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Lean and green in action: interdependencies and performance of pollution prevention projects

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ABSTRACT

As manufacturing plants strive to achieve more environmentally sound operations, management teams must undertake pollution prevention projects that do not hamper manufacturing results. In these projects, firms often adopt both lean and green practices. The literature has provided some evidence of the synergistic interaction of lean practices and green practices to improve plant performance. However, few studies provide a thorough and in-depth examination of such processes' interactions. Using a case study methodology, this paper aims to discern how the two sets of practices interact and how they yield maximum synergy in improving both operational and environmental performance. Based on the analysis of three pollution-prevention projects undertaken by two manufacturing plants of two large multinational firms, we find that lean and green practices may be implemented either sequentially or simultaneously, generating sequential or reciprocal interdependencies, respectively. The latter case is more likely to be associated with the involvement of external suppliers and, ultimately, with higher operational performance.

1. Introduction

As the environmental perspective has been gaining an important role in firms' corporate strategies and consumers' preferences, companies are increasingly including environmental management issues in their business agendas (Agatiello, 2009; Florida and Davison, 2001; Marcus and Fremeth, 2009; Toffel, 2004). The environmental implications on management have been studied in a stream of literature at the crossroads of different disciplines, such as marketing, research and development, operations, organizational behavior, and corporate strategy (Kock et al., 2012; Lefevbre et al., 2003; Madsen, 2009; Marcus, 2005; Shrivastava, 1994; Simpson, 2012). Although several contributions provide empirical evidence of the "green pays" debate (Clemens, 2006; Dixon-Fowler et al., 2013; Hart and Ahuja, 1996; Orsato, 2006; Russo and Fouts, 1997) as well as the related opportunities for pollution abatement in terms of competitive advantages, such as the creation of new market niches and higher innovation, and efficiency-driven outcomes (Aragon-Correa and Sharma, 2003; Porter and van der Linde, 1995a,b; Schoenherr, 2012; Sharma et al., 2007; Shrivastava, 1995), environmental management also incurs considerable costs related to compliance with environmental goals that frequently offset the associated benefits (Clarke, 1994; Filbeck and Gorman, 2004; Kassinis and Vafeas, 2009; Molina-Azorin et al., 2009; Walley and Whitehead, 1994; Yu et al., 2009). The empirical evidence, therefore, ranges from a negative to a positive effect on firm performance associated with the implementation of environmental (or green) practices, thus yielding controversial and unclear conclusions.

Resource-based studies explain firm performance as the result of distinctive resources and capabilities that draw upon unique ways of developing and aligning firm resources (Barney, 1986, 1991; Penrose, 1959; Wernerfelt, 1984). In the context of the natural resource-based view (NRBV), the development of distinctive environmental resources and capabilities results from the implementation of green practices (Hart, 1995). Green practices are conducive to enhanced employee skills, better reputations, and, more generally, better organizational capabilities (Gonzalez-Benito and Gonzalez-Benito, 2008; Porter and van der Linde, 1995a,b; Russo and Fouts, 1997; Schoenherr, 2012; Sharma and Vredenburg, 1998). However, some scholars argue that the extent to which green practices affect plant performance depends upon the process of implementing green practices (Christmann, 2000; Gavronski et al., 2011; Wagner, 2007; Yang et al., 2010, 2011). In particular, green

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practices should draw on existing resources and capabilities if firms are to improve their competitive advantages (Christmann, 2000).

Literature on lean manufacturing demonstrates that companies develop distinctive operational resources and capabilities through the implementation of bundles of lean practices (Anand et al., 2010; Ferdows and de Mayer, 1990; Hayes and Wheelwright, 1984; Helfat et al., 2007; Schroeder et al., 2002; Schroeder and Flynn, 2001; Tan et al., 2007). These authors show that lean companies generally aim to reduce any rework and scraps when modifying processes to increase efficiency and when involving employees in efforts toward continuous improvement that require certain capabilities in order to implement and coordinate lean practices. In addition, extant literature finds that such distinctive operational resources and capabilities reduce the costs and time of the introduction of environmental practices, thus allowing a plant to reap more benefits from said implementation (Aragon-Correa and Sharma, 2003; Christmann, 2000; Huang and Wu, 2010; Klassen and Whybark, 1999a; Pagell and Gobeli, 2009; Russo and Harrison, 2005; Simpson and Power, 2005).

The investigation of the relationship between green practices and lean practices may help to unveil how to implement environmental management in accordance with existing resources and capabilities in lean production, as well as how the joint implementation of lean and green practices affects firm performance. Few studies are being done on the relationship between lean and green practices (Florida, 1996; Hajmohammad et al., 2013; King and Lenox, 2001), however, they are mainly quantitative and, thus do not delve into the relationship between lean and green practices and the conditions under which these interactions yield maximum synergies. To fill this gap, the present study aims to investigate how lean practices interact with green practices, as well as if this interaction leads to synergistic effects on plant performance. We studied three instances of the successful implementation of lean and green practices in two manufacturing plants belonging to two large multinational companies operating in the refrigeration and the cooling and water pump industries, respectively. We adopted the case study methodology to disentangle the complex relationships between lean and green practices.

Our research provides both managerial and academic contributions. From a practice-related standpoint, it helps managers understand how the process of implementing lean and green practices affects the endowment of resources and capabilities, as well as plant performance. From a theoretical standpoint, it provides insights into the environmental management literature that supports the complementary natures of lean and green practices; moreover, our findings on two approaches (i.e., sequential and simultaneous) to managing the interactions between these practices are explained in terms of combinations of resources and capabilities, thus extending our knowledge related to the path-dependence notion within the framework of the NRBV literature. Finally, our results show that the two approaches are associated with different coordination modes with external suppliers, hinting at the existence of contingency factors that support closer collaboration with suppliers.

2. Theoretical background

In this section, we first provide precise definitions of lean practices and green practices. We then review the literature on lean management and environmental management to explore the effects of lean and green practices on operational and environmental performance. Finally, using the NRBV as a theoretical framework, we review previous research focusing on the interactions between lean and green practices.

2.1. Definitions of lean practices and green practices

We define lean practices as a set of techniques that aim to eliminate each form of waste along the value chain. These techniques are clustered into bundles of practices, such as just in time (JIT), total quality management (TQM), and total preventive maintenance (TPM) (Furlan et al., 2011), which, on the whole, implement the lean philosophy of waste elimination and continuous improvement. Lean practices also apply to the supply chain through strict collaboration with stakeholders, with the ultimate goal of streamlining the whole production process. Lean management literature has well demonstrated that lean practices have positive effects on operational performance (Dal Pont et al., 2008; Flynn et al., 1997; Furlan et al., 2011; Schroeder and Flynn, 2001; Shah and Ward, 2003).

We define green practices as a set of techniques that limit or reduce the possible negative impacts of the production and consumption of products and services on the natural environment, thus improving a firm's environmental footprint (Rao, 2004; Shrivastava, 1995). There are two types of environmental practices: pollution prevention technologies and pollution control technologies (Hart, 1995; Klassen and Whybark, 1999a). The former entails all the activities that change the structure of the manufacturing process and adopt more environmentally friendly resources (Hart, 1995; Klassen and Whybark, 1999a). The latter entails all of the end-of-pipeline equipment that recognizes, captures, and disposes of the emissions caused by the production process, without any structural intervention (Hart, 1995; Klassen and Whybark, 1999a).

2.2. Lean and green practices and their effects on plant performance

Some researchers (e.g., Dües et al., 2013; Hajmohammad et al., 2013; Klassen, 2000; Larson and Greenwood, 2004; Yang et al., 2010) postulate that lean production and environmental management show some similarities, having both a strong commitment to zero-waste and efficiency-driven practices. A number of authors explore lean and green practices to understand whether they also have similar positive effects on both operational and environmental performance.

On the one hand, some authors support the idea that lean practices have a positive impact on environmental performance (Corbett and Van Wassenhove, 1993; Lewis, 2000; Maxwell et al., 1998; Sawhney et al., 2007; Vachon and Klassen, 2006). Specifically, firms introducing TQM practices search for continuous improvements in product and process quality, which in turn can create positive spillover effects in terms of waste disposal and higher efficiency/lower pollution (Corbett and Van Wassenhove, 1993). Also, strict collaboration with suppliers encourages the adoption of pollution-prevention technologies (Vachon and Klassen, 2006; Vachon, 2007), which positively affect environmental performance.

On the other hand, some authors believe that the implementation of green practices allows firms to improve their operational performance (Jabbour et al., 2012, 2013; Klassen and Whybark, 1999a; Melnyk et al., 2002; Sroufe, 2003; Vachon and Klassen, 2008). For example, Sroufe (2003) explored the effects of environmental management systems (EMSs) on operational performance and found that EMSs affect operational performance, both directly and indirectly, through the implementation of environmental design practices and environmental waste practices. Jabbour et al. (2013) investigated 72 firms in the Brazilian automotive sector in terms of their relationships between environmental management and operational performance. They found that environmentally driven practices encompassing production