TRANSFERRING CAPABILITIES IN INTERNATIONAL MANUFACTURING OPERATIONS: THE ROLE OF THE HOME MANUFACTURING KNOWLEDGE MANAGEMENT PRACTICES AND ATTITUDES

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Abstract

In their search for competitive advantage, multinational firms need not only coordinate cross-boarder activities but must also integrate and coordinate access to global resource advantages and exploit their globally dispersed internal capabilities. For international manufacturing operations, this challenge is shifted on how to use their networks of factories situated in different countries for achieving strategic flexibility at the global level.

In this paper, we argue that the ability to achieve this objective depends on the knowledge management practices and attitudes in the manufacturing units of the corporate centre and on the means by which they are transferred to the foreign locations, both at the installation phase and continuously during operation. To support our claim, we present indicative results from a study conducted to a sample of Greek manufacturing firms with international operations. In addition, we present two short case studies developed to exploit further our empirical findings.

Keywords: knowledge management, internationalization, manufacturing capabilities, manufacturing strategy.

Transferring capabilities in international manufacturing operations: The role of the home manufacturing knowledge management practices and attitudes

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Suggested track: A Managing organizational knowledge and competence

1 Introduction

The development of equity-holding manufacturing facilities abroad constitutes the most committed form of internationalization process. Recent analysis has shown that this form of internationalization is the best choice vis-à-vis more loose forms, such as alliances, subcontracting etc., when the firm has a strong knowledge base and does not aim at gathering new capabilities in foreign factor markets (Madhock, 1997). Furthermore, it has been extensively argued that multinational firms could be in a competitive disadvantage in the future if they do not think and act globally (e.g. Hout et

al. 1982; Yip, 1992) not only for coordinating cross-border activities, but also for integrating and coordinating access to global resources advantages and for exploiting their internal capabilities (Fleenor, 1993). In manufacturing systems terms, these imply that the strategic role of the firm's international manufacturing base should not only address foreign markets, but, most importantly, act as enabler of *strategic flexibility*, i.e. to exploit the network of facilities to address different global strategic (cost, differentiation, etc) and different operational (product volumes and ranges, due dates, etc) objectives, at the same, or adjacent time periods.

From the firm's capabilities point of view, the objective of strategic flexibility becomes a problem of coordinating a network of specialised knowledge sources (the individual production units situated in different countries) to create new knowledge deployed at the global level. To achieve this through transnational manufacturing, firms are seeking efficient production ramp-up and controlled operations by transferring manufacturing-related capabilities from the corporate (manufacturing) centre. In some cases, e.g. when the development of international operations is through an acquisition of a foreign factory, this transfer may be bi-directional. In both cases, what is sought for is efficient transfer of a diverse set of manufacturing-related technical and organizational capabilities in two phases: during the establishment or (re)organisation of the manufacturing facilities or processes and during their operation.

The influence of the industrial and organisational context in the transfer of capabilities with respect to the rate of innovation has been extensively investigated by many authors (e.g. Teece, 2000; Grant, 2001). However, studies specific to knowledge management issues in manufacturing settings and to the transfer of manufacturing-related capabilities are scarce and mainly conducted at the industry or industrial district levels (Scarso, 1999). In addition, only few researchers have paid attention to and started to redefine manufacturing as a globally distributed and coordinated network, distinct from the traditional plant model (Ferdows 1997; Shi and Gregory, 1998). In the view of manufacturing operations as an extension of the firm's brain, rather than its muscles, knowledge management and capability development at the shop-floor and across facilities can significantly contribute to the achievement of competitive advantage.

Towards this end, an important question that arises in the internationalisation of manufacturing is how and to what extent the manufacturing centre's knowledge management practices and attitudes facilitate or impede the transfer of capabilities and influence the knowledge management practices in the production units abroad, and, on the other hand, how they facilitate or impede the transfer of capabilities from abroad, when the transfer is bidirectional. In every case, the bottom line question relates to how the resulting knowledge management practices contribute to the objective of strategic flexibility at global level.

To investigate these questions, in this paper we first develop a knowledge-based view of manufacturing by indicating the sources (individual skills and competences, as well as information artefacts), accumulations and knowledge transformation activities that are involved in manufacturing operations and their interface with the marketing and product development functions, and secondly we investigate the relationship between knowledge management practices in the corporate centre's production units and the mechanisms and content of knowledge transfer from the centre to the manufacturing site abroad and vice versa. The effect of this transfer on the target sites' operations is also discussed with respect to the achievement of both strategic and operational flexibility. Then, we present the results of an empirical study conducted in a sample of Greek international manufacturing firms and we analyse the attitudes, practices and achievements of two of them by means of short case study descriptions.

2 Knowledge management in manufacturing

Decisions and activities related to manufacturing can be classified into three interrelated levels: those that aim at achieving conformance to the short-term operational objectives (e.g. attain a specific quality level, meet a specific due date), those that are directed towards operational improvements (e.g. improve quality by 10%, reduce set-up times) and those that support innovation and integration of the manufacturing function with the other functions of the firm (e.g. introduction of a new process of a novel product). The latter have longer time horizons and can be considered as strategic in contrast to the former which is short-term and purely operational. There exist linkages between the three levels, as operational decisions and activities trigger improvement activities, and improved operations augment the strategic decisions space.

Practice indicates that the conformance activities are dominated by knowledge codification in the form of process maps, Standard Operating Procedures, Quality Control Charts, etc. In general, operating standards communicate sets of codified rules to the shop-floor personnel and are used to guarantee the control of the manufacturing process. The documentation/codification process is a facilitated but participative process which generates knowledge by extracting tacit knowledge from those involved (Benezech, et al., 2001). Depending on the human resources practices, this process may be iterating, continuously constructing new knowledge. For example, well-trained operators which are given the freedom to accomplish their tasks in the way they find most appropriate, as long as the minimum expected outcomes are guaranteed, may collaboratively find better ways of doing the work than those defined. These constitute ad-hoc improvement activities, which usually result in updating the related documentation, or they many just establish new practices (e.g. a new way to utilize a production scheduling software tool). In addition, improvement activities may be more formally organized as planned meetings with structured agendas which use data from performance measurement systems and personal experiences to improve operations and their associated documentation. In general, HR practices that promote the cooperation among shop-floor employees and manufacturing managers enhance new knowledge production by integrating different sources of tacit knowledge accumulated through experience.

At the strategic level, traditionally the role of manufacturing-related decisions has been to achieve alignment with the strategies of the other functions of the firm (particularly with marketing strategy) and the market. However, modern approaches to manufacturing strategy divert from this static view and concentrate on the development of organizational capabilities by selecting improvement paths that can lead to the objective of strategic flexibility, i.e. to be able to move easily across strategic objectives such as cost, flexibility, quality, etc. (Hayes et al., 1996). Therefore, in contrast to the traditional views, current manufacturing-strategy thinking deserves an active role to the manufacturing function as its asset base (resources and capabilities) determines the range and the economies of the activities in which it can engage at any point in time (Ghemawat, et al. 2001).

Strategic manufacturing decision areas include capacity and facilities management, sourcing and integration, customer interfacing and process organization and technology. Put under the same objective of strategic flexibility, all these areas become part of the product-process interface management, where the basic question becomes how to develop efficiently a manufacturing system's structure and infra-structure that corresponds to a dynamically changing set of market requirements.

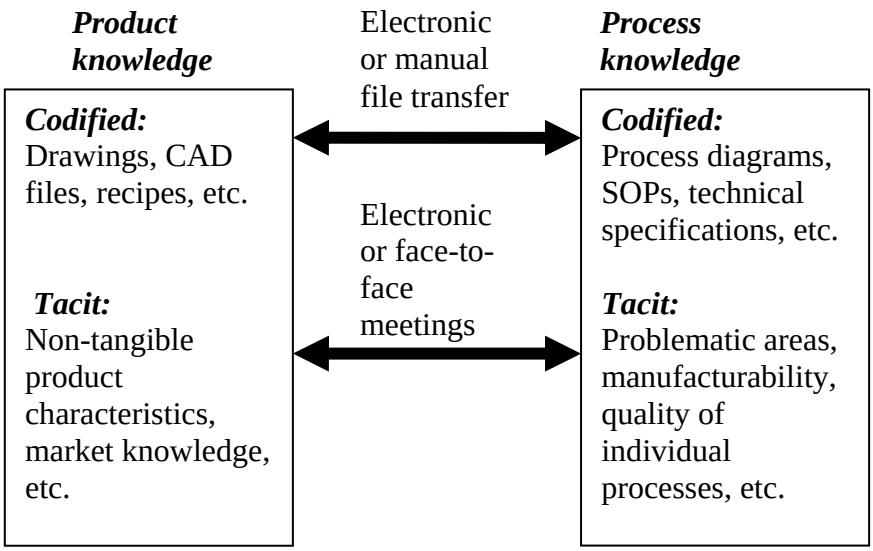

Fig.1. Knowledge transfer across the product-process interface

From the knowledge management point of view, the product-process interface is a knowledge transformation activity. Product information in the form of drawings, recipes, nominal capacities etc. is translated into process data in the form of equipment technical specifications and operating instructions. In produce-to-order systems this may be limited to equipment set-up and operating instructions for flexible machinery. It has been shown that the knowledge management practices within the process development function and across the product-process interface influence significantly the performance of the process development process (Pisano, 1997). In addition to the communication of codified knowledge, collaboration and dissemination of tacit knowledge between the two functions improves both product and process development. For facilities situated in different countries, the question is whether the knowledge management practices of the corporate centre influence the establishment and operation of the mechanisms that implement the product-process interface knowledge flows and, in turn, the effects they have in the performance of the firm with respect to the objective of strategic flexibility.

3 Transferring manufacturing capabilities in foreign facilities: An empirical study

To investigate the above question, a two phase research procedure was followed. First, based on the preceding analysis, a questionnaire was developed, validated and sent to thirty-eight Greek manufacturing companies of which fifteen valid answers were received. The questionnaire had a section of questions on the form of knowledge resources and the extent of knowledge-management activities related to the manufacturing activities in the home production unit(s) and a corresponding section for the facilities abroad. A different section contained questions on the mechanisms of knowledge and capability transfer between production units (home and abroad). Other sections contained questions for providing estimates of the relative to expectations performance of the ramp-up and operating processes (home and abroad), on the results of (any) improvement initiatives or programmes (again, home and abroad), as well as on the product-process integration practices and (any) process innovations initiated by the manufacturing units (home and abroad). Finally, questions for determining qualitative measures of the alignment of the manufacturing system with the market through product profiling (Hill, 2000) were included.

After tabulation and analysis (descriptive statistics) of the response data, two companies have been selected as extreme examples (archetypes) of knowledge management practices and internationalization processes to be used as reference cases and undergo further investigation. The first company is a third-party manufacturer of pharmaceuticals with pan-European presence, whereas the second a fashion garments manufacturer with production units in the Balkans. Answers to the questionnaire indicated that the first company had a home production system with formal procedures where codified knowledge predominated, a hierarchical organisational structure and centralised decision-making, but continuously promoted collaboration between marketing and manufacturing. In the second, tacit knowledge, informality and distributed decision-making predominated, but the product-process interface heavily relied on information technology. With respect to figure 1, in the first company, the internal product and process development procedures were dominated by codified knowledge and formal communications, whereas their interface was activated by tacit knowledge flows through informal communications. The opposite was observed in the second company. In the first company, internationalization took place in more mature and stable economic environments, whereas in the second in

developing countries. Thorough examination of company data and face-to-face interviews with local manufacturing managers and managers responsible for the international operations were carried out to gain a deeper understanding and develop the cases described in section 3.2.

3.1 Questionnaires

Some of the characteristics of the fifteen manufacturing companies that answered our questionnaire as they were determined form its introductory section, are shown in Table 1. It can be seen that the extent of use of operating standards, codification in product development and common training was quite high (values indicate answers in a 1-5 Likert-type scale). Use of codified knowledge in process development and improvement initiates was relative low. Collaboration across the product-process interface was not very intensive, whereas the formation of communities of practice seemed to be quite rare.

Table 1. Characteristics of the sample

	Use of stand.	**Codif. product.**	**Codif. proc.**	**Codif. impr.**	**Comm. train.**	**COP**	**Collab. develop.**
Food processing1	4	4	3	3	3	2	2
Food processing2	4	3	3	3	3	2	3
Food processing3	3	5	5	2	4	3	2
Food processing4	5	5	4	2	4	2	2
Fashion garments1	1	5	1	1	2	1	1
Fashion garments2	3	5	1	3	2	1	2
Fashion garments3	2	2	2	1	3	1	1
Office furniture1	4	2	2	3	4	1	3
Office furniture2	4	3	2	3	2	2	3
Plastics1	3	4	3	2	1	1	2
Construction1	5	3	2	1	2	1	4
Steel products1	2	5	5	2	3	2	2
Pharmaceuticals1	5	3	3	4	5	3	5
Paper products1	4	2	5	2	4	2	2
Cement1	4	4	4	4	4	3	3
Mean	*3.53*	*3.67*	*2.87*	*2.40*	*3.07*	*1.80*	*2.47*
Standard deviation	*1.19*	*1.17*	*1.25*	*0.98*	*1.10*	*0.77*	*1.06*

In the same section there were also questions regarding the use of CAD/CAM technology (mean = 3.27, St. Dev. = 0.88) and the extent of control exercised on the workforce for following work instructions (mean = 4.33, St. Dev. = 0.62). Answers to the

questionnaire indicated a positive correlation between the use of standards and common training (r = 0.48) and between the use of standards and the extent of codification in process development (r = 0.74). However, a negative correlation was found between the use of standards and level of codification in product development. In addition, the responses indicated a weak correlation between the use of standards and the extent of control on the workforce (r= 0.23).

The second section asked for information on the same items, but for the international operations. As table 2 indicates the correlation between the answers for the home operations and the international ones were quite high. However, it should be noted that in some answers the data are distorted by the fact that not all functions exist in every operation/facility.

Table 2. Internal knowledge management practices

	Centre Mean/SD	**Abroad** Mean/SD	**Correlation coefficient**
Use of standards	3.53 1.19	3.37 1.29	0.76
Use of formal production planning and control	3.20 1.32	2.90 1.27	0.68
Codification in product development	3.67 1.17	3.48 1.92	0.76
Codification in process development	2.87 1.25	3.43 1.81	0.83
Codification in improvement	2.40 0.98	1.89 1.11	0.65
Common training programmes	3.07 1.10	1.57 1.23	0.43
Collaboration in product and process development	2.47 1.06	1.57 1.36	0.47
Communities of practice	1.80 0.77	1.23 0.67	0.79
Use of CAD/CAM	3.27 0.88	3.48 1.24	0.91
Control of work	4.33 0.62	4.45 0.69	0.94

Table 3 shows the results of the section concerning the content of capability transfer between the manufacturing base and the foreign sites and vice versa. As far as the means of the transfer are concerned, the responders indicated a preference towards information technology (internet, file transfer), rather than through meetings, visits and working groups (mean value of 3.07 and standard deviation of 1.03 in scale that 5 indicated information technology only, and 1 face-to-face communications). The average percentage of common products across international operations was 56 (St. Dev. = 35.26) and the average percentage of common processes was 70 (St. Dev. = 33.65).

Table 3. Knowledge transfer across international operations

	Home – International	**International-Home**
	Mean/	**Mean/**
	St. Dev.	**St. Dev.**
Knowledge transfer for process development	4.07	1.93
	1.39	1.28
Knowledge transfer for production management	3.60	1.73
	1.45	1.16
Knowledge transfer for quality management	3.67	1.93
	1.54	1.22
Knowledge transfer for supplier development	3.20	1.73
	1.26	0.80
Knowledge transfer for the integration of manufacturing	3.27	1.80
	1.58	1.01
Knowledge transfer for setting strategic objectives	2.20	1.80
	1.06	0.94

Returned questionnaires indicated that only limited process development is undertaken in international operations (mean = 2.23, SD = 1.78) and that there is a weak correlation between the use of technology in capability transfer and process development abroad (r = 0.38). However, a negative correlation was indicated between internal collaboration in the product-process interface and process development in international manufacturing operations (r = -0.26). Negative correlations were also found between the use of standards, the level of codification in product development and the level of codification in process development in the one hand, and estimations

of ramp-up efficiency on the other (-0.45, -0.34, -0.27, respectively). Positive correlations were found between the level of codification in product and process development and the transfer of production management capability (r = 0.58), quality management capability (r = 0.63), and manufacturing integration capability (r = 0.48). Similar correlations were found for the level of codification in process development (0.49, 0.53, 0.36, respectively). Finally, positive correlation was found between the degree of internal collaboration and the transfer of capabilities related to supplier development (r = 0.71) and negative between the use of formal production planning and control methods and the transfer of production management capability (r=-38).

By considering five key indicators (product range, level of products standardization, customer order size, rate of new product introductions, process flexibility), the alignment of the responders manufacturing systems with the market was determined. The mean value of the sample (2.63) indicated an average alignment (St. dev. = 1.21). A negative correlation between the level of alignment and the use of standards was found (r = -0.56).

3.2 Short case studies

Company A: Pharmaceuticals contract manufacturer

Company A is one of the leading contract manufacturers of pharmaceuticals in Europe. The company was formed in Greece the late forties to manufacture its own brands of low technology drugs and cosmetics. Gradually, it shifted its interests and operations towards contract manufacturing and acquired capacity from large multinational companies producing in Greece. It developed manufacturing capabilities for a wide range of products and established GMP standards, continuously modernizing its technology. During the nineties, it acquired five production plants across Europe aiming at achieving strategic flexibility, i.e. to use any site for fulfilling orders from any market. Currently, it can only partially achieve this objective.

The key manufacturing-related capability that Company A has developed over the years is at the integration-innovation level. It persistently insisted in the collaboration of personnel from different functions and on following common training programmes. This

has enabled the marketing and sales personnel to provide very fast quotations to customers (as they are quite aware of the company's manufacturing capabilities). Furthermore, process development and installation has become very fast as process engineers understood product characteristics and customers requirements. Being into the pharmaceuticals sector which is dominated by standards and regulations, the company has developed capabilities for codifying product structures and operating rules and procedures in an efficient way. Extensive use of information systems allows Company A to use this information (e.g. bills of materials) for conformance tasks (production planning and control) and to identify areas of potential improvement.

As far as manufacturing operations are concerned, since now, the internationalization of the company helped in two complementary ways. On the one hand, the experience of the "informal" process development was transferred to the foreign sites through mutual visits and through the enforcement of collaboration practices. On the other hand, practices to develop and follow standards more efficiently were transferred to the manufacturing centre in Greece. However, there is an apparent difficulty for Company to achieve the objective of strategic flexibility through the coordination of manufacturing sites, as orders received at a particular market cannot easily fulfilled from a facility in a different country.

Company B: Fashion garments manufacturer

Company B is a fashion garments manufacturer that followed the opposite direction in relation to Company A. It started as a contract manufacturer for multinational brands in the mid-seventies but gradually developed its own brands and distribution channels in Greece. This was initiated by the introduction high-tech dyeing machinery and CAD/CAM equipment and software, followed by the establishment of a design department. Now, designs are automatically transferred into production where textiles are cut accordingly. Sewing and finishing takes place manually. The manufacturing department divides labour according to (similar) processes/tasks. This specialization is almost permanent. No production data other than labour productivity is recorded and stored. Production planning and control is accomplished empirically by supervisors.

In the mid-nineties the company acquired a manufacturing site in Bulgaria to produce its low-end products for the local market. In renovating the factory, similar equipment to

those in the home factory were installed. The local personnel were trained marginally. Productivity and quality was quite low and only simple garments were in the product range. Gradually, however, both performance metrics were substantially increased, and according to the market requirements, designs can be sent from Greece to be manufactured there and then distributed in Greece and in Germany. Currently, the company is setting up a second factory in the same country using the same procedures and is planning to operate it in the same logic.

4 Summary of findings

Although both the sample size and the cases presented are limited and can be considered only as indicative, the findings of our study can be summarised in the following:

Industry/sector is a major determinant of the nature of knowledge management activities undertaken both at home and abroad. Firms belonging to sectors whose manufacturing activities are dominated by standards (e.g. GMP for the pharmaceuticals sector) give emphasis on conformance routines, home and abroad. What they try to export or import are capabilities related to the strict conformance with standards.

Companies that rely on face to face collaboration in the product-process interface have a difficulty in coordinating this effort between sites situated in different countries. The product-process interface across international operations can be managed more effectively by companies that rely on the transfer of codified knowledge through the use of information technology.

Independent of the sector they belong, firms that give great importance to the conformance to operating standards, such as ISO 9000 quality management standards or ISO1400 environmental management standards, try to export these capabilities through the transfer of codified knowledge. Although they may have some improvement projects at home (usually quality improvement initiatives within the framework of the ISO standards), they are not particularly interested in developing their human capital abroad towards involvement in the higher levels of the manufacturing

manager's hierarchy of tasks (improvement and integration/innovation). Control prevails over creativity and learning.

The level of information technology infrastructure at the home factories is a determinant of the means of capability transfer and its content. Companies with factories that use software systems for production planning and control (e.g. MRP) are interested in transferring capabilities for using these systems rather than for understanding manufacturing operations and for providing tailor-made (perhaps better) or more innovative solutions when these systems fail. Information systems are used as the medium for transferring this codified knowledge. On the other hand, companies with factories with a lower degree of information systems usage rely on operators' tacit knowledge for scheduling, planning and control and they seem to have a difficulty in exporting this capability. Factories abroad are less efficient with respect to planning and control (conformance activities).

Production ramp-up depends on the type of knowledge that dominates the home factories (ramp-up was estimated in comparison to the home factory's operating standards). Companies with factories dominated by codified knowledge are less efficient in setting up foreign units than companies with factories that are tacit knowledge dominated. This is because the latter seem to have more flexibility in decision making and less bureaucratic processes in selecting equipment, personnel and suppliers.

Knowledge management orientation (tacit vs. codified) in both home and foreign factories depends on the level of alignment of the manufacturing system with the market, rather than on the nature of the manufacturing system itself (i.e. whether it is a jobbing, batch or flow system). The more the system is misaligned the more the effort spent to rationalise operating processes through the development and use of formalised processes and standards.

5 Conclusions

In this paper we have presented an explorative study of the role of the knowledge management practices and attitudes of the corporate centre's manufacturing units on the transfer of capabilities for the development and operation of manufacturing

operations abroad. Although, the results obtained can be considered only as indicative, they confirm the views expressed in the literature that multinational manufacturing requires a different perspective from that of a single country, if the firm aims at using its network of operations for achieving strategic flexibility at the global level.

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