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Implementation of technology and production strategy practices: Relationship levels in different industries

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ABSTRACT

Many industries face open, global markets with requirements for rapid response and low costs. Given the major role that technology plays in business competitiveness, proper technology management (T) in combination with a good production strategy (S), is important to address current challenges. This paper analyzes the nature of T & S implementation in different industrial contexts to examine whether there are differences in how T & S are implemented in different sectors, whether implementation is linked to performance, and whether contextual factors explain the differences. A database from the High Performance Manufacturing Project is used to test the research questions based on a survey of 267 plants across nine countries in three different industrial contexts (machinery, electronics and auto suppliers). The findings show some differences between the T and S practice modes in the three industries. T and S implementation is observed to be related to performance, but not in the same way. Three of the eight contextual factors are found to differ in the three sectors, which may explain the differences found in T and S implementation. The results imply that plants should consider the joint implementation of T and S as their interdependencies may affect performance, outweighing the possible differences between industries in which plants operate. However, when implementing a specific technology practice, not all plants necessarily consider the same production strategy practices across industries. Likewise, when adopting a certain production strategy, it is not necessarily influenced by the same technology practices across industries.

1. Introduction

Most of literature on the common implementation of production practices in both production strategy (S) and technology (T) programs is largely prescriptive, with little systematic empirical research (e.g., Banerjee, 2000; Mohanty and Deshmukh, 1998). On the one hand, it is theoretically clear that when implementing strategy, production achieves the long-term goal of effectiveness. In any event, any production practice employed in a manufacturing plant should be consistent with its production strategy. One example of this is that production strategy allocates pertinent technological resources, such as technology practices, and aligns these resources with its strategy, so that technology practices can be efficiently used to meet the objectives set out in the plant's strategies. Hence, technology practices are expected to be more effective in a plant that has a well-defined production strategy than in one that does not (Dekkers et al., 2013).

On the other hand, implementing technologies embodied in production is an important issue that influences long-term strategy at any manufacturing plant. From a perspective of production strategy, technology is often seen as a source of core strategic competence for improving the reliability and attractiveness of products and/or reducing manufacturing costs. One way to obtain an advantage from production strategy in technology-intensive manufacturing industries is to exploit emergent product and process technologies to develop and introduce attractive new products (Singh and Khanduja, 2010).

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While implementations of many S and T practices in plants have been successful, many others have failed. Previous research still does not provide enough insight into why some practices are a success in one plant and the very same practices are a failure in its competitor. Although most empirical studies on S and T investigate these programs separately (e.g., Thun, 2008; Manthou and Vlachopoulou, 2001; Rho et al., 2001), successful manufacturing plants are likely to combine the implementation of production strategy and technology practices, considering both.

Furthermore, special importance is placed on the relationship between the organizational system and its environment in the contingency theory conceptual framework. Plants also vary internally depending on whether they are located in stable or changing environments and they must be capable of not only implementing manufacturing programs within certain contextual aspects, but also of interconnecting these programs, in order to move plants forward into a better competitive position (Singh et al., 2008).

In volatile markets, such as the case of electronics companies, for example (Mallick and Schroeder, 2005; Fine, 2000), a primary factor for being competitive could be high levels of technology practices implemented in product and processes. Conversely, in other types of industries, where markets are more stable and product cycles longer, such as auto suppliers and machinery, technology practices alone will not create competitive advantages unless they are related to other production practices (Schroeder and Flynn, 2001).

However, while only a few studies have tried to explore the relationship between S and T practices empirically (e.g., Matsui, 2002), even fewer, if any, have tested the two together, considering different industries worldwide. Therefore, the purpose of this paper is to compare whether there are differences when implementing practices from both programs in different contexts. This is the basis used to formulate the next three research questions: (1) do plants need to implement the same production practices from S and T regardless of their industry?, (2) are high performers in all industries implementing the production practices from S and T in the same way?; and (3) are contextual factors the key to industry differences in the implementation of T and S practices? These issues will be addressed empirically using a unique and valuable database of technology and production strategy practices adopted by production plants around the world, the associated competitive performance and plants' contexts. To be specific, the research focuses on the dependence relationships between implementations of production strategy and technology practices in three industrial sectors: machinery, electronics, and auto suppliers, from nine countries around the world. This is one of few studies testing for multidimensional performance differences in multi-practice T–S linkages within multi-industrial environments.

The research mainly builds on earlier studies carried out internationally on the relationship between production practices in these two manufacturing programs and takes the interdependence focus as its reference. For data analysis the fit model will be used (Meilich, 2006; Drazin and Van de Ven, 1985). This is suitable for the objective of this study as it is based on the assumption that for a production practice to be controlled or improved, its levels of implementation have to be regulated or adapted, taking into consideration the level of some other production practice, and/or vice-versa, as well as the common implementation of all practices together. A comparison is made of the three industrial sectors under study using the results to ascertain whether there are similarities or differences in the interrelationships between the practices in the two programs due to differences in the sectors.

The remainder of this paper is divided into four sections. The following section sets out the theoretical framework that establishes and defines both programs' production practices and their proposed relationships as the basis for the hypotheses. Subsequently, the methodology used to evaluate the hypotheses is described. Next, the analysis of results and their discussion are presented. Finally, the main conclusions and some lines of future research are presented.

2. Theoretical background and hypotheses

This paper considers the previous literature on S practices and T practices, but, to avoid an extensive discussion, empirical work is mostly presented in this section.

2.1. Production strategy (S)

There is still insufficient broad empirical research in the documented production literature that clearly addresses a well-implemented production strategy based on its practices (Gonçalves Zangiski et al., 2013; Adamides and Pomonis, 2009; Amoako-Gyampah and Acquaah, 2008; Hill and Hill, 2009; Hill, 2000). Consequently, this sub-section focuses on the fact that for a properly implemented and well-aligned production strategy, plants should consider four of its practices: *anticipation of new technology*; *manufacturing-business strategy linkage*; *formal strategic planning* involving plant management; and *communication of manufacturing strategy* (Schroeder and Flynn, 2001). Logically, these four aspects (practices) do not represent the whole content of S, but they are sufficiently significant to have been studied in previous papers.

On the one hand, there are clear signs that production strategies play a fundamental role in the assessment of new technologies, since an analysis of appropriate technologies can eliminate many risks. Hence, strategy practices such as *anticipation of new technology* are key factors in global competitiveness (Machuca et al., 2011).

In other regards, according to the classic conception defined in the strategy literature, which distinguishes between processes and content (e.g., Kandemir and Acur, 2012; Swamidass and Newell, 1987), it can be said that the strategy practice of *formal strategic planning* process, which is successfully aligned with the business strategy, is key to the formulation of production strategy. The formal planning perspective is clearly distinguished from the concept of strategy solely as a model (guideline) for decision-making based on past actions. The alignment of the external coupling (market) and the internal coupling (technology and organization) through a strategy is so important that the literature suggests that a company can only survive if the correct production and business advantages are interconnected in the strategy practice of *manufacturing-business strategy linkage* (Yarbrough et al., 2011; Bates et al., 1995; Skinner, 1969).

Finally, production strategy must be communicated and permeated to the plant personnel for it to be used as a guide in decision-making, as this is crucial to it being successfully implemented (Ortega Jimenez et al., 2011; Bates et al., 1995). Through *communication of manufacturing strategy*, the production function is capable of providing appropriate support to business strategy.

2.2. Technology management (T)

The general trend towards an increase in the use of technology in manufacturing plants exists on the premise that it will impact on effectiveness and efficiency (Torkkeli and Tuominen, 2002). However, these investments are often criticized for not providing the desired results, i.e., technology initiatives often lead to neither effective deployment of new practices nor the desired competitiveness being reached as quickly as desired. For this to be understood, it is necessary to take into account that the performance effects of technology are influenced by a number of factors,

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