Oper Manag Res (2014) 7:117–133
DOI 10.1007/s12063-014-0089-6

The relationships between manufacturing strategy process, manufacturing-marketing integration, and plant performance: an empirical study of Korean manufacturers

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Received: 12 November 2013 / Revised: 19 May 2014 / Accepted: 23 May 2014 / Published online: 12 June 2014

Abstract The purpose of this study is to examine the interrelationships between manufacturing strategy process (manufacturing strategy formulation and manufacturing strategy implementation), manufacturing-marketing integration and plant performance. For this study, a survey was conducted on 221 manufacturers from the machinery, automotive and electronics in South Korea. Subsequently, the related hypotheses were tested using structural equation modeling. According to the results, positive relationships were observed between the manufacturing strategy process, manufacturing-marketing integration and plant performance. Specifically, manufacturing strategy formulation positively influenced both manufacturing strategy implementation and manufacturing-marketing integration. Further, not only manufacturing strategy implementation, but manufacturing-marketing integration also has a direct positive influence on plant performance. Although manufacturing strategy formulation does not directly affect plant performance, its influence on plant performance is transmitted through two paths intermediated by both manufacturing strategy implementation and manufacturing-marketing integration, respectively. In contrast to quite a number of studies focused on the manufacturing strategy content, there only exists a relatively small number of studies related to the manufacturing strategy process. Therefore, this study is one of the few broad empirical studies that investigated the interrelationships between manufacturing strategy formulation, manufacturing strategy implementation, manufacturing-marketing cooperation and plant performance using structural equation modeling. Furthermore, it also verified that the manufacturing strategy process can be a source of plant performance improvement.

Keywords Manufacturing strategy process · Manufacturing strategy formulation · Manufacturing strategy implementation · Manufacturing-marketing integration · Korean manufacturers

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1 Introduction

Triggered by Skinner's seminal work (1969), an extensive body of literature on manufacturing strategy (MS) has emerged. Included in this group are studies of the Japanese manufacturing system (e.g., Schonberger 1986; Womack et al. 1990) and of the causal relationships between manufacturing and competitive advantage/performance (e.g., Boyer and McDermott 1999; Hayes and Wheelwright 1984; Miller and Roth 1994; Vickery et al. 1993). Earlier studies of MS were predominantly axiomatic and normative in nature, particularly investigating what should be studied with regard to the MS (Craighead and Meredith 2008; Kiridena et al. 2009). A consensus reached by the studies indicated that MS could be better analyzed using the following two dimensions, manufacturing strategy process (MSP) and manufacturing strategy content (MSC) (Adam and Swamidass 1989); the former is comprised of MS formulation (MSF) and MS implementation (MSI), whereas the latter encompasses competitive priorities, decision areas and action plans.

In contrast to quite a number of MS studies focused on MSC, there exists a relatively small number of MSP-related studies. The primary objective of the earlier research on MSP was to identify an ideal MSP framework rather than to investigate the causal relationship between MSP and business performance (e.g., Leong et al. 1990; Mills et al. 1995). This early aim of MSP studies remained largely unchanged in later works. Even in the 2000s, most MSP-related papers (e.g., Barnes 2002; Kiridena et al. 2009; Rytter 2007) were focused on improving the MSP framework in order to conform to reality. Consequently, a greater part of MSP studies were conceptual and prescriptive (Anderson et al. 1991; Barnes 2002; Brown et al. 2010; Brown and Blackmon 2005; Craighead and Meredith 2008; Kiridena et al. 2009; Rytter 2007; Swink and Way 1995). In fact, up until recently, very few studies have looked empirically into the direct effect of MSP on firm performance (Brown et al. 2010; Eppler et al. 2009; Machuca et al. 2011; Papke-Shields et al. 2006; Rytter et al. 2007). Even the few empirical studies of the relationships between MSP-related practices and competitive advantage/performance did not pay much attention to the two distinct components of MSP, MSF and MSI as well as to the interrelationships between MSF, MSI and performance.

The necessity of cooperation between manufacturing and marketing to improve firm performance was strongly advocated as early as in the 1970s (Shapiro 1977). Such need was followed by a few studies stressing the desirable effect of cross-functional cooperation—coined as manufacturing-marketing integration (MMI)—on business performance (e.g., Hayes and Wheelwright 1984; Hill 1985; Swink and Song 2007). Nevertheless, a very small number of studies have delved into the contribution of MMI to securing a firm's competitive position and improving performance only in a special context. As a consequence, the investigation of the influence of MMI on performance in the context of a manufacturing organization's normal operations has remained yet to be undertaken. Furthermore, in spite of the apparent interactions between MMI, MSF and MSI, few studies have investigated the interactions and how they actually affect the influence of MMI, MSF and MSI on performance. Therefore, a critical deficiency in MS literature is that no broad empirical study has yet investigated the interrelationships between MSF, MSI, MMI and performance (Machuca et al. 2011).

Accordingly, the purpose of this study is to empirically verify the interrelationships between the four constructs, MSF, MSI, MMI and plant performance, based on a large random sample. In addition, this study aims to find paths through which the effect of MSF on performance is transmitted. Hence, this study will empirically corroborate some of its conventional wisdom regarding the MSP and further refine the results from previous studies. In view of the purpose of and the research questions of this study, a plant is chosen as the unit of analysis (Leong et al. 1990; Swink and Way 1995; Choi and Eboch 1998). Further, we used structural equation modeling (SEM) so as to treat the constructs simultaneously.

More specifically, this study, treating MSF, MSI, MMI and performance, simultaneously addresses the following four research questions (RQ):

RQ1 What is the relationship between the formulation process of a manufacturing strategy and its implementation? Does the formulation process positively affect the implementation?

RQ2 What is the relationship between a manufacturing strategy process and manufacturing-marketing integration? Does the formulation process of a manufacturing strategy positively affect the manufacturing-marketing integration, whereas the integration affects the implementation of a manufacturing strategy?

RQ3 What is the relationship between manufacturing-marketing integration and plant performance? Does the integration positively influence plant performance?

RQ4 What is the relationship between manufacturing strategy process and plant performance? Do both the formulation and the implementation processes of a manufacturing strategy contribute to the performance? Or does either of them only contribute to the performance?

To find the answers to these questions, a survey was conducted on South Korean manufacturing suppliers from the machinery, automotive and electronics industries, and the hypotheses were tested via SEM. The next section reviews the relevant literature followed by the constructs and hypotheses. Section 4 describes the research methodology. The results are presented in section 5. The final section discusses the research results and offers some concluding remarks along with the contributions and limitations of this study.

2 Literature review

2.1 The manufacturing strategy process: Formulation and implementation

Although Adam and Swamidass (1989) were the first to suggest the framework of MS comprising MSP and MSC, the explication of the MSP can be found in earlier MS studies (e.g., Hayes and Wheelwright 1984; Hill 1985; Skinner 1969). Skinner (1969), for example, emphasized a top-down manner of MSF, whereas Hayes and Wheelwright (1984) suggested the use of a four-stage model. The hierarchical top-down/two-stage framework of the MSP—MSF and MSI, however, appeared to be too simplistic and aggregated. Consequently, subsequent studies suggested alternatives to the two-stage model of the MSP: a three-stage framework (Leong et al. 1990; Mills et al. 1995), a model "involving a combination of deliberate and emergent actions and decisions" (Barnes 2002), a two-stage model of talk and action (Rytter et al. 2007), and a model of "linear and parallel, converging and diverging, sequential and iterative progression of initiatives" (Kiridena et al. 2009). However, the resource-based view (RBV) of the firm lacks the development of a more specific MSP model (Ketokivi and Schroeder 2004; Paiva and Fensterseifer 2007; Schroeder et al. 2002). Nevertheless, the two-stage model remains valuable for its simplicity as an MSP research framework. Thus, this study used the commonly accepted model of MSP, which is comprised of MSF and MSI.

In general, an MS is formulated through the process of MSF from a business/corporate strategy via both a marketing strategy and manufacturing objectives in a top-down manner (Barnes 2002). Thus, Anderson et al. (1991) advocated that the manufacturing department should participate in establishing a corporate strategy as well as develop an MS independently. In fact, firms in which the staffs of the manufacturing department are eagerly involved during the strategic planning process tend to achieve a closer strategic alignment of MS with the corporate strategy (Brown and Blackmon 2005). With regard to the goal of MSF, Garvin (1993) advocated the development of a concrete, quantified "strategic manufacturing initiative," which is to be achieved through an MSI program, whereas Kim and Arnold (1996) suggested determining the competitive priorities, manufacturing objectives and action plans as the goal. To assess the MSF procedure, Platts et al. (1996) proposed an effective evaluation tool based on seven criteria.

In spite of the critical importance of the implementation process, few studies have investigated it in-depth. In a study of the fast-moving consumer goods sector, Lowson (2002) found that an operations strategy is implemented through a number of "building blocks" that conform to their operations strategy. This may be supported by the findings of Ward et al. (2007), which indicate that the observed manufacturing capabilities of firms conform to their business strategy (BS). Although these studies seem to imply a seamless transition from MS formulation to implementation, this may not always hold true. Marucheck (1990) discovered that implementation is less structured and a behaviorally-oriented process. This is also supported by the findings of Rho et al. (2000) that the gaps between a formulated strategy and implemented practices exist, thereby discriminating the superior from the inferior firms in terms of performance. Accordingly, some measures that may enhance MSI have been recommended. First, employees in the manufacturing department need to have a good understanding of their MS, communicate actively and build a pattern of action with the aim to implement the future MS by exploiting various MS charts (Mills et al. 1998). Second, human resource management should be considered as more important than the organization or system factors (Kinnie and Staughton 1993; Minarro-Viseras et al. 2005).

The work of Marucheck (1990) may be one of the typical earlier case studies that examined the process of MSF and MSI as practiced by firms. Recently, Papke-Shields et al. (2006) investigated the effects of MSF characteristics on firm performance; they divided U.S. manufacturers into four planning groups according to the degrees of 'rationality' and 'adaptability' of planning, and found that firms with "rational adaptive" planning outperformed those with "irrational adaptive" planning; thus, their study suggests that research on the "linkages" between the MSP and business performance is called for. A more recent study of Machuca et al. (2011), based on self-report measures of MS, technology practices and plant performance, examined the influences of MS practices (anticipation of new technology, MS-BS link and formal strategic planning) and technology practices (inter-functional design efforts, effective process implementation and supplier involvement) on operational performance. The results revealed that the former is positively related to the operational performance while the latter is not; however, the study did not clearly classify the MS practices into MSF and MSI and moreover, excluded cross-functional cooperation MMI as a variable affecting the performance.

2.2 Manufacturing-marketing integration

To better match its manufacturing capabilities with the market demand, the current and the future as well, the manufacturing department requires market information about the ever-changing customer needs and competing products. The marketing department, on the other hand, requires information about manufacturing capabilities, both existing and planned, in order to identify a target market segment as well as develop a market offering or a set of feasible competitive priorities so as to outperform its competitors. This simple fact immediately signifies that the close cross-functional coordination between the two departments will be one major key to success in MS and corporate strategy as well, which has been long advocated in the literature.

Shapiro (1977) appears to be one of the earliest papers recognizing and foreseeing the crucial importance of MMI; he expounded the context as well as the causes of the conflict between the manufacturing and marketing departments, and stressed the necessity of interdepartmental cooperation. A decade later, Hayes and Wheelwright (1984) envisioned the most advanced stage of MMI, in which manufacturing becomes involved in major marketing and engineering decision making and vice versa. Furthermore, Hill (1985), presenting an order-winning model, stressed the importance of an alignment of an MS with marketing and corporate strategies, and insisted that manufacturing decisions should be guided by the order-winning dimensions in which a company excels. Prabhaker (2001) only recently rediscovered the real significance of the strategic, operational integration of marketing with manufacturing; he claimed that the integration would allow firms to make the best use of advanced manufacturing technologies to better satisfy more sophisticated and ever-demanding customers. While recognizing a potential interdepartmental conflict, subsequent studies (e.g., Hausman et al. 2002; Pagell 2004; Swamidass et al. 2001; Swink et al. 2005; Swink and Song 2007) reiterated Hill's proposition: Manufacturing firms should make their manufacturing and marketing departments interact and become closely involved at every stage of the MS and corporate strategy processes in order to outperform their competitors. From a resource-based viewpoint, Lewis and Boyer (2002) reframed Hill's proposition that interaction, communication and collaboration between the marketing and manufacturing departments are essential for carrying out the purpose of MS, matching the manufacturing capabilities with the market demand.

In spite of the long advocated importance of MMI, empirical studies on MMI-related issues are few (Gupta et al. 2006). In a study of new venture firms, Deane et al. (1991) found that the effect of the interaction between manufacturing and marketing decisions helps predict the success of new venture firms. In a different context, Hausman et al. (2002) demonstrated that MMI enhances a firm's competitive position, morale and profit. Recently, Swink and Song (2007) discovered that in a new product development process, MMI is positively associated with the competitive advantage of the new product and return on investment, but with lengthened project time. Similarly, Swink et al. (2005) noted that the coordination between manufacturing and corporate strategies, the latter being usually formulated based on the marketing strategy, improves cost efficiency, new-product flexibility and firm performance. In a study of the online grocery industry, Boyer and Hult (2005) also demonstrated that MMI has a significant direct effect on customers' intent to repurchase; however, BS and environmental uncertainty moderate the effect of MMI on firm performance (O'Leary-Kelly and Flores 2002). Of particular note is the study of Pavia et al. (2007), which indicated that a competitive advantage could be secured through the interactive processes between manufacturing knowledge and cross-functional activities.

Hence, there is no doubt that both MSF and MSI may require the commitment of all functional departments, the marketing department in particular. For example, identifying the competitive priorities to define a goal of the manufacturing function requires the heavy involvement of the marketing department. This is particularly so when it comes to the selection of a product and its manufacture. Even during the MSI process, changes in market demand can occur, which will require a corresponding adjustment in an MS. This adjustment will likely oblige the manufacturing and marketing departments to cooperate with each other. Thus, MSF, MSI and MMI seem to closely interact, although it is not easy to predict the causality between them. Nonetheless, we can hardly find any conceptual or empirical studies in the literature examining the interactions between them. In view of the significance of the interactions, any in-depth study of the influence of MMI on a manufacturing organization's performance should be taken into consideration.

3 Constructs and hypotheses

3.1 Constructs: Manufacturing strategy formulation, manufacturing strategy implementation, manufacturing-marketing integration and plant performance

Based on the previous studies (Hallgren and Olhager 2006; Slack and Lewis 2007; Swink and Way 1995), MSF can be defined as a set of sequential decision-making procedures and methods to determine the concrete content of an MS aligned with the corporate strategy, whereas MSI can be defined as a set of activities for executing a formulated MS. In addition, from the prior studies, we found that a manufacturing organization with a comprehensive and systematic MSF is supposed to (1) develop and maintain a concrete MS, (2) share the MS with other functional departments, (3) maintain the MS aligned with the corporate strategy, (4) maintain the MS that is periodically reviewed and revised as the circumstances demand, (5) get involved in developing the corporate and other functions' strategies, and (6) develop long-term manufacturing capabilities congruent with the MS. Accordingly, the construct MSF in this study is formed from these six practices that are well-established in the previous studies.

Likewise, it was found from the literature on MS that a manufacturing organization maintaining an effective MSI is supposed to optimize a mix of at least ten practices in order to faithfully implement its MS. These practices include the following: (1) employee training and education, (2) employee self-inspection of products-in-process, (3) continuous improvement derived from the employees, (4) statistical control of process innovations, (5) installation of information systems, (6) investment in proprietary equipment, (7) introduction of state-of-the-art equipment, (8) maintenance, repair and improvement of equipment, (9) development and improvement of the process technology, and (10) investment in advanced manufacturing technologies. These ten practices formed the measurement variables for the construct, MSI, in this study.

MMI can be defined as the cross-functional integration of the activities of manufacturing and the marketing departments, which leads to greater exchanges and cooperation (e.g., O'Leary-Kelly and Flores 2002; Swink and Song 2007). It aims to promote manufacturing-marketing collaboration in the formulation and implementation of the corporate strategy. The major practices of MMI identified in the literature include (1) manufacturing-marketing cooperation in corporate strategy formulation, (2) manufacturing-marketing cooperation in corporate strategy implementation, (3) manufacturing-marketing communication and information sharing, (4) manufacturing-marketing cooperation in product development and problem solving, and (5) the mutual understanding of the goal of the other department. Accordingly, the measurement variables for the construct MMI in this study are formed from these practices. Because this study focused on the investigation of the interrelationships between the MSP, MMI and plant performance, marketing strategy, whose possible mediating role is expected to be partly taken by MMI, was not incorporated into the research model, as shown in Fig. 1.

From the literature and our own experiences, we observed that the primary concerns of managers at a plant are as follows: First, they wish to increase market share by rapid sales growth and make profit from the operation of the plant. Second, they wish to achieve high levels of customer satisfaction with current products, which is a prerequisite for attaining a high customer retention rate in order to accomplish any revenue growth and profit objectives. Third, as they continue to develop new products and upgrade current products, they wish to succeed in winning customers' order for those products. Fourth, they endeavor to outperform competitors by enhancing their competitive priorities, focusing on quality-competitiveness-against-cost. Overall, these observations led us to select the following five measurement variables for the construct, plant performance: (1) the sales growth of the plant, (2) the operating profit of the plant, (3) the customer order-winning of new products, (4) customer satisfaction with products and (5) quality competitiveness against cost, as shown in Table 1. All of these five measurement variables could be found in the literature (Li et al. 2006; Papke-Shields et al. 2006; Swink et al. 2007; Tracey et al. 2004; Venkatraman 1989). Hence, we believe that the content validity of the five measurement variables has been established.

This study chose a plant (i.e., the shop floor) rather than the overall firm or a strategic business unit as the unit of measurement for the following four reasons. First, the research questions being addressed deal with the effects of MSF, MSI and MMI practices on plant performance. Second, an MS is a functional strategy and is thus formulated and executed at a plant, and an MMI is a cross-functional integration of the activities of a plant and the marketing department. Therefore, managers at a plant are most knowledgeable about the practices of MSF, MSI and MMI, along with their impacts on plant performance. This point was succinctly stated by several previous studies (e.g., Bozarth et al. 2009; Choi and Eboch 1998; Phan and Matsui 2010; Swink et al. 2007). Third, MSF, MSI and MMI are only remotely related to many other sources of strategic-business-unit performance; therefore, evaluating the contributions of MSF, MSI and MMI practices to strategic-business-unit performance is less meaningful. Fourth, the use of a plant as the unit of analysis has become a well-established practice in the literature on operations management (e.g., Bozarth et al. 2009; Brown et al. 2007; Brown et al. 2010; Ketokivi and Schroeder 2004; Machuca et al. 2011; Oliver et al. 1996; Zheng et al. 2013; Sawhney 2013; Schroeder et al. 2002; Swink et al. 2007; Womack et al. 1990). Overall, the research model shown in Fig. 1 illustrates the conceptual causal relationships between MSF, MSI, MMI and plant performance.

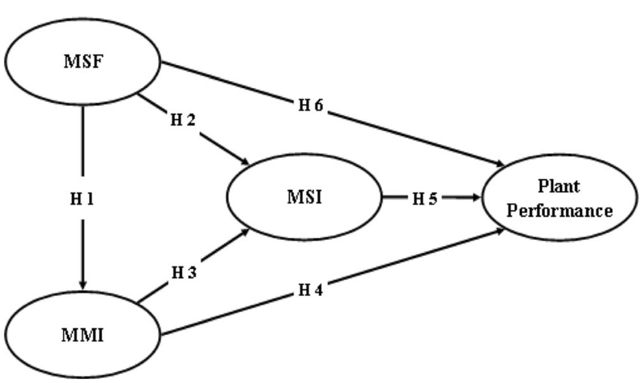

Fig. 1 Research model

3.2 Hypotheses

It has been observed that as a department's strategy gains significance, its collaboration with the other departments becomes more vigorous (Ward et al. 1994). Thus, in a company where manufacturing capabilities are regarded as critical to attaining and sustaining its competitive advantage, there would be lively communication and interaction between the manufacturing, marketing and other functional departments (Tunälv 1990). This immediately implies that a manufacturing organization pursuing an MS, which is aligned with its competitive strategy to adapt its manufacturing capabilities to the dynamic and unpredictable market requirements, would be under constant pressure to enhance the harmony of the manufacturing-marketing interface. Hence, we can expect that the manufacturing-marketing interface harmony will be bolstered with greater emphasis placed on the MS, as observed by Hausman et al. (2002). As the formulation process of an MS is more comprehensive and systematic, it is therefore likely to lead, by sheer necessity, to a closer integration of the manufacturing department with the marketing and other departments (Pagell 2004). It will also necessitate the manufacturing department's active participation in the formulation process of corporate, marketing and other functional departments' strategies. Accordingly, the following hypothesis, which could answer the first part of research question RQ2, can be suggested:

Hypothesis 1 (H1) The formulation of an MS is positively associated with manufacturing-marketing integration.

Table 1 Operationalization of measurement variables

Construct	Measurement variable	Operational definition	Reference
MSF	Formalization	Concrete and definite manufacturing strategy	Anderson et al. (1991)
	Sharing	Sharing of manufacturing strategy in the firm	Acur et al. (2003)
	Consistency	Manufacturing strategy consistent with corporate strategy	Marucheck et al. (1990)
	Involvement	Involvement of manufacturing in corporate/other departments strategy formulation	Dangayach and Deshmukh (2001)
	Revision	Periodic review and revision of manufacturing strategy	Platts et al. (1996)
	Development	Long-term development of manufacturing capabilities according to manufacturing strategy	Hayes and Wheelwright (1984)
MMI	Planning	Manufacturing-marketing cooperation in corporate strategy formulation	Hausman et al. (2002)
	Implementation	Manufacturing-marketing cooperation in corporate strategy implementation	
	Communication	Manufacturing-marketing communication/information sharing	Pagell (2004)
	Product	Manufacturing-marketing cooperation in product development and problem solving	Swink and Song (2007)
	Understanding	Mutual understanding of the goal of the other department	O'Leary-Kelly and Flores (2002)
MSI	Training	Regular employee training/education	Boyer and McDermott (1999)
	Inspection	Employee self-inspection of products/work-in process	Ward et al. (2007)
	CI	Continuous improvement derived from employees	Evans (2004)
	SPC	Statistical control of process innovation	Schmenner and Vastag (2006)
	IS	Installation of information systems	Ward et al. (2007)
	Investment	Investment in proprietary equipments	Ketokivi and Schroeder (2004)
	Equipment	Introduction of state-of-the-art equipments	Schroeder et al. (2002)
	TPM	Maintenance, repair, and improvement of equipments	Zhang et al. (2006)
	PT	Development and improvement of process technology	Schroeder et al. (2002)
	AMT	Investment in advanced manufacturing technologies	Boyer and McDermott (1999)
Plant Performance	Sales	Sales growth of the plant	Papke-Shields et al. (2006)
	Profit	Operating profit of the plant	Venkatraman (1989)
	Retention	Customer order-winning of new products	Swink et al. (2007)
	Satisfaction	Customer satisfaction with products	Tracey et al. (2004)
	Quality	Quality competitiveness against cost	Li et al. (2006)

If a manufacturing organization accomplishes strategic fitness by formulating its MS in harmony with its corporate strategy, the corporate strategy will be effectively carried out in the field of manufacturing; accordingly, the MS will enhance the level of manufacturing-related capabilities (Brown 1998; Hayes and Pisano 1996) and will link a firm's competitive priorities to its action plans (Acur et al. 2003). To develop unique manufacturing capabilities that would enable a manufacturing organization to outperform its competitors, it needs well-streamlined MSF (Brown and Blackmon 2005; Flynn et al. 1994; Garvin 1993). If a manufacturing organization's MSF process is comprehensive and systematic, its choices, decisions and action plans of an MS will be realistic and precise enough to be readily executable, thereby enabling fuller implementation of the MS (Gianesi 1998). Under such circumstances, the staff of the manufacturing department will actively get involved in the planning process and will also become fully aware of their responsibility to implement the MS successfully. All of these factors will contribute to fuller MSI and thus, the following hypothesis addressing research question RQ1 can be suggested:

Hypothesis 2 (H2) The formulation of an MS is positively associated with the implementation of the MS.

If the manufacturing-marketing collaboration in MSF could help ensure a horizontal consistency between an MS and a marketing strategy, and their alignment with the corporate strategy (Gianesi 1998), then it is conceivable that the collaboration could also help implement the MS more fully. As closer manufacturing-marketing collaboration necessarily involves improved mutual understanding, animated communication and more frequent formal and informal contacts between the manufacturing and marketing departments, they may be able to more effectively and jointly address any unanticipated problems that it may encounter in MSI. This is particularly so in view of the fact that, traditionally, the marketing department is the most active participant in the development and execution of the corporate strategy (Anderson et al. 1991; Barnes 2002; Swamidass et al. 2001). Thus, the marketing department, through MMI, is expected to exercise influence on not only aligning an MS with the corporate strategy, but also implementing the MS. Therefore, the following hypothesis, which can answer the second part of research question RQ2, can be offered:

Hypothesis 3 (H3) The greater the degree of manufacturing-marketing integration, the fuller the implementation of an MS will become.

Although we could not find any previous studies dealing with the causal relationship between MMI and plant performance, there are some articles that focus on such kind of relationship by considering not the plant performance, but the corporate level or customer performance. Pavia et al. (2007) found that collaborative actions between manufacturing, marketing and other functions facilitate the development of competitive capabilities as sources of a sustainable competitive advantage. This may partly be due to the closer alignment of an MS with a marketing strategy which is affected by the cross-functional cooperation between manufacturing and marketing. This postulation seems to be partially supported by some empirical studies (Hausman et al. 2002; O'Leary-Kelly and Flores 2002; Olson et al. 2005; Swink et al. 2005; Swink and Song 2007). Moreover, a study of supply chain management by Esper et al. (2010) and a study of returns management by Mollenkopf et al. (2011) found that the better functional integration of marketing and operations could engender a closer corporate-resource alignment, thus improving customer value. Therefore, the following hypothesis addressing research question RQ3 can be proposed:

Hypothesis 4 (H4) The greater the degree of manufacturing-marketing integration, the higher the level of plant performance will become.

The positive influence of the enhanced and systematized MSP on firm performance may partly be attributable to the fuller implementation of an MS (Papke-Shields et al. 2006; Schroeder et al. 2002). To attain those targeted manufacturing capabilities in alignment with the firm's competitive strategy, the decisions and action plans made in the formulation process must be implemented through programs and projects (Minnaro-Visera et al. 2005). The manufacturing capabilities thus developed are found to improve business performance (Leong et al. 1990; Vickery et al. 1993; Ward et al. 1994). The implementation of the programs and projects, however, may not go smoothly according to the blueprint due to diverse impediments: sheer misunderstanding, insufficient information sharing, unstructured control procedures, unanticipated supplier problems, financial constraints, inadequate skills, departmental cultural differences, and personal preferences among others. As these impediments obstruct the implementation of the decisions and action plans, the materialized manufacturing capabilities may not be consistent with the firm's competitive strategy and thus cannot meet the market requirements; this in turn will suppress the level of MS contribution to firm performance (Rho et al. 2000). All the above discussions suggest that enhanced MSI would contribute to the improvement of plant performance (Lowson 2002). This is also compatible with RBV, which might expound that vigorous and enhanced MSI will lead to the creation of manufacturing capabilities, which will be the source of competitive advantages. Thus, the following hypothesis, which could answer the first part of research question RQ4, can be offered:

Hypothesis 5 (H5) The fuller the implementation of an MS, the higher the level of plant performance will become.

A few researchers (e.g., Acquaah et al. 2011; Brown et al. 2007; Gupta et al. 1991; Kim and Arnold 1996; Papke-Shields and Malhotra 2001; Tunälv 1992; Ward et al. 1994) advocated the importance of a closer alignment of an MS with the corporate strategy and the manufacturing department's active involvement in formulating the corporate strategy for improving business performance. Acquaah et al. (2011), for example, advocated that a firm with an MS that is harmonious with its competitive strategy could better meet the ever-changing market demands with flexibility and adaptability as well as improve its performance. Similarly, in a study of the PC industry, Brown et al. (2010) found that a comprehensive MSP characterized by the active involvement of the senior managers in the MSF improves both the quality and inventory control. Thus, it can be postulated that comprehensive and systematic MSF will help map out a comprehensive MS aligned with the corporate strategy and other functional strategies; further, such an MS is expected to reflect the market demand better. The MS thus developed may exert a positive direct influence over plant performance. Accordingly, the following hypothesis, which addressed the second part of research question RQ4, can be suggested:

Hypothesis 6 (H6) The formulation of an MS is positively associated with plant performance.

4 Methodology

4.1 Operationalization, measurement and sample size

Table 1 presents the operational definitions of the measurement variables for the four constructs—MSF, MSI, MMI and plant performance. Previous literature established the content validities of the variables. Hayes and Wheelwright (1984) first introduced variables related to MSF, which were subsequently operationalized. Variables related to MMI measure the contents of the cooperation at both the strategic and tactical levels, whereas variables related to MSI were operationalized based on prior studies that used several operations practices as the measurement indices (Acur et al. 2003; Kim and Arnold 1996) as well as the manufacturing decisions identified by Hayes and Wheelwright (1984). The ten measurement variables thus indentified from the literature are as follows: Investment, Equipment and TPM (Total Preventive Maintenance) for facilities; PT (Process Technology) and AMT (Advanced Manufacturing Technology) for technology; Training, Inspection and CI (Continuous Improvement) for human resources and organization; SPC (Statistical Process Control) and TPM for quality; and IS (Information System) for manufacturing planning and control. Furthermore, these practices are considered to be essential for achieving the competitive priorities: quality (Training, Inspection, CI, SPC and TPM), cost (CI, Investment, Equipment, TPM and PT), delivery (CI, IS and AMT), and flexibility (Training, IS, AMT, Investment and Equipment). In fact, these variables represent the major means of implementing an MS regardless of the types of competitive priorities a firm may pursue. Three manufacturing decision areas, vertical integration, new-product development and capacity development, were not considered for the measurement of MSI for the following reasons: (1) In the strict sense, vertical integration is within the realm of SCM and not of MS. (2) In the same logic, new-product development belongs to the area of R&D management. (3) Capacity development is not a routine operational issue, but a long-term issue; thus, decisions regarding capacity are made intermittently, approximately once every three to five years. Furthermore, in view of the size of a fund required for and the scope of decisions on the capacity development, making capacity decisions may exceed the plant manager's competence. Accordingly, one can observe that capacity decisions are made at the firm-level organization. Hence, capacity development was not incorporated in the measurement variables for MSI. Variables related to plant performance were measured according to sales growth (Sales), profitability (Profit), order winning of new products (Retention), customer satisfaction (Satisfaction) and quality competitiveness against cost (Position).

In our survey questionnaire, all of the 26 measurement variables were numbered from 1 to 26, arranged in order. In order to measure the variables, we then used a 7-point Likert scale (1 = strong disagreement; 7 = strong agreement) instead of the 5-point one in order to mitigate the attenuation problem caused by the range restriction (Curkovic et al. 2000). The respondents were asked to indicate the degree to which they agree with each question as compared to their competitors in the trade. For instance, in the case of the Formalization variable, the respondents were asked to indicate the degree on a scale of 1 to 7 to which they agree with the following statement: "We have a more concrete and definite manufacturing strategy compared to our competitors in the trade." In the case of Sales measuring plant performance, the respondents were asked to indicate on a 7-point Likert scale to the degree to which they agree with their plant's position after reading the following statement: "The annual rate of sales growth of our plant is higher than that of our competitors in the trade."

Prior knowledge of SEM warns us that one should be wary of a possible distortion in the $\chi 2$ or RMSEA while testing the goodness-of-fit when the sample size is too small (Jackson 2003; Shah and Goldstein 2006). The sample size in this study was 221, which was greater than the minimum requirement of 200 (Hair et al. 2006). Therefore, the size was sufficient to generate reliable results, as confirmed by the power of test (0.9707); the value was greater than the minimum requirement of 0.8 (MacCallum et al. 1996). Hence, the sample size in this study was appropriate and moreover, it did not compromise the reliability of the results.

4.2 Sampling and data collection

The sample was drawn from the database of small- and medium-sized enterprises listed by the Small and Medium Business Administration (SMBA) of the South Korean government (http://sminfo.smba.go.kr/). Sample suppliers were drawn from three industries, machinery, automotive and electronics, for the following reasons. First, measurement scales may not be applicable to diverse populations, although the generalizations of the research findings can be secured with the diversity of the population (Gerwin 1987). In addition, even a research targeting a single sector may provide valuable insight into the nature of the interrelationships between the MSP, MMI and performance (Pfeffer 1998). Second, more importantly, the three industries, in view of their share of the Korean manufacturing-sector GDP (59.2 % in the year 2011), are regarded as representing the manufacturing industry approximately in terms of output. Third, the production processes of the three target industries include most process types, which is, project, job shop, batch or line process, except continuous process, which might lessen the process-related limitations. Fourth, the three industries have been globalized over the past three decades. In some corporations within the industries, overseas subsidiaries account for more than 50 % of the sales volume and a majority of the shareholders are foreigners.

To gather reliable data, firms of a reasonable size need to be selected in order to meet the sample size criterion (Koste et al. 2004). Accordingly, excluding non-external auditing suppliers for reliability reasons, firms whose annual sales were greater than US$30 million were selected, accounting for more than 90 % of all suppliers' gross sales. Thus, 1,150 South Korean manufacturing companies in the machinery, automotive and electronics industries were selected as the targets for this study. Prior to sending out the survey questionnaires to the target firms, we called managers at the manufacturing management departments or in a few cases, managers at the manufacturing process technology departments, when the former were not available. Then we explained the purpose and contents of the survey to them, and in view of the contents of the survey, we specifically requested them to respond to the survey questionnaire themselves. If this was not possible, we asked them to recommend eligible respondents for the survey. Of 1,150 firms, 550 virtually single-plant firms agreed to participate in the survey and copies of the survey questionnaire were sent via e-mail or ground mail to the team leaders or deputy team leaders at the manufacturing management or the manufacturing process technology departments thus identified. The respondents who were primarily team leaders or deputy team leaders told us, through follow-up calls, that they would be able to answer the questions with the help of other functional departments, if necessary; and in fact, they were quite willing to cooperate with us.

These team leaders or deputy team leaders are in charge of developing and implementing an MS, production planning, quality management, outsourcing and product improvement among others. In the process of fulfilling their responsibility, they are under constant pressure to outperform their competitors in the trade, particularly in the realms of the unit cost of production, quality and delivery time. In addition, they are supposed to support the plant manager, who mandatorily participates in the corporate level decision-making process, which is a typical practice in a single-plant firm. As a consequence, the team leaders or deputy team leaders have to pay closer attention to and be aware of their competitors in the trade. Besides their own corporate information, they collect information on their competitors from a multitude of sources: open sources such as newspapers and magazines; externally audited competitors' annual financial statements; meetings such as frequently-held-supplier meetings sponsored by buyers; buyers' annual supplier-evaluation reports; 2nd-tier suppliers which also supply products to the competitors; private connections such as regional relations, school relations, and kinship among others. Two important factors that might alleviate their burden of collecting the information are the relatively small number of competitors and the geographical proximity of suppliers to one another clustering around their major buyers. Finally, of 550 firms, 234 responded (42.2 % response rate), of which 221 were used in the final analysis (excluding 13 incomplete questionnaires).

The non-response bias was examined via a multivariate analysis of variance (MANOVA) and χ^2 test. First, the companies were divided into two groups based on their timely completion of the questionnaires—companies that responded to the initial call for participation formed the "early group" (128 companies), and those that responded only after the follow-up calls were designated as the "late group" (93 companies). The means of the 26 items in both groups were compared via MANOVA. Of the 26 items, no item differed significantly at a 0.05 confidence level. Second, a χ^2 test was conducted to compare the two groups with respect to the distribution ratios of the types of industry; however, no significant difference was found (p=0.191). Considering these two test results, non-response bias was not a concern in this study.

Two ways suggested by Podsakoff et al. (2003) were employed in order to determine whether there was a significant common method bias (CMB) due to the testing of a single set of respondents. First, four factors had eigenvalues greater than 1.0, signifying that there was more than one single factor and that the linear combination of more than one single latent factor can thus explain the correlations between a set of measurement variables (see Table 3). Second, MMI, the first factor with the greatest eigenvalue, explained 19.1 % of the variance when rotated and 43.6 % when unrotated. These proportions of variance explained were relatively small; thus, the proposition that MMI alone could explain the whole variance was not supported (Paulraj et al. 2008). Hence, these results suggest that this study was free from CMB.

Table 2 presents the suppliers, classified by industry type, revenue volume and product type. Overall, 50.7 % of the companies were in the automotive industry, 43.6 % had a sales record greater than US$100 million, and 11.3 % (25 companies) produced consumer goods. Only few of the companies produced raw materials or a simple component. To determine whether the data gathered from the different types of industries could be pooled together, MANOVA was conducted with respect to the four constructs (MSF, MSI, MMI and plant performance). Of the 26 items, only one item (Sales) differed significantly at the 0.05 confidence level. As shown in section 5.1, however, the item was removed based on the result of the exploratory factor analysis (EFA). Thus, the data can be pooled together.

5 Results

5.1 Exploratory factor analysis and reliability analysis

Although we derived many of the measurement variables from previous studies, studies on MS have not used these variables consistently. Thus, the EFA and reliability analyses were conducted prior to the confirmatory factor analysis (CFA) using both the SEM and hypothesis tests.

Subjecting the 26 variables to the common factor analysis with Varimax rotation method using SPSS 12.0 resulted in four factors for which the eigenvalues of more than 1 were identified, as portrayed in Table 3: MSF (manufacturing strategy formulation factor), MMI (manufacturing-marketing integration factor), MSI (manufacturing strategy implementation factor) and PERF (plant performance factor). Given that the mean value of MSI is small, the findings imply that MSI is not fully activated, as opposed to MSF.

To decide which items need to be dropped, the factor-loading scores and the communalities of the items should be compared with the cut-off values (Hair et al. 2006). Of the 26 measurement variables, only Involvement had a factor-loading score that was lower than the cut-off value of 0.4, and both IS and Sales had communality scores lower than the minimum value of 0.5. Therefore, these three variables were dropped from all further analyses. The convergent validity and reliability of the remaining variables were confirmed because all the factor-loading scores and Cronbach's alpha values were larger than the cut-off values (0.4 and 0.7, respectively). Additionally, the factors were no longer divided into subfactors and thus, unidimensionality was confirmed.

Table 2 Supplier classification

Industry type	Number of companies (percentage)
a) Supplier distribution by industry	
Machinery	49 (22.2 %)
Automotive	112 (50.7 %)
Electronics	60 (27.1 %)
Total	221 (100 %)
b) Supplier distribution by sales volume	
Less than \$50 million	56 (25.3 %)
Between \$50 million and \$99.9 million	69 (31.2 %)
Between \$100 million and \$299.9 million	68 (30.8 %)
Between \$300 million and \$499.9 million	13 (5.9 %)
\$500 million or more	15 (6.8 %)
Total	221 (100 %)
c) Supplier distribution by product type	
Material or component	46 (20.8 %)
Subassembly	32 (14.5 %)
Assembly	63 (28.5 %)
Module	15 (6.8 %)
Consumer goods	25 (11.3 %)
Other production goods	40 (18.1 %)
Total	221 (100 %)

5.2 Measurement model estimation

In SEM, a measurement model was estimated for CFA and a structural model for testing the hypotheses. In this study, LISREL 8.70 was used for both measurement and structural-model estimation. First, the variables that dropped out from the normality assumption test were normalized in PRELIS. The results of the measurement model estimation using SIMPLIS are shown in Table 4. As expected, four latent variables were extracted as a result of CFA. The results of the CFA indicated that the standardized factor-loading scores of all measurement variables were greater than the cut-off value (0.5), with $p<0.01$, thus confirming the convergent validity as indicated through EFA. The composite reliabilities (CR) and the average variance extracted (AVE) of the latent variables exceeded the cut-off values (0.7 and 0.5, respectively), confirming the reliabilities of the latent variables (Hair et al. 2006). In this study, as shown in Table 4, the CR values of the two latent variables (MSF and MSI) were lower than the minimum value of 0.7. The AVE and Cronbach's alpha values of all latent variables, including MSF and MSI, were greater than the cut-off values of 0.5 and 0.7, respectively, thereby confirming the reliabilities of all latent variables.

To assess the degree to which similar latent variables are distinct from one another, the discriminant validity should be checked (Hair et al. 2006). In this study, the discriminant validity was confirmed using three methods. First, from the covariance matrix between the latent variables presented in Table 5, all covariance coefficients were found to be smaller than the standard value (0.9), hence, supporting the discriminant validity (Bagozzi et al. 1991). Second, all squared covariance coefficients in Table 5 were smaller than their related AVE values, further confirming the discriminant validity (Fornell and Larcker 1981). For example, the squared covariance coefficient between MMI and PERF ($=0.81^2=0.65$) was smaller than the corresponding AVE values for these variables (0.696 and 0.651); thus, the discriminant validity was confirmed. Finally, the χ^2 difference test was conducted to assess the discriminant validity. As there were four latent variables in this study, six pairs of latent variables could be formed. If the χ^2 difference between the unconstrained model, which was the same as the measurement model, and the constrained model, in which the correlation coefficient between two latent variables was set to 1, was statistically significant, the discriminant validity between the pairs of latent variables could be affirmed (Fornell and Larcker 1981). For example, in Table 6, when the correlation coefficient between MSF and MMI was set to 1, the χ^2 difference between the unconstrained model ($\chi^2=360.47$, with degrees of freedom 247) and the constrained model ($\chi^2=562.46$, with degrees of freedom 248) was statistically significant, with $p<0.01$. This result provides additional support for the discriminant validity between MSF and MMI. Repeating this procedure for the remaining five pairs, all the χ^2 differences were significant, thereby confirming their discriminant validity.

Table 3 Results of exploratory factor analysis and reliability test

Measurement variables	Factor loading scores					Factor Names	Factor means
Formalization	0.279	0.275	0.595	0.214	0.091	MSF	5.296
Sharing	0.278	0.176	0.647	0.058	0.003		
Consistency	0.339	0.206	0.591	0.262	0.028		
Involvement [a]	0.314	0.147	0.289	0.129	0.119		
Revision	0.345	0.293	0.500	0.119	0.116		
Development	0.262	0.224	0.640	0.218	0.209		
Planning	0.778	0.170	0.249	0.103	0.103	MMI	5.337
Implementation	0.833	0.184	0.237	0.150	0.153		
Communication	0.811	0.120	0.210	0.149	−0.006		
Product	0.736	0.186	0.204	0.132	0.038		
Understanding	0.740	0.223	0.263	0.116	0.243		
Training	0.176	0.402	0.370	0.182	0.239	MSI	4.857
Inspection	0.352	0.429	0.247	0.148	0.118		
CI	0.084	0.535	0.365	0.192	0.160		
SPC	0.231	0.645	0.241	0.202	0.043		
IS [b]	0.086	0.566	0.109	0.104	−0.005		
Investment	0.208	0.555	0.123	0.237	0.255		
Equipment	0.192	0.761	0.142	0.274	0.362		
TPM	0.314	0.440	0.348	0.163	0.277		
PT	0.246	0.534	0.183	0.171	0.352		
AMT	0.147	0.607	0.126	0.070	0.238		
Sales [b]	0.006	−0.016	0.292	0.428	0.283	PERF	5.109
Profit	−0.010	0.056	0.271	0.597	0.214		
Retention	0.154	0.294	0.096	0.593	0.080		
Satisfaction	0.334	0.240	0.154	0.748	0.042		
Quality	0.382	0.341	0.027	0.598	0.037		

[a] This variable was deleted because its factor loading score is lower than the cut-off value 0.4

[b] These variables were deleted because their communalities are lower than the cut-off value 0.4

5.3 Structural-model estimation and hypothesis tests

The fit of the model statistics are presented in Table 7. The ratio of χ^2 to the degrees of freedom was smaller than the minimum value of 2 (Rosenzweig and Roth 2004). The RMSEA and RMR values were also smaller than the standard values (0.05 and 0.10). The other goodness-of-fit indices, except for GFI and RFI (both 0.88), exceeded the standard value (0.9). Although GFI and RFI were not larger than the standard value, in view of the other indices, it can still be concluded that the model fits the data well. Note that no standard PNFI and PGFI values exist against which the model parsimoniousness can be tested. However, we can conclude that this research model was parsimonious because PNFI had a value between 0.6 and 0.9, and PGFI had a value of around 1 (Williams and Hazer 1986).

In Fig. 2, as expected, the four estimated coefficients of the paths that connect the latent variables were statistically significant, whereas the coefficients of the paths that connect MSF to PERF and MMI to MSI were not. Thus, the four hypotheses—H1, H2, H4 and H5 (except H3 and H6)—were supported. First, when the firm places a greater emphasis on MSF, MMI and MSI become more vigorous (H1 and H2). Second, although MMI does not exert a positive influence on MSI (H3), it has a direct influence on plant performance (H4). Lastly, if a firm enhances MSI, plant performance improves (H5). In contrast to MSI, however, MSF does not have a direct influence on plant performance (H6). Overall, the results of the hypothesis tests are summarized in Table 8.

The z-statistics, which tested the influence of the intermediating variable MSI between MSF and PERF, was 3.11 ($p<0.01$), implying that MSF influences PERF through MSI indirectly, but positively (Sobel 1982). In the same way, the z-statistics that tested the influence of the intermediating variable MMI between MSF and PERF was 2.30 ($p<0.05$); thus, MSF also exerts a positive indirect influence on PERF through MMI. The intermediating effect of the variable MSI on the relationship between MMI and PERF is inconsequential, as demonstrated by the insignificant coefficient of the path between MMI and MSI. It is particularly noteworthy to

Table 4 Results of measurement model estimation

Latent variables	Measurement variable	Standardized factor loading score[a]	Measurement error	Cronbach's α	Composite reliability	Average variance extracted
MSF	Formalization	0.67	0.47	0.850	0.602	0.510
	Sharing	0.60	0.57			
	Consistency	0.69	0.43			
	Revision	0.71	0.42			
	Development	0.75	0.37			
MMI	Planning	0.74	0.38	0.927	0.740	0.696
	Implementation	0.80	0.29			
	Communication	0.81	0.25			
	Product	0.80	0.28			
	Understanding	0.86	0.21			
MSI	Training	0.73	0.46	0.885	0.646	0.580
	Inspection	0.71	0.47			
	CI	0.74	0.44			
	SPC	0.75	0.44			
	Investment	0.78	0.40			
	Equipment	0.78	0.37			
	TPM	0.82	0.31			
	PT	0.79	0.35			
	AMT	0.70	0.49			
PERF	Profit	0.69	0.39	0.792	0.711	0.651
	Retention	0.74	0.31			
	Satisfaction	0.83	0.21			
	Position	0.76	0.32			

[a] All standardized factor loading scores are statistically significant at a 99 % confidence level ($p<0.01$)

observe the fact that the level of the indirect influence of MSF on PERF was 0.560 (=0.74×0.52+0.73×0.24), which is greater compared to the effects of MSI and MMI on PERF (0.52 and 0.24, respectively). Therefore, although MSF did not appear to influence PERF directly, it exerted a considerable indirect influence on PERF through MSI and MMI.

6 Discussion and conclusion

6.1 Summary and discussion of research results

The findings of this study can be summarized as follows: First of all, the invigoration of the formulation process of an MS will lead to closer cooperation, communication and better mutual understanding between manufacturing and marketing, as conveyed by the support of hypothesis H1; thus, the answer to the first part of research question RQ2 is affirmative. In a competitive environment, the manufacturing department needs timely information on the ever-changing market demand in order to build its manufacturing capabilities in alignment with its competitive strategy. Thus, for example, the manufacturing department will be able to develop cost reduction capabilities at the right time only when the marketing department provides timely information, that price competition will be intensified as the firm's product reaches its

Table 5 Covariance matrix of latent variables

	MSF	MMI	MSI	PERF
MSF	1.000			
MMI	0.630	1.000		
MSI	0.570	0.670	1.000	
PERF	0.710	0.810	0.600	1.000

Table 6 Results of χ^2 difference test

Pair of latent variable	χ^2 (d.f.) of constrained model	$\Delta\chi^2$ (Δ d.f.)
MSF-MMI	562.46 (248)	201.99 (1) ***
MSF-MSI	471.71 (248)	111.24 (1) ***
MSF-PERF	560.59 (248)	200.12 (1) ***
MMI-MSI	1021.41 (248)	660.94 (1) ***
MMI-PERF	608.44 (248)	247.97 (1) ***
MSI-PERF	521.59 (248)	161.12 (1) ***

*** $p<0.01$

Table 7 Goodness-of fit-index

Index	Statistics	Suggested range
χ^2	360.47	N/A
Degrees of freedom (d.f.)	247	N/A
$\chi^2 \div$ d.f.	1.459	< 2.00
RMSEA	0.046	< 0.05
RMR	0.076	< 0.ten
GFI	0.88	> 0.90
NFI	0.90	> 0.90
NNFI	0.95	> 0.90
CFI	0.96	> 0.90
RFI	0.88	> 0.90
PNFI	0.80	Between 0.6 and 0.9
PGFI	0.72	A model is parsimonious if PGFI is near 1

maturity stage. Likewise, timely information on the changing and diversifying customer needs provided by the marketing department will enable the manufacturing department to increase its flexibility capability. These factors all imply that the comprehensive and systematic formulation of an MS calls for an enhanced MMI. This may also hold true for the marketing department, which needs timely information on the manufacturing capabilities that are being planned for development in order to formulate its marketing strategy. Hence, the support of hypothesis H1 can be considered as the natural outcome of the two departments' incentive to cooperate with each other in the MS formulation stage. H2, which provides an affirmative answer to research question RQ1, was supported; hence, by making the formulation process of an MS more comprehensive and systematic, a manufacturing organization could generate more scrupulous and readily executable decisions and action plans to develop the future manufacturing capabilities needed. Thus, those decisions and action plans would be promptly put into practice through industrial practices, such as greater employee training, the installation of new equipments and information systems, the introduction of advanced manufacturing technologies, and improved operations practices.

H3, contrary to our expectation, was not supported; thus, a negative answer was given to the second part of research question RQ2. This implies that the comprehensive and systematic formulation of an MS aiming at its alignment with the marketing and the corporate strategies would call for a closer cooperation between the manufacturing and the marketing departments (H1); however, once such an MS has been formulated, the entire task of implementing it by selecting and employing appropriate industrial practices could be performed by the manufacturing department without much cooperation of the marketing department. Furthermore, operational practices related to MSI are routinely conducted and thus, intermittent cooperation between the two departments may have

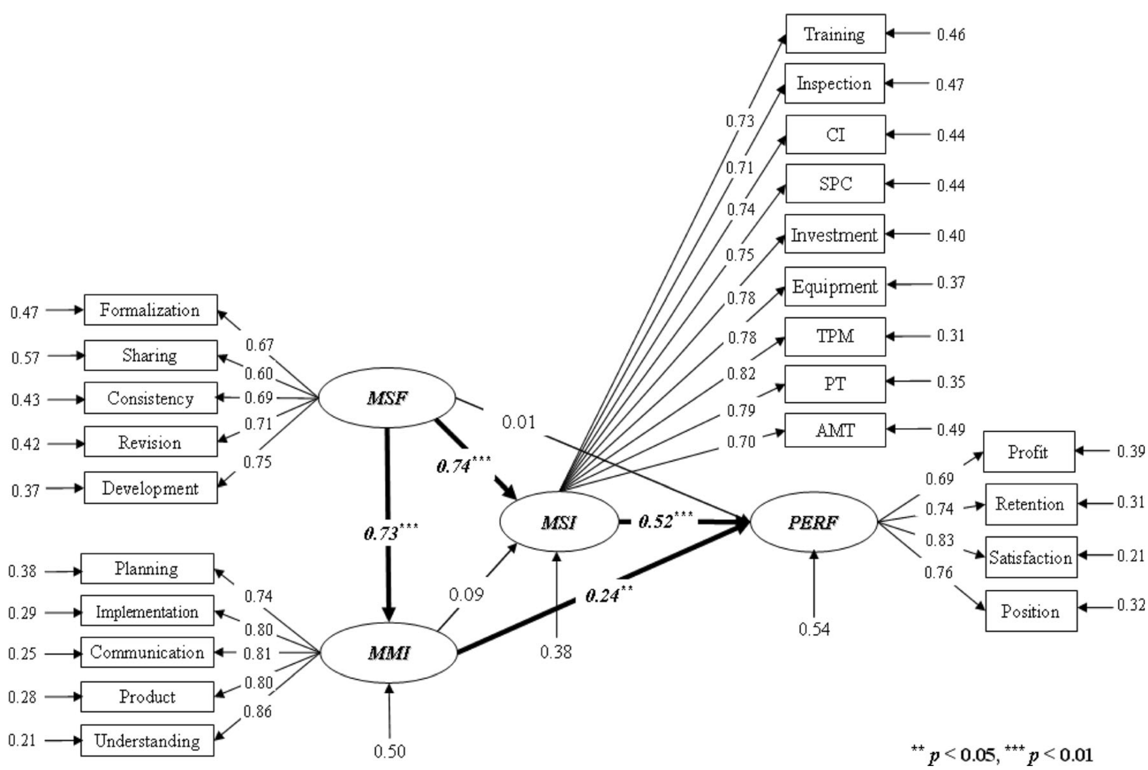

Fig. 2 Model estimation

Table 8 Summary of hypothesis test

	Path coefficient	Standard error	Related hypothesis
MSF → MMI	0.73***	0.091	H1 (supported)
MSF → MSI	0.74***	0.130	H2 (supported)
MMI → MSI	0.09	0.094	H3 (not supported)
MMI → PERF	0.24**	0.100	H4 (supported)
MSI → PERF	0.52***	0.140	H5 (supported)
MSF → PERF	0.01	0.154	H6 (not supported)

** $p<0.05$

*** $p<0.01$

little effect on the invigoration of MSI. The result also supported hypothesis H4, which gave an affirmative answer to research question RQ3; thus, a greater degree of MMI leads to enhanced plant performance. This is not difficult to interpret in light of the activities comprising the integration—cooperation in the formulation and implementation of the corporate strategy, cooperation in product development and problem solving, a greater degree of communication and information sharing, and enhanced mutual understanding of the other's goals. Thus, improved communication could resolve any possible conflicts in time between the two departments with regard to competitive priorities, while enhanced information sharing would facilitate the development of long-term manufacturing and marketing strategies as well as engage in timely product repositioning in order to respond to short-term market changes. All of these actions are expected to improve the plant's performance.

H5 was supported, which provided an affirmative answer to the first part of research question RQ4; thus, a manufacturing organization with a rational MS well aligned with the corporate strategy, if more fully implemented, could fulfill the manufacturing capabilities that are prerequisite for achieving its competitive strategy. The capabilities thus developed would in turn improve the performance (Lowson 2002). Finally, H6 was not supported, which gave a negative answer to the second part of research question RQ4; thus, the formulation process of an MS cannot be regarded as exerting a direct influence on plant performance. However, even though MSF, per se, does not exert a direct influence on plant performance, it exercises an indirect influence over plant performance through the intermediation of MSI and MMI, as reflected in Fig. 2. The result that does not support H6 contradicts the earlier findings of most previous studies which claimed that invigorated MSF positively affect performance (e.g., Brown et al. 2007; Papke-Shields and Malhotra 2001; Tunälv 1992; Ward et al. 1994). This contradiction might be due to the fact that the previous studies only estimated a simple bilateral relationship between MSF and performance without considering the intermediating roles of MSI and MMI, or because they took corporate performance, not plant performance, as a dependent variable engendering the problem of inappropriate choice of a unit of analysis. Consequently, what they actually estimated might not be directly comparable to the result of this study. The relationships between the research questions and the hypothesis test results are summarized in Table 9.

6.2 Theoretical and practical implications

In view of the fact that the four constructs—MSF, MSI, MMI and performance—are inextricably interwoven with each other, this study developed a research framework to investigate the interrelationships between the four constructs by taking all the four constructs into consideration simultaneously through the SEM. Taking this approach, we could better investigate the interrelationships and paths through which the influence of MSF on performance is transmitted and intermediators involved therein. In accordance with the research framework and on the basis of a large random sample, this study empirically verified positive relationships between MSF, MSI, MMI and performance. It also identified two paths—one from MSF to MSI to performance intermediated by MSI and the other from MSF to MMI to performance intermediated by MMI—through which the influence of MSF on plant performance is transmitted.

By empirically verifying the distinctness of MSF from MSI, this study, may shed some light on the possible debate, that MSF and MSI are conceptually and pragmatically inseparable. In addition, by finding a positive relationship between MSF and MMI, this study suggests that more comprehensive and systematic MS formulation process calls for a greater level of MMI activities in order to bring manufacturing into close alignment with marketing and corporate strategies. Furthermore, MMI, independently of the formulation and implementation of an MS, was found to contribute to enhancing performance. This fact reiterates the significance of manufacturing and marketing cooperation in the stages of

Table 9 Research questions and corresponding hypothesis test results

Research questions	Corresponding hypothesis test results
RQ1. What is the relationship between the formulation process of a manufacturing strategy and its implementation?	H2: Supported
RQ2. What is the relationship between a manufacturing strategy process and manufacturing-marketing integration?	H1: Supported H3: Not supported
RQ3. What is the relationship between manufacturing-marketing integration and plant performance?	H4: Supported
RQ4. What is the relationship between the manufacturing strategy process and plant performance	H5: Supported H6: Not Supported

corporate strategy formulation in order to align an MS with a corporate strategy for improving performance. Finally, the two paths identified in this study indicate that the activities of MSF will ultimately have an effect on the performance through the intermediation of MSI and MMI, even though the activities of MSF themselves do not directly contribute to performance improvement. This again highlights the crucial importance of MSF to enhancing performance. Hence, these findings might contribute empirically to corroborate and refine conventional wisdom regarding the interrelationships between MSF, MSI, MMI and performance. Ultimately, this study might contribute to broaden our knowledge base of MS, particularly when empirical studies regarding the interrelationship between MSP and MMI are very few.

Further, the findings of this study may also have some practical implications for manufacturing organizations. First, manufacturing organizations can improve plant performance by instituting and implementing the practices of the three constructs, MSF, MSI and MMI, listed as measurement variables in Table 1. We believe they are comprehensive sets of practices identified by previous studies of MSP and MMI, and tested empirically by this study. Second, manufacturing organizations can improve plant performance by enhancing the formulation process of an MS in particular, which will lead to a more complete implementation of the MS, closer manufacturing-marketing integration and ultimately, enhanced performance. Third, manufacturing organizations need to enhance closer manufacturing-marketing cooperation during the formulation stage of a corporate strategy in particular, as enhanced exchanges, information sharing and collaboration in the stages will ultimately improve plant performance.

6.3 Limitations and suggestions for future research

This study has some limitations. First, the samples of suppliers were drawn from only three South Korean industries (machinery, automotive and electronics). This figure may limit the generalizations of the research findings to other countries and industries, in spite of some facts moderating this concern, as discussed in the section "Sampling and data collection." Second, this study, in the absence of public data at the plant level, used plant managers' self-reported, perceptual measures of plant performance. This would be one of the weak points of this study, even though plant managers are strongly believed to have information on the plant performance, which is a prerequisite for performing their tasks—drawing up a production plan, controlling the unit cost of manufacturing, delivering finished products to clients and managing returns. Third, the analytical framework of this study does not consider MSC concurrently with MSP due to the difficulty in modeling a multitude of different strategic choices in content and the difficulty in operationalizing the quality of the content. The inclusion of MSC would have made the findings of this study less robust. This limitation is a challenge that the following studies need to address. Fourth, in order to put a sharp focus on the analysis of the MS, a marketing strategy was not incorporated explicitly into the research model of this study. However, leaving the marketing strategy out of the model might have precluded its possible mediating roles between the constructs being investigated. This is one of the more important limitations of this study. Fifth, softer issues, such as ownership of strategy, were not addressed and incorporated into the set of measurement variables, which is another significant limitation of this study. Finally, this study did not consider the cross-functional integration other than MMI, although in light of the ever-expanding globalization, the success of strategic manufacturing depends increasingly on the careful integration of human resources, R&D and financial-risk management.

Future research directions should (1) develop a more robust MS model by integrating MSC with the MSP; (2) consider contingency variables, such as environment or technology uncertainty (as it is conceivable that the cost of cross-functional integration will increase with uncertainty, offsetting its benefit; therefore, further study needs to determine the moderating effect of uncertainty on the causal relationships between MSP, MMI and firm performance); and (3) design a study that would unify the manufacturing and supply chain management strategies in order to strengthen their internal capabilities through cooperation with the suppliers and customers, in view of the growing importance of firms' participation in a common supply chain with other firms.

Acknowledgements This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2011-332-B00142).

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