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KNOWLEDGE FLOWS IN INTERNATIONAL MANUFACTURING NETWORKS

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Abstract: *The purpose of this paper is to investigate different knowledge flows within an international manufacturing network. To achieve this, a manufacturing network of a multinational manufacturer has been studied using case study research method. Data were collected from on-site interviews and archival documents. The results refer to several knowledge flows, either internal or external that could be utilized for the effective management of knowledge.*

Key Words: ***International manufacturing network, Knowledge management, Case study***

1. INTRODUCTION

Knowledge is considered as the most strategically significant resource of a firm [1, p. 375, 2]. In fact, a company is a collection of unique, heterogeneous, scarce, embedded, inimitable, valuable, both tangible and intangible resources, including knowledge, that are utilized to respond to market opportunities [3]. For Multinational corporations (MNCs) that operate several plants over the world, known as international manufacturing network (IMN), there is a need to distribute knowledge in different directions. Internally, the plants in such network can learn from each other and benefit from new knowledge developed by other units. This consequently leads to inter-plant cooperation, increased innovativeness [4], increased internal learning [5], and dissemination of best practice [6]. Also, external knowledge sources can provide the plants of a network with required critical knowledge that is not available within the borders of a company. The aforementioned arguments highlight the significance of knowledge and knowledge flows as the foundation of learning that is one of four capabilities of an IMN i.e. accessibility, thriftiness, mobility, and learning [6-8]. Therefore, identification of knowledge flows, either internally among the plants or from external sources is both important and beneficial for an IMN.

In the literature, there has been a set of diverse research agenda regarding knowledge and knowledge management (KM) areas. "Knowledge" itself has been deeply defined and elaborated [9, 10]. It is such an important asset for companies that even the theory of knowledge-based firms has evolved in the literature [11, 12]. The importance of knowledge has led to development of organizational KM and different approaches for such purpose [2, 13].

Following KM studies, the transfer of knowledge between individuals, teams, within and among organizations has gained importance. For instance, based on a sample of 102 US organizations, the effectiveness and efficiency of knowledge transfer (KT) from the international business affiliates of those organizations have been examined [14]. Furthermore, intra-organizational KT inside multi-unit organizations has been looked into with a network perspective. Besides, inter-organizational KT including different dimensions has been researched [15]. Some researchers have focused their studies on transfer of knowledge among the production plants or units of an IMN. For example, transfer of knowledge across units has been analyzed as a central challenge for MNC management [16].

Still, KM in IMNs remains a challenge for practitioners and therefore demands the attention of academics. In order to decrease the complexity of management of knowledge flows in an IMN, identification of knowledge flows seems necessary as a primary step. Therefore, in this paper we try to identify different types of knowledge flows within and outside an IMN. We will respond to the research question:

- *What are the different knowledge flows either among the plants of an IMN or the knowledge that is obtained from a source external to the network?*

In the first section we refer to literature regarding knowledge, KM, and KT. Furthermore, we provide a short review of the existing theories on IMNs. Then we elaborate the research method and introduce the case company. Finally, the results and conclusions are provided.

2. LITERATURE REVIEW

2.1. Position of this study

To organize the literature on KM in organizations, a matrix is suggested which consists of two dimensions [13]. First, the context within which KM occurs that includes properties of the units, properties of the

relationships between units, and properties of the knowledge. Second dimension incorporates KM outcomes including creation, retention, and transfer of knowledge. This study is positioned primarily in the KM outcome dimension as highlighted in Figure 1.

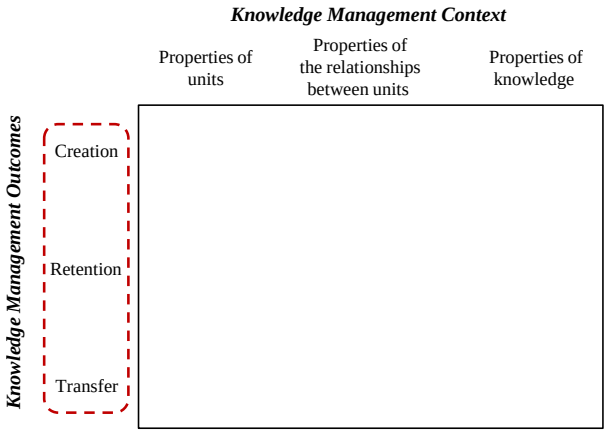

Figure 1- Theoretical framework for organizing research on KM and the position of this research

To give a wide insight to the existing literature, we reviewed literature in knowledge and KT area. Some of the main studied references in this paper are mentioned in Table 1.

Table 1. *Some of the main references in order of their focus*

Reference	Title	Focus
[17]	Intra-network knowledge roles and division performance in multi-business firms	Intra-organizational
[4]	KT in intra-organizational networks: Effects of network position and absorptive capacity on business unit innovation and performance	Intra-organizational
[18]	The effect of quantity, quality and timing of headquarters-initiated knowledge flows on subsidiary performance.	Intra-organizational
[14]	Effectiveness and efficiency of cross-border KT: An empirical examination	Intra-organizational
[19]	Knowledge flows within multinational corporations: Explaining subsidiary isolation and its performance implications	Intra-organizational
[20]	Transferring knowledge in MNCs: The role of sources of subsidiary knowledge and organizational context	Intra-organizational
[21]	Knowledge flows within multinational corporations	Intra-organizational
[22]	MNC organizational form and subsidiary motivation problems: Controlling intervention hazards in the network MNC	Intra-organizational
[23]	Toward understanding inter-organizational KT needs in SMEs: insight from a UK investigation	Inter-firm
[24]	Inter-organizational KT: the perspective of knowledge governance	Inter- firm
[25]	The effects of trust and shared vision on inward KT in subsidiaries	Inter-firm and Intra-organizational

2.2. Knowledge and KM

Knowledge is a broad and abstract notion [2]. The terms knowledge and information are used interchangeably in the literature, but a distinction is necessary [26]. If knowledge is not something that is different from data or information, then there is nothing new or interesting about KM [2]. Data is raw. It simply exists and has no significance beyond its existence [27]. Information is data that has been given meaning by way of relational connection and knowledge is the appropriate collection of information, such that its intent is to be useful and applicable [27]. Knowledge, divided into explicit and tacit knowledge [9, 28], is considered as a state of mind, an object, a process, access to information and a capability [2]. In this paper, we use "knowledge" broadly to refer to the managerial and production knowledge in an IMN.

Due to the importance of knowledge for IMNs, KM methods, tools and applications have been developed [29]. KM is the generation, representation, storage, transfer, transformation, application, embedding, and protection of organizational knowledge [30]. Different phases in KM that allow an organization to learn, reflect, and unlearn and relearn, are usually considered essential for building, maintaining, and replenishing of core competencies [31].

For an IMN to develop and expand, it is of utmost importance for its manufacturing plants to circulate knowledge among them recurrently. Effective leveraging of knowledge resources through the transfer and reuse of existing knowledge within and outside of and IMN, is an important aspect of most KM projects [32].

2.3. KT in IMNs

KT is defined as a process through which one organization (or unit within) identifies and learns specific knowledge that resides in another organization (or unit) and reapplies this knowledge in other contexts [33]. A sophisticated KT project results in successful creation and application of knowledge in organizations [9]. KT lies within the KM area that includes knowledge creation, validation, presentation, distribution, and application [31].

Researchers have argued that the ability to leverage valuable existing knowledge internally is critical to building competitive advantage [32]. One important way of leveraging existing knowledge is through the transfer and reuse of existing firm-specific knowledge among different plants within an IMN. Also, the importance of KT to foster external learning sources has been recognized [34]. Such internal and external KT are critical sources of competitive advantage and a driver of firm performance [32]. A major competitive advantage of IMNs is their ability to exploit locally created knowledge worldwide. As international manufacturing companies aim to replicate their success across borders, they will need to focus not just on "what" they know, but "how" they gain that knowledge and diffuse it throughout the enterprise [35]. Without proper knowledge flow between plants in an IMN, the parent firm and its subsidiaries would be nothing more than standalone entities and the whole would not be more than the sum of its parts [36]. This is basically the main purpose of having synergy among plants in an IMN [37]

that allows redeployment of resources between units and results in superior financial performance [16].

Many studies have considered the direction of KT in multi-unit organizations. There are more research about traditional forward transfer i.e. from the headquarters plant to the subsidiary plants [38]. The less conventional "lateral" transfer (from subsidiary to subsidiary) has also been discussed. There has been even research on a sort of reverse KT, i.e. transfers from successful subsidiaries to the headquarters [39]. Nevertheless, not much attention has been paid to identify the types of knowledge flows within IMNs. As mentioned earlier, we draw the attention towards different knowledge flows, either internally or externally and their classification within an IMN.

3. RESEARCH METHODOLOGY

We follow a case study methodology which allows us to better understand the complex linkages between relevant constructs, and to retain holistic and meaningful characteristics of it [40].

We collected data from the manufacturing network of a Swedish company. The case company was a global contract manufacturer in automotive, mining and construction, telecommunication and general industries sectors with 11 production plants in six countries. The primary criterion for the selection of the case company was (1) the geographical dispersion of the plants and (2) the significance of knowledge in the expansion of the company what has been mentioned in the strategic plan of the company and its long term horizon. All interviewed managers confirmed and recognized the need of identifying knowledge flows within and outside the network in order to manage them effectively that made them a suitable multisite firm for the context of this study.

Data were collected in two phases: (1) on-site semi-structured interviews with people from different levels of the case companies that all practiced KT projects, and (2) archival data to triangulate information gathered from the on-site interviews. To capture a wide scope of data, the interviews targetted two main areas: (1) a historical perspective on the case company's technological development and market expansion, and (2) three KT projects that were performed within the same case company. More details regarding the role of the interviewed persons and the subject of the KT projects are provided in Table 2 and Table 3 respectively.

Table 2. *The role of the respondents*

Respondent position	Time(min)
Project leader	120
Technical Manager	90
Gear cutting technician*	80
Machining technician*	80
Chief financial officer	90
Managing director	90
Production and maintenance	90
Heat treatment specialist	90
Quality coordinator	90
Global quality manager	120
Global manager XPS	120
Global Ind. Development Manager	100
Global project director	90
Gear grinding specialist*	90

* Except the respondents marked by star symbol that came from a Brazilian plant all others worked in Swedish plants

Table 3. *The subject of KT projects*

KT project subject	Sender/Receiver
Gear cutting and machining	Sweden/ Brazil
Gear cutting process	Sweden/ Brazil
Machining process	Sweden/ Brazil
Establishment of a production line	Sweden/ Brazil
Establishment of a production line	Sweden/ Brazil
Production know-how of a component	Sweden/ Latvia
Heat treatment of gear	Sweden/ Brazil
XPS of the company	Sweden/ All plants

All interviews were recorded, transcribed and stored in a database. Data was analyzed following certain guidelines [41] and the results were shared and discussed with the repondents before publication.

4. RESULTS

As mentioned earlier, we concentrated our data collection on the technological developments of the case company as well as three performed KT projects in the company. Thereby, our findings refer to how the company gained knowledge during its evolution. Then, some details regarding the studied KT projects are provided.

4.1. Technological development of the case company

The case company was a multinational manufacturer founded in 1982 in central part of Sweden. The company developed its operation from two small manufacturing workshops in Sweden in 1982 to 11 production plants in six countries in 2016 i.e. Sweden, Germany, Hungary, Latvia, Brazil, and China. Throughout its expansion journey, the company obtained the required knowledge types in different points in time from various sources and transferred knowledge through and outside of the network in different directions. We hereby go through a chronological review of the knowledge that the case company acquired during the years 1990-2013.

In the beginning, the company had merely basic knowledge of fundamental machining processes to produce metal components in automotive sector i.e. turning, milling and grinding. However, in 1990, the company acquired a small plant in Sweden and thereby gained the knowledge needed to produce components for mining industries. This enabled the company to reach a new customer that was a global Swedish manufacturer of industrial tools and equipment for mining industries.

Similarly, the acquisition of another plant in Sweden in 1993 led to gain gear and spline cutting knowledge. This was strategically significant due to the fact that the acquired company could have otherwise captured the case company's gear and spline market share.

Moreover in 2000, a large global Swedish power and automation company suggested outsourcing one of their products i.e. shafts for electrical motors and clutch collars for axles to the case company. The case company then found it necessary to gain automation knowledge needed to produce components in high volume. The required knowledge regarding automation was obtained through: (1) cooperation with the customer that was actively involved in automation business area and produced industrial robots, (2) training and educating existing engineers in the headquarters plant and (3) recruiting knowledgeable engineers.

Also, in 2003 the case company transferred knowledge from the headquarters plant to their subsidiary plant in Latvia to increase the competence level of the Latvian plant. This enabled the company to move simple products to the Latvian plant which was a low-cost manufacturing plant and consequently increase the capacity in plants with high competence.

In 2004, the company brought in a certain type of heat treatment knowledge i.e. induction hardening as well as opening its first metallurgy laboratory by recruiting the right people with the right knowledge. The heat treatment knowledge was even expanded later in 2010 by acquiring case hardening knowledge through an internal research initiative that resulted in the improvement of metallurgy laboratories to world-class standards.

By encouraging the staff to learn, either through studying or taking the required courses, the case company has been also able to create knowledge in an organic manner. Some of those types of knowledge for instance were 4-axis and 5-axis CNC machining, gear shaving, straightening and micro-crack detection.

In 2008, the case company acquired a plant in Sweden from one of its largest global customers that paved their way to gain production know-how of propeller shaft for commercial vehicles. This product turned to be a best seller product in the market that later even attracted global customers in South America and India market. This resulted in establishment of a green field plant in Brazil in 2012 and planning a factory in India.

Moreover, the company acquired a plant in Germany that enabled them to produce gear components as well as being able to transfer gear manufacturing know-how where required.

4.2. Knowledge transfer projects

Apart from the technological development of the case company, three KT projects were also studied. The first KT project was the production of gearbox components in Brazilian plant. The goal of the project was to establish a production line with the potential annual capacity of about 20,000 gears and shafts in this plant. The required knowledge was running and maintaining a production line including the processes of turning, milling, gear hobbing, gear shaving, gear shaping, broaching, washing, and measurement systems. The project was planned to be conducted in three years from the nomination of the supplier up to the start of production. The knowledge required to run and maintain production line was mainly transferred by a few managers and engineers that travelled from Swedish headquarters plant to the Brazilian plant. Moreover, knowledge regarding a coating process (phosphating) was acquired through a recently recruited heat treatment expert.

In the second KT project, the goal was to transfer the gear manufacturing knowledge of two components called planet gear and sun gear from the Swedish headquarters plant to the subsidiary plant in Brazil. Some processes that were transferred were gear cutting and heat treatment. The length of the project was primarily planned one year; however, due to some deviations and miscommunications, it took more than expected.

The third project was about disseminating the specific production system (XPS) of the company [42] and how it was implemented in the plants of the network. The case company had a training program for the plants that was implemented in three levels. The plants were qualified and certified according to those levels. The project duration varied from a plant to another. However, on average it took three years to achieve an acceptable level of the company's specific production system.

5. DISCUSSION

Our results refer to several flows of knowledge within and outside of an IMN (See Figure 2).

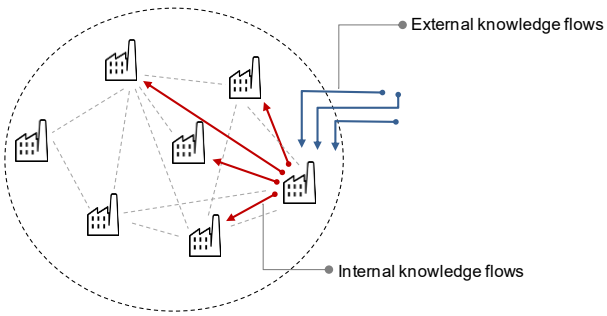

Figure 2- Internal and external knowledge flows in an IMN

To provide a clear and practical insight, we have classified the knowledge flows into two categories: (1) internal and (2) external.

From the analysis of the data regarding the type of knowledge being transferred within a firm, it was revealed that internal knowledge i.e. the knowledge that flows within the borders of an IMN includes:

- The culture, working "way" and specific production system (XPS) of a company mainly from the headquarters plant to other plants of a network
- The production know-how that is either created in a plant or transferred from the lead factory [43] to other plants which require such knowledge
- The administrative knowledge, mainly including the working routines, daily information and news

On the other hand, there are some channels by which knowledge is transferred to an IMN externally. The external knowledge flows identified in this study are:

- The production knowledge and know-how
- Knowledge regarding market trends and upcoming technologies
- Considerable knowledge brought in by recruited experts such as production know-how and competitors' strategy

- Knowledge regarding working methods, business regulations, offshore plants, and so on from inter-organizational partnership or alliance
- Knowledge regarding the raw material, product design and its interface with production process brought to the company
- Knowledge gained from the plants that join the company via mergers and acquisitions (M&A) process.

The results are elaborated and presented in Figure 3.

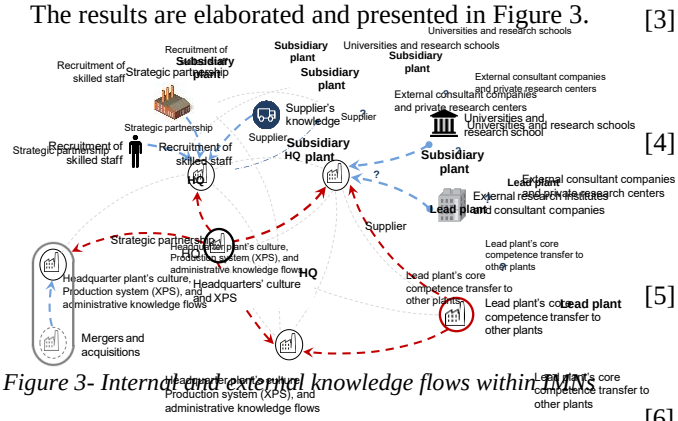

Figure 3- Internal and external knowledge flows within IMNs

As illustrated in Figure 3, the sources of internal knowledge flows are:

- Headquarters plant
- Subsidiary plants
- Research initiatives within the firm
- Trained and educated personnel

Similarly, the sources of external knowledge flows are:

- Universities and governmental research institutes
- Consultant companies
- External experts entering the company
- Merged or acquired plants
- Strategic alliances and partners
- Suppliers and customers

6. CONCLUSIONS

I this paper, we studied a network of a manufacturing company based in Sweden. The goal of the paper was to provide some insight to different knowledge flows within and outside of an IMN. Identification of those flows is the first step towards:

- Mapping the existing knowledge and identifying the knowledge gaps
- The effective management of knowledge flows
- Exploiting the knowledge in line with a firm's strategy

Our results refer to diverse knowledge flows and put them into straightforward classification including internal and external categories as well as elaborating the knowledge types which flow within and outside of an IMN.

The results of this study could be used as an input to a more comprehensive framework dealing with the whole process of KM for an IMN. Nevertheless, our results are based on a limited number of cases of one IMN. To be able to generalize the results and increase the validity, there is a need for wider research including more cases.

Also, we investigated the knowledge flows without considering the characteristics of the transferred knowledge. As prospective research path, one could look deeper into identifying the characteristics of knowledge to be transferred.

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