



# A meta-analytic study of the impact of Lean Production on business performance<sup>☆</sup>

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## ABSTRACT

Lean Production (LP) is one of the most common initiatives in Operations Management that firms adopt to boost their competitiveness. The purpose of this paper is to examine the extant research on the relationship between LP and business performance (BP). The study analyses the data from 30 articles published from 2000 to 2016 that meet two targeted criteria, that they have: (i) empirically analysed the relationship between LP, or any measure of LP, and at least one measure of BP, and (ii) reported the effect size of the relationship between LP and BP measured with Pearson's correlation coefficients or related methods. Distinctions are made between two different performance outcomes (financial and market) and six LP practices. Using the Hunter and Schmidt (2004) meta-analysis based correlations approach, the obtained results show that a positive and moderate relationship exists between aggregate level LP and aggregate level business performance ( $r' = 0.31$ ). There is also a positive relationship with market performance, but not with financial performance. Only three individual practices are statistically related to business performance (Process Control and Improvement, Workforce Development, and Customer Focus). The country's level of economic development is also found to act as a moderating variable in several of the studied relationships and to have a greater effect in Emerging Economies than in Advanced Economies.

## 1. Introduction

Firms need to continuously improve to compete in an increasingly globalized environment and in recent decades new approaches have emerged to this end in the operations area (Cua et al., 2006; Flynn et al., 1995; Fullerton et al., 2014; Fullerton and Wempe, 2009; Shah and Ward, 2003, 2007; Yang et al., 2011). One of the best known of these is Lean Production (LP) (Hines et al., 2004; Camacho-Miñano et al., 2013; Bhamu and Singh Sangwan, 2014).

LP has been defined as an integrated set of socio-technical practices designed to eliminate waste along the whole of the value chain within and across companies (Womack et al., 1990; Holweg, 2007). Since its introduction, the lean approach has increasingly expanded in the field of operations management until it has now become a fully holistic business

strategy. Lean involves nearly all aspects of the organisation. Numerous tools, techniques and practices have been developed over time for this approach to be implemented, and many others that already existed have easily slotted into Lean's broader focus. Many of these LP practices have been integrated into extensive packages or focuses related to aspects such as quality (total quality management, TQM), production flow (just-in-time production, JIT) and maintenance (total productive maintenance, TPM) (Cua et al., 2006; Shah and Ward, 2003; Furlan et al., 2011a; Dal Pont et al., 2008).

Firms that espouse LP benefit from many advantages (manufacturing costs, productivity, inventory turnover, lead time, on-time delivery, fast delivery, flexibility, quality, space requirement, etc.). In fact, studies of LP have traditionally been associated with an analysis of its impact on operational performance (e.g., Shah and Ward, 2003; Dal Pont et al.,

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2008; Fullerton and Wempe, 2009)). The benefits have usually been measured using operational performance measures, perhaps because they can be monitored at plant level, which is the unit where LP is generally applied (Abdel-Maksoud et al., 2005; Nawanir et al., 2013).

Some meta-analytic studies were found in the reviewed scientific literature (Nair, 2006; Mackelprang and Nair, 2010) that confirm positive relationships between some of the dimensions of Lean (specifically JIT and TQM) and operational performance.

The LP-business performance (expressed as financial and market performance) relationship has also been empirically studied. Despite a number of relevant studies finding that LP has a positive effect on performance (Brah et al., 2000; Kaynak, 2003; Yang et al., 2011; Agus and Hajinoor, 2012; Hofer et al., 2012), some controversy still exists as to its general applicability (Kannan and Tan, 2005; Avittathur and Swamidass, 2007; Jayaram et al., 2008; Camacho-Miñano et al., 2013; Klingenberg et al., 2013). This, and the fact that no meta-analysis has been conducted of this relationship, was the motivation for the present research.

As Shah and Ward (2003) state, it should be borne in mind when analysing the benefits of LP that 'Lean production is a multi-dimensional approach that encompasses a wide variety of management practices... in an integrated system'. So, although LP implementation only actually happens through the application of an array of practices, the overall result is not simply the sum of the outcomes of each of these. To the contrary, these practices complement and mutually support each other, creating synergistic effects that boost the benefits to the company. Several authors (Womack and Jones, 1996; Schroeder and Flynn, 2002; New, 2007) examine complementarity among the various lean practices and their positive effect on performance from the theoretical point-of-view. However, the majority of empirical studies with similar aims have sought to study the effect of this complementarity or interrelationship on operational performance (Shah and Ward, 2003; Dal Pon et al., 2008; Furlan et al., 2011a, 2011b; Konecny and Thun, 2011).

Empirical studies analysing the effect of this synergy on financial or market performance are extremely scarce. However, Hofer et al. (2012) determined that the simultaneous implementation of internally-focused and externally-focused lean practices has a positive effect on financial performance (with ROS as the indicator). We therefore consider that conducting a meta-analysis of the relationship between lean practices and business performance that considers any possible interdependencies among the various lean practices might help to fill this gap and thus enhance the scientific literature in this respect.

The purpose of this study is, therefore, to conduct a meta-analysis to help clarify the relationship between LP implementation (in general, and of the main lean practices individually) and business performance using financial and market performance indicators. The aim is to synthesize the empirical evidence available to date and provide some direction to future research efforts. The study seeks to respond to the following three research questions on the LP-business performance relationship in particular:

- a) Is LP (as an aggregate, considering any interrelationships among lean practices) positively correlated with (financial and market) business performance? If so, how strong is the relationship?
- b) Which LP practices have a stronger impact on business performance?
- c) Is this relationship homogenous or is it affected by any moderators?

The paper answers these questions using a meta-analysis of correlations approach with data taken from research studies published in 2000 or later, and follows the Hunter and Schmidt (2004) procedure. Meta-analysis is a powerful method for conducting systematic syntheses of empirical literature, as it enables conflictive findings to be resolved and the potential sources of these conflicts to be evaluated through moderator analyses (Card, 2012).

The paper is structured in 6 sections. Following this Introduction (Section 1), a brief review of the literature on the LP-Performance relationship is given in Section 2. Section 3 describes the research

methodology, including details of the sample and the methods used for the analysis. The main research results are then presented in Section 4, followed by the discussion in Section 5 and conclusions in Section 6.

## 2. Literature review

This section begins with a brief reference to the origins and development of Lean Production and a discussion on how LP implementation has been measured in the literature. This is followed by an analysis of the LP-business performance relationship and the identification of the main dimensions used to measure lean practices. Next, some of the factors are discussed that, as moderators or control variables, might affect the LP-BP relationship. Lastly, the research model is presented and the hypotheses that are to be tested are formulated.

### 2.1. Lean production: evolution and implementation

Although LP did not become popular until the beginning of the 1990s, the literature on Lean Manufacturing can be traced back to the 1970s. Several works have analysed Lean's origins and development, either through historical or conceptual reviews (e.g., Shah and Ward, 2007; Hines et al., 2004; Holweg, 2007; New, 2007) or through literature reviews (e.g., Pettersen, 2009; Moyano-Fuentes and Sacristán-Díaz, 2012; Stone, 2013; Camacho-Miñano et al., 2013; Bhamu and Singh Sangwan, 2014; Negrão et al., 2017). Stone (2013) identified five phases of lean evolution: Discovery phase (1970–1990); Dissemination phase (1991–1996); Implementation phase (1997–2000); Enterprise phase (2001–2005); and Performance phase (2006–2009). The same author explained that during the late 1990s and early 2000s the focus shifted from implementing lean exclusively on the manufacturing shop floor to its application in other areas of the enterprise (Stone, 2013). In an extensive literature review, Bhamu and Singh Sangwan, 2014 differentiated between four periods: a) origin and development (pre 1994), b) wider dissemination (1994–1999), c) propagation into product development, marketing, sales, service, accounting, etc. (2000–2005), and d) performance phase and development of new principles (2006 onwards). According to these authors, up to 2000 the predominant research methodology was conceptual and descriptive, but then went on to be for the main part more empirical and exploratory. In the same line, Shah and Ward (2007) considered the 1988–2000 period as one of academic progress.

The Lean concept has gradually spread beyond manufacturing (Lean Manufacturing) and Lean management is currently spoken of as an organisational philosophy based on the principles of the elimination of wastage and an increase in value for the customer. However, the present study focuses on Lean Production, which refers to a set of production-and/or service-related lean practices inspired by the foregoing principles. We regard Lean Production as an extension of Lean Manufacturing that can also be used in service companies.

Apart from a holistic management focus based on a number of objectives and principles (Womack and Jones, 2003; Liker, 2004), Lean also encompasses a set of practices, tools, techniques and methodologies that enable objectives to be met through the application of these principles. However, Bhamu and Singh Sangwan, 2014 found that there is no standard LP implementation framework and no dedicated LP implementation tools, techniques, or methodologies exist, but, rather, most of these are standalone matured tools, such as 5S, six sigma, TPM, JIT, VSM, kaizen, etc. A very high number and great variety of these practices have been identified in the literature to measure LP implementation (see Appendix A). Nawanir et al. (2013) states that although many researchers and practitioners have attempted to identify the main LP practices, there is no single agreement among them regarding the relative importance of the practices. Moreover, some LP tools and techniques have multiple names and overlap with others (Bhamu and Singh Sangwan, 2014).

Malmbrandt and Åhlström (2013) drew up a table with an overview of ten instruments to assess lean manufacturing adoption that they had

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