory automation (MP2)</td>
</tr>
<tr>
<td></td>
<td>Extent of invested resources - process redesign (MP3)</td>
</tr>
<tr>
<td>Manufacturing system (MS)</td>
<td>Extent of invested resources - enterprise Resource Planning (MS1)</td>
</tr>
<tr>
<td></td>
<td>Extent of invested resources - material Requirements Planning (MS2)</td>
</tr>
<tr>
<td></td>
<td>Extent of invested resources - Just-in-time (MS3)</td>
</tr>
<tr>
<td>Manufacturing quality (MQ)</td>
<td>Extent of invested resources - Total quality management (MQ1)</td>
</tr>
<tr>
<td></td>
<td>Extent of invested resources - ISO 9000 (MQ2)</td>
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<tr>
<td></td>
<td>Extent of invested resources - supplier certification (MQ3)</td>
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<td>Extent of invested resources - statistical process control (MQ4)</td>
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<tr>
<td></td>
<td>Extent of invested resources - ISO 14000 certification (ME1)</td>
</tr>
<tr>
<td>Manufacturing environment (ME)</td>
<td>Extent of invested resources - pollution prevention (ME2)</td>
</tr>
<tr>
<td></td>
<td>Extent of invested resources - recycling of resources (ME3)</td>
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<td></td>
<td>Extent of invested resources - waste reduction actives (ME4)</td>
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<td></td>
<td>Extent of invested resources - work place health and safety (ME5)</td>
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<tr>
<td>Process efficiency (PE)</td>
<td>Compared to competitors - manufacturing throughput time reduction (PE1)</td>
</tr>
<tr>
<td></td>
<td>Compared to competitors - setup time reduction (PE2)</td>
</tr>
<tr>
<td></td>
<td>Compared to competitors - new product design time reduction (PE3)</td>
</tr>
<tr>
<td></td>
<td>Compared to competitors - increasing utilization rate of manufacturing plant &amp; equipment (PE4)</td>
</tr>
<tr>
<td>Operational performance (OP)</td>
<td>Performance compared to competitors - manufacturing costs (OP1)</td>
</tr>
<tr>
<td></td>
<td>Performance compared to competitors - product performance (OP2)</td>
</tr>
<tr>
<td></td>
<td>Performance compared to competitors - product quality (OP3)</td>
</tr>
<tr>
<td></td>
<td>Performance compared to competitors - order fulfillment speed (OP4)</td>
</tr>
<tr>
<td></td>
<td>% rejects of incoming material by now (QP1)</td>
</tr>
<tr>
<td></td>
<td>% rejects of during processing by now (QP2)</td>
</tr>
<tr>
<td></td>
<td>% rejects of the final inspection by now (QP3)</td>
</tr>
<tr>
<td>Quality performance (QP)</td>
<td>% returns from customer by now (QP4)</td>
</tr>
</tbody>
</table>

RESULTS AND CONCLUSION

Structural equation modeling (SEM) will be used to test the hypotheses. AMOS 17.0 is chosen for this study by virtue of its powerful graphic representations and easy-to-use interfaces. The results of this study will be provided after analyzing the GMRG data.

REFERENCES


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