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**Relationship of TQM and Business Performance with  
Mediators of SPC, Lean Production and TPM**

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*Abstract*

In today's highly competitive market, the demand for quality is the single most critical factor for companies to survive in the ever-expanding global marketplace. The concept of Total Quality Management (TQM) has been developed as a result of intense global competition. Most of the previous works show that TQM has significant relationship with business performance. However, the examining of moderators is less given in previous work, which mediators are known generally as general tools and techniques without specific focus on types of improvement. The purpose of this paper is to propose relationship between TQM practices and business performance with mediators of Statistical Process Control (SPC), Lean Production (LP) and Total Productive Maintenance (TPM) based on extensive review of the literature. Study on TQM, Lean Production, TPM and SPC generally investigate the practices and business performance in isolation. The main contribution of this paper is to identify the relationships among TQM, TPM, SPC and Lean Production practices as a conceptual model. This proposed conceptual model will help the academicians and industry players to have better understanding on the relationship between the practices and step by step implementation to improve business performance. The structural equation modeling (SEM) techniques are used to examine the relationships of the practices.

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**Keywords:** Total Quality Management (TQM), Lean Production, Statistic Process Control (SPC), Totol Productive Maintenance (TPM), Business performance, structural equation modeling (SEM),

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## 1. Introduction

The concept of total quality management (TQM) has been developed as a result of intense global competition (Garvin, 1988). Firms that conduct international trade in global competition have put emphasis on TQM philosophy, procedures, tools and techniques. According to Garvin (1988), international competition requires higher levels of quality achievement to meet the customer satisfaction. TQM is a management philosophy that helps manage their organization to improve the effectiveness and performance to achieve world class status for the past two decades (Konecny & Thun, 2011). Research on TQM, Lean production, TPM and SPC investigated the implementation and their impact in isolation. What are the relationships among these four practices with business performance? TQM, Lean production, TPM and SPC have similar goals: continuous improvement, waste reduction and improving performance (Teeravaraprug, Kitiwanwong, & Saetong, 2011). These practices are a comprehensive set of manufacturing improvement practices directed towards improving business performance. Lean production eliminates waste through inventory control and reduction time delay of process (Fullerton & Wempe, 2009). TPM helps maximize equipment performance and prevents break-down (Breja, Banwet, & Iyer, 2011) and TQM aims to maintain and improve product quality and business performance. Furthermore, SPC is a monitoring process to ensure process is under control and stable (Juran, 1998). The proposed hypotheses are shown in Table 1.

Table 1: Hypotheses of relationship between TQM, TPM, Lean Production, SPC and Performance

	TQM	TPM	Lean Production	SPC	Performance
TQM	X	H1	H2	H4	H7
TPM	H3	X	H3	H5	H8
Lean Production	H2	H5	X	H6	H9
SPC	H4	H6	H8	X	H10
Performance	H1	H7	H9	H10	X

## 2. Hypotheses and Literature Review

### H1: Relationship between TQM and Business Performance

There is a strong relationship between TQM and business performance as in previous studies. The benefits of TQM are improved quality, employee participation, teamwork, working relationships, customer satisfaction, employees satisfaction, productivity, communication and market share (Besterfield, 2009). Most previous studies show a positive relationship between TQM practices and business performance (Jun et al., 2006; Bou & Beltrán, 2007; Gunday et al., 2011; Miyagawa & Yoshida, 2010). However, there are also studies that show TQM did not improve the business performance (Corredor & Goñi, 2011; Demirbag et al., 2006). Some of the findings also partially correlated with the business performance (Demirbag et al., 2006; Feng et.al., 2006; Arumugam et al., 2008). Therefore, accordingly, it is proposed that:

*H1: The TQM practices has a direct, positive effect and leads to better Businesss performance.*

### 2.1 Relationship between TQM and mediators (Lean Production, TPM and SPC)

#### H2: Relationship TQM and Lean Production

Juran (1998) states that TQM is the fundamental pillars for implementing Lean production practices. TQM has become an umbrella for a variety of concepts, methods and production tools. Lean

production is a method that promotes waste reduction and enhances business performance. Thus, Lean production lead to better operational performance, such as lower inventory, higher quality and shorter process time, which in turn, will improve financial performance (Hofer et.al., 2012). However, the production process should be stable and predictable to ensure no interruption at production line, thus, enforcement of TQM is a first step before implementing Lean production (Besterfield, 2004)

**H2:** *TQM practices is positively correlated with Lean Production.*

### **H3:** Relationship TQM and TPM

TPM is significantly supported by TQM for improving business performance (Konecny & Thun, 2011). Teeravaraprug et al. (2011) study shows that TQM and TPM should be implemented before implementing Lean production. Two sets of factors which are critical for the effectiveness of TQM and TPM: universally significant factors for all the three approaches like leadership, process management and strategic planning; and approach-specific factors like equipment management and focus on customer satisfaction (Seth & Tripathi, 2005). TPM is a comprehensive improvement, originate from the concept of zero defects of TQM which applies to control equipment performance (Seth & Tripathi, 2006).

**H3:** *TQM practices is positively correlated with TPM.*

### **H4:** Relationship TQM and SPC

Statistical process control can assume a stable process, but predictions cannot be made until the process is fully defined and controlled (Flott, 1995). TQM provides infrastructure such as top management support, employee participation and improvement to implement other practices, thus, TQM should be implemented before the execution of SPC and TPM (Juran, 1998). SPC reduces process variance, and this gives a significant impact on performance improvement, cost savings and customer satisfaction (Taj & Morosan, 2011).

**H4:** *TQM practices is positively correlated with SPC.*

## **2.2 Relationship among TPM and Lean Production, SPC and business performance**

### **H5:** Relationship between TPM and Lean Production

TPM is one of the pillars that support Lean production , but it is difficult to distinguish their effects on the business performance among TQM, Lean Production and TPM (Imai, 1986). For example, Mckone et al. (2001) examines the relationship between TPM and business performance with Lean Production as mediator. The study shows that TPM has positive and significant direct and indirect relationships through the Lean Production with competitive cost, quality and delivery performance.

**H5:** *TPM practices is positively correlated with Lean production.*

### **H6:** Relationship between TPM and SPC

Monitoring the quality of products is to prevent deterioration of performance due to factors beyond the control and TPM improves equipment to the optimum performance as new machine and prevents failure (Mehrafrooz & Noorossana, 2011). SPC requires stable process for eliminating abnormal causes such as machine distortion and incompetent workers. TPM provides stable and consistent output for controlling variability of equipment in the process (Juran, 1998) and should be implemented before SPC.

**H6:** *TPM practices is positively correlated with SPC*

### **H7:** Relationship between TPM and business performance

Ahuja & Khamba (2008) notes that the critical success factors of TPM such as top management leadership and involvement, maintenance practices and holistic TPM initiatives enhance business

performance in Indian industry. Konecny & Thun (2011) study indicates that TQM and TPM, supported by HR practices, have a significant potential to improve business performance.

**H7:** *TPM practices is positively correlated with business performance.*

#### **H8:** Relationship Lean Production and SPC

Lean Production implementation requires stable and consistent production. SPC is a statistical method to monitor and predict production process stability (Besterfield, 2009). Lean production is characterized by JIT, which leads to susceptible to flow interruption if there is a lot of reject in the process. Schonberger (2007) notes that some companies have problems in implementing lean production because there is a risk of causing damage in the process and will affect production delay. Thus, SPC should be implemented before implenting Lean production.

**H8:** *Lean Production practices is positively correlated with SPC*

#### **H9:** Relationship Lean Production and business performance

Findings of previous studies are consistent positive relationship between Lean production practices and financial performance indicators (Shah & Ward, 2003). Firm that adopt Lean production have lower inventories than firm that do not adopt Lean production practices (Demeter & Matyusz, 2011). Fullerton & Wempe (2009) study found that the substantial evidence that utilization of non-financial impacts measures as a mediator of the relationship between Lean production and financial performance. Furthermore, Lean production practice is also positively related to environmental management practices (Yang et al. 2011).

**H9:** *Lean Production practices is positively correlated with Performance.*

#### **H10:** Relationship SPC and business performance

Control charts could be adapted to monitor the supplier interface and the results could potentially be used to monitor and manage the supplier performance effectively (Morgan & Dewhurst, 2008). Rohani et al. ( 2009) collected survey from 326 responses from Malaysian automotive industry and the result shows that there is a positive relationship between SPC and business performance. Information provided by the SPC system enhance the ability of top management to make decisions based on SPC data. Therefore, SPC leads to increase productivity by reducing waste and improving quality for short and long term benefits (Sanjoy, 1991),

**H10:** *SPC practices is positively correlated with Performance*

### **3.0 Conceptual model**

Structural equation modeling (SEM) techniques are utilized to examine the relationships. Based on a comprehensive review of previous studies, a conceptual model has been proposed to understand the relationships as presented in Figure 1.

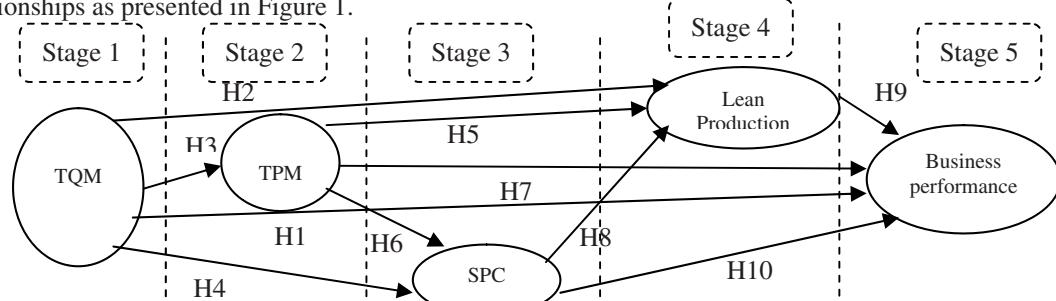


Figure 1: Proposed conceptual model of TQM with mediators of Lean Production, TPM and SPC

#### 4.0 Conclusion

The main objectives of this study are to investigate the relationships among TQM, TPM, SPC, Lean Production and business performances as a conceptual model. Ten hypotheses regarding the relations among TQM, TPM, SPC, Lean production and business performance have been specified and conceptual framework have been proposed for future work.

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