



Impact of lean manufacturing and environmental management on business performance: An empirical study of manufacturing firms

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ABSTRACT

This paper explores relationships between lean manufacturing practices, environmental management (e.g., environmental management practices and environmental performance) and business performance outcomes (e.g., market and financial performance). The hypothesized relationships of this model are tested with data collected from 309 international manufacturing firms (IMSS IV) by using AMOS. The findings suggest that prior lean manufacturing experiences are positively related to environmental management practices. Environmental management practices alone are negatively related to market and financial performance. However, improved environmental performance substantially reduces the negative impact of environmental management practices on market and financial performance. The paper provides empirical evidences with large sample size that environmental management practices become an important mediating variable to resolve the conflicts between lean manufacturing and environmental performance. Additional contextual analyses suggest that differences exist in terms of the strengths and statistical significance of some of the proposed relationships. Thus, for effective implementation of environmental management, firms need to measure environmental performance through which the impact of environmental management on other business performance outcomes is examined.

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1. Introduction

With an increasing social demand of environmental sustainability, firms embrace the strategic importance of environmental management practices for competitive advantage (Porter and van der Linde, 1995; Sroufe, 2003; Kleindorfer et al., 2005; Pagell and Gobeli, 2009; Yang et al., 2010). In spite of the ongoing debate on the relationships between environmental management and financial performance, the previous research is often inconsistent and ambiguous (Russo and Fouts, 1997; Jiménez and Lorente, 2001; Rao and Holt, 2005). The business press also reflects this debate among practitioners regarding the compatibility of environmental objectives with economic viability (Hayward, 2009; Stavins, 2009; Totty, 2009). In light of these divergent views, while organizations recognize that environmental sustainability has implications for their competitive positions, firms are unclear about the implementation details of environmental management practices (Montabon et al., 2007).

Good research requires rigor, relevance and clarity (Palmer et al., 2009; Suddaby, 2010). Building sound theory may start with the obvious and then move into more unclear, controversial and fuzzy areas (Handfield and Melnyk, 1998). In this paper, we start with the relationship between lean manufacturing and environment management practices. We then present an integrated framework that includes lean manufacturing, environmental management practices, and environmental and business performance. In the next section we provide a research model conceptual framework that presents key variables based on relevant literature review. In the hypotheses development section the inter-relationships between variables are defined and explained. In the subsequent section we discuss the research design, analysis and results. The final section presents the theoretical and managerial implications, and concludes with a summary of limitations and future research directions.

2. Literature review

An important task of empirical validation is to test the internal and external validity. For this reason, construct clarity is to measure what needs to measure (Suddaby, 2010). In this paper, we have carefully defined each construct in terms of essential characteristics with the support of relevant literature base. The detail measures ensure adequate construct validity. We then examine

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Table 1
Variables definition and supporting literature.

Variables	Definition	Supporting literature
Lean manufacturing	A set of practices focused on reduction of wastes and non-value added activities from a firm's manufacturing operations.	Womack et al. (1990), McLachlin (1997), Shah and Ward (2003, 2007), Li et al. (2005), Browning and Heath (2009)
Just-in-time flow	A set of interrelated practices for managing production flow.	McLachlin (1997), Shah and Ward (2003), Swink et al. (2005)
Quality management	A set of interrelated initiatives to assure the quality of the products and the equipment used to manufacture them.	McKone et al., (1999), Fullerton et al. (2003), Shah and Ward (2003, 2007), Linderman et al. (2006)
Employee involvement	The human element of lean manufacturing such as formal training programs, problem solving groups, self-directed work teams and autonomous problem solving.	MacDuffie (1995), McLachlin (1997), Shah and Ward (2003, 2007), Tu et al. (2006)
Environmental management practices	A set of programs to improve environmental performance of processes and products in the forms of environmental management system, Life-Cycle Analysis, Design for Environment, Environmental certification.	Miettinen and Hamalainen (1997), Melnyk et al. (2003), Sroufe (2003), Matos and Hall (2007), Montabon et al. (2007)
Environmental performance	The degree to which an organization improves its performance in respect to its environmental responsibilities.	Sroufe (2003), Kleindorfer et al. (2005), Matos and Hall (2007), Montabon et al. (2007)
Market performance	The degree to which an organization achieves market-valued outcomes (e.g., sales and market growth).	Narasimhan and Kim (2002), Lin et al. (2005), Menor et al. (2007)
Financial performance	The degree to which an organization achieves profit-oriented outcomes (e.g., ROS and ROI).	Narasimhan and Kim (2002), Lin et al. (2005), Menor et al. (2007)

how these constructs are related. Table 1 is a summary of each construct (definitions and supporting literature). Appendix A shows the items of each construct, mean, standard deviation, factor loadings and *t*-value

2.1. Lean manufacturing (LM)

Since the conception of the assembly line and the following development of the Toyota Production System (TPS), efficiency has been a central objective of manufacturing (Holweg, 2007). Lean manufacturing focuses on the systematic elimination of wastes from an organization's operations through a set of synergistic work practices to produce products and services at the rate of demand (Womack et al., 1990; Fullerton et al., 2003; Simpson and Power, 2005; Shah and Ward, 2007). Lean manufacturing represents a multifaceted concept that may be grouped together as distinct bundles of organizational practices (McLachlin, 1997; MacDuffie, 1995). A list of bundles of lean practices includes JIT, total quality management, total preventative maintenance, and human resource management, pull, flow, low setup, controlled processes, productive maintenance and involved employees (McKone et al., 1999; Swink et al., 2005; Linderman et al., 2006; Shah and Ward, 2007). For the purpose of this study we define *lean manufacturing* as a set of practices focused on reduction of wastes and non-value added activities from a firm's manufacturing operations (Womack et al., 1990; McLachlin, 1997; Shah and Ward, 2003, 2007; Li et al., 2005; Browning and Heath, 2009).

2.2. Environmental management practices (EMPs)

Firms that have successfully reduced their internal waste through lean production methods also implement practices for better environment management (Melnyk et al., 2003; Sroufe, 2003; Montabon et al., 2007). Such practices expand the scope of waste reduction efforts beyond efficiency within the organization (Zhu and Sarkis, 2004; Kleindorfer et al., 2005). A diverse set of stakeholders (e.g., customers, shareholders, local communities and government regulators) influence firms' decision making processes and their corporate strategic practices (Henriques and Sadosky,

1999; Buysse and Verbeke, 2003). Environmental management covers from product development to final delivery and ultimate disposal of the product (Klassen and Whybark, 1999; Sroufe, 2003). ISO 14000 standards, an essential element of Environmental Management System (EMS) help firms in assessing, managing, coordinating and monitoring corporate environmental activities (Melnyk et al., 2003; Sroufe, 2003). In this paper, *environmental management practices* refer to programs to improve environmental performance of processes and products in the forms of eco-design (e.g., design for environment), recycling, waste management and life-cycle analysis (Miettinen and Hamalainen, 1997; Sroufe, 2003; Matos and Hall, 2007; Montabon et al., 2007).

2.3. Performance outcomes

Organizational performance is multifaceted and of interest for our research are the two aspects of environmental performance and business performance. *Environmental performance* refers to the organization's performance with respect to their environmental responsibilities (Kleindorfer et al., 2005). *Business performance* takes into account the organizations responsibilities towards their shareholders and has a profit maximization objective (Rappaport, 1987). In line with earlier research business performance may be conceptualized with the two dimensions of *market performance* and *financial performance* (Narasimhan and Kim, 2002; Lin et al., 2005; Menor et al., 2007).

3. Hypotheses development

Fig. 1 is a research framework that represents how lean manufacturing, environmental management practices, environmental performance, market performance and financial performance are related. Specific hypotheses are discussed next.

3.1. Lean manufacturing, environmental management practices and environmental performance

Lean manufacturing focuses on elimination of waste from within the firm's production systems through continuous improvement and process changes for reducing non-value added activities

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