

## Supplier involvement and manufacturing flexibility

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### Abstract

Supplier involvement is touted as enhancing a firm's competitive edge, but its linkage with specific dimensions of manufacturing flexibility (e.g., volume flexibility) has not been established. This study investigates the relationship between supplier involvement, manufacturing flexibility, and business performance in the motherboard industry. Using data collected from 105 manufacturing firms, we first verified the effect of manufacturing flexibility on business performance. A field study was then conducted to benchmark various supplier involvement practices in the motherboard industry and to decipher the impact of supplier involvement on different dimensions of manufacturing flexibility. Our findings indicate that supplier involvement plays a major role in the development and performance of a firm's manufacturing flexibility. More importantly, we found specific associations between various supplier involvement activities and different dimensions of manufacturing flexibility. Not all supplier activities contribute equally to the development of different types of manufacturing flexibility, and manufacturing flexibility should be integrated with supply chain management. Finally, research propositions are presented and several managerial implications are discussed.

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### 1. Introduction

There has been substantial research in the area of manufacturing flexibility over the last two decades as evidenced by the number of related publications (e.g., see the following articles that reviewed those publications: Beach et al., 2000; De Toni and Tonchia, 1998; Gerwin, 1993; Sethi and Sethi, 1990; Vokurka and O'Leary-Kelly, 2000). Manufacturing flexibility is one of the more important and most studied research issues in the field of operations management. While there are many aspects of manufacturing flexibility (e.g., measurement, performance, and moderating variables) to be investigated, this study extends the knowledge of manufacturing flexibility regarding its integration with supply chain activities.

Supplier involvement and collaboration has been touted as necessary to improve supply chain effectiveness and a firm's competitiveness. In practice, supplier involvement includes a wide range of collaboration activities such as just-in-time delivery, quality improvement, new product design, green purchasing and so on (Krause, 1997). We have learned from industry that those collaboration activities could improve firms' responsiveness to market demands. For instance, Li & Fung, a Hong-Kong fashion retailer, speeds up new product development time and reduces manufacturing cycle time by participating in its buyers' product design process and pre-reserving factory capacity from suppliers (Magretta, 1998). Clearly, supplier involvement can be an important source of developing manufacturing flexibility, and previous studies have acknowledged the effect of supplier involvement (Narasimhan and Das, 1999). Missing from the literature, however, is knowledge of *how* these two strategic components, supplier involvement and manufacturing flexibility, can be integrated and, *how* such integration affects the performance of manufacturing flexibility. The premise of

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this study is that both supplier involvement and manufacturing flexibility are multi-dimensional concepts; managers must understand how various supplier activities correspond to different dimensions of manufacturing flexibility. This knowledge enables firms to align their supply chain efforts with their manufacturing flexibility programs.

We chose to study this issue using data collected from the motherboard industry due to the strategic implication of manufacturing flexibility and traditionally close manufacturer–supplier collaboration in this industry. We first reviewed the relevant literature including performance of manufacturing flexibility and the effects of supplier involvement. Three types of flexibility (new product, product mix, and volume) considered to be critical to competitiveness in the motherboard industry were studied. Next, we performed a survey study to test the performance of these three types of manufacturing flexibility. A field study was then conducted to explain the statistical results and to explore the effect of supplier involvement in the development and performance of manufacturing flexibility. Related research propositions and managerial implications are presented.

## 2. Literature review

Upton (1994) defines manufacturing flexibility as the ability to respond to environmental changes in less time and for lower cost. Other researchers suggest that flexibility is a multi-dimensional construct and could be measured in many different ways (De Toni and Tonchia, 1998; Gerwin, 1993; Sethi and Sethi, 1990). Several studies have classified flexibility into *internal* and *external* flexibility (Upton, 1994). External flexibility is related to the needs of customers and, thus, to a firm's competitive advantage. It is also referred to as "first order" flexibility (Suarez et al., 1996). Examples of external flexibility are new product, product mix, modifications, delivery, and volume flexibility. External flexibility is usually recognized and perceived better than internal flexibility, since it directly affects a firm's competitiveness. In contrast, internal flexibility is related to the need for operations efficiency, and it is not directly related to market demand and environmental uncertainties.

Examples of internal flexibility are machine, material handling, and routing flexibility. Its impact on a firm's market competitiveness is rather indirect and is usually not recognized by customers. For the purpose of this study, we focused on the relationship between business performance and external flexibility.

Regardless of the type of flexibility, research has provided inconsistent findings on the effect of manufacturing flexibility on business performance indices such as market share, sales growth and profit (Ariss and Zhang, 2002; Narasimhan et al., 2004; Vokurka and O'Leary-Kelly, 2000). Upton (1995) studied the paper industry and found that much of its manufacturing flexibility enhance-

ment effort was not successful. Gaimon and Singhal (1992) showed that, in some situations, flexibility could actually lead to negative result. Pagell and Krause (1997) studied users of advanced manufacturing technologies (AMT) and found no relationship between uncertainty and manufacturing flexibility. Firms do not benefit from the matching of internal manufacturing flexibility with environmental uncertainty. It seems that more flexibility is not equivalent to higher competitiveness.

In contrast, there is another group of researchers who confirmed the positive impact of flexibility on business performance. For instance, Swamidass and Newell (1987) reported the positive effect of product mix and new product flexibility on sales growth and net profit rate. More specifically, those firms that offered various product options were able to increase their market share (Bolwijn and Kumpe, 1990). In a related area, Gerwin (1993), Suarez et al. (1996) and Tannous (1996) showed the positive effect of volume flexibility on sales growth and net profit. Finally, several studies reinforced the situational performance of manufacturing flexibility (Chang et al., 2002, 2003; Gupta and Somers, 1996). Managers must invest in and develop specific types of manufacturing flexibility to respond to their environment and business strategy.

The supply chain management literature offers various ways that firms can improve their competitive advantage by working with their suppliers (Handfield et al., 1999; Krause, 1997; Wong, 2001). Manufacturing firms are increasingly obtaining volume, design, and technology capabilities through strategic supply chain management. For instance, early supplier involvement in the design process is a way to leverage the supplier's knowledge early in the design process to reduce costs and lead times (Handfield et al., 1999). Strategic alliances or long-term relationships (e.g. Choi and Hartley, 1996) are also ways to leverage the supplier's unique capabilities to improve firms' performance and to share risk for reducing uncertainty. Additional factors such as supplier partnering practices, trust, assistance in supplier development, purchasing personnel skills, purchasing's strategic orientation, and supplier optimization have been found valuable in leveraging supplier capabilities for competitive advantage.

Overall, many supplier programs directly or indirectly enhance a firm's competitive edge, but their linkage with specific dimensions of manufacturing flexibility (e.g., volume flexibility) has not been established. Previous studies offer sparse and incomplete discussion regarding the relationship between these two important strategic components (i.e., manufacturing flexibility and supplier involvement) and how such a relationship could affect manufacturing performance. For instance, Narasimhan et al. (2004) proposed a list of supplier-related activities that could impact the development of manufacturing flexibility: supplier's ability to modify products to meet customer needs, responsiveness to schedule delivery changes, responsiveness to schedule volume changes, assistance in product

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