International Journal of Operations & Production Management

Re-examining manufacturing strategy from knowledge advantages: A task domain perspective

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A task domain perspective

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Received 10 October 2014
Revised 19 June 2015
11 May 2016
20 September 2016
3 December 2016
2 February 2017
Accepted 3 February 2017

Abstract

Purpose – During this current era of the knowledge economy, knowledge activities have greatly impacted manufacturing activities, with knowledge being treated as a critical factor that creates and sustains competitive advantages. Past studies tended to relate knowledge works with organizational tasks and assumed that knowledge workers implement those tasks to achieve organizational goals. Accordingly, the purpose of this paper is to employ the perspective of task domain as the basis to clarify the impact of manufacturing task domains on the manufacturing strategy, as well as the mediating effects of knowledge advantage on such an impact.

Design/methodology/approach – The authors follow Becerra-Fernandez and Sabherwal's (2001) task which focus/task breadth dichotomy as the basis to define market-based task domains, employs Leonard-Barton's (1995) T-shaped skill as the theoretical base to construct knowledge advantages, i.e., knowledge depth (I-shaped skill), diversity (hyphened skill), and convergence (T-shaped skill), and uses the conventional typology to measure the manufacturing strategy (i.e. cost, quality, flexibility, and delivery). The empirical study is conducted via a questionnaire survey and selects Taiwan's top 600 manufacturers as the population and accordingly collects 131 effective observations.

Findings – The empirical evidence indicates that firms' priorities on cost and delivery are positively caused by the focus orientation of the tasks, while their priorities on quality and flexibility are positively caused by both focus and diversity orientations of the tasks. The results also signify that knowledge advantages perform complete mediation on the previous relationships. In more detail, knowledge depth presents mediation on focus orientation, and knowledge convergence exhibits mediating effects both on focus and breadth orientations. The statistics point out that knowledge depth has the highest impact on the manufacturing strategy, but knowledge diversity fails to significantly explain the manufacturing strategy.

Originality/value – Literature assumed that knowledge activities are task-driven issue; this study hence examines knowledge advantage based on the task domain perspective to clarify the architecture and contents of knowledge advantages.

Keywords Manufacturing strategy, Knowledge advantage, Market-based tasks, Task domain perspective

Paper type Research paper

Introduction

Ever since the seminal work of Skinner (1969), the manufacturing strategy has been treated as a critical issue in the management field. Past studies particularly put forth much effort on examining competitive priorities, including cost, quality, flexibility, and delivery (Hayes and Wheelwrights, 1984; Swamidass and Newell, 1987). Studies regarding the manufacturing

This paper is sponsored by the grant of the Ministry of Science and Technology (MOST), Taiwan (the Project No. is NSC96-2416-H-017-002-MY3). MOST is a governmental institute that provides supports for academic research without any potential conflicts of interest with the researchers. The authors have noted it in the acknowledgments in the cover letter.

International Journal of Operations & Production Management
Vol. 37 No. 10, 2017
pp. 1475-1495

0144-3577
DOI 10.1108/IJOPM-09-2014-0449

strategy have been extensively connected with related fields such as marketing and new product development (Minor *et al.*, 1994; Dangayach and Deshmukh, 2001). The manufacturing strategy plays a critical role in management academia.

Drucker (1959, 1993) mentioned that "knowledge worker productivity demands that we ask the question: what is the task?" Recent studies indeed have targeted the task perspective of knowledge workers (Lin and Huang, 2008). Becerra-Fernandez and Sabherwal (2001) also employed the task perspective to examine Nonaka and Takeuchi's (1995) Knowledge Spiral theory. It is thus evident that manufacturers determine their knowledge works based on their manufacturing tasks.

Knowledge and the knowledge-based view (KBV) have been critical, including their association with manufacturing. Plenty of manufacturers employ knowledge resources to improve product quality (Palaniswami and Jenicke, 1992; Kodali, 1992; Abdallah, 1995; Naylor *et al.*, 2001), purify product design (Richtnér and Åhlström, 2010) or expand the lifespan of products (Karacapilidis *et al.*, 2006). Recent studies commenced to re-examine manufacturing issues utilizing KBV (e.g. Moran and Meso, 2008; Paiva *et al.*, 2008), arguing that firms frame the manufacturing strategy based on their advantages originating from the knowledge they possess (Mohanty and Deshmukh, 1999). Recent efforts signified that the knowledge advantage of an organization is an antecedent of its emphasis on competitive priorities (Henriksen and Rolstadås, 2010). For instance, firms that cross over to broad knowledge domains are capable of manufacturing products with the features of flexibility and diversity, while those that concentrate on specific manufacturing operations can focus on efficiency, such that they pay more attention to productivity and cost reduction (Porter, 1980; Boyer and Lewis, 2002). Hussain *et al.* (2015) employed multi-criteria decision making of knowledge attributes to identify competitive priorities of large and small manufacturers to achieve customer focus. Their analytical evidence pointed out that knowledge factors play a particular role on the setting of competitive priorities. Henriksen and Rolstadås (2010) indicated that lean manufacturers demand more on synthetic and broad knowledge base, while the mass manufacturers employed more focused and analytical knowledge base.

Hence, we may ask a potential research question:

RQ1. How does the knowledge advantage of an organization determine its competitive priority?

Manufacturing strategy is one major element of an organization's function-level strategies and is thus formulated based on pre-determined factors such as environment and business-level strategy, in which market-related factors play a crucial role (Ward *et al.*, 1996). Many studies have endeavored to clarify the effects of market-based factors on the manufacturing strategy selection (e.g. Miller and Roth, 1994; Atuahene-Gima, 1995).

De Luca and Atuahene-Gima (2007) built a four-dimension framework to examine how market knowledge that an organization possesses leads to a knowledge interaction mechanism. The four dimensions are knowledge depth, breadth, tacit, and specificity. Of the four, knowledge depth and breadth are major issues in the knowledge-related literature. Becerra-Fernandez and Sabherwal (2001) employed the task perspective to explore the fit between contingencies of market-based tasks and knowledge creation. To converge the above background, we are interested in the association between market-based task domains, knowledge advantages, and the manufacturing strategy. Hence, this study attempts to answer the research question:

RQ2. Do market-based task domains of a manufacturer determine the development of its knowledge advantage and hence influence its competitive priority?

On the basis of task breadth and focus, the current study endeavors to answer this research question and thus re-examines the manufacturing strategy issue from an alternative perspective.

Theoretical background

Market-based task domain: focus and breadth

Organizational task is frequently linked with knowledge-related studies (Storey and Kahn, 2010). We concentrate on the literature regarding market-based task, as various recent studies have provided insights into the focus-breadth facets. Becerra-Fernandez and Sabherwal (2001) employed the task perspective to explore the fit between market-based task domains (i.e. breadth vs focus) and the four knowledge creation modes (i.e. socialization, externalization, combination, and internalization).

The first dimension of a market-based task domain is task breadth. Becerra-Fernandez and Sabherwal (2001) defined breadth by the degree of task variety, while Ryu *et al.* (2005) specified it through task diversity. Similar concepts include the combinative capability of the T-shaped skill (Lee and Choi, 2003; Koruna, 2004), knowledge generalist (vs specialist; Nonaka and Takeuchi, 1995), heterogeneity, and relatedness (Tanriverdi and Venkatraman, 2005). Breadth and depth are treated as primary dichotomies for knowledge attributes (De Luca and Atuahene-Gima, 2007; Makri *et al.*, 2010). We define broad market-based tasks as those activities that employ multiple knowledge domains to meet heterogeneous and variant demand in the marketplace.

The second dimension is the task focus. Becerra-Fernandez and Sabherwal (2001) and Ryu *et al.* (2005) defined focus by the degree of task specialization, which is also denominated as task depth. Related subjects include knowledge depth (Hedlund, 1994; Koruna, 2004) and specialist (vs generalist, Nonaka and Takeuchi, 1995). This study defines focused market-based tasks as those activities that concentrate on the current knowledge domains to meet the specific demand of the customers.

Knowledge advantages

Among previous studies, the T-shaped skill put forth by Lee and Choi (2003) and Koruna (2004) merits much attention. The original concept of the T-shaped skill can be traced back to Palmer (1990) in the mass media, who pointed it out as an essential skill that knowledge workers (named as hybrids) in the IT field need, meaning that they should possess a rich knowledge breadth (the horizontal stroke on the T) based on a particular knowledge focus (the vertical stroke). In addition to the two strokes, Guest (1991) emphasized the whole letter, T, i.e., the capability to concentrate on the focused domain while integrating multiple knowledge domains. Hansen and von Oetinger (2001) introduced it in practice-oriented periodicals and advocated it is an essential ability for management.

After an extensive exploration for practical purposes, some follow-up literature was published from academic perspectives. Madhavan and Grover (1998) examined the effects of knowledge types on new product performance and further offered a third type of skill, hyphenated skill, in addition to T-shaped skills, meaning the diversity of knowledge domains an organization possesses or the capability to cross-over two (or more) domains. I-shaped and hyphenated skills highly correspond to the pre-mentioned focus-breadth dichotomy, respectively. Among previous skills, the T-shaped skill is the most praiseworthy (Leonard-Barton, 1995), with Lee and Choi (2003) and Koruna (2004) extending it as organizational capability and one factor of knowledge management enablers. Interestingly, some studies queried the value of hyphenated skill, because it may lack proficient knowledge focus.

Based on the process views of knowledge in Ramesh (2002) and Edwards (2011), this study examines the knowledge advantage issue on the basis of I-shaped, T-shaped, and hyphenated skills and correspondingly constructs knowledge advantage with knowledge depth, knowledge diversity, and knowledge convergence.

Theoretical model and hypotheses

Moran and Meso (2008) reviewed major studies and concluded that the most primary competitive priorities are cost, quality, delivery, and flexibility. Our study employs these four as the basis of competitive priorities for investigative efforts.

As for the individuality/integrity of competitive priorities, some studies argued that there are trade-offs between the priorities and thus treated them as mutually exclusive (Kenneth and Lewis, 2009; Boyer and Pagell, 2000), while some studies viewed them as mutual supportive and classified them as a particular configuration or typologies that are coherent sets consisting of competitive priorities (Ward *et al.*, 1996; Frohlich and Dixon, 2001). Both perspectives are empirically supported. For instance, Ward *et al.* (1996) linked business- and manufacturing-level strategies and classified the observations as four types of the manufacturing strategy through cluster analysis – namely, broad differentiators, cost leaders, lean competitors, and niche differentiators – to compare the differences between the four types. The next sections offer inferences for each competitive priority independently. We also conducted an alternative analysis based on a configuration or typology perspective.

Task domain, knowledge advantage, and manufacturing cost

Cost is one of the most critical competitive priorities in the literature and is treated as a major generic competitive advantage. Relative to manufacturing quality and flexibility, firms that emphasize cost tend to be concerned about efficiency, and so they concentrate on the outcome of cost reduction (Porter, 1980). A typical theorem of efficiency is the output relative to the particular input. Thus, firms that emphasize cost tend to focus on an increase in output and a decrease in input during production. As for the demand side in the market, customers concerned about manufacturing cost pay attention to the price and economy of the orders, while they prefer to sacrifice the benefits from value addition, including product differentiation, diversification, and esthetic design (Swink and Way, 1995), and so they place less emphasis on the diversity factors of the products.

Studies and practices have indicated that firms pursuing cost advantage may concentrate on minimizing inventory cost or raising capacity utilization and labor productivity (Boyer and Lewis, 2002) with a focus on limited product items under low-variety high-volume production for economies of scale (Hill, 1989). Such conduct focuses on lean production to achieve the experience curve effect (Goldhar and Jelinek, 1983; Bozarth, 1993), contracts out disadvantageous activities by assessing the cost of each manufacturing task in the value chain (Porter, 1980), and targets on improving each activity in the process to control operational cost (Wheelwright, 1981). To sum up the reviews from the supply and demand sides, firms place a priority on low-cost target manufacturing efficiency, and hence they tend to focus, rather than broaden, their tasks on particular activities.

The focused market-based task domain for manufacturing cost influences the development of manufacturers' knowledge advantage. The firms endeavor to concentrate their knowledge resource so as to raise their existing level of knowledge depth of production skills and technology (Paiva *et al.*, 2012), upgrade their production resource on advanced manufacturing technology (Karacapilidis *et al.*, 2006), and expand their knowledge domains based on efficiency and customers' demand on low cost (Paiva *et al.*, 2008). Their efforts at reducing manufacturing cost rely on a high level of focused and deep knowledge activities, rather than broader and diversified knowledge works. Hence, we set up *H1a* and *H1b* regarding market-based task domain, knowledge advantage, and priority on cost:

H1a. The degree of a firm's market-based task focus is positively associated with the priority of cost.

H1b. Knowledge depth of a firm positively mediates the association of task focus with the priority of cost.

Task domain, knowledge advantage, and manufacturing quality

Firms that take quality as a high competitive priority tend to endeavor to provide products that match the demand and usage conditions of their customers (Wheelwright, 1984). Manufacturers' efforts on quality are relevant both to task focus and breadth. For task focus, manufacturers may raise quality by strengthening consistency and reliability (Boyer and Lewis, 2002), through continual product improvement (Boyer and Lewis, 2002; Germain and Droge, 2001; Hayashi, 2004), through constant product modification and purification (Tushman and O'Reilly, 1997), and by providing products with high consistency for particular clients or orders (Boyer and Lewis, 2002).

As for market-based task breadth, past studies linked quality issues with value-added activities, including product designs, features, and esthetic elements (Fine and Hax, 1985; Swamidass, 1986). Manufacturers may provide products with multiple functions and higher performance (Boyer and Lewis, 2002), modify products by utilizing external and internal knowledge sources (McNamara *et al.*, 2002; Hayashi, 2004), and raise product quality with unique features through interdisciplinary collaboration (Nonaka and Takeuchi, 1995; Soo *et al.*, 2002).

The focused and broad market-based tasks for quality force firms to acquire both a deeper and diversified scope of knowledge activities so as to assess their manufacturing capability to meet the demand and usage condition of the marketplace (Song and Montoya-Weiss, 1998). First, the effort on product reliability focuses on the improvement of product outcomes. Firms need to comprehend the specific demand and requirement of the marketplace, keeping up with advanced technology and skills to modify the incompatibility of the current products, as well as upgrading the level of knowledge depth to decrease the failure rate of the existing products (Karacapilidis *et al.*, 2006). Second, past studies also indicated that manufacturers consume higher resource input to engage in cross-functional teamwork (Crawford and Benedetto, 2003; Frischer, 1993), modify products by integrating knowledge from diversified domains (McNamara *et al.*, 2002; Hayashi, 2004), conduct interdisciplinary collaboration (Soo *et al.*, 2002), and integrate diversified product features to perform superior benefits and additive functions (Gill, 2008). Hence, we can infer that efforts on raising product quality not only develop knowledge depth, but also expand a firm's knowledge diversity and converge the diversified knowledge domains to deepen product quality through improving consistency, design, and performance of the products. Thus, we now present the following hypothesis:

H2a. The degree of a firm's market-based task focus has a positive association with the priority of quality.

H2b. The degree of a firm's market-based task breadth has a positive association with the priority of quality.

H2c. Knowledge depth of a firm positively mediates the association of task focus and breadth with the priority of quality.

H2d. Knowledge diversity of a firm positively mediates the association of task focus and breadth with the priority of quality.

H2e. Knowledge convergence of a firm positively mediates the association of task focus and breadth with the priority of quality.

Task domains, knowledge advantages, and manufacturing flexibility

Manufacturing flexibility refers to adaptation capability on production quality, quantity, and variation in order to fit with changes in the environment (Wheelwright, 1984). Of the four competitive priorities, flexibility may be the one that involves the broadest market-based task domain. To raise flexibility, manufacturers put forth efforts that have a high extent of task breadth and focus, in particularly the former. Flexibility relies upon the fast adaptation of product design, features, and volume, as well as a combination of raw materials (Williams *et al.*, 1995; Boyer and Lewis, 2002), and thus manufacturers need to consider the changes in customers' demand, product elements, and technological evolution inside and outside of their industry (Boyer and Lewis, 2002). The degree of flexibility is highly associated with broad market-based tasks as well as focused tasks. Flexibility relies upon the adaptation of existing product elements and paradigm and is thus rooted in a solid manufacturing base and skill capability (Miller and Roth, 1994). Manufacturers tend to maintain concern on the demand and usage of customers so as to develop compatible products that are suitable to the contextual change of the marketplace (Wang *et al.*, 2009).

The previous review signifies that flexibility is concerned about both market-based task breadth and focus. Thus, manufacturers have to flexibly integrate knowledge and technologies from diversified domains to meet changes in the environment (Carayannis and Alexander, 2002; Christiansen *et al.*, 2003). They also converge knowledge by crossing over into different fields on the basis of existing knowledge (Claycomb *et al.*, 2005). In order to comprehend the contexts of the marketplace, they should develop a solid knowledge base of production (Miller and Roth, 1994) and take notice of the changing conditions of particular market niches to realize the similarity/difference between recent and past orders (Hussain *et al.*, 2015). Thus, firms may employ detailed market research via KMS to investigate and specify consumer behavior as the basis for further manufacturing efforts (Karacapilidis *et al.*, 2006). Here, we set up the following hypotheses regarding market-based task domain, knowledge advantage, and priority on flexibility:

H3a. The degree of a firm's market-based task focus has a positive association with the priority of flexibility.

H3b. The degree of a firm's market-based task breadth has a positive association with the priority of flexibility.

H3c. Knowledge depth of a firm positively mediates the association of task focus and breadth with the priority of flexibility.

H3d. Knowledge diversity of a firm positively mediates the association of task focus and breadth with the priority of flexibility.

H3e. Knowledge convergence of a firm positively mediates the association of task focus and breadth with the priority of flexibility.

Task domains, knowledge advantages, and manufacturing delivery

Manufacturing delivery refers to the accuracy under which manufacturers provide products on time and show reliability based on customers' demand. Past studies usually divided it up between delivery on time and on speed (Hayes and Wheelwright, 1984). Recent manufacturing concepts and technologies, such as just-in-time inventory and manufacturing, reinforce customers to raise their demand on accuracy in delivery time, product style, and speed, resulting in delivery capability becoming more critical than before. As for the demand side, customers who care about delivery can ask for providers' commitment towards satisfying the specific demand of the products and/or the process (Boyer and Lewis, 2002). These concerns force manufacturers to focus their operations on the outcomes of the delivery time span and the reduction of time lags and delays. Relative to the priorities on quality and flexibility, these delivery-driven manufacturers focus more on the particular demands of customers, rather than those variant factors such as product features and styles. They concentrate on the know-how and skills of manufacturing, e.g., the utilization of standard operating procedures, standardized production modules, and just-in-time systems, to strengthen their delivery capability (Christiansen *et al.*, 2003). This induces a higher extent of task focus to take on market demand and rival firms.

Focused task domain and concern on delivery both lead to attention being paid toward market demand, production outcomes, and behaviors of rivals. Manufacturers need to concentrate their knowledge to comprehend the specific demands and requirements of the delivery time, speed, and product outcomes, while at the same time deepening their technology and skills to modify the incompatibility of the current products as well as upgrading the knowledge depth level to decrease recent delivery inefficiency (Paiva *et al.*, 2008, 2012). They can target their knowledge activities on clarifying customers' experience over the products and understanding more about the tasks and contexts of using and purchasing the products (Hussain *et al.*, 2015). Hence, we can infer that delivery capability is rooted in the focus on knowledge depth. We thus build the next hypotheses regarding manufacturing delivery:

H4a. The degree of a firm's market-based task focus is positively associated with the priority of delivery.

H4b. Knowledge depth of a firm positively mediates the association of task focus with the priority of delivery.

Methodology

Measurement

This study is interested in the manufacturing and knowledge issues of firms; we thus took the firm as the unit of analysis. To guide the respondents to respond to the measurement, each item began with a descriptor "Your company […]". The empirical survey measured competitive priorities by employing Lin *et al.*'s (1993) scale. We developed the measurements of market-based task domain (six items of descriptors) and knowledge advantage (nine items). The draft versions of the two scales were built after reviewing the related literature. Accordingly, we invited five experts with strong experience in manufacturing and knowledge management, three of whom were college educators and the other two were practitioners, to verify face validity so as to modify the scale descriptors. The experts modified the descriptors and resolved to delete descriptors, so that we consequently measured the market-based task domain with five items and knowledge advantage with eight items of descriptors in this stage. Accordingly, the modified scales were tested with 30 manufacturers as the observations for the pilot test for the new measurement. The sample source was observations randomly selected from Top 1,000 Manufacturers Ranking in Taiwan, which is one of the most trustworthy industrial rankings in Taiwan. The pilot and the formal surveys were all measured with Likert's five-point scale (1 = strongly disagree, 5 = strongly agree, listed in Table I). Some basic statistics, e.g., the amount of capital and employees, were also collected as the control variables (Likert's five-point scale, 1 = much fewer than the competitors, 5 = much more than the competitors).

The data were analyzed with exploratory factor analysis and internal consistency (Cronbach's α coefficients) for the pilot test. The statistics in Table I point out some critical findings. We set 0.50 as the threshold of factor loadings and 0.3 as the standard of cross-factor loadings to extract the factors of the new scales. The results indicated that all the Cronbach's α coefficients of the constructs were higher than 0.54; the item-total correlation coefficients ranged between 0.28 and 0.83 with statistical significance under the $p < 0.01$ level, signifying that the constructs matched the requirements of internal consistency. Finally, the inter-construct correlation coefficients were located between 0.06 and 0.66, and they were mostly centered in the range of 0.20 to 0.40 (listed in Table II), indicating a low to medium level

Constructs (Cronbach's α)	Item descriptors[a]	Item-total correlation	Means	SD	Sources
Knowledge diversity (hyphenated skill) (0.64)	Endeavors to crossover expertise from multiple domains to strengthen the knowledge level of your company	0.44	3.72	0.70	Self-design based on Leonard-Barton (1995)
	Extensively collaborate with external colleagues to improve knowledge/technology of your company	0.46	3.71	0.85	
	Addresses to adopt ideas and expertise from diversified sources	0.45	3.68	0.73	
Knowledge depth (I-shaped skill) (0.77)	Continuously strengthens the existing technology and expertise to sustain competitive advantages	0.65	4.17	0.57	Self-design based on Leonard-Barton (1995)
	Endeavors to keep an advanced position in knowledge/technology compared to your competitors	0.60	3.92	0.73	
	Addresses to continually concentrate on and deepen the existing level of technology/knowledge	0.58	4.00	0.58	
Knowledge convergence (T-shaped skill) (0.90)	Finds new ways to innovate the existing knowledge/technology	0.83	3.95	0.70	Self-design based on Lee and Choi (2003)
	Is good at applying current knowledge/technology to develop diversified products/services	0.83	4.02	0.70	
Task focus (0.66)	Has to concentrate on particular manufacturing domain rooted in the current knowledge basis	0.46	3.87	0.63	Self-design based on Becerra-Fernandez and Sabherwal (2001) and De Luca and Atuahene-Gima (2007)
	Is used to focus on specific manufacturing tasks	0.54	3.75	0.62	
	Holds on specific professional domains, so that it is very hard to transfer knowledge/technology to other companies	0.37	3.58	0.87	
Task breadth (0.54)	Usually utilizes manufacturing knowledge/technology from diversified domains within and outside of your company	0.37	3.51	0.84	
	Has to apply current knowledge/technology to develop new products for new domains	0.37	3.79	0.66	
Priority on cost (0.64)	Works to reduce cost by strict budgeting	0.28	3.86	0.80	Self-design based on Lin *et al.* (1993)
	Addresses to bring in new skills to reduce cost	0.49	3.82	0.77	
	Pays attention to manufacturing process to decrease cost.	0.43	4.30	0.59	
	Works to reduce cost by trying new supplies or materials	0.48	3.84	0.85	
Priority on quality (0.65)	Addresses to provide diversified products	0.53	3.81	0.91	Self-design based on Lin *et al.* (1993)

(*continued*)

Table I.
Scale measurement and basic statistics

Constructs (Cronbach's α)	Item descriptors[a]	Item-total correlation	Means	SD	Sources
	Endeavors to develop products with high performance and functionality	0.59	3.92	0.80	
	Addresses to provide reliable and good quality products	0.31	4.14	0.61	
Priority on flexibility (0.81)	Pays attention to customers' demand and rapidly modifies the products	0.51	4.11	0.73	Self-design based on Lin *et al.* (1993)
	Works to introduce new products according to demand of the marketplace	0.56	3.65	0.87	
	Endeavors to adjust productivity according to market demand	0.75	4.02	0.74	
	Addresses to adapt product mix	0.74	3.86	0.80	
Priority on delivery (0.82)	Endeavors to produce and provide products based on customers' demand	0.70	4.26	0.57	Self-design based on Lin *et al.* (1993)
	Works to deliver the product just in time	0.70	4.35	0.61	

Note: [a]All the item descriptors begin with "Your company […]"

Table I.

	Task breadth (A)	Task focus (B)	Knowledge diversity (C)	Knowledge depth (D)	Knowledge convergence (E)	Priority on cost (F)	Priority on quality (G)	Priority on flexibility (H)	Priority on delivery (I)
(A)	1.00								
(B)	0.32**	1.00							
(C)	0.43**	0.36**	1.00						
(D)	0.66**	0.33**	0.42**	1.00					
(E)	0.49**	0.34**	0.32**	0.63**	1.00				
(F)	0.22**	0.06	0.09	0.31**	0.20*	1.00			
(G)	0.36**	0.28**	0.26**	0.53**	0.65**	0.40**	1.00		
(H)	0.32**	0.23**	0.24**	0.54**	0.55**	0.45**	0.60**	1.00	
(I)	0.37**	0.12	0.14	0.47**	0.37**	0.35**	0.43**	0.50**	1.00

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$

Table II. Correlations among the constructs

of inter-construct collinearity and match the basic statistical requirement of regression analysis. The previous results of the pilot test showed that the new scales that this study constructed matched the requirements of scale assessment.

Sampling and the samples

For the formal survey, we targeted Top 1,000 Manufacturers Ranking in Taiwan as the samples again. The survey sampled 600 observations from the ranking. Systematic sampling was used as the sampling method. After ordering the numbers of the 1,000 observations, we set 3 as the interval of sampling and circulated the sampling with a return to the top, once the end of the list is passed. Every third observation was chosen after a random starting point between 1 and 1,000 (chosen as numbers 1, 4, 7…, 998, 2, 5 … 497, 500). Based on the past practices of survey targeting in industrial sectors (e.g. Jobber, 1986; Lindberg *et al.*, 1998; Laosirihongthong and Dangayach, 2005), this study sets 20 percent for the response rate, with 70 observations for the sample size as the standards. Thus, we set 600×20 percent $= 120$ as the threshold for the usable sampling observations. We also called the selected respondents to speed up the collection to maximize the response before the sample size achieved 120 observations.

Considering the acquaintance and relevance to market-based tasks, knowledge advantages, and manufacturing strategy, this study set CEOs or those executives in charge of strategic planning, manufacturing, and R&D tasks as the target observations. Prior to the survey, we gave two options of survey types: personal interview and mailing survey. For the respondents who were willing to directly contact our interviewers, personal interviews were conducted by trained interviewers who visited their workplaces to explain the items and to guide the responses. We finally gathered 23 observations. The remaining questionnaires $(600 - 23 = 577)$ were mailed to the respondents with a description mentioning their names and job titles on the envelopes. The t-test results indicated that the differences of items means between the two types were all not significant. After a 45-day period of data collection, 136 observations were returned. After deleting five unusable ones, this study gathered 131 effective respondents (21.8 percent rate of return).

As for the test of non-response bias, we followed Armstrong and Overton's (1977) method to pairwise compare the mean values of early (those first 75 percent returned in sequence) and late (those latter 25 percent) respondents. Another pairwise t-test was made to compare the mean value from different positions. The t-statistics of all the items were insignificantly different between the early/late groups and their job positions. Moreover, the results from the test of homogeneity indicated that the χ^2 value was not statistically significant ($p > 0.70$) on the industry ratios between response and non-response observations, meaning that the ratios between the two were consistent.

Statistical analysis techniques

Aside from the previous methods for scale reliability and validity, including EFA, internal consistency analysis, and correlation analysis, multiple regression models were finally employed to test the hypotheses. The hypotheses with mediating effects (i.e. *H1b-H4b*) were examined with Baron and Kenny's (1986) technique, and the results of regression analysis are exhibited in Table III. Models 1, 4, 7, and 10 list the impacts of task domains on competitive priorities (i.e. *H1a-H4a*); Models 2, 5, 8, and 11 list the explanations of knowledge advantages on competitive priorities; Models 3, 6, 9, and 12 present the mediation of knowledge advantage in the relationship between task domains and competitive priorities (i.e. *H1b-H4b*).

Results

Table III exhibits the results of hierarchical regression. The DW values in all the 12 models are located between 1.75 and 2.25, indicating insignificant autocorrelation. VIFs range from 1.11 to 2.01, indicating low multicollinearity.

Cost

Table III signifies that the manufacturers' priority on cost is significantly associated with task focus (M1, $\beta = 0.18$), but its association with task breadth is not significant, meaning that the empirical results support *H1a*. Model 2 presents the impact of knowledge advantage on the priority of cost. The results indicate that only knowledge depth is positively correlated with the priority of cost, while the parameters of knowledge diversity and convergence are insignificant.

Model 3 tests the mediation of knowledge advantage. The impact of task focus on the priority of manufacturing cost in the previous direct relationship vanishes (the β value

Table III. Association between manufacturing task domains, knowledge advantages, and competitive priorities

Models	Priority on cost			Priority on quality			Priority on flexibility			Priority on delivery		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Intercept	3.29**	2.86**	3.09**	1.65**	1.14**	1.11**	1.69**	0.98*	1.05*	2.68**	2.32**	2.29**
Capital	−0.00	−0.01	−0.03	−0.02	0.00	−0.00	−0.03	−0.03	−0.04	−0.08	−0.11	−0.10
Employees	0.01	0.03	0.01	0.08	−0.01	−0.01	0.09	0.01	0.00	0.12	0.07	0.07
Task breadth	−0.01		−0.04	0.25**		0.10	0.22*		0.06	0.04		−0.05
Task focus	0.18*		−0.00	0.31**		−0.09	0.33**		−0.13	0.36**		0.05
Knowledge diversity		−0.09	−0.08		0.02	0.01		0.02	0.02		−0.06	−0.05
Knowledge depth		0.37**	0.42**		0.21*	0.28*		0.38**	0.48**		0.48**	0.43**
Knowledge convergence		−0.03	−0.06		0.48**	0.43**		0.34**	0.30**		0.10	0.14
R^2	0.037	0.107	0.116	0.200	0.458	0.459	0.165	0.378	0.381	0.151	0.269	0.286
F	1.13	2.89	2.17	7.45	20.48	14.04	5.88	14.67	10.18	5.31	8.90	6.62
p	0.34	0.02	0.04	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
DW	1.82	1.86	1.75	2.25	2.18	2.22	1.89	1.83	1.85	2.07	2.08	2.01
VIF maximum	1.49	2.01	2.01	1.49	2.01	2.01	1.49	2.01	2.01	1.49	2.01	2.01

Notes: $*p < 0.05$; $**p < 0.01$

reduces from 0.18 in Model 1 to −0.00 in Model 3), while the impact of knowledge depth rises (0.37 in Model 2 increases to 0.42 in Model 3). The indicators of overall model fit also present a slight increase in explained variance ($\Delta R^2 = 0.079$). The above evidence presents a complete mediation on the relationship between task focus and the priority of cost, supporting *H1b*.

Quality

Table III shows that both task focus and breadth have a significantly positive association with firms' priority on manufacturing (βs in Model 4 are 0.25 and 0.31, respectively), i.e., *H2a* and *H2b* are supported. As for the effects of knowledge advantage, the statistics in Model 5 signify that knowledge depth and convergence present positive impacts on firms' emphasis on quality (βs are 0.21 and 0.48, respectively), while the effects of knowledge diversity are not supported ($\beta = 0.02$).

The model including the mediating effect indicates very consistent results. Knowledge depth and convergence present a positive explanation on firms' priority to quality (βs in Model 6 are 0.28 and 0.43, respectively); they also completely mediate the effect of knowledge breadth and depth (βs fall from 0.25 and 0.31 in Model 4 to 0.10 and −0.09 in Model 6, respectively); but knowledge diversity fails to significantly explain the priority on quality. Here, R^2 in the overall model significantly increases 0.259 (0.200 in Model 4 to 0.459 in Model 6). The previous evidence supports the inferences of *H2c* and *H2e*: knowledge depth and convergence play complete mediating roles in the association between task focus and breadth with firms' priority on quality, while the effect of knowledge diversity (*H2d*) is not verified.

Flexibility

Table III demonstrates that the levels of task breadth and focus both exhibit a positive impact on firms' priority on flexibility (for Model 7, β values are 0.22 and 0.33, respectively), pointing to a confirmation of *H3a* and *H3b*. Model 8 signifies that knowledge depth and convergence are positively associated with firms' emphasis on flexibility (β values are 0.38 and 0.34, respectively), while knowledge diversity is insufficient to exhibit a significant effect as well ($\beta = 0.02$).

The impact involving mediating effects (Model 9) is identical to those in Models 7 and 8. Knowledge depth and convergence show a positive explanation for firms' importance of flexibility (β values are 0.48 and 0.30, respectively) and demonstrate complete mediating effects from task focus and breadth on quite a large scale (β values drop from 0.22 and 0.33 in Model 7 to 0.06 and −0.13 in Model 9); the effect from knowledge diversity is not significant yet ($\beta = 0.02$). The explained variance of the overall model dramatically rises to 0.216 (R^2 goes from 0.165 to 0.381). The above results indicate that knowledge depth and convergence act in complete mediation on the relationship between task focus/breadth and firms' emphasis on flexibility, while the effect of knowledge diversity is not revealed, thus supporting *H3c* and *H3e*, but not supporting *H3d*.

Delivery

Table III exhibits that the priority on delivery is positively associated with task focus (Model 10, $\beta = 0.36$), while its association with task breadth is not significant ($\beta = 0.04$). Hence, *H4a* is supported in the empirical study. As for the impact of knowledge advantages, the evidence also presents that firms with higher knowledge depth tend to give higher priority to manufacturing delivery (Model 11, $\beta = 0.48$). The effect of knowledge diversity is insignificant.

The empirical results similarly clarify the complete mediation effect after adding knowledge depth as the mediator. The β value in the direct relationship declines and is insignificant (falls from 0.36 in Model 10 to 0.05 in Model 12), and the degree of knowledge depth is positively associated with the concerns for manufacturing delivery ($\beta = 0.43$, Model 12). Here, ΔR^2 increases 0.135 in the overall model. The previous results confirm *H4b*: knowledge depth plays a mediating role in the positive association of task focus and manufacturing delivery.

Tasks, knowledge advantages, and manufacturing strategy configuration

For practical considerations, this study also sets up an exploratory classification based on a typological perspective. We followed Ward *et al.*'s (1996) efforts linking business and manufacturing strategies and so classified the observations as four types of the manufacturing strategy through cluster analysis. The results of ANOVA indicate that the competitive priorities between the four types are statistically different (presented as Table IV). Based on Ward *et al.*'s (1996) classification and terminology, the four types are named as follows.

Broad differentiators. Firms of cluster A perform with a high degree of quality, flexibility, and delivery (all three means are the second highest of the four types), meaning that they attempt to serve a wide range of competitive priorities to provide a variety of segments and products. They are concerned more on the multiple facets of manufacturing except for low cost (the lowest mean of cost among the four).

Cost leaders. Opposite to the broad differentiators, the samples in cluster B paid less emphasis on quality, flexibility, and delivery (having the lowest or second lowest means of the four clusters), while they are concerned a lot on cost control (the second highest mean of the four clusters).

Lean competitors. Firms in cluster C perform the highest level on all four competitive priorities among the clusters, which match the features of Womack *et al.* (1990) and Ward *et al.*'s (1996) lean competitors. Their strategy is to incrementally accumulate stocks through their capabilities on quality, cost, delivery performance, and flexibility, and thus there is a high level for each competitive priority.

Niche differentiators. Firms of cluster D exerted less efforts on cost, quality, and flexibility (having the lowest or second lowest means of the four clusters), while they are concerned much on delivery (the second highest mean of the four clusters). They focus on maintaining delivery capabilities to accommodate the demand of particular customers and orders.

We accordingly used discriminant analysis based on the previous classification. The results of theoretical and actual classifications exhibited a 67 percent hit ratio (91/136) and a 28 percent error count. The discriminant coefficients listed in Table V signified that the most influential factors that explain the manufacturing strategy configuration are knowledge depth (with coefficients ranging from 19.43 to 23.14), followed by task focus (10.21 to 12.15), and breadth (4.35 to 7.11). Such findings are consistent with what we saw in the examination of previous hypotheses: knowledge depth has more general effects on cost

Competitive Priorities	Cluster A	Cluster B	Cluster C	Cluster D	Pairwise comparison
Cost	2.84 (4)	3.65 (2)	4.86 (1)	3.16 (3)	C > B > D > A
Quality	4.14 (2)	3.90 (3)	4.63 (1)	2.45 (4)	C > A > B > D
Flexibility	3.88 (2)	3.73 (3)	4.61 (1)	2.80 (4)	C > A, B > D
Delivery	4.64 (3)	3.79 (4)	5.00 (1)	4.82 (2)	C > D, A > B
Naming of Clusters	Broad differentiators	Cost leaders	Lean competitors	Niche differentiators	

Note: The numbers in the parentheses are the orders of means of each competitive priority

Table IV. Results of cluster analysis and ANOVA and delivery than quality and flexibility, while the effects of knowledge diversity and convergence are relatively weak. Moreover, both market-based task domains can explain the configuration of the manufacturing strategy and in particular the degree of task focus.

Discussions and conclusions

The empirical study herein targets the top 1,000 manufacturers in Taiwan as the sample population with the results from 131 observations signifying the following. First, firms' priorities on cost and delivery are positively associated with task focus, but not related to task breadth. Second, priorities on quality and flexibility are positively associated with task focus and breadth. In further detail, the β coefficients of task focus in both regression models are relatively higher than those of task breadth (0.31 > 0.25 in Model 4 and 0.33 > 0.22 in Model 7). The empirical results support *H1a-H4a*.

In regards to the mediation of knowledge advantages, the empirical evidence confirms the hypothesis that manufacturers with a focused task tend to create knowledge depth if they are targeting competitive priorities on cost and delivery. Firms with both focus and broad tasks tend to develop knowledge depth and convergence so as to conduct competitive actions in quality and flexibility. All the previous mediations show positive effects. Knowledge diversity, however, fails to explain the degree of competitive priorities, neither in direct effects nor for mediating effects (βs are located between −0.09 and 0.02). Thus, *H1b-H4b* are partially supported in the empirical study.

As for the effects of market-based tasks and knowledge advantages on the manufacturing strategy configuration. The empirical evidence indicated that knowledge depth has stronger explanations on cost and delivery than quality and flexibility, while the effects of knowledge diversity and convergence are relatively weak. The degree of task focus has a better explanation on the configuration of the manufacturing strategy than that of task focus.

Discussions

This paper's findings bring forth some interesting issues, with the first regarding the explanation of market-based task domains. Identical to the hypotheses, knowledge advantages, and competitive priorities are both determined by the market-based task domains. Such results support the assumptions from the literature: knowledge works are rooted in the tasks, such that knowledge activities are determined by the task domains of organizations (e.g. Drucker, 1993). The positive empirical results justify that the theoretical basis of task domains, i.e., Becerra-Fernandez and Sabherwal's (2001) focus-breadth dichotomy, may be a potential perspective to examine knowledge-related issues for future research efforts.

Of the four, knowledge depth has stronger effects on cost and delivery than quality and flexibility. Such results can echo the arguments of manufacturing strategy studies. The literature has often linked manufacturing cost with issues of efficiency, focus, and lean

Table V.
Results of discriminant analysis

Clusters	Broad differentiators	Cost leaders	Lean competitors	Niche differentiators	
Constant	−94.18	−77.22	−100.72	−78.84	Hit ratio = 0.67
Task breadth	7.11	4.47	6.48	4.35	Error count = 0.28
Task focus	12.15	10.21	11.92	11.33	
Knowledge diversity	−1.57	3.26	2.88	0.23	
Knowledge depth	23.14	19.43	22.02	20.34	
Knowledge convergence	−1.50	1.08	0.52	2.49	

production (Boyer and Lewis, 2002; Schmenner, 1987, 1988; Goldhar and Jelinek, 1983; Hill, 1989; Bozarth, 1993) and treated manufacturing delivery as an issue close to accuracy and outcome focus (Williams *et al.*, 1995; Boyer and Lewis, 2002), which all are related activities that need focused attention and efforts on the part of manufacturers.

As for quality and flexibility, the past literature signified that they are highly associated with knowledge diversity and convergence, while they greatly rely on knowledge depth. In particular, the capability of manufacturing quality may accompany a focus on production, such as consistency, reliability, and improvement of existing products (Tushman and O'Reilly, 1997; Soo *et al.*, 2002; Germain and Droge, 2001; Hayashi, 2004). Flexibility performance is often built upon a specialized knowledge base, solid technologies and skills, and a profound core knowledge of production (Claycomb *et al.*, 2005). Moreover, past studies identically emphasized that knowledge depth is an essential and critical factor in knowledge activities (Makri *et al.* 2010; De Luca and Atuahene-Gima, 2007; Hedlund, 1994; Lee and Choi, 2003). Herein, we have re-examined the results of our empirical survey, indicating that knowledge depth presents higher explanatory power on flexibility than knowledge diversity and convergence (M8 and M9). The previous discussions signify that knowledge depth has overall effects on the four competitive priorities.

This study has inferred that the association of knowledge diversity with the priority on quality and flexibility is neither supported in the direct relationship nor in the mediating effects, and insignificant results also occur in the cases of manufacturing cost and delivery. The empirical results are quite near to the findings from past studies. Relative to efforts of knowledge depth issues, little attention has been paid to topics regarding knowledge diversity and breadth (Turner *et al.*, 2002; Makri *et al.* 2010), with some empirical findings failing to verify their effects on corresponding organizational performance (De Luca and Atuahene-Gima, 2007). Previous results and comparisons signified that knowledge diversity is not a sufficient factor to create and sustain competitive advantages.

We finally review the role of knowledge convergence. The role of knowledge convergence is contingent upon the market-based task. Specifically, manufacturers develop their capability of knowledge convergence only when the market-based tasks are in essence both broad and focused. In other words, knowledge convergence is hard to develop if organizations encounter either broad or focused tasks. In addition, knowledge convergence does not result in universal effects on all four competitive priorities; it only presents a significant impact on firms' emphasis on quality and flexibility, including that on direct and mediating matter and its impact on quality is better than that on flexibility (β values are 0.43 and 0.30, respectively). As inferred based on the past literature, quality and flexibility highly rely on interdisciplinary technology, integrated innovation, and converging internal and external resources (Germain and Droge, 2001; McNamara *et al.*, 2002; Hayashi, 2004; Paiva *et al.*, 2008), thus inducing manufacturers to develop advantages regarding knowledge convergence. The previous results reveal that the effects of the T-shaped skill (knowledge convergence) are contingent upon the task domains that the manufacturers encounter.

Managerial implication and practical suggestions

This study provides some implications and suggestions for practice. The empirical results confirm that market-based task domains influence knowledge advantages and the emphasis on competitive priorities. The evidence exhibits that organizations plan and implement their management strategy by following the tasks they encounter. We employ Becerra-Fernandez and Sabherwal's (2001) breadth-focus dimensions as the basis for the task domain perspective. In order to form the basis for successive managerial conducts, it is essential to raise employees' sense and understandings toward the tasks of customer orders via education and training – in particular, those market-based factors including customers' usage condition, decision making, and the behaviors of competitors.

The literature from diversified fields clarified the essence of knowledge depth. Studies therein have treated focused and core knowledge domains as essential factors to meet the contexts with broad task domains, including product line extension, diversification (Breschi *et al.*, 2003), international expansion, and competitive strategy (Porter, 1980). Manufacturers that attempt to develop knowledge diversity and convergence should build a focused knowledge base and hence advance their derivative knowledge on this basis, which is exactly the fundamental concept of the T-shaped skill. In practice, firms should make sure they own a competitive knowledge base and solid expertise prior to expanding their knowledge domains. Without the basis of knowledge depth, manufacturers will expend futile efforts on knowledge diversity and convergence. Based on such a focus, the firms can work to catch up to the knowledge and technology levels relative to those in existing circumstances and can manage their distance to their competitive rivals.

The final implication regards the effect of knowledge convergence. The empirical evidence indicates only a conditional explanation for competitive priorities: knowledge convergence can only explain a firm's emphasis on manufacturing quality and flexibility. Similarly, firms tend to develop knowledge convergence capability simply when they encounter focused and broad market-based tasks. The above results exhibit a practical implication: knowledge convergence is built upon the existing knowledge base and the integration of multiple knowledge domains from multiple sources. Compared to simply building a knowledge depth advantage, the development of knowledge convergence requires more complicated knowledge resource and managerial efforts, but it does not necessarily influence subsequent conducts, such as the determination of competitive priorities. This evidence echoes the viewpoints of the contingency school in that appropriate managerial conducts depend on matching the contexts, including the tasks and strategies of the organizations (Becerra-Fernandez and Sabherwal, 2001). Hence, manufacturers may collaborate with external knowledge sources to add more product features so as to increase product quality; they may also converge new technology to increase product elements in order to increase adaptation and flexibility. Prior to these efforts on knowledge diversity and convergence, however, they have to stand on a focused knowledge basis. Knowledge resource and efforts may not matter in the context of knowledge advantage if they are not rooted in a concentrated knowledge depth.

Limitations and directions for future studies

This study induces some limitations and potential directions for follow-up studies. The first one pertains to the efforts to re-examine the definition and framework of the task domain perspective for knowledge activities. We employ Becerra-Fernandez and Sabherwal's (2001) focus-breadth dimension as the basis to explore the task domain, and the empirical results herein also confirm the construction of the architecture and measurement. However, organizational task is still a broad and indefinite issue in practical and academic efforts. Further studies can set up a specific construction and measurement for each task. For example, we can treat the task domain of cost reduction based on its efficiency focus, while treating that of quality based on the conditions of the customers. Moreover, some related viewpoints in the past literature, including task structure, routine, repetition, and consistency (Te'eni *et al.*, 2007), are possible directions for future research. Future efforts can also explore alternative facets of tasks by rooting them out from organizational practices in order to clarify the roles of the organizational task of managerial behaviors.

Knowledge advantage is the primary construct of this study. We employ T-shaped skill as the theoretical basis and extend it as the framework of knowledge advantage. Our empirical results confirm the three-element framework and obtain some valuable findings, hence verifying that T-shaped skill is an effective and feasible basis for knowledge-related issues. Future research can extend it to advanced issues. We can also employ alternative perspectives to reframe knowledge advantage issues, such as linking up with generic competitive advantages (Porter, 1980) and product advantages (Atuahene-Gima, 1995), in order to strengthen our theoretical depth and scope.

Finally, due to insufficient empirical evidence and measurement tools in the past literature, this study has presented an exploratory re-examination on the manufacturing strategy issue and the association between task domain and knowledge advantages. Future research efforts can target a causality basis, such as an advanced clarification of the causality between the constructs based on a solid literature review, longitudinal empirical studies, dyadic studies involving both customers and manufacturers, and causality-base statistical analysis like structural equation modeling.

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