THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Knowledge Dissemination in Multinational Corporations

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Göteborg, Sweden, 2013

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Knowledge Dissemination in Multinational Corporations
- Exploring Factors that Influence Knowledge Dissemination in Product Realizing MNCs

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Abstract

Today's globalization trend in industry is of major importance for world economy. One effect of the globalization trend is that international companies are exposed to a broadened knowledge base. A major competitive advantage for a multinational corporation (MNC) is its ability to utilize knowledge that is situated at the different locations. Thus, in order to improve and manage the utilization of knowledge within MNCs, it is necessary to try to get a better understanding of factors that influence knowledge dissemination (KD). Therefore, the overall research purpose of this thesis is to explore factors that influence KD in product realizing MNCs. Three research questions have been formulated and a research model of KD consisting of five components (Actors, Content, Media, Context, and Activity) has been developed in order to specify and fulfill this purpose. The five components are used to group previously identified influencing factors.

The primary research strategy has been to use case studies. The main empirical data stem from five studies of Swedish product realizing MNCs performed over a 13-year period. Three were case studies performed at Volvo Car Corporation. The fourth was a multiple case study including four other MNCs. In addition to this, one survey has been performed, where the respondents were representatives from R&D units at 18 MNCs.

The findings regarding the first research question (*How can an introduction of IT-based media for KD affect product and production verification processes?*) suggest that the use of IT-based media has a negative influence, directly or indirectly. Several of the factors associated with the component Actors are found to have a negative influence on KD. However, regarding Content, mainly negative effects have been observed due to information overload effects. The observed effects are mixed for the component Media. Positive effects, such as the possibility for actors to revisit and secure their original interpretations thanks to the use of data bases and e-mail, have been observed. This is particularly relevant within time zone separated MNCs. Negative factors include the information overload aspect as well as de-contextualization. Therefore, concerning Context, language distance exhibits the characters of an obstacle or an inhibitor depending on which level of IT-maturity the involved actors display. The mechanisms displayed when a common "computer"-language is

introduced are similar to the one's displayed when bi-lingual intermediaries are used or when intra-organizational boundaries are bridged thanks to temporary project constellations. Thus, with Activity, it is clear that the introduction enables companies to start the KD process earlier. The results for a local geographical setting indicate that there is an inhibiting effect on KD. However in the MNC setting, this introduction seems to provide an opportunity for virtual socialization, positive for KD.

The findings regarding the second research question (*How can an increased use of IT-based media affect KD in the interface between Product Development and Manufacturing?)* suggest that IT-maturity is highly relevant for the Actors. However, the obstacle-like character of IT-maturity implies that this aspect should be included in the recruitment processes in order to secure a high IT-maturity in parts of MNCs where this is not obvious, while for Media, the increased use is a facilitator. This is particularly clear for actors with lower degrees of IT-maturity. However, for Context, overarching organizational solutions (such as boundary-bridging projects) increase trust, which is positive for KD. It has also been shown that several of the factors considered crucial in order to achieve efficiency in the PD / manufacturing interface are influenced in positive as well as in negative ways.

Therefore, regarding the third research question (*How can factors be classified to enable management of – and influence - KD?)* a categorization of factors, focusing on their relative impact on KD, has been developed. This categorization comprises Facilitators (which have a positive impact on KD), Inhibitors (which have a negative impact on KD), and Obstacles (factors that obstruct KD until certain conditions or levels are fulfilled). The analysis indicates that several factors, influencing KD in the local - national and co-located - verification setting, are also present in the expanded multinational setting. Furthermore, there is evidence that several factors are applicable on multiple interaction levels.

Keywords: Knowledge dissemination, knowledge transfer, knowledge sharing, MNCs, product realization, influencing factors, facilitators, inhibitors, obstacles.

List of publications

This dissertation includes summaries of the following five papers, which are also appended in full. The papers will be referred to in the text by Roman numerals as follows:

PAPER I

Paulin, D. and Almgren, H., (2001) "Virtual Development and Verification of Products and Processes - Current Trends and Challenges in the Automotive Industry", Presented at the 16th International Conference on Production Research (ICPR-16), Czech Technical University, Prague, Czech Republic, 28 July – 3 August 2001.

PAPER II

Paulin, D., (2006) "The Effects on Knowledge Creation and Transfer in Production Process Verification due to Virtual Prototypes", *The Electronic Journal of Knowledge Management*, Vol. 4, No. 2, pp. 181-188.

PAPER III

Paulin, D. and Suneson, K. (2012) "Knowledge Transfer, Knowledge Sharing and Knowledge Barriers – Three Blurry Terms in KM", *The Electronic Journal of Knowledge Management*, Vol. 10, No. 1, pp. 81-91.

PAPER IV

Paulin, D., "Communication Channels and Knowledge Carriers within International Engineering Companies - Their Relation to Knowledge Sharing and Cooperation"

Accepted (2012) for publication in *Knowledge Management Research & Practice*.

PAPER V

Paulin, D. and Winroth, M., "Facilitators, Inhibitors and Obstacles: A Refined Categorization Regarding Barriers for Knowledge Transfer, Sharing and Flow"

Submitted (2013) for publication in an international journal.

Preface

When I began my PhD-studies during spring 1999, I could not foresee the chain of events that has influenced my research process. It has been a long and enduring task affected by the foreseeable and unforeseeable events that constitute life, and without these events this thesis would have been quite different. They have influenced my methodological choices and views. They have also created possibilities and put restraints on the way I have performed my research. It is for this reason that I want to give you a glimpse of the background of how this thesis has come about.

Thesis topic

The choice to study knowledge management aspects of the product realization process grew out the initial studies performed at Volvo Cars during the end of the 1990's. They have been presented in my master thesis (Palmqvist and Paulin, 1998) and in Paper I. The focus during those studies was primarily on the quantitative outcomes in terms of cost, time and quality related measurements of the introduction of a new product into an existing manufacturing process. This focus was very much in line with the normative, causal and digital way of looking at the world that came out of my background as a mechanical engineer. One of the underlying factors influencing the outcome in these early studies was the methods that were used to transfer knowledge from the R&D-engineers to the assembly workers. My initial studies indicated that this factor was powerful and had a strong economic potential, and this is why I became more and more interested in the method related factors. One of the central aspects of introducing new work methods was, in my opinion, related to knowledge transfer. The final study that I made during the licentiate phase was focused on the effects on knowledge transfer that this transition from physical to virtual prototypes in the product and process verification process. One of the directions for future studies presented was to study the effects that the new work method had on learning activities when other influencing factors came into play. The effects due to language and/or cultural barriers within verification teams or between verification teams (the knowledge creators) and the receivers of the knowledge (for example, suppliers or own employees abroad) were highlighted as two important examples.

After receiving my licentiate degree I applied for a teaching position at Chalmers Lindholmen (CHL). I have always had an interest in teaching and this new position enabled me to develop my understanding for the teaching/learning situation. The teaching situation at CHL

also meant that I could broaden the field in which I was teaching from solely courses in Operations Management to courses in behavioral science, marketing, quality sciences as well as more specialized courses on prototyping. This expansion has resulted in that my view of the research area has widened which in turn has given me insight into new perspectives, thus enabling a more holistic understanding. The move to CHL has also meant that my foundations have been shaken thanks to my colleague and co-author on Paper III and two additional papers not included in this thesis. Kaj comes from a different, more critically oriented research background. His constant questioning has influenced my having a more critical view, while at the same time, our research interests have converged towards knowledge related issues. The more one-dimensional and engineering-oriented perspective of knowledge transfer has turned towards the more multi-dimensional and equal perspective that knowledge sharing constitutes.

A year later I became involved in the postgraduate education activities at Chalmers Advanced Management Programs (or CHAMPS). There, I have had the opportunity to meet smart and generous professionals from different companies, industries and countries who have influenced my view of the truth in the normative and theoretical perspective that I had taken. Their descriptions of the practical challenges that managers in industry face on a daily bases has influenced my view of the truth. At the same time they have also provided me with other mind opening discussions as well as new research opportunities. The studies that led to Papers IV and V have been facilitated by my connection to participants in the CHAMPS programs. My involvement in the CHAMPS programs has also had the additional benefit of a resolved research funding situation. The international perspective has become much more relevant and natural to study thanks to this involvement, and thereby both the linguistic and cultural aspects on this issue. The manufacturing perspective has, at the same time, prevailed thanks to the involvement in the International Management of Production (IMOP) program.

During my later studies, I have been guided by a belief that knowledge is something that cannot be transferred (in other words; to be passed on, and away from, someone to someone else), but only shared and disseminated between individuals in organizations. This view has had an influence on the way the research studies have performed, which you will see in the method chapter.

Research methods

My master thesis tutor, and co-author on Paper I, introduced me to a rather practical way of performing research. It consisted of doing observations, taking measurements, performing semi-structured interviews as well as informal discussions with people who were doing their jobs related to the introduction of a new car model. One of the most important things to do as a PhD-student was to be actively present at the research object. Later, I became aware that this approach could be labeled "a case study". During the latter phase of my studies I have taken the opportunity to pursue other methods in line with what the research questions have permitted. The survey performed for Paper IV was an attempt to create a broader, more general understanding of the studied phenomena. The structured interviews and the extended time frame for the studies resulting in Paper V have also been one conscious way in which to create a better understanding of the thesis topic.

Additional academic publications

I have written and contributed to four publications in addition to this thesis and the appended papers. Since they are a part of my academic development leading up to this thesis they are mentioned here in chronological order

The first academic paper that I was involved in (Paulin and Lindér, 2001) preceded Paper I. I was the lead author and my initial supervisor was co-author. The purpose of that paper was similar to Paper I, and Paper I can be regarded as a deepening of the arguments and results from this paper. The empirical studies were performed in 1998-2000. It was presented at the 12th Annual Conference of the Product and Operations Management Society (POMS-2001).

The second publication was my licentiate thesis (Paulin, 2002) in which the previously mentioned paper and Paper I was appended. The focus in the covering paper was knowledge transfer and Paper II (Paulin, 2006) is a development of this covering paper. The empirical studies were performed in 1998-2001.

The third publication was a paper titled "Virtual Reality as a New Tool in the City Planning Process" (Sunesson *et al.*, 2008b) and was related to experiences of the user of an advanced technology (VR) during evaluations of architectural proposals. I was third author and contributed by performing parts of the empirical investigations (mainly interviews with individuals involved in the evaluation process) and a minor part of the paper writing. I also contributed to the presentation of an earlier version of this paper presented at the 13th International Conference on Virtual Systems and Multimedia (VSMM'07).

A derivative from the third paper was presented at the 12th International Conference on Knowledge-Based Intelligent Information and Engineering Systems (KES 2008) and is published in the conference proceedings (Sunesson *et al.*, 2008a). The two final publications are based on studies performed during 2007 and 2008.

And a final "preflection"…

The discussion on what constitutes knowledge has been ongoing at least since the time of Socrates and Plato, and in Aristotles (n.d.) *Nicomacean Ethics,* the five virtues of thought are presented. These virtues can be connected to knowledge categories. Schwartz (2006) presents them in the following way:

Epistémé: Factual of scientific knowledge

Téchné: Skills-based technical and action-oriented knowledge

Phrónésis: Experiential self-knowledge or practical wisdom based on experience

Noûs: Intuition

Sophia: Theoretical knowledge of universal truths or first principles

However, in the following writings on knowledge dissemination and influencing factors, distinctions in line with Aristotle's virtues will not be made. But this research can hopefully be described as "studies of epistémé, téchné and phrónésis influenced by the authors' noûs leading to sophia".

Acknowledgements

All my colleagues in the EDIT-I-team – Wolfgang Ahrendt, Samuel Bengmark, Jörgen Blennow, Patrik Jansson, Peter Lundin, Lena Peterson, Manne Stenberg and Cecilia Åberg. Thank you for your support and your continuous strive for excellent education at Chalmers.

My supportive and motivating colleague from Chalmers Lindholmen, Technology and Society and Operations Management - Kaj Suneson. Next time it is your turn! After that we will have time for real education development…

My other supportive and motivating colleague at Chalmers Lindholmen - Susanne Kullberg. Great thanks for your encouraging everyday support!

All my friends – I've finally finished my book!

My loving parents - Ilme and John - and my big brother - Mats. Thank you for your continuous support!

My amazing kids - Moa, Erik and Tuva. You are an inexhaustible source of joy, frustration and laughter. I love you so much!

My fantastic wife – Irene. Thank you so very much for helping me to realize this goal. I love you with every beat of my heart and every winding of my brain!

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1 Introduction

1.1 Research problem area

Knowledge is, by many, regarded as a strategic asset of firms in line with the reasoning by Spender (1996) on the knowledge-based theory of the firm, and by Teece (1998) on the essence in capturing value from knowledge assets. Thus, in order to take advantage of this potential economic resource and to achieve a sustainable and beneficial competitive advantage, knowledge management is proposed as a suitable solution (e.g. Drucker, 2001). Discussions regarding knowledge management (KM) issues have been intense during the last fifteen years and numerous ideas, theories and models have been presented from several different perspectives.

There is, at the same time, a clear globalization trend in industry today and efficient international relations are of major importance for world economy. One effect of the globalization trend is that international companies are exposed to a broadened knowledge base and, for companies based in countries and regions with high wage levels and limited local markets, it is particularly important to strive for good international relations in order to broaden the manufacturing base as well as their potential customer base. A major competitive advantage for a multinational corporation (MNC) is its ability to utilize knowledge that is situated in the different locations (Zander and Kogut, 1995; Gupta and Govindarajan, 2000) and both knowledge transfer and knowledge sharing have specifically been identified as critical for organizations to create and sustain competitive advantages (Lee and Wu, 2010; Anantatmula and Kanungo, 2010).

Here, the following two definitions are used: Knowledge transfer is defined as "an exchange of knowledge in which the focus is on structural capital (knowledge that has been built into processes, products, or services) between groups, within organizations and between organizations" (McKinnell Jacobson in Schwartz (2006), Chapter "Knowledge Sharing Between Individuals", section "Key Terms"). Knowledge sharing is defined as "an exchange of knowledge between two individuals: one who communicates knowledge and one who assimilates it. Moreover, in knowledge sharing, the focus is on human capital and the interaction of individuals. Strictly speaking, knowledge can never be shared. Because it exists in a context; the receiver interprets it in the light of his or her own background"

(McKinnell Jacobson in Schwartz (2006), Chapter "Knowledge Sharing Between Individuals", section "Key Terms").

Since both terms have been identified as critical at the same time as they sometimes are used synonymously (Paulin and Suneson, 2012), an overarching term is utilized in this thesis. This thesis will define the term *knowledge dissemination* as:

A collective term encompassing both knowledge transfer and knowledge sharing.

There are alternative definitions of knowledge dissemination. According to Hutchinson and Huberman (1994, p. 28), the most common definition is "the transfer of knowledge within and across settings, with the expectation that the knowledge will be "used" conceptually (as learning, enlightenment, or the acquisition of new perspectives or attitudes) or instrumentally, (in the form of modified or new practices.)". The area of use for this definition is within science and mathematics education. There are alternative definitions used within health care research, research on economic geography and other areas. Generally, the term is applied on an inter-organizational level. However, there are few applications of this term within the knowledge management area, especially on intra-organizational or group levels.

However, in order to create and sustain competitive advantages through dissemination it is essential to firstly understand what knowledge is, secondly to understand what knowledge should be utilized for, and thirdly what influences knowledge dissemination. These issues will be addressed in the upcoming sections. Initially, research streams on multinational corporations are briefly presented in order to set the stage for the knowledge dissemination to take place.

1.2 Research streams on multinational corporations

The classification of multinational corporations by Bartlett and Ghoshal (1989) is adopted in this thesis. A corporation needs to fulfill the following two criteria to be classified as a MNC: They need to have substantial direct investments in foreign countries, not just an export business. They also need to be engaged in the active management of these offshore assets rather than simply holding them in a passive financial portfolio.

There is an abundance of literature on multinational corporations (MNCs) in business research today, and the ongoing globalization trend has increased the interest even more. There are several research streams that are related to MNCs. Therefore, in this section,

some of the streams are introduced in order to assist the reader in developing a basic understanding of the different aspects that can influence knowledge dissemination in MNCs.

Paterson and Brock (2002) present a thorough review of this field when they summarize four research streams on MNCs: the strategy-structure, the head-quarters-subsidiary relationship, the subsidiary role, and the subsidiary development stream. Similar views can be found in KM, which is why they are introduced followed by examples of related KM literature.

A key concern in the strategy-structure stream was that corporations needed more flexible structures than the old hierarchical setting if they would be able to cope with increased global competition. One of the most prominent contributions from this stream is the Bartlett and Ghoshal (1988) concept - the transnational corporation. A transnational corporation has built flexible central and local management capabilities, linked these capabilities in an organization that can "think globally and act locally" (Bartlett and Ghoshal, 1988; p. 73). Literature in the KM field is closely related to the strategy area insomuch that contributions such as Bartlett and Ghoshal (1989) and Gupta and Govindarajan (1994) can be included.

Moreover, in the headquarters-subsidiary relationship stream issues on centralization and decision-making were in focus. The basic idea was that headquarters should be able to use the subsidiaries to the utmost, while simultaneously allowing the subsidiaries to have certain autonomy and influence. Thus in some situations headquarters might even need the involvement of the subsidiary during decision-making (Hedlund, 1994). There were, in other words, indications that relations between headquarters and subsidiaries were reciprocal to a higher extent than was depicted in the strategy-structure stream. KM literature is again so closely related to the strategic perspective that, for example, the contributions by Hedlund (1986; 1994) are used as a point of departure in many paper introductions.

The subsidiary role stream focused on the subsidiary and dealt more peripherally with the headquarters. Furthermore, within this stream we find, for example, literature dealing with centers of excellence (CoE), which from a KM perspective can be characterized as islands of unique resources. Bartlett and Ghoshal (1986) took a similar position when they focused on how the corporation could capitalize on these resources. More recently, there was a debate as to whether the benefits associated with a CoE outweigh the costs and decentralization of resources that follow. Here, we find contributions in the KM field (e.g. Foss and Pedersen, 2004; Adenfelt and Lagerström, 2006). This stream could also be connected to the KM literature regarding knowledge hoarding (e.g. Wolfe and Loraas, 2008; Milne, 2007).

The subsidiary development stream deals with "[t]he concept of a subsidiary developing on the basis of its own strategic decisions" (Paterson and Brock, 2002; p. 147). Here, focus on the subsidiary increases even further. However, in some of the contributions to this stream (e.g. Birkinshaw, 1998; Solberg, 2000), there is an awareness of the need for balance between the headquarters and the subsidiary. KM literature related to this stream can be exemplified by Noorderhaven and Harzing (2009) in which they study the relation between knowledge sharing and social interaction, and find that social interaction shows a considerable effect on all intra-MNE[1] knowledge flows. Another relevant contribution is Schulz (2003) who studies inflows of knowledge from peers and supervising units into subunits of MNCs, and finds that knowledge flows from large knowledge bases along established ties to locally responsive knowledge bases.

1.3 Knowledge

This section introduces relevant issues relating to knowledge.

1.3.1 Views and conceptualizations of knowledge

A commonly discussed way of conceptualizing knowledge is to look at it in combination with data and information. Davenport and Prusak (1998) state that these three concepts are not interchangeable, while Tsoukas (2004), who assumes a constructivist view, regards them as part of a continuum with increasing human involvement and judgment. Here, definitions of the three concepts are given to provide the reader with a starting point for the upcoming discussions.

Data is defined as a set of "discrete, objective facts about events" (Davenport and Prusak, 1998, p. 2). Data are normally structured, but they do not contain any information on how to use them in a particular context (Chini, 2005). They are the raw material possible to process, but since they do not give any hints on how to use them they can be regarded as being of limited use. Nowadays, data is normally stored in some kind of IT-system and, with the abundance of data available in organizations today, problems of information overload may arise.

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[1] MNE stands for Multinational Enterprise, an extension of the MNC.

Thus, in relation to data, information can be said to possess one additional component, namely significance (Davenport and Prusak, 1998). Information is in other words data that are considered valuable for the user.

Moreover, if the terms data and information are relatively clear-cut when it come to their definitions, this cannot be said for knowledge. Here again, the starting point is taken in the wordings of Davenport and Prusak (1998; p. 5):

"Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms."

There is debate as to whether the final sentence in the quote is relevant and true. There are authors that advocate that there is no such thing as organizational knowledge but that knowledge only exists in individuals and is related to the context in which it is applied.

1.3.2 Knowledge: An object or a subjective contextual construct?

Another way of conceptualizing knowledge is through its properties. Sveiby (2007) identifies two opposing views in literature today: knowledge as an object and knowledge as a subjective contextual construct.

Sveiby (2007, p. 1638) presents the object oriented view of knowledge as common within management, with variants such as knowledge: "contained in stock (Gupta and Govindarajan, 2000; Foss and Pedersen, 2002), derived from its form of content (Szulanski, 1996; Dixon, 2000; Schlegelmilch and Chini, 2003) or as objects implicitly defined by the choice of variables for statistical analysis (Cummings, 2004; Hansen, 2002; Hansen *et al.*, 2005; Tsai, 2001; Simonin, 1999)". This seems especially true for literature from the strategic management domain and from literature related to the knowledge-based theory of the firm (e.g. Grant, 1996; Spender, 1996; Teece, 1998). One consequence of this view is that knowledge can be packaged, stored and retrieved with relative ease (even though it still is regarded as a resource that is difficult to copy and therefore suitable to build sustainable competitive advantages on). This view has also had an effect on the terminology when knowledge transfer and sharing are used, which will be presented when the two terms are introduced.

An opposing view originates from Polanyi (1958) and holds an alternative ontology and epistemology. His view was that knowledge cannot be separated either from its context or from the individual holding it, and that it is constructed in a social context. This view is supported by several authors of whom Nonaka and Takeuchi (1995) and Sveiby (2007) are most relevant for this thesis.

One deviant interpretation of Szulanskis position is suggested when Chini (2005) expresses that *stickiness* (a concept initially researched by Szulanski (1995) and von Hippel (1994)) leads to decreased knowledge transferability. This interpretation can be seen as an intermediate position between the two views.

A final contribution of relevance for this discussion comes from Blomberg and Werr (2006). They identify four different approaches to inter-organizational knowledge work, alliances for learning, industrial networks, innovation / diffusion / clusters, and social networks. They identify the primary views of knowledge characteristics within these approaches and present these views in a comparative table. In alliances for learning, knowledge is objectified in line with the strategic management perspective presented earlier in this sub-section. For the other three approaches, Blomberg and Werr (2006) classify the general views as being more embedded in network relations and activities (the industrial network view), in persons and relations (the innovation / diffusion / clusters view), or in community (the social networks view).

1.3.3 Tacit and explicit knowledge

A third important partition within the notion of knowledge (or rather quality difference) originates from Polanyi's introduction of tacit and explicit knowledge (Polanyi, 1966). This partition is commonly used by researchers today and is therefore relevant to highlight. It should however be mentioned that Polanyi himself, states that every piece of knowledge contains explicit and tacit dimensions and that they are inseparable.

Explicit knowledge consists of some sort of systematic language and it is codified through words, numbers, and codes (Hedlund, 1994). This codification leads to the possibility to transfer. However, at the same time, it can be regarded as an interpretation by the codifier.

Tacit, or implicit, knowledge is the un-articulated, intuitive, and non-verbalized knowledge (Hedlund, 1994). Since it is tacit, it is difficult, but not impossible, to formalize. At the same time Zack (1999) argues that this is what creates competitive advantages. Zack applies the

concept to the business world, but there are no real reasons why this should not be applicable to other levels. On the contrary, there are authors (e.g. Bock *et al.*, 2005), who claim that knowledge sharing is hampered by individuals, who want to sustain the competitive advantages, which they possess through their tacit knowledge base.

One of the most prominent and influential theoretical models including this nomenclature was presented by Nonaka and Takeuchi (1995) in their theory on knowledge creation. Here, they separate the two notions clearly from each other creating boundaries between them. For example, while tacit knowledge is regarded as analogue and practice, explicit knowledge is defined as digital and as theory. This interpretation with clear distinctions has been criticized by authors that refuse to see this division and that claim that the two concepts are much more blurred than that. Shin *et al.* (2001) propose that tacit knowledge is given too much importance.

1.3.4 Interaction levels

A fourth classification of relevance regards interaction levels. Therefore, the definition of knowledge, the debate on individual and/or organizational knowledge has already been indicated. Here, a classification proposed by Choo and Neto (2010) is introduced.

The highest level of interaction is inter-organizational. Typical examples of studies on this level are studies on networks (e.g. Kreis-Hoyer and Gruenberg-Bochard, 2005; Mentzas *et al.*, 2006; Ahmad and Daghfous, 2010), alliances (e.g. Tezuka and Niwa, 2004), and within certain businesses (e.g. Appleyard, 1996; Gottschalk and Khandelwal, 2002). At this level there are empirically based papers suggesting that inter-organizational knowledge transfer supports, for example, improved profitability (Zahra *et al.*, 2000; Sorenson(2003), new product development (Tsai, 2001; McEvily and Chakravarthy, 2002), and improved product quality (Tsang *et al.*, 2004). The second level is organizational or intra-organizational. Here, studies of individual companies are predominant. This includes studies within MNCs and a central area of research here are headquarter – subsidiary relations (e.g. Bartlett and Ghoshal, 1989; Gupta and Govindarajan, 2000; Zander and Kogut, 1995; Foss and Pedersen, 2002; ibid, 2004; Adenfelt and Lagerström, 2006). The third level is group. Studies here are often related to teams and different aspects thereof (e.g. Postrel, 2002; MacNeil, 2003; Vithessonthi, 2008). The fourth and final level is individual. Here, we find papers on issues like motivation (e.g. Bock *et al.*, 2005), reputation (e.g. Ensign and Hébert, 2010), and trust (e.g. Holste and Fields, 2010).

Few studies deal with multiple levels. Here, examples are inter-organizational - organizational levels (van Wijk *et al.*, 2008; Cummings, 2002; Cummings and Teng, 2006) and group – individual levels (Haas and Hansen, 2007; McNeish and Mann, 2010). Moreover, in order to obtain a holistic view of knowledge dissemination within and between organizations it could be argued that multiple level studies are important and that additional studies would be relevant.

1.3.5 Utilization of knowledge

Furthermore, knowledge in itself is not important to most people in business and industry. However, there are plenty of situations where knowledge is essential to organizations that have the overall objective of making money through sales of innovated or developed products. Therefore, it is commonly known that it is of the essence to develop new products as inexpensively and quickly as possible, while still meeting and exceeding customer demands (Johannesson *et al.*, 2004), for companies that are involved in product realization and that are exposed to market pull. Thus, in order to realize a product there are many activities that need to be performed. An overall term for the entire chain of activities required to develop and produce a product is product realization process (PRP) (Poli, 2001; Gabrielsson, 2002). Poli (2001, p. 3) defines a product realization process as "the set of cognitive and physical processes, by which new and modified products are conceived, designed, produced, brought to market, serviced, and disposed of."

However, in this thesis, the terms "production" and "manufacturing" are interchangeable and the definition used here is based on the definition provided by The International Academy for Production Engineering (CIRP) of manufacturing production: "the act or process (or the connected series of acts or processes) of actually physically making a product from its material constituents, as distinct from designing the product, planning and controlling its production, assuring its quality" (CIRP, 1990, p. 736). Moreover, in this thesis it is not only the act of process of making a product, but also the organization responsible for performing this act or process and the individuals associated with that organization. Many authors have proposed similar and other solutions to manage knowledge within (e.g Nonaka and Takeuchi, 1995) and between companies (e.g. Easterby-Smith et al., 2008). Academics as well as practitioners have been actively involved in discussions regarding KM and its support during product realization, but it seems that companies have difficulties in making use of the knowledge that is available (Bullinger et al, 1998 in Chini, 2005). , Here, there still seems to

be a need for research and development of practices despite there being a vastness of literature on the subject.

1.4 Research purpose

Furthermore, in this thesis, knowledge dissemination in product realizing MNCs is investigated, and in particular, factors that influence knowledge dissemination are studied. Since the number of potential influencing factors is very high, and that a complete mapping of all factors influencing knowledge dissemination would be too extensive to aim for in a thesis, it is necessary to focus on studying factors that are central within this type of companies. Therefore, in order to address this issue, the theoretical and empirical studies of this thesis focus on exploring knowledge dissemination in different multinational industrial settings. The overall research purpose is to:

> *Explore factors that influence knowledge dissemination in product realizing MNCs.*

1.5 Outline of the thesis

The outline of the thesis is presented in this section, and should be regarded as a guide for the reader. This thesis consists of a frame and five appended papers.

Chapter 2 presents a theoretical overview (or frame of reference) covering areas within knowledge management that are regarded as particularly relevant for this thesis, and the organizational interface studied. Three research questions are formulated at the end of this chapter.

Chapter 3 presents the scientific approach and the methods used during this research process.

Chapter 4 includes a description of how each of the appended papers contributes to the thesis.

Chapter 5 shows you the analysis of the three research questions followed by a discussion about the findings and practical implications connected to the findings.

The final chapter will present conclusions, main contributions from this thesis, implications for practitioners, and suggestions for future research.

2 Theoretical overview and research questions

An exploration of relevant academic literature is necessary in order to identify and formulate relevant research questions, and to meet the objective in this thesis. This section mainly contains a review of literature on knowledge related topics. Initially a review of literature on the product realization processes and the product development – manufacturing interface is presented. Chapter 2.2 will give a brief discussion on knowledge dissemination. Chapter 2.3 starts with the presentation of four contributions important in order to understand knowledge dissemination (KD), followed by a section covering relevant studies within parts (here called components) of knowledge dissemination. After that, the research model utilized in this thesis in presented. The research model consists of five components and is based on the aforementioned four contributions, after which a compilation of factors influencing knowledge dissemination will follow. The chapter ends with a presentation of the research questions.

2.1 Product realization processes

There has so far been an understanding of the importance of knowledge in an organization. Some people regard knowledge as a mean in itself. However most people in business and industry would reject that idea and strongly stress that knowledge is only important in order to support the overall objectives of their organization. For organizations that have the overall objective to make money through sales of innovated or developed products there are plenty of situations where knowledge is necessary. Sometimes that knowledge is not available when and where it is needed or desired. This section shows the context in which knowledge dissemination is important. There are many activities that need to be performed in order to realize a product,. An overall term used by Gabrielsson (2002) for the entire chain of activities required to develop and produce a product is a product realization process (PRP). There are many other concepts available in literature, such as Integrated Product Development (Vajna & Burchardt, 1998), New Product Development and Design (Peters *et al.*, 1999), and Dynamic Product Development (Ottosson, 2004). There are also generic descriptions of product development models (Ulrich and Eppinger, 1995) and company-specific models that have reached public awareness, such as the Toyota Product Development System (Morgan and Liker, 2006).

According to the model proposed by Gabrielsson (2002), a product realization process consists of a number of building blocks (product development, production, support functions,

and other company-internal functions) as well as input, output, main collaborators, and customers. A refined model in presented here (see Figure 1) in which the term production is changed to manufacturing[2] and production development and additional feedback channels have been added, since this describes the process in a more relevant way.
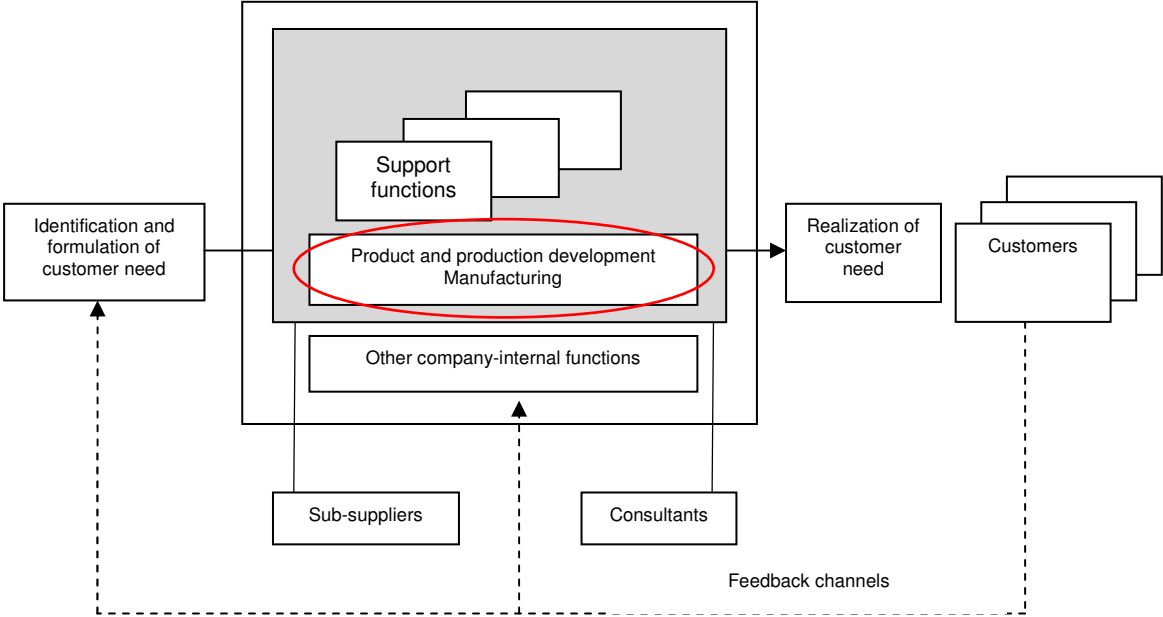
Figure 1: The product realization process (modified from Gabrielsson, 2002, p. 49) with the two central functions highlighted.

However, in order to support product development, functions such as IT, Quality and Process development, Production technology, Order handling and Pre-production engineering, and Supply Management are required (Gabrielsson, 2002).

Since the process consists of activities within and between several different units and sub-processes, there will also be interfaces of some kind. Some of these interfaces have attracted more attention (Technology development – product development) and others less attention (Product development – Production) (Ettlie, 1995). Ettlie also stated that empirical research in the area was limited and Vandevelde and Van Dierdonck (2003) a few years later

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[2] In this thesis manufacturing will be used henceforth, since the objects of research are manufacturing companies. The term production is understood as a wider concept including, for instance, production of services, which is not dealt with in this thesis.

were of a similar opinion. However, during the last decade this last area has gained more attention. Moreover, in a more recent research project, the interfaces within the product realization process have been in focus. Two interfaces were identified as being of particular interest: the interfaces between technology development and product development and product development and production respectively (Säfsten *et al.*, 2010). Central activities involving knowledge dissemination in the second of these interfaces are product and production verification activities (Paulin, 2002).

A survey was sent out to Swedish companies (Säfsten *et al.*, 2010) in order to find out which aspects that need to be managed in order to achieve efficiency in the two previously mentioned interfaces. The following aspects were among those six that were considered crucial: Early integration of production into product development, continuous communication between product development and production, the feeling of involvement in development projects by production, and that product development and production have the same target image. Other aspects deemed important for efficiency included sufficient information and learning aspects. Additional aspects that have been found to affect the product realization process are organizational and geographical separation, cultural and lingual differences, and difference in time zones between the units (Terwiesch *et al.*, 2001; Sosa *et al.*, 2002). Several of the aspects mentioned above are clearly related to knowledge dissemination, which is why the relevance of studies in both of these interfaces is high.

2.2 Knowledge dissemination

This section describes the concept knowledge dissemination (KD). Initially, key terms are presented, then theoretical models central to this thesis are presented. The third sub-section presents previous research regarding KD in MNCs is highlighted together with the research model. Finally, a compilation of factors influencing KD is presented.

2.2.1 Key terms

As initially mentioned, the overarching term knowledge dissemination (KD) used in this thesis consists of the two more commonly used terms, i.e. knowledge transfer (KT) and knowledge sharing (KS). However, in this section KT and KS will be addressed separately. The origins of those terms can be traced back to Plato and Aristotle, but the reemergence of the terms into management literature seems to come mainly from two directions. Firstly - and perhaps most significantly - through the writings of Michael Polanyi and his discussions on tacit and

explicit knowledge, the strategic management literature and Nonaka's (1994; Nonaka and Takeuchi, 1995) seminal work on knowledge creation. Secondly, from the product innovation and technology transfer literature where authors like Lawrence and Lorsch (1967), Allen (1977), and Clark and Fujimoto (1991) touch primarily on technology transfer[3]. Initially, the terms were used interchangeably (e.g. Badaracco, 1991; Hansen, 1999), but during the early 2000's, a separation between the terms could be seen. Some authors tried to show this separation by arguing that the concept of KS lies within the boundaries of KT (cf. Cabrera and Cabrera, 2005). Lately, the use of the terms seems to have converged again (Paulin and Suneson, 2012). Knowledge flow is a term related to KT and KS and Ribière (in Schwartz, 2006) proposes that it is regarded as a broader concept than KT and KS, while Kumar and Ganesh (2009) subsume knowledge flows and KS under KT. However, in this thesis the focus is on KT and KS. There is a lack of clarity in the use of the two terms KT and KS, which is why a clarification would be highly relevant for the conceptual apparatus within this field.

2.2.2 Theoretical models

Therefore, in several of the articles discussing KT or KS (e.g. Szulanski, 1996; Cummings and Teng, 2003; Chini, 2005; Liyanage *et al.,* 2009; Duan *et al.*, 2010), the view is influenced by a classical communications model originally presented by Shannon and Weaver (1949). The model (see Figure 2) originally described communication between machines (in telecommunications), but has been developed and adapted to other types of communications as well as KT and KS. It includes the following elements: An information source, a transmitter/sender, a receiver/recipient, a destination, noise/influencing factors, and context(s). Even though this model in its original version does not fully connect to an egalitarian view[4], it will be used as the basis for the reasoning here, since later interpretations and developments admit a more equal relationship between the sender and the recipient. This is due to the bidirectional flow necessary to ensure the understanding of each party involved. From a competitive advantage view, a bidirectional flow is also essential since this

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[3] Technology transfer is a narrower concept than knowledge transfer, since KT includes managerial, administrative and marketing knowledge besides technological knowledge (Simonin, 1999).

[4] Robertson and O'Malley Hammersley (2000) claim that a highly egalitarian environment is one of the main factors that contribute to the success of the knowledge-intensive firm they studied.

increases the knowledge base of the company. This has been highlighted in a number of articles (e.g. Mudambi, 2002; Schlegelmilch and Chini, 2003; Haas and Hansen, 2005; Napier, 2006).
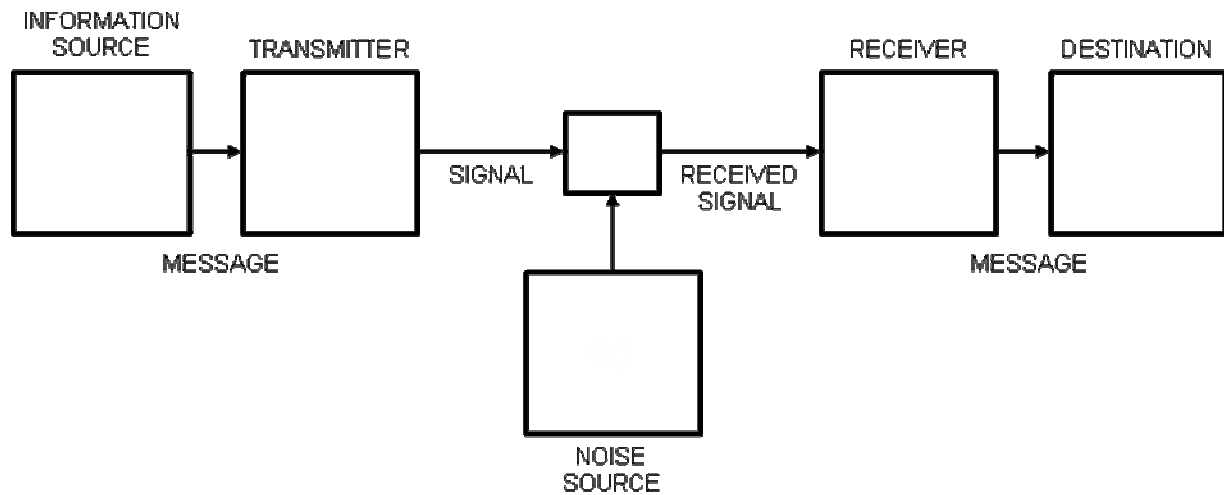
Figure 2: The original Shannon-Weaver communication model (Shannon and Weaver, 1949).

Lindkvist (2001) develops a linear communication model adapted for intra-organizational communication between R&D projects based on the Shannon-Weaver model. Moreover, in this model, he adds the element "media" in which the transfer takes place and a feedback loop to enable two-way communication. Lindkvist continues by identifying and categorizing forms of knowledge transfer followed by identification and categorization of hinders[5]. Finally Lindkvist analyzes the effect from the organizational design on the knowledge transfer process. His main findings are: 1) A categorization of hinder including individual, organizational and other hinders plus sub-categories under each main category, 2) The identification of both independent and dependent factors related to the knowledge transfer process Lindkvist refers to the independent factors as general hinders and the dependent factors as specific hinders. This contributes to this study by firstly including the bidirectional flow previously identified as important, and secondly to highlighting several factors relevant from a communications perspective such as motivation (an individual factor), organizational culture (organizational factor), and geographical and physical separation (other factors). Lindkvist's thesis is a central contribution to the understanding of KD.

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[5] Lindkvist uses the term hinder instead of barrier, but with a similar meaning.

The second important contribution was presented by Cummings and Teng (2003). This piece of research is based on a study of both domestic and international R&D partners and focuses on key factors affecting KT success. Their research model includes knowledge context, relational context, recipient context and activity context. They study nine key factors including articulability and embeddedness (parts of the knowledge context), organizational, physical, knowledge, and norm distances (parts of the relational context), transfer activities (included in the activity context), learning culture and priority (in the recipient context). They find that the following factors are statistically significantly related to KT success: Articulability (negatively related), embeddedness (negatively), knowledge distance (negatively), norm distance (negatively), and transfer activities (positively). This study contributes to this thesis firstly by including the importance of different contexts and secondly by identifying the character of the impact by the key factors (negative or positive influence).

The third important contribution was presented by Minbaeva (2007) relating to a study on knowledge transfer in MNCs. The focus here was KT from headquarters to subsidiaries, which is similar to the R&D to manufacturing relationship. Minbaeva 's view of KT differs from Lindkvist as well as Cummings and Teng in that she does not view KT primarily as a communication process, but as an effect of cost and benefits. The paper starts with a review of conceptual and empirical studies contributing to intra-organizational KT in MNC's and identifies over 90 determinants (or barriers) of KT. However, she does not present these determinants individually but classifies them into four groups building on the work by Argote (1999), and Szulanski (1996, 2000). The four determinant groups are characteristics of knowledge, characteristics of knowledge senders, characteristics of knowledge receivers, and characteristics of the relationship between senders and receivers. Minbaeva concludes that all four elements impact the degree of KT. Characteristics of knowledge is negatively related to KT, but not significantly so. The other three are positively related to KT in a significant way. This study contributes to this thesis firstly by the more resource-based view (KT as an effect of costs and benefits) than the previously mentioned studies. This provides an indication that regardless of the view, the elements and determinants are similar. Secondly, the effects on the degree of KT due to the overall variation in the grouped determinants are important to acknowledge, since this tells us that not only individual factors/determinants have an effect on KT.

The fourth highly relevant model dealing with KT was presented by Duan *et al.* (2010). They have studied transnational KT, in which they include KT in MNC's. They include actors, context, content and media in their four components affecting KT. These four components

consist of 24 identified, so-called associated factors. Among these 24 associated factors, the most relevant ten factors were identified by an expert panel. These ten factors were cultural awareness, motivation, knowledge distance, trust, openness, relationship, selection of appropriate partners, objectives and focus, language and transfer channel. This study contributes with its more qualitative approach (the contributions from Minbaeva (2007) as well as Cummings and Teng (2003) originate from quantitative studies) indicating that certain factors are highly relevant regardless if the research design varies.

Even though these studies complement each other regarding views on KT (communication process or a more resource-based view), and the way the studies were performed (qualitative or quantitative), they do not extend to a holistic perspective encompassing both KT and KS. Therefore, in order to enable such a holistic perspective, the previously identified contributions are synthesized. When this is done, five components are central: Actors (which includes both sender and receiver), Content, Context, Media and Activity, and in the following section, previous research regarding these components is presented.

2.2.3 Knowledge Dissemination in MNCs and the Research Model

Since there are numerous articles published on KT and KS, this compilation of relevant literature focus primarily on KT and KS in MNCs. Several authors have performed in depth literature reviews on these terms (e.g. Chini, 2005; Kumar and Ganesh, 2009; Duan *et al.*, 2010). This compilation will expand and complement their reviews.

The first body of knowledge is related to the component Actors [6]. An early contribution affecting this area comes from Attewell (1992) who objects to the traditional communication model (Shannon and Weaver, 1949) in which the transfer activity can be affected by disturbances (or noise as Shannon and Weaver use) but comes through anyway. Attewell (1992) uses the term knowledge barrier to depict an obstacle, which cannot be overcome other than through time. The obstacle is due to insufficient technology knowledge of the receiver. Here we also find contributions like Hansen (1999) in which he investigates the role

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[6] Examples of terms used instead of actors include agents, parties, source and recipients, and sender and receiver.

of weak ties in sharing knowledge [7]between units within a MNC and finds that weak inter-unit ties slow down projects when the knowledge to be transferred is highly complex. Tsai (2001) focuses on the effects of network position and absorptive capacity on KT, which in turn affect business unit innovation and performance. He finds that the interaction between two studied concepts has significant, positive effects on business unit innovation and performance. A third highly quoted paper is Foss and Pedersen (2002) who focus on the sources of potentially transferable knowledge in subsidiaries. Kalling (2003) addresses an area related to the more psychological aspects, namely motivation. He concludes that motivation affects cognitive factors and that management control routines and organizational context may substitute motivation if it is not in place naturally. There are also entire streams of research on headquarters (HQ) – subsidiary relations (e.g.Forsgren *et al.*, 1995) and subsidiary – subsidiary relations (e.g. Schleimer and Riege, 2009).

KS contributions related to Actors are, for example, when Michailova and Husted (2003) deal with three obstacles originating from individual behavior: knowledge hoarding, the not-invented-here syndrome (or NIH syndrome), and apprehensions about failures. According to Michailova and Husted there are two major reasons for knowledge hoarding. First, they believe that their personal value is decreased if they share knowledge with others. Second, sharing may cost the individuals too much, either due to the time spent on KS or the time it would take them to express tacit knowledge (or both). The NIH syndrome, introduced by Katz and Allen (1982) deals with resistance towards knowledge that is created elsewhere. One reason for this behavior is that it is more prestigious to create new knowledge instead of reusing "old" knowledge. Another reason is that people do not trust the quality of the shared knowledge or the source. This is supported by Szulanski (1996) during the examination on causal ambiguity in his study on transfer of best practices. The third dimension addressed by Michailova and Husted (2003) is individuals' apprehensions about failures. Organizational reality is not as idealistic and open as the organization would like them to be in order to optimize knowledge sharing. However, in many cases, individuals bury and consciously keep failures from their environment in fear of getting punished for the mistake. Another aspect on actors is addressed by Cabrera *et al.* (2006) who show that individuals that are more confident in their own ability to share useful knowledge are more likely to express their

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[7] Hansen uses the term "sharing knowledge" in his paper, but since he discusses knowledge dissemination between subunits within a MNC, it is classified within the KT area in this thesis.

intentions to share and to be involved in KS. Furthermore, in a study on shared knowledge, similarity of the national-cultural background, and similarity of organizational status, Mäkelä *et al.* (2007) argue that interpersonal similarity is one key driver for KS in MNCs. They also argue that knowledge flows better if homophily is established over organizational boundaries.

Additional to the mentioned areas, issues on trust can be related to actors or to context. Here, thesis trust is treated in the section on context.

The second body of knowledge is related to the component Content, which is transferred. Here, contributions regarding the type of knowledge can be found. Kang *et al.* (2010) conclude that knowledge that is more tacit, difficult, and important requires more effort to transfer. Pedersen *et al.* (2003) show that explicit knowledge is more likely to be transferred through written or electronic modes, while tacit knowledge should be transferred via rich communication media. They also conclude that in reality, this is seldom done. Furthermore, in their study on Danish MNCs they found that up to one third of all of the observed combinations (being choice of media combined with knowledge characteristics) were mismatches. Davis et al., (2005, p. 101) study KS at a large MNC and find that KM systems "need to the integrative and flexible enough to facilitate the dynamic interplay between different forms of knowledge across the space and time".

The third area is related to the component Media in which the knowledge is transferred. Gold *et al.* (2001) suggest that a knowledge infrastructure consisting of technology, structure, and culture along with knowledge process architecture are essential preconditions for effective KM. This study encompasses more than media and Gold *et al.* (2001) claim that it is important that a holistic perspective is adapted. Regarding media in particular, they put forward that information and communication systems can assist in integrating fragmented flows of information and knowledge. At the same time, they draw attention to the necessity to invest in a comprehensive infrastructure that supports the various types of knowledge that are critical. Lee and Wu (2010) indicate that IT can increase KT. They have a practical approach to the issue and propose that computer networks and such things as electronic bulletin boards and video technologies can enhance KT.

A foundational aspect regarding the component media in KS is the issue of technology. O'Dell and Grayson (1998) raise the discussion on the compatibility between individuals' needs and what the technology admits. Mismatches can create problems and unwillingness to use the systems that are available. Another issue related to the possibilities enabled by

information technology is information overload. Edwards and Wolff (2008) position "tackling information overload" as the #2 issue on their top-ten list in a study of the most important KM challenges faced by organizations and practitioners.. When it comes to the use of technology in supporting KS, McNeish and Mann (2010) conclude that technology is less effective for the sharing of tacit knowledge. A study that connects actors with media is presented by Jarvenpaa and Staples (2000) in which they conclude that actors propensity to share were significantly related to their use of collaborative media.

Wang and Noe (2010) outline understanding differences between interpersonal and technology-aided knowledge sharing as an under-researched area. Szulanski (2000) points at the importance of this kind of study, but there still seem to be a lack of studies within this area.

A differentiating take on media and KS can be found in a paper by Geiger (2010) on the role of argument and narration in KS. His study shows that narrative-based KS "encounters serious shortcomings and must frequently be supplemented by an argumentative mode of communication" (ibid, p. 291), even though narratives passed along by individuals are generally regarded as a favorable media (Patriotta, 2003).

The fourth body of knowledge is related to the component Context and the context in which knowledge transfer takes place. Therefore, in this area, numerous different aspects - such as available time, physical distance between actors, cultural distance, organization size, organizational priority and social proximity - are addressed. Only a few will be elaborated on in this section.. One overarching contribution comes from Inkpen and Dinur (1998) and their study on how context impacts KT. Their conclusions include that similarity in context and the nature of KT mechanisms are the key success factors. The impact of national cultures is an area that has attracted a lot of attention during the last decade (e.g. De Long and Fahey, 2000; Ipe, 2003; Qin *et al.*, 2009). This is understandable due to the increased focus on globalization and the rise of China and India in world economy. One contribution of particular interest is made by Ambos and Ambos (2009) when they study the impact of three different distances (cultural, physical, and lingual) on KT. They conclude that personal coordination mechanisms (such as face-to-face meetings) are moderated by distance while technology-based coordination mechanisms function relatively context-free. Liao and Hu (2007) add another contextual aspect: environmental uncertainty. Thus, in their study on companies in the Taiwanese semi-conductor industry, they conclude that environmental uncertainty could hinder KT.

Studies within the KS field on organizational context are rather common, and we find topics such as organizational culture (De Long and Fahey, 2000); organizational climate (Schepers and Van Den Berg, 2007), innovation emphasizing cultures (Bock *et al.*, 2005), learning culture (Taylor and Wright, 2004), and trust. Trust is regarded as important in the sharing of knowledge (Davenport and Prusak, 1998). McNeish and Mann (2010) present a preliminary model of trust related to knowledge sharing. Renzl (2008) focuses on trust in management and show that it has a positive effect on knowledge sharing. She supports her claims with the results of a questionnaire study on members in project teams. Related to Renzl's study we find other studies that deal with management support. Jang-Hwan *et al.* (2006) show that top management support affects employee commitment and through that commitment, both level and quality of knowledge sharing, while Cabrera *et al.* (2006) includes perceived supervisor and coworkers support among the factors with positive influence on willingness to share. Rewards and incentives are another area that has been researched and Yao *et al.*(2007) suggests that a lack of incentives is a major barrier to knowledge sharing across cultures. Bock *et al.* (2005) found that anticipated extrinsic rewards had a negative effect on KS.

The fifth component includes the activities of transferring the knowledge from one actor to another. An influential contribution in this area comes from Szulanski (2000) where he offers a process model with stages related to each phase of the transfer (initiation, implementation, ramp-up, and integration). Furthermore, in each phase he introduces the concept "stickiness" (von Hippel, 1994; Szulanski, 1995) as an influencing factor.

Kwan and Cheung (2006) present a review of empirical studies, build on Szulanskis model and suggest a four-stage process model (including motivation, matching, implementation, and retention) in which determinants for success at each stage are defined. Duanmu and Fai (2007) investigate vertical knowledge transfers from multinational enterprises (MNEs) to indigenous Chinese suppliers and conclude that the type of knowledge transferred (technological or managerial knowledge) influences the relationship and cooperative activities between the actors.

Moreover, in most of the studies mentioned above a HQ – subsidiary or subsidiary – subsidiary perspective is adopted, and in addition to those perspectives, a third stream which deals with reverse knowledge flows has emerged (cf. Mudambi, 2002; Napier, 2006).

KS contributions related to activity are, for example, when Lawson *et al.* (2009) approach the area from a background in Operations Management and New Product Development (NPD).

They study the relationship between formal and informal socialization mechanisms and knowledge sharing within inter-organizational development teams. Their conclusion is that informal, rather than formal, socialization mechanisms are the most important means of facilitating knowledge sharing within such teams. Kalla (2005) addresses the issue of knowledge sharing from a background in communications. She focuses on communication and the relation between integrated internal communications and knowledge sharing. Effective communication if defined as "an interactive two-way communication process resulting in an action of decision" (Kalla, 2005; p. 304). The four communication domains that should be integrated are business, management, corporate, and organizational communication. Kalla's conclusions include that knowledge sharing should be seen as a function of integrated internal communications.

The Research Model

The previously identified components are synthesized into a research model for knowledge dissemination that is used in this thesis, in order to structure this thesis and the related research.. This model includes the five components: Actors (which includes both source and recipient), Content, Context, Media, and Activity (see Figure 3 below).
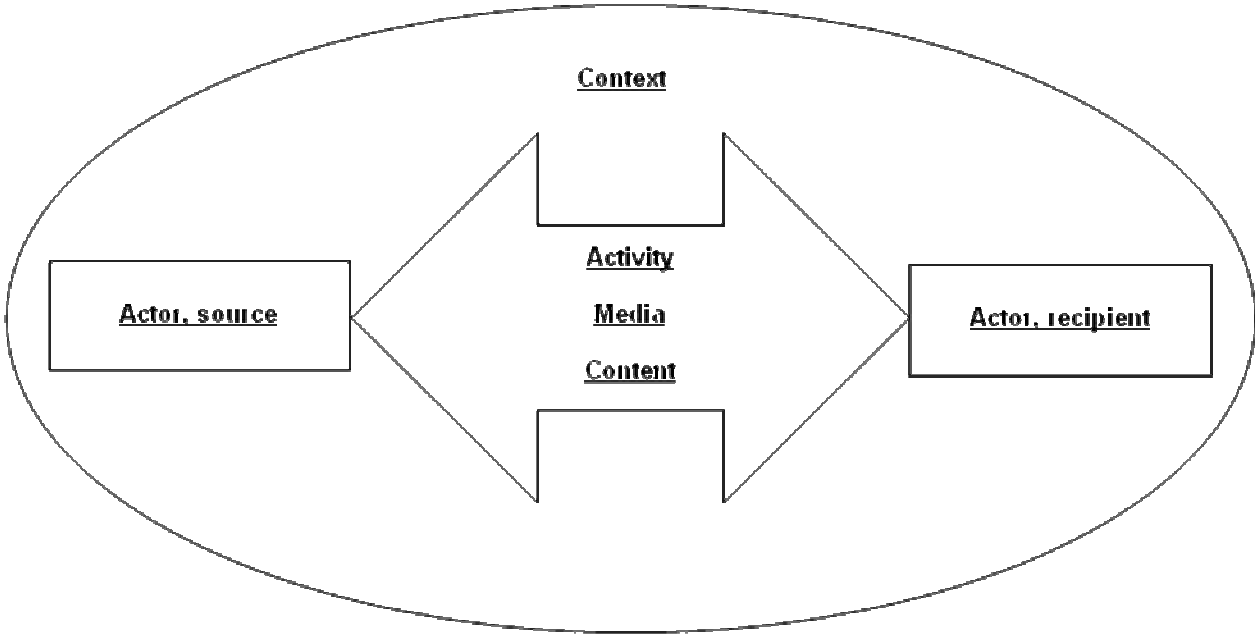
Figure 3: The research model

Each of these five components consists of several associated factors (or just factors) in the same way as the model presented by Duan *et al.* (2010). This research model will be used to structure the following sections and chapters, but also as the base for the analysis, the conclusions and implications in following chapters.

2.2.4 Factors influencing knowledge dissemination

It is necessary to try to get a better understanding of what influence the outcome of knowledge dissemination activities in order to improve and manage the utilization of knowledge. The literature on KT and KS is extensive and there are numerous authors who have identified different factors that influence these processes. A complete compilation would be too extensive so this will not be done. Instead, central contributions that are used to form a base of factors influencing knowledge dissemination are summarized in Table 1 below.

Table 1: A summary of factors influencing knowledge dissemination

Component in the Knowledge Dissemination Model	Influencing factors	Authors
Actor, source	Articulability. Embeddedness. Protectionism. Ability to share. Ambiguity	Cummings and Teng, 2003; Riege, 2005; Minbaeva and Michailova, 2004; Simonin, 1999
Actor, recipient	Learning culture. Priority. Absorptive capacity. Knowledge level.	Cummings and Teng, 2003; Kayes *et al.*, 2005 (in Duan *et al.*, 2010); Szulanski, 1996; Mu *et al.*, 2010; Attewell, 1992; Riege, 2005
Actors	Knowledge distance. Openness. Trust. Motivation. Age distance. Gender distance. Leadership.	Gupta and Govindarajan, 2000; Delios and Björkman, 2000; Minbaeva *et al.*, 2003; Osterloh and Frey, 2000; Szulanski, 2000 (all in Duan *et al.*, 2010); Cummings and Teng, 2003; Riege, 2005; Goh, 2002; Kalling, 2003
Content	Causal ambiguity. Type of knowledge	Goh, 2002; Szulanski, 2000 (both in Duan *et al*, 2010); Szulanski, 1996; Riege, 2005
Media	Linguistic distance. IT-systems. Communication channels. Transfer channels.	Kayes *et al*, 2005; Syed-Ikhsan and Rowland, 2004 (all in Duan *et al*, 2010); Schomaker, 2006; Ambos and Ambos, 2009;

		Davenport *et al*, 1998; Rhodes *et al*, 2008; Riege, 2005
Context	Strength in ties between groups. Organizational distance. Physical distance. Physical space. Distance between norms. Cultural distance. Learning/sharing culture. KM integration. Organization size. Organizational priority. Environmental uncertainty. Relationship. Social capital. Available/suitable space. Available time.	Hansen and Løvås, 2004; Abou-Zeid, 2005; De Long and Fahey, 2000; Goh, 2002; Ipe, 2003; Schlegelmilch and Chini, 2004; Inkpen and Pien, 2006; Seibert *et al*, 2001 (all in Duan *et al*, 2010); Hansen, 1999; Nonaka, 1994; Cummings and Teng, 2003; Albino *et al*, 1998; Riege, 2005; Ambos and Ambos, 2009; Goh, 2002; Liao and Hu, 2007
Activity	Frequence/intensity in transfer activities	Cummings and Teng, 2003

The term barriers are used in the majority of papers addressing factors that influence knowledge dissemination.. Other terms that can be found are enablers or facilitators (depicting factors with positive influence), constraints (depicting factors with negative influence) or influencing factors (depicting a neutral position).

There are numerous studies on possible knowledge transfer barriers and facilitators[8] within the management area however there are few extensive compilations. Furthermore, within the KT area there is a couple that stands out. Cummings and Teng (2003) and Duan *et al*. (2010) have already been presented in chapter 2.3.1. Another example of an overarching compilation is provided by Riege (2007). He proposes actions to overcome knowledge transfer barriers in MNCs and he addresses 20 different individual, 14 organizational, and six technological barriers. However, he partly bases his advice on findings described in a previous paper (Riege, 2005) in which he presents 39 knowledge-sharing barriers divided into 17 individual, 14 organizational, and 8 technological. This creates confusion, since it is not clear what the author means when it appears that he uses the terms as substitutes for one another. Two papers which focus on KS are Wang and Noe (2010) and Søndergaard *et*

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[8] Riege (2007) refers to Argote (1999), De Long and Fahey (2000), Gupta and Govindarajan (2001), Kogut and Zander (1996), Michailova and Husted (2003), Minbaeva *et al.(*2003), Möller and Svahn (2004), Nahapiet and Ghoshal (1998), Riege (2005), and Sveiby and Simons (2002).

al. (2007). Thus, in Wang and Noe (2010), three other categories are used (environmental, individual, and motivational factors) in which multiple sub factors are included, while in Søndergaard *et al.* (2007), three categories (leadership, organizational, and individual factors) and three sub-factors (trust, individual motivation and geographical location) are examined. However, neither of the categorizations used include any qualitative dimension other than the occasional use of barriers, enablers, facilitators, or constraints. Nor are there any known authors that have discussed a compilation of influencing factors from that viewpoint.

2.3   Identifying and formulating research questions

Furthermore, in Schwartz' (2006) thorough exposition on Knowledge Management, he resembles KM with a multilayered onion so that we find the theoretical and philosophical in the core, then the next layer consists of KM processes, with the main one's being Acquisition, Organization, and Distribution. The third layer consists of organizational, social, and managerial elements. The fourth layer includes supporting and enabling technologies. One could argue that all concepts mentioned in each layer are important. However, since no knowledge would spread within an organization without knowledge dissemination across organizational interfaces, this is highly relevant. However, in the fourth layer, most of the terms mentioned are related to IT-systems, which is why it seems particularly important to also address aspects of IT-systems.

What can be seen in this chapter, are the close connections between research within the product development, production development, and KM areas. This is also supported by Verona (1999), who states that the design of new product development work is well rooted in KM. Furthermore, in all three areas are studies that deal with the issues of overcoming (or bridging) the gaps between product development and manufacturing. There are several studies that identify and discuss barriers and factors that influence knowledge dissemination, or efficiency in the product realization process. There are also a number of studies in which barriers and factors are categorized. However, there are few that take an integrated perspective and combine the findings in order to provide a more comprehensive description and even fewer that focus on the relative effects of the influencing factors from this integrated perspective. This is the overarching idea behind this thesis. It is therefore relevant to focus the exploration here to factors influencing knowledge dissemination in the interface between Product Development and Manufacturing.

Moreover, out of the support functions mentioned by Gabrielsson (2002) as required by product development and production, IT support can be regarded as the relative newcomer. At the same time, this is an area of technology that has developed quickly and has profoundly impacted the traditional product realization process during the last 20 years. Within the KM area there are several research streams that focus solely on IT solutions related to the capturing and dissemination of knowledge within and between organizations. However, this is still an area that deserves further attention since there are important aspects of use of IT for KM purposes combined with practical product realization work that needs to be more thoroughly researched. Examples are the introduction of computer based (or virtual) prototypes in product verification, and the use of IT in knowledge dissemination between geographically separated organizational units. This is why the first research question is stated as follows:

RQ 1:   *How can an introduction of IT-based media for knowledge dissemination affect product and production verification processes?*

This RQ has been treated primarily in Papers I and II, but also to a limited extent in Paper IV.

Furthermore, in previous research on Knowledge Management in MNCs the use of IT-based solutions such as the media via which knowledge is disseminated is of particular interest. At the same time the interface between Product Development and Manufacturing has been identified as of particular interest in the section treating the Product Realization Process. However, both areas deserved further attention. The second research question is therefore formulated as follows:

RQ 2:   *How can an increased use of IT-based media affect knowledge dissemination in the interface between Product Development and Manufacturing?*

This research question has been treated primarily in Paper IV.

The third research question is derived from the increased practical challenges arising with increased globalization, namely to be able to manage knowledge dissemination in a geographically dispersed corporation, and in the present literature various barriers for KT and KS have been identified and classified. However, there has been no categorization based on the barriers' (or more accurately - the influencing factors') relative impact on knowledge dissemination.

The RQ 3 is stated as follows in order to enable management of knowledge dissemination through management of factors influencing knowledge dissemination:

RQ 3:   *How can factors be classified to enable management of – and influence - knowledge dissemination?*

RQ 3 has been treated primarily in Paper V, but also to a certain extent in Paper IV and to a minor extent in Paper II.

Factors influencing knowledge dissemination have been identified for both KT and KS and these two concepts are used for several organizational levels. It is therefore important to clarify whether there is any underlying difference in the use of these two concepts, in order to understand whether there is a qualitative difference in how the previously identified factors affect knowledge dissemination. This high relevance has previously been identified in chapter 2.2. Therefore, a prerequisite for answering RQ 3 – and RQ 2 partly - is to understand how the two terms constituting knowledge dissemination can be contradistinguished, and in order to create such understanding the theoretical study leading up to Paper III was conducted. Paper III can therefore be seen as underlying both Paper IV and V.

3 Method

The different methods used for each piece of research performed are presented in this chapter. Thus, in the first section, the research purpose, framework, and reasons for the methodological choices made are presented, and in sections 2-5, data collection, sample selection and analysis for the studies contributing to this thesis are shown.

3.1 Introduction

When studying knowledge dissemination, there are (at least) two actors that are of interest: someone harboring knowledge and someone meant to obtain knowledge. Moreover, in some of the empirical studies only one part of this combination has been studied, and only representatives from product development units were respondents in the investigations leading up to Paper IV, and also in some of the investigations leading up to the empirical support for Paper V, few representatives from the manufacturing units were involved.

As for any lengthy research, contextual factors have changed several times during this research process. For example, today it is common that individuals working with product and production development within industry have more extensive experience in international cooperation. This affects several of the factors influencing knowledge dissemination. Another change is the development of IT-tools, which has changed the possibilities of making knowledge explicit and of incorporating information about products and production solutions into IT support systems. This can make some of the early work (in Papers I and II) seem outdated. Even though this can be true for the specific solutions, it is not valid for the underlying mechanisms.

During this research process, my views on knowledge have changed (for an elaborate description, see the foreword), which has mainly resulted in two things: 1) The term knowledge transfer is used quite stringently in Papers I and II to denote knowledge dissemination. However, from a view of knowledge as a subjective contextual construct, the wording "transfer" can be questioned. 2) The studies resulting in Papers IV and V were not originally focused on knowledge sharing between individuals, but on knowledge dissemination within (and between) organizations. However, this does not mean that knowledge sharing cannot be analyzed based on these studies, but only that wordings in interview guides and questionnaires in the appended papers are related to organization.

3.2 Research Process

Therefore, as the research regards communication and knowledge dissemination, which is clearly related to the social context, and the RQ's are "how"-questions a qualitative approach is preferred (Yin, 2009). However, in order to explore a wider empirical base (relevant for RQ 3) certain research items benefit from a more quantitative, cross-sectional approach. Finally, in order to deepen the understanding of the phenomena observed in the initial qualitative - and the subsequent quantitative – studies, another qualitative study could be performed in line with the reasoning by Miles and Huberman (1994, p. 41).

During the initial part of the studies (1999-2002), the principal orientation to theory's role in relation to research was clearly inductive (Bryman and Bell, 2007). Empirical observations were performed guided by a belief that this area of research had high industrial relevance and that it was important to try to measure the outcome of the verification process to be able to compare the effects of a change at the case companies. From those observations an understanding developed which in turn led to the development, in Paper II, of a theoretical model (The Knowledge Transfer in Verification Processes model, or KTVP), to explain the change.

During the latter studies (2005-2010) a more varied approach has been pursued, even if the overarching orientation is still towards induction. However, for the study resulting in Paper IV more of a deductive approach was taken. This study was inspired mainly by theories underlying the KTVP model from which a set of concerns were derived, questions to a web survey developed, research sites and subjects selected, survey administered, data processed and analyzed and conclusions drawn. Thus, very much in line with the main steps of a quantitative research strategy as presented by Bryman and Bell (2007, p. 155). The reason for this change in research approach is mainly personal. The author had a desire to try to perform research in a different way than previously. This approach was found suitable when the expansion of the research settings and the slightly changed focus enabled another approach. The expansion meant changing from knowledge transfer within a single company with geographically co-located units to knowledge sharing within companies with geographically dispersed units. The changed focus meant going from the quantitative outcome of verification processes to knowledge related issues.

Thus, in the study resulting in Paper V, an inductive approach was again taken. Furthermore, from the previous studies, there were indications that the factors influencing the knowledge sharing process did not have the same impact everywhere; that they were situational. However, the prevailing theories did not seem to take this enough into consideration, but were much more positivistic and objectivistic than what was found to be suitable for research on this kind of phenomenon.

However, when looking at the **entire** PhD process leading up to this thesis, the research approach is very similar to the research strategy "Systematic Combining" as presented by Dubois and Gadde (2002). This is an iterative approach in which the theories coming out of the initial studies are verified in later studies which are followed by new studies which generate new theories. During research processes as long as this one, this is a logical consequence since it is difficult to pursue one orientation over this kind of time period. Alternative theories to the one's originally used and developed are brought forward by other researchers and these theories need to be taken into consideration in order for the later studies to be relevant and up-to-date.

The epistemological orientation has also changed during these studies. Initially, it was a more positivistic view grounded in the author's background as an engineer. The latter parts of these studies have been influenced by colleagues coming from other backgrounds which have brought an increasingly interpretive view.

Even if there is a change in the authors view on scientific knowledge and the mechanisms affecting knowledge transfer and knowledge sharing, the ontological orientation is still more objectivistic than constructionist.

3.3 Overview of the main empirical studies – Methods used and Research quality

This thesis is mainly based on five empirical studies (Studies 1-5), summarized in chronological order in Table 2. Therefore, in the following sections, the studies related to the four empirically based papers will be briefly described and the research quality will be discussed. The literature review leading up to Paper III – and performed to answer RQ 3 - will not be described here (for details, see the appended paper).

Table 2: Overview of the connections between the empirical studies, resulting papers and research questions

Empirical Studies	Year	Unit of study	Data collection methods	Resulting paper	Connected to which RQ
1 – Volvo Car Corporation, part 1	1998-1999	Manufacturing ramp-up processes, work teams, individuals	Semi-structured interviews, archival records, documentation, informal discussions and direct observations	Paper I and II (2001, 2006).	RQ 1
2 – Volvo Car Corporation, part 2	1999-2000	Product and process verification processes, work teams, individuals	Semi-structured interviews, archival records, documentation, direct and participant observations	Paper I and II (2001, 2006).	RQ 1
3 – Volvo Car Corporation, part 3	2000-2001	Product and process verification processes, work teams, individuals	Semi-structured interviews, Archival records, documentation, direct and participant observations	Paper I and II (2001, 2006).	RQ 1 and RQ 3
4 – Knowledge Transfer in MNCs	2009	Product development units, managers	Web based questionnaire	Paper IV (2012)	RQ 1, 2 and RQ 3
5 – Knowledge sharing in MNCs	2005-2010 (main parts 2007 and 2008)	Product development, industrialization, and manufacturing units. Managers, supervisors, assembly staff	Semi-structured interviews, documentation, informal discussions, web based questionnaire, and direct observations	Paper V (2013)	RQ 3

3.3.1 Methods used and research quality - Studies resulting in Papers I and II

The empirical investigations that resulted in Papers I-II were performed during the time span 1998-2001. They have previously been presented in more detail in Paulin (2002) so I will therefore refer you to that source for a fuller description. Here, the core characteristics are highlighted and evaluated.

The investigations were performed within three different studies (Study 1, 2 and 3). All of them can be classified as case studies or comparative studies if they are viewed separately. They can also be classified as one longitudinal case study if viewed as a single unit. Generally speaking, the list of data collection methods suitable for case study research is long. However, according to Yin (1994) there are six different types that are more useful; namely archival records, direct observation, documentation, Interviews, participants observation and physical artifacts.

Study 1 was performed during the manufacturing ramp-up phase within a product development process. Here, mainly historical recollections of the process were gathered through semi-structured interviews, archival records and documentation were used and informal discussions and direct observations were performed.

The archival records consisted mainly of data related to the outcome of the verification process which were collected solely from secondary sources. The documentation used was primarily background material about the company, products and process descriptions. The informal discussions were held with individuals participating in the studied process and the direct observations consisted mainly of passive participation during project meetings. The observations were made prior to the formal start of these PhD studies, namely during the completion of a master thesis (Palmqvist and Paulin, 1998).

Studies 2 and 3 were also performed during a product development process. This time it was performed in real time during the product and process verification part, which was an earlier part of the process. Here, five of the six preferred types of data collection were used. The primary source of information was the interviews performed with participants in the verification process. The interviewees selected needed to be able to compare the current process (Process 3) with the two processes to which the comparison was made (Process 1 and 2). They should also represent the different functions participating in the verification process (R&D, Industrialization and Manufacturing) and represent both the perspectives of managers and workers in order to increase fairness (Lincoln and Guba, 1985). The outcome

of the processes was measured by the company itself, and in order to get hold of it archival records in the form of historically collected data and documentation in the form of company internal reports were used. Direct and participant observations were also performed during these studies. Direct observations were primarily performed during the verification meetings when the functional representatives met to evaluate the current product and process solutions. Participant observations were performed during meetings leading up to, or as follow-up meetings to, the verification meetings.

Therefore, in order to evaluate the quality of data in quantitative research, one would discuss different aspects of reliability and validity (external, internal and construct), and in the authors licentiate thesis these concepts were used to evaluate Study 1-3. Moreover, in this thesis, the discussion on research quality is instead based on terms more appropriate for qualitative research in general, and for research on a concept so closely connected to interpretivism and constructionism as knowledge sharing is, namely trustworthiness (Lincoln and Guba, 1985; Guba and Lincoln in Denzin and Lincoln (eds.), 1994). Trustworthiness is made up of four criteria, credibility (paralleling internal validity), transferability (paralleling external validity), dependability (paralleling reliability), and confirmability (paralleling objectivity) (Guba and Lincoln in Denzin and Lincoln (eds.), 1994).

Bryman and Bell (2007) propose that the researcher should ensure that a good research practice is ensured, and that the findings are submitted to the people studied for confirmation, in order to increase the credibility of these studies. During studies 1-3 respondent validation was used in order to secure the accuracy of the descriptions built on all of the types of data collection that were previously mentioned in Section 3.2 and 3.3. The effects of not letting the respondents comment on the descriptions until they were compiled from several different sources can be regarded as something that has a negative impact on the credibility. However, at the same time, it admits that a fuller description is validated, which would suggest that the respondents get to validate their statements in context. This is strengthening from the perspective of researcher with a constructionist predisposition..

The transferability of these studies should be judged from two perspectives. Firstly, in Paper I and II and in the licentiate thesis (Paulin, 2002) descriptions of the study objects are given Geertz (1973a in Bryman and Bell, 2007; p. 413) advocate that *thick* descriptions are produced in order to secure transferability. Secondly, since 2002 the findings have been presented and discussed with many practitioners -from manufacturing and R&D- from other companies in the same, as well as from other, industries. The responses that have been

received indicate that their view is similar to the one put forward here. This ensures that the results from these studies have a relatively high degree of transferability.

The dependability of the results from a qualitative study can be ensured through taking and keeping complete records of all phases of the research process (Lincoln and Guba, 1985). Therefore, in these three studies, vast volumes of material from secondary sources such as company-internal reports, process descriptions, and process output were collected. This material is unfortunately classified by the company, so the possibility for external auditors to evaluate this material is small, and in addition to this, interviews were performed. However, due to the informal nature of the interviews, they were not taped and transcribed. Instead notes were taken by the researcher during the interviews and transcribed afterwards. According to Lincoln and Guba (1985) this decreases the dependability of these studies, so the overall judgment is that the dependability of these studies is lowered.

The fourth trustworthiness criteria brought forward by Lincoln and Guba (1985) is confirmability. They propose that establishing confirmability should be an auditor objective. Thus the readers of this thesis have to make up their own mind on this issue. However, the author has tried to be aware of his personal values and biases towards certain appealing theories and sources such as Szulanski (1996) and Nonaka and Takeuchi (1995) when performing these studies.

Paper I was written early in the research process and more than ten years ago. The IT-tools that were in focus during these early studies have been significantly developed during the last ten years, which has created changed prerequisites for the product and process verification processes that were studied. The results and conclusions could have come out quite differently if these studies had been replicated today. However, their contribution in terms of underlying process understanding and initial insight into influencing factors in this organizational interface is significant. Paper II is the stronger of these two papers, in that it has strengths both empirically through the in-depth case studies and theoretically through its development of current theories in the area. The conclusions in Paper II are also more applicable thanks to their less technology-specific character.

3.3.2 Methods used and research quality - Study resulting in Paper IV

This paper clearly differs from the others through its quantitative research strategy and cross-sectional research design. Here, a web-based survey was used to capture information in order to examine relations between the use of different communication channels and

knowledge carriers, and the perceived quality on intra-organizational knowledge sharing and cooperation.

The following concepts will be used in order to evaluate the research quality of Paper IV: Reliability, replicability, and validity. Bryman and Bell (2007) address the issue of quality in cross-sectional research in general. They state that reliability and measurement validity should be evaluated no differently than other quantitative studies, replicability demands well described procedures, internal validity is typically weak due to the difficulty to establish causal directions from the data, external validity is questionable when non-random methods of sampling are employed and ecological validity may be jeopardized.

Bryman and Bell (2007) highlight three factors that need to be taken into consideration in order to evaluate reliability. These are stability, internal reliability and inter-observer consistency. The stability is normally measured through a test-retest method. Moreover, in this case, this was not done due to the cross-sectional design, which excludes follow-up measures. Therefore the stability of this study is unclear. Internal reliability was tested through calculations of Cronbach's α values for three main factors (see Paper IV for details). Inter-observer consistency has been attempted through a single researcher approach, which decreases the risk of lack of consistency.

Furthermore, in order to establish measurement validity only measures ensuring face validity were taken. The questionnaire was pre-tested by both experts on surveys and academic experts and experienced practitioners within the researched area. A minor pilot test with three respondents was also performed. However, no measures ensuring concurrent, predictive, or construct validity were taken. The replicability of the study should be evaluated through the description of the research procedures (see Paper IV for details). Here, the procedure is described in detail. Internal validity can be classified as low. However, since the aim was not primarily to establish causal directions but to examine relations, this is not as important. Since non-random sampling is used, one should be careful when proclaiming external validity. However, for the selected business areas the external validity can be regarded as better than that of companies in general.

However, for Paper IV, the deficiencies mentioned above should be noted and some carefulness should be used regarding the conclusions. Nevertheless, it has value thanks to findings in studies performed in other contexts that support these findings. However, it is of

great value as an exploration and examination of an area new to this researcher and as an attempt to broaden the methodological toolbox and understanding..

3.3.3 Methods used and research quality - Study resulting in Paper V

The studies performed to collect information to Paper V can be categorized as a multiple case study (Bryman and Bell, 2007) comprising mainly of information from y four Swedish multinational companies. The main method of data collection was interviews with representatives from primarily R&D and Industrialization units in these companies, but also with some supervisors and assembly staff at manufacturing units. The interviews included both structured ones as well as informal discussions performed within a five-year time span.

Other sources include written ones such as official company documentation, in-company material and a questionnaire (the same as for Paper IV). Official documents have been collected primarily via the Internet and in-company material has been supplied by interviewees as well as by other representatives from the companies.

Here, the research quality is again evaluated in terms closely connected to the interpretive and constructionist nature of knowledge sharing, namely trustworthiness and its four criteria: credibility, transferability, dependability, and confirmability. Therefore, to ensure credibility, interviews and discussions were both structured and informal, broadly spread in the companies, validated by respondents, and the information was triangulated by means of both official and un-official documents. The descriptions should enable readers to make their judgment about the possible transferability of the study. Therefore, in order to increase the dependability, records of the research process have been kept as far as possible and other researchers (primarily closely associated) as well as students (on two main occasions) have been involved in various parts of the study, which has enabled auditing. Early research results have also been presented at two international research conferences to receive comments from the research community. Confirmability is established through the efforts of the researcher to stay as objective as possible. This has been attempted via ongoing discussions with colleagues throughout the study.

This paper is stronger in comparison with Papers I and IV, in terms of its theoretical support as well as the depth in the empirical material. It is comparable with Paper II through its enhancement of current theory and it is stringent in its position in the fuzzy terminology landscape. Therefore, as regards the applicability of the conclusions, this is high thanks to the broadened empirical base.

3.4 Distribution of work in studies and paper realization

Three of the papers included in this thesis are co-written with other researchers. Thus, in order to clarify my own contribution, the elements in which the co-authors have contributed are presented here (detailed descriptions can be found in each appended paper). For Paper I the general research questions were developed by me and my co-author jointly. The research object was identified and selected by my co-author. This was also relevant for Paper II, since the studies leading up to Paper II were a continuation of the studies performed for Paper I. The entire process leading up to Paper III was performed in cooperation. During study resulting in Paper IV, six students performing their bachelor's thesis were involved during the selection of subjects, data collection, and initial interpretation of data. The general research questions were formulated by me, the industries selected by me, data analysis and interpretation in its current form was performed by me, and the conclusions were drawn by me. The students identified the companies, designed the questionnaire draft, set up the web based questionnaire solution and distributed the questionnaire to the selected companies. Regarding Paper V, two other bachelor students transcribed all interviews and performed the initial interview with company Gamma together with me. My co-author, Mats Winroth, contributed from the second paper draft and forward to improve the quality of the paper.

4 Summaries of the appended papers

This thesis is based on five appended papers, and they are presented briefly in sequential order. Papers I and II originate from studies performed mainly at Volvo Car Corporation (VCC) and the automotive industry. Paper III is a theoretical paper dealing with the three key terms knowledge transfer, knowledge sharing and knowledge barriers. Papers IV and V use empirical observations from product realizing industries such as telecommunications, industrial machinery and manufacturing.

4.1 Paper I

The background for the study leading up to Paper I was the growing need for decreased product development time and cost within the automotive industry. Several different strategies and methods were used by companies all over the world, and among them we find Toyota Production System (or Lean Production), Design for Manufacturing (Susman, 1992) and product modularization (Sundgren, 1998; Holmqvist, 2004; Persson, 2004). The development line that was studied here was the use of IT-tools in R&D processes, more specific in the final verification process which was a scarcely studied area at that time.

This paper's main objective was two-fold: 1/ To present the trends in product and process verification at that time. 2/ To highlight the effects on product development performance (in terms of quality, time and costs) when virtual methods were used instead of physical. The paper builds on findings from Paulin and Lindér (2001), and probes deeper into the influencing factor "Method". Furthermore, in Paulin and Lindér (2001) four influencing factors (organization, method, product and process) were studied. There is also a stronger focus in this paper on knowledge transfer and creation.

A case study approach (Yin, 1994) was used in order to meet the second objective (the first objective was met through a literature study and discussions with company representatives). The main source of information was interviews (14 in total) with representatives from the R&D department, the verification support organization and the manufacturing department. Information was also gathered through informal discussions with people involved in verification as well as through studies of information in company databases. Meetings were attended where different aspects on verification were discussed. Finally, two verification

series were attended. All in all, the activities can be classified as participant observations (Bryman and Bell, 2007).

The main findings include the outcomes of the verification process. The outcome parameters were time, cost, and quality. The time span for all verification activities was decreased by 4.3% from Case 1 to Case 2. The costs for prototypes built during verification decreased by 73.6%. Again, the quality related outcome was ambiguous in that the number of potential quality problems found (i.e. issues that might have resulted in problems but were discovered during the verification activities) decreased by more than 72%. The proposed explanation is that product newness for the product in Case 2 was significantly less than for Case 1. The degree of commonality between the products was estimated by company representatives to be approximately 55%. This would mean that many of the potential quality problems had already been solved during the verification process in Case 1.

4.2 Paper II

The background for this study was the growing need for decreased product development time and cost within the automotive industry and the increased use of computer based tools in product realization processes. Moreover, in addition to this, knowledge issues in product development are mentioned as something that has been studied to larger extent, but that studies related to knowledge issues in the Prototype Building phase (described by Wheelwright and Clark (1992) as one of the main product development phases) are scarce.

The purpose of this article is to analyze how the use of virtual prototypes affects knowledge creation within product and process verification units, and knowledge transfer between product development and manufacturing units.

Therefore, in order to fulfill the purpose, a theoretical model of knowledge transfer in verification processes named the KTVP model (see Paper III for details) was developed based on the organizational knowledge creation model by Nonaka and Takeuchi (1995) and Szulanskis studies on knowledge transfer (Szulanski, 1996). Tell's (2001) ideas on justification are included in the theoretical frame for a certain phase in the knowledge transfer process.

Once again the method used here is the case study approach since this paper builds on the same empirical base as Paper I. This paper is also supported by material from an additional case study performed mainly by two students as a part of the work with their master thesis at

another Swedish automotive company. Additional details on methods used can be found in the appended paper.

The main findings in this paper are strongly connected to the research questions in this thesis. Conclusions are drawn from an analysis conducted through the use the KTVP model and the conclusions in the paper are (quoted from Paulin, 2006, p. 187):

- The introduction of virtual prototypes in the verification process resulted in clearly changed prerequisites for knowledge transfer and creation

- These changes arose mainly in the phases incoming knowledge transfer, creating concepts, and justifying concepts, although the efficiency in the other phases was also affected by this introduction

- The use of computer created images obstructed the creation of shared mental models during incoming knowledge transfer since the participants had difficulties utilizing imitation and practice to strengthen the tacit knowledge

- The participants' lack of experience regarding working in a virtual environment affected their efficiency. However, the team members' inability to externalize their individual tacit knowledge must be regarded as the primary reason for the difficulties experienced during the verification process.

- The new method was not accepted by all of the participants. There was a need for a greater focus on justification activities. The possibility for the assembly staff to learn the new assembly sequences has decreased since the skilled workers participating in the verification process did not have the same possibility to practice the assemblies as they were used to.

4.3 Paper III

The background for this paper is the need to clarify terms that are of particular interest for this thesis. There are many different terms flying around in the knowledge management world and some are more important and frequently used than others. Thus, in this paper, we present and discuss the development and views of three terms: knowledge transfer, knowledge sharing and knowledge barriers.

Knowledge transfer and knowledge sharing are sometimes used synonymously or are considered to have overlapping content. There seems to be somewhat of a confusion when these terms are used. Several authors have pointed out this confusion while other authors have attempted to clarify the differences and define the terms. Knowledge barriers as a term seem to have a slightly more obvious content although the borders between knowledge barriers and connecting terms, such as "barriers to knowledge sharing", seem to blur discussions and views.

The aim in this paper is to make a contribution in finding appropriate demarcations between these concepts.

After having reviewed Knowledge Management literature, one conclusion is that the three terms, i.e. knowledge transfer, knowledge sharing and knowledge barriers, are blurry. Furthermore, for knowledge transfer and knowledge sharing, the blurriness is linked mainly to the fact that the analytical level each term is related to has come and gone and come back again, while for knowledge barriers, the blurriness comes from the development of the term. The mere existence of the many different categorizations of knowledge barriers implies that the concept itself is blurry. The concept seems clear cut and focuses on knowledge although it is also broad and later sources have included much more than knowledge.

Another conclusion is that both KT and KS have different meanings depending on the authors' different knowledge views (knowledge as an object - or the K-O view - and knowledge as a subjective contextual construction - or the K-SCC view). Also, regarding use of the terms, there are clear indications that authors who use the term KT have a tendency towards the K-O perspective, while those who use the term KS are drawn more towards the K-SCC perspective. The view of KBs and the interpretations of how to lower or pass a KB differ depending on the view. It is therefore, necessary to adapt it to the specific situation in order to find useful content in any definition.

Furthermore, in this paper, effects on the terms when the two knowledge views are applied are highlighted. One effect would be how to manage the processes of KT and KS and KBs related to those processes. Therefore, if you have a K-O perspective and want to create good conditions for knowledge flow, you amplify the enablers, suppress disabling conditions and overcome obstacles, including the barriers, or in a K-SCC perspective, you focus more on the development of "ba" ("ba" is a Japanese word that roughly translates as "space" or "environment" and it was introduced into the KM sphere by Nonaka and Konno (1998)), to

better fit individuals who need to develop personal knowledge with the help of those who have already developed it.

The clarifications are supported by examples from companies in different industries (such as Cargotec and IKEA) and emergency services.

The authors of this article believe that the positive effect of KM will improve if a well thought out standpoint of practitioners and researchers would fit the type of problem together with the ontological thoughts. These standpoints also need to be considered when, for example, IT-systems aimed at improving KM are developed so that functions and content match what is requested.

4.4 Paper IV

The background for this paper is the increased importance of good international relations for international companies due to the ongoing globalization trend. The globalization trend results in an exposure to broadened knowledge bases for these companies. Therefore, in order to create and sustain competitive advantages, it is important that the broadened knowledge bases are explored and utilized. This can be done through strong knowledge sharing. Knowledge sharing in international settings has received considerable attention, but most of these studies have dealt with knowledge sharing between Anglo-Saxon and East Asian countries. Few studies have dealt with knowledge sharing between Nordic and East Asian countries, even though the importance of this relation is significant according to Eurostat (2009) and even fewer studies have dealt with factors influencing knowledge sharing in this setting.

The aim of this study is to examine relations between the use of different communication channels and knowledge carriers, and the perceived quality on intra-organizational knowledge sharing and cooperation between R&D units in Sweden, and manufacturing units in China, in international engineering companies.

One of the objectives of this paper was to broaden the view on knowledge sharing between R&D and manufacturing through an increase in the number of companies and a broadened industry perspective combined with an international setting that none of the first three papers had touched upon.

Furthermore, in order to study relations between several different factors and to be able to draw more general conclusions, a cross-sectional research design and a quantitative research approach was used. A web based questionnaire consisting of 32 questions overall was designed. Moreover, in order to identify the most relevant industries to focus on, Svensk Näringsgrenindelning (SNI) classification was used. Four industries (Manufacture of rubber and plastics, Manufacture of fabricated metal products (except machinery and equipment), Manufacture of machinery and equipment and Manufacture of motor vehicles, trailers and semi-trailers) were selected based on their importance for total trade value. Additionally, the selected industries display a higher frequency with regards to the prerequisite organizational setup (R&D in Sweden and manufacturing in China) than average. One of the selected industries also overlaps with the companies studied for Papers I-II. Questionnaires were only sent out to the R&D units (not to the manufacturing units).

The two main findings in this paper are:

- There is an indication that a more frequent use of communication channels had a positive effect on perceived knowledge sharing at the same time as cooperation is negatively affected. Possible explanations for this include that cooperation is obstructed by information overload in line with reasoning by Lindkvist (2001), that the current level of cooperation has triggered an increase in communication (since this study only gives a snapshot of the situation, a definite answer cannot be given) is that social communication increases the perceived knowledge sharing (but not quality of cooperation).

- The use of IT-based knowledge carriers (digital prototypes and common data bases) is positively correlated with perceived cooperation. Previous studies (Paulin, 2002 and Paper II) have not given this kind of result. One possible explanation is that IT maturity has increased in the companies, and another possibility is that the functionality of the IT systems has increased. However, both sender and receiver would benefit from an increased IT maturity and high acceptance of IT-based knowledge carriers within their organizations.

4.5 Paper V

When any organization strives towards distribution or dispersion of knowledge, knowledge barriers should be taken into consideration. Barriers come in many forms and in order to

create some order among them, some authors have developed categories based on the *type* of barrier. However, there is a lack of categorizations that divide the barriers based on their *relative effect* on knowledge transfer, sharing or flow. We argue this kind of categorization is of higher relevance for several types of actors, from practitioners that want to manage knowledge dissemination and academics who want to try to optimize knowledge flows to academics who want to develop an improved understanding for mechanisms related to knowledge related issues.

The purpose of the paper is to present a refined categorization regarding factors that influence knowledge dissemination and to show how previously identified "barriers" fit into this new categorization.

The developed theories are supported with examples from a study performed with the purpose of studying how different influencing factors come into play in knowledge dissemination activities in four multinational companies with R&D units in Sweden and manufacturing units in China. The companies come from four different industries (industrial machinery, home furnishings, telecommunications, and manufacturing) and were selected based on the convenience in obtaining information. The main sources have been semi-structured interviews and informal discussion during a five-year time span (2005-2010). An interview guide was used for the semi-structured interviews. Therefore, in addition to the formal interviews, numerous information discussions in person and via e-mail have been performed and different kinds of official and internal documentation have been used (for more details, see Paper V).

The two main contributions in the paper are:

- A proposed refined categorization of influencing factors based on their effect on knowledge sharing. This refined structure includes three categories: Facilitators (a factor that has a positive influence on knowledge dissemination), Inhibitors (factors that have a negative, moderating influence on knowledge dissemination), and Obstacles (factors that obstruct knowledge dissemination until certain conditions or levels are fulfilled). These three terms assist us in grouping influencing factors based on their effect on knowledge dissemination.

- A suggested classification of influencing factors according to the refined categorization. The influencing factors used as examples in Paper V are classified and placed within the communications model proposed by Cummings and Teng

(2003) (see Paper V for an illustration). The examples are named with a symbol after each factor, denoting its particular influence on knowledge sharing. A plus sign (+) is used to denote a facilitator, a minus sign (-) corresponds to an inhibitor and a vertical line (|) corresponds to an obstacle. Identified Facilitators are: Motivation (Actors), Absorptive capacity (Actors, recipient), and Available time (Context). Identified Inhibitors are: Knowledge distance (Actors), Arduous relationship (Context), Causal ambiguity (Context), Geographical/physical distance (Context), Organizational distance (Context), Unprovenness (Content), and Linguistic distance (Media). Identified Obstacles are: Trust (Actors), Technical know-how (Actors, recipient), and Basic infrastructure and sharing capabilities (Media).

5 Analysis

Thus, in this chapter, an analysis is performed in order to answer the research questions, followed by a discussion. This chapter also serves as base for the conclusions and implications presented in the final chapter of this thesis. The research model presented in chapter 2 and shown in Figure 4 below is used to structure the first three sections in this chapter.
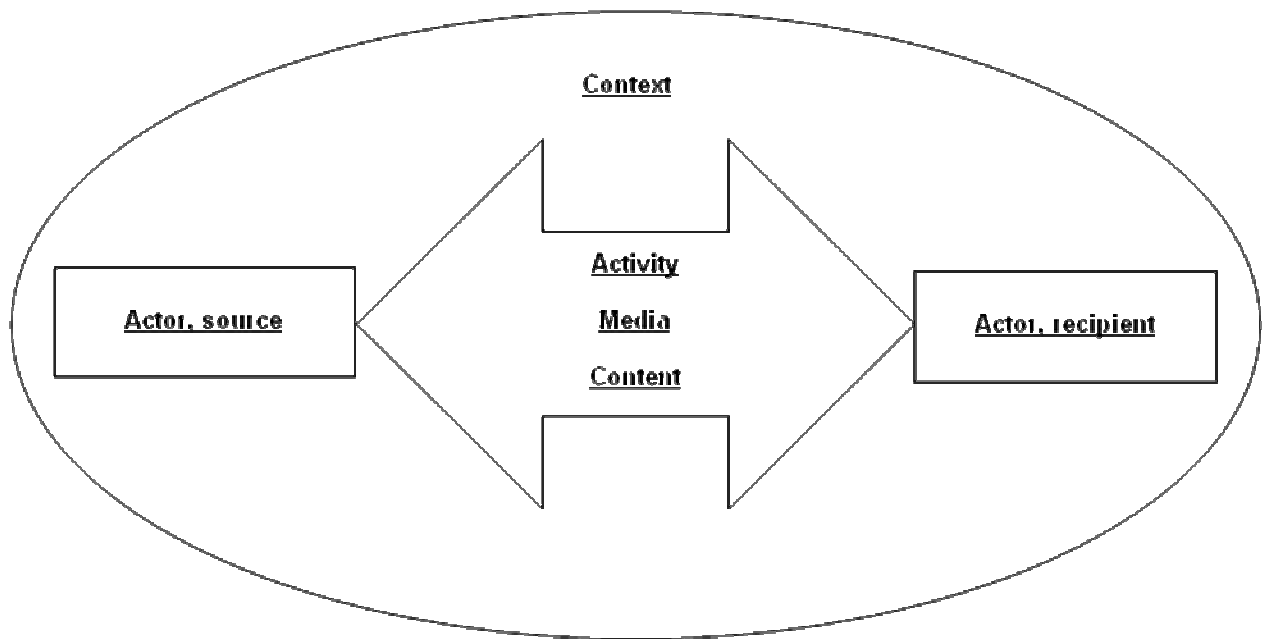
Figure 4: The research model

5.1 Knowledge dissemination and IT-based media

As has been shown in chapter 2, there is a need to study what happens when IT-based media as a mean for knowledge dissemination is introduced in product and production verification processes.

Regarding the first component in the research model - Actors - the participants' technical know-how is addressed in Paper I. The question of technical know-how was addressed by Attewell (1992) and his conclusions included that technology acts as a knowledge barrier. The results from Paper I contradict that conclusion. They do so by indicating that despite the

lack of technical know-how (due to the introduction of IT-based media) negatively affecting the possibilities for the manufacturing representatives to disseminate their knowledge, it did not block it. Similar results are indicated in Paper IV, but not verified, regarding the R&D representatives' abilities to disseminate their knowledge. Moreover, as regards what type of influencing factors the technical know-how should be categorized as, the results show that it is not a definite barrier. It is more that of an inhibitor. The introduction of IT-based media can also be analyzed in relation to motivation. One of the conclusions in Paper II is that the actors' uncertainty (which was related to their motivation) leads to a lack of acceptance of the new work method. This new method was a result of the introduction of IT-based media in the product verification process. Kalling (2003) concludes that motivation affects cognitive factors. Therefore, the introduction affects both the acceptance of the new method as well as indirectly the cognitive ability to accomplish the method as intended. The risk of decreased efficiency is thus apparent. Additional support for the introduction's negative influence is found in Michailova and Husted's (2003) conclusion that actors' apprehension about failures has a negative influence on KS. The actors' lack of acceptance mentioned above has an obvious relation to their apprehension about failures, which adds to the negative influence. However, for MNC's, additional negative effects can be paired with the not-invented-here syndrome (Katz and Allen, 1982) as long as the participation of both senders and recipients are not present in the design of the product and process. A final aspect in this component is the negative effects that interpersonal similarity (Mäkelä *et al.*, 2007) has on KS. Furthermore, in Paper II, we found that the introduction of IT-based media had a negative effect on the actors' shared mental models. Since shared mental models can be viewed as a micro-level prerequisite of interpersonal similarity, this will have a negative impact on KS.

Thus, regarding the second component in the research model - Content - there is empirical evidence from Paper II that indicates that a sole use of IT-tools in not the answer when a complex type of content is disseminated. The theoretical model on knowledge creation and sharing in verification processes developed in Paper II is referred to in this part. Moreover, for the first phase (Incoming KT), Nonaka and Takeuchi (1995) point out that there are four different ways to share tacit knowledge, e.g. it can take place through dialogue, observation, imitation or practice. The observations from Paper II show that imitation and practice could not be used when IT-tools were introduced. This indication is supported by the reasoning by Polanyi (1966) when he states that explicit integration cannot replace its tacit counterpart. However, in the second phase (Creating Concepts), the difficulties for participants in expressing their individual tacit knowledge due to inability to draw analogies from previous

experience is an important observation since it causes a need for practitioners to complement the method with something (such as some physical artifacts) to enable analogies to be drawn. This should also be complemented with the findings by Pedersen *et al.* (2003), who show that explicit knowledge is more likely to be transferred through written or electronic modes, while tacit knowledge should be transferred via rich communication media. They conclude that in reality, this is seldom done, which is why a recommendation to anyone pursuing knowledge dissemination in MNC's would be that they try to analyze the degrees of explicit and implicit content and to design a KM system that can facilitate the interplay between these forms (which is clearly supported by Davis *et al.* (2005). The low acceptance in the third phase of the introduced IT-based media needs further investigation, since it is not clarified that it is the IT-tools that have caused this reaction. It could be the change in itself that triggers this reaction.

Moreover, for the third component in the research model – Media - there are contributions supporting as well as cautioning the use of IT-based media and Gold *et al.* (2001) point out the necessity to invest in a comprehensive IT-infrastructure, Jarvenpaa and Staples (2000) conclude that actors propensity to share knowledge is significantly related to their use of collaborative media. McNeish and Mann (2010) conclude in a more recent paper that technology is less effective for the sharing of tacit knowledge. There is a discussion in Paper I that the use of common databases enables information sharing. However at the same time it creates a need for selection processes due to the vastness of information available for the participants in the verification activities. The conclusion is that there is an obvious need for effective information systems. This is supported by Edwards and Wolff (2008) who seven years after Paper I was presented, positioned tackling information overload as being highly important to deal with. Mohamed *et al.* (2009) also supports this when they conclude that integrated information and communication technologies lead to overload and, furthermore, that digitalization leads to knowledge dilution, "de-contextualization". Their conclusion is that benefits of such systems outweigh these drawbacks. Here, the overall conclusion is, in other words, in line with the varying statements from other researchers.

There are several interesting aspects related to the fourth component - Context. However here the main focus will be on language, since this is an ever-present fact in MNCs. There is a discussion in Paper I on linguistic differences between the actors. The conclusion is that the demands on the actors changed with the introduction of IT-based media. During the use of physical objects, the participants did not have to verbally communicate their knowledge to

the same extent as during virtual verification. After the introduction, the senders (here, manufacturing representatives) had to be able to verbalize what they meant since they could not show the recipients (the engineers) directly what they meant. The language used during product verification affects the transfer process. Another conclusion is that the effects vary depending on if the participants come from different countries or only from different parts of the organization. This conclusion is supported by Ambos and Ambos (2009), who claim that increased linguistic distance has a negative effect on KT. The introduction of IT-based media (in Paper I referred to as virtual verification tools) leads to one difference in language, since everyone involved does have the same understanding of the "computer"-language. Possible solutions to address these differences can be found in the empirical observation presented in Paper V (even though this paper does not focus on IT-based media). Company Beta utilizes bi-lingual intermediaries, which has a perceived positive effect on knowledge dissemination. Company Gammas strategy to recruit only English-speaking staff since this leads to easier communication than expected, is another possible solution.

When regarding the fifth component - Activity - it is clear from the observations made in Paper I that IT-tools enable companies to begin verification activities earlier and to perform more verification iterations. This observation is clearly supported by Thomke and Fujimoto (2000). The possibility to begin verification activities earlier can have other significant effects such as an increased time for integration between individuals from different units, which in turn can improve the socialization phase (Nonaka and Takeuchi, 1995) which holds the key to knowledge creation and is an important phase for knowledge dissemination. There is an analysis in Paper II, in which knowledge transfer is analyzed for each phase in the verification process (Incoming KT, Creating Concepts, Justifying Concepts, Building Archetypes, and Outgoing KT). During the first phase, the results show that there were difficulties in creating shared mental models due to the changed work method. During the second phase (socialization), the results show that the participants had problems expressing their individual tacit knowledge due to their inability to draw analogies from their previous experiences. As previously mentioned, Nonaka and Takeuchi (1995) claim that this phase holds the key to knowledge creation, which is why the following phases will be influenced by the deficiencies in this phase. One important observation during the third phase (Justifying Concepts) was the low acceptance regarding the new work method. However, this cannot contribute solely to the introduction of IT-tools in this process, since it might be an effect from the change in itself. The main observations from the fourth phase have already been presented in the previous sub-section when the use of common databases was discussed.

The fifth and final phase (Outgoing KT) is not directly affected according to the results in Paper II. Instead there are secondary effects due to the deficiencies in the previous phases. Another aspect to observe for this component comes from another direction (namely Operations Management and New Product Development) when Lawson *et al.* (2009) conclude that informal socialization mechanisms are the most important means of facilitating KS within teams. Observations during the studies leading up to Papers I and II, showed that the introduction of IT-tools had a negative effect on informal socialization opportunities. This was relevant for the localized setting. However, in Paper IV, increased use of IT-based media was found to have a positive effect on perceived cooperation. One conclusion that could be drawn is that in the local setting, there could be an inhibiting effect, but that a frequent use of IT-based media at least provides the actors in the multinational setting an opportunity for virtual socialization. As stated in Paper II, one can also discuss whether or not the rise of social (IT-based) media affects this conclusion, today and in the future, when work relations expand beyond the work place and into the virtual sphere.

In summary, an introduction of IT-based media for knowledge dissemination affects product and production verification processes for all five components in the research model.

5.2 *Increased use of IT-based media*

The second research question focuses on the increased use of IT-based media. Introduction of IT-based media can be interpreted as a subset of this question, which is why the findings in the previous section are closely related to this question. Therefore the focus in this section will be primarily on three out of the five components in the research model, Actors, Media and Context. Additionally, a more holistic perspective is taken to analyze the effects on crucial prerequisites for product realization processes.

For the first component in the research model - Actors - IT-maturity is of high importance. The question about the influence by IT-maturity on knowledge dissemination is addressed in both Paper II and IV. The conclusions that both Product Development and Manufacturing would benefit from an increased IT-maturity and high acceptance of IT-based knowledge carriers within their organizations are partly supported by Huang *et al.* (2010) who conclude that effective KS depends largely on the IT infrastructure system, and that without reaching a reasonable level of IT-maturity, the implementation of KS would be impossible. However, the results are contrasted by Szulanski (1996) who address the related question of unprovenness and finds very weak established relationships between KT and unprovenness.

It should thus be noted that Szulanski does not address IT-maturity specifically, but unproven knowledge in general.

The component Media includes for instance the use of digital prototypes. The observation from Paper IV is that digital prototypes are enabling knowledge transfer, but that supporting reports seem to be necessary to decrease the inhibiting effect of low acceptance is interesting since there seem to be few studies that have looked into this combination. There are several potential explanations for this observation. First, the use of written reports may depend on low trustworthiness in the digital prototype. Szulanski (1996) addresses a parallel issue in his discussion about sources that are not perceived as reliable. He builds his argument on prior research that shows that formal structure and systems affect the number of attempts to transfer knowledge and the outcome of those attempts. Second, companies that use digital prototypes have begun doing this recently, which is why older work methods linger on. Third, the IT-maturity is too low for some of the individuals involved in the transfer, which cause companies to complement the digital prototypes with written reports. Cummings and Teng (2003) presented a related finding where their hypothesis that articulability and transfer success would be positively correlated, was rejected. Therefore, in other words, that "knowledge that can be readily codified in manuals, diagrams, etc. is *less* likely to be internalized within the recipient than less articulated knowledge" (Cummings and Teng, 2003, p. 57). Thus, that finding would suggest that the written reports would have a less positive influence than those of the more flexible and unarticulated digital prototypes. Further studies are necessary to explain this behavior. The results from Paper IV complement the observations in Paper I, since positive correlations are found between the use of digital prototypes and perceived cooperation, and between the use of IT-based knowledge carriers and perceived cooperation. This contribution expands the extent of the conclusions from the verification activities in particular to cooperation between product development and manufacturing in general. Additional support is provided by Rhodes *et al.* (2008) in their conclusions that IT has a strong impact on knowledge transfer in general.

The observation that use of IT-based knowledge carriers is positively correlated with perceived cooperation is not surprising. However there seems to be few studies that have addressed this particular issue. There are studies that address IT-systems and cooperation-based outcome, such as knowledge management systems and productivity (e.g. Alavi and Leidner, 1999; Davenport and Prusak, 1998). An interesting consequence of the use of IT-systems is presented by Makido *et al.* (2003) who conclude that cooperative IT-systems that

can be implemented with substantial internal and external cooperation, support sustainable competitive advantages. The use of IT-based media could, in other words, support sustainable competitive advantages.

Thus, for the component in the research model - Context - one issue related to the previously mentioned lingual differences is how differences in organizational culture affect KD (e.g. De Long and Fahey, 2000; Qin *et al.*, 2009; Mäkelä *at al.*, 2007). There are empirical observations in Paper V that indicate possible solutions when Company Gamma bridges an intra-organizational boundary by introducing a temporary project constellation consisting of actors from both Product Development and Manufacturing. This solution also increased the trust between the actors, according to the respondents in that study. Trust has been identified by, for example, Davenport and Prusak (1998) as important in the sharing of knowledge, which is why there is a double advantage in this solution.

The use of IT-based media for knowledge dissemination into the product realization process has clearly been influential from a holistic perspective, e.g., many of the conditions for product realization changed. Säfsten *et al.*, (2010) presented six factors that were considered crucial in order to achieve efficiency in the product development / manufacturing interface. Several of them are influenced by this introduction to a greater or lesser extent. Early introduction of production into product development can be achieved as long as contextual factors provide advantageous conditions. The results in Paper IV support the conclusion that continuous communication (and improved cooperation) between product development and production is enabled if IT-tools are used and providing even better prerequisites, such factors as available time and time zone differences should be managed wisely. The feeling of involvement in development projects by production is not supported directly by the empirical observations, but an indirect relation to this factor can be indicated through the impact IT-tools have on perceived cooperation. However, there is also a counteracting influence through the distancing effect that changed work methods (activities) and aggravated knowledge sharing due to this introduction. The influence from IT-based media on the possibilities of achieving the same target image has not been studied, which is why no conclusions can be drawn here. Additional factors deemed important for efficiency, as identified by Säfsten *et al.* (2010), include sufficient information and learning aspects. Both of those factors can be claimed to have been affected. Sufficient information has been affected in two ways: 1) IT-systems improve information sharing capabilities significantly. 2) The hazard of information overload increases. Mohamed *et al.* (2009) claim that the benefits

gained by using information and communication technologies outweigh such drawbacks. At the same time, the conclusions from Papers I and IV that both product development and manufacturing would benefit from an increased IT-maturity in order to share knowledge within the organization, are supported by Huang *et al.* (2010). Corporations are therefore recommended to attempt to countervail differences in technical know-how, as well as lingual, organizational, and cultural differences in order to provide advantageous prerequisites for these crucial factors.

In summary, an increased use of IT-based media has a positive effect on knowledge dissemination between Product Development and Manufacturing provided sufficient IT-maturity have been reached. During the development of IT-maturity, it has been shown that supporting physical prototypes and written reports are beneficial for the knowledge dissemination.

5.3 Classification of factors influencing knowledge dissemination

The influence from different factors on knowledge dissemination has been discussed in many research contributions and in chapter 2 it was stated that a complete compilation of influencing factors would be too extensive. For that reason, the aim here is to highlight, and to nuance current conclusions in this area in order to provide an improved classification of factors in order to enable improved management of knowledge dissemination.

Clarification of current conclusions of influencing factors structured in line with the research model can be found in Appendix A. An additional discussion on the validity and applicability of the influencing factors previously identified by other authors, on other organizational levels than the original can be found in Appendix B.

As can been seen in Paper V, most current categorizations focus on other types of dimensions such as individual, organizational and other factors (Lindkvist, 2001), individual, organizational, and technological (Riege, 2005) or personal, organizational, and multidimensional (Barson et al. (2000) in Schwartz (ed.), 2006). Søndergaard *et al.* (2007) indicates a more qualitative categorization when including the terms facilitators and barriers. The main contribution to RQ 3 from Paper V is the categorization of influencing factors, the FIO-structure. This structure includes three categories: Facilitators (a factor that has a positive influence on KD), Inhibitors (factors that have a negative, moderating influence on KD), and Obstacles (factors that obstruct KD until certain conditions or levels are fulfilled).

These three terms assist us in grouping factors based on their effect on KD. A proposed classification of additional influencing factors was included in Paper V and is in line with that categorization, in Paper V and that proposed classification is presented in Table 3. The signs are put into brackets for factors where clear empirical support, from *original* [9]studies, cannot be found. A plus sign (+) is used to depict a facilitator, a minus sign (-) corresponds to an inhibitor and a vertical line (|) corresponds to an obstacle.

Table 3: Classification of influencing factors according to the FIO structure

Type of influence	Factor	Component in the research model
+	Frequency / intensity in transfer activities	Activity
+	Ability to share	Actor, source
+	Absorptive capacity	Actor, recipient
+	Openness. Motivation. Leadership	Actors
+	Strength in ties between groups. Organization size. Relationship. Social capital. Social proximity. Available time	Context
+	IT systems	Media
(+)	Learning culture. Priority	Actor, recipient
(+)	Physical space. Learning/sharing culture. KM integration. Organizational priority. Available/suitable space	Context
-	Embeddedness. Ambiguity	Actor, source
-	Knowledge distance	Actors
-	Causal ambiguity. Unprovenness. Arduous relationship. Organizational distance. Geographic / physical distance. Distance between norms. Cultural distance. Environmental uncertainty	Content
-	Linguistic distance	Media
(-)	Articulability. Protectionism	Actor, source
(-)	Age distance. Gender distance	Actors

[9] Original studies are studies performed by authors, other than the thesis author, where factors influencing KD have been identified and their effects determined.

|	Technical know-how	Actor, recipient
|	Trust	Actors
|	Basic infrastructure and sharing capabilities	Media

(+), (-)	Communication channels. Transfer channels	Media
(+), (-)	Type of knowledge	Content

This classification is a summary of previously published studies in order that external support can be regarded as satisfactory. A clarification of the arguments used by the original authors is provided in Appendix A.

When influencing factors are structured both in line with the research model and the FIO-structure, a compilation of factors and their respective influence on knowledge dissemination in MNCs can be presented (see Table 4). On the x-axis, the five components in the research model are shown. On the y-axis, the categories from the FIO-structure plus a separate row for factors with ambiguous influence are displayed.

Table 4: A compilation of factors and their respective influence on knowledge dissemination

	Actors	Content	Media	Context	Activity
Facilitators	Motivation Leadership Learning culture Priority Openness		IT systems	Available time Learning / sharing culture Integration of KM strategy into companies goals and strategic approach Available / suitable space	Frequence / intensity in transfer activities
Inhibitors	Absorptive capacity Embeddedness Protectionism / Knowledge hoarding Ability to share Knowledge distance Articulability	Causal ambiguity	Linguistic distance	Organizational distance Physical distance Distance between norms Cultural distance Environmental uncertainty	

	Age distance Gender distance				
Obstacles	Knowledge level / technical know-how Trust				
Unclear influence		Type of knowledge	Communication channels Transfer channels	Organizational size Relationship	

Notable in Table 6 is that some elements in the matrix do not contain any factors and some of the influencing factors cannot be categorized according to the FIO-structure. These are observations that are suitable for future studies. There may be other studies that address factors that are not included in this table, which is why further literature reviews would be advantageous to perform.

5.4 Discussion

Proposed contributions from this thesis and applicability of the findings are discussed in this section, and in addition, some more peripheral aspects related to the research questions are highlighted and alternative views to Knowledge Management are addressed.

The introduction of IT-based media into product and production verification activities influence knowledge dissemination (as concluded in the previous section), but are there any theoretical or practical consequences related to that? Early empirical research discuss both practical consequences for work methods (cf. Gomes de Sà, 1999) and managerial implications (cf. Thomke and Fujimoto, 2000), but during the studies leading up to Paper V (approx. 10 years later) there were representatives from several of the companies that displayed low awareness for primarily the practical implications for work methods. The strategic value was rather clear, especially regarding potential cost reductions. Already in Paulin and Lindér (2001), the necessity to develop work methods that enable supplementary learning possibilities due to the use of IT-based media that has negative effects on knowledge transfer possibilities were addressed. Even though the general IT-maturity has increased in many parts of the world since the end of the last millennium, the later studies

indicate that it is still of essence to work with method development in order to reap the benefits of technology advancements and to keep up with technology development.

One area that is not directly included in the objective of this thesis, but still is of significant importance for academics and practitioners alike is knowledge creation, and this is why it deserves to be included in this discussion. The issue of knowledge creation can be regarded as a prerequisite for knowledge dissemination (Wickramasinghe in Schultz, 2006) and in product and process verification processes there are certain phases and activities where knowledge creation is pursued and desired. Thus, in Paper II, Nonaka and Takeuchi's theory on organizational knowledge creation (Nonaka and Takeuchi, 1995) is adapted to fit product and process verification processes and that framework allows knowledge creation to be analyzed (as well as knowledge transfer which was its original purpose). What can be observed if that is done is that the introduction of IT-based media into this process affects the conditions for knowledge creation. Both the overall possibilities to transform tacit knowledge into explicit knowledge, and the possibilities of creating new concepts are negatively influenced. This will have practical implications for both product development and production development within the product realization process. Bellgran and Säfsten (2010) provide a thorough review of production development and they highlight obstacles and facilitators for knowledge transfer in the context of production system development. However, the findings in this thesis expand their discussion and add the dimension of knowledge creation. This constitutes an important element in any development activity, such as those included in product realization processes.

An additional aspect is whether the findings related to the verification activities can be expanded to the larger domain, the general MNC setting. Empirical observations from Paper V indicate that factors that influence knowledge dissemination in the local - national and co-located - verification setting (such as the inhibiting influence by knowledge distance between actors discussed in Paper II) are present in the expanded multinational setting. However, how strongly these factors influence knowledge dissemination in the two respective settings is not clarified in this thesis, which is why further studies are recommended.

This thesis addresses the research questions primarily from a Knowledge Management perspective. However, there are other alternative research areas of streams that could be of interest, and this is why some of them are addressed here.

The first perspective is research originating from the R&D and Operations Management areas. Verona (1999) states that design of new product development (NPD) work is well rooted in KM. Therefore, in the frame of reference, the focus is on outlining the studied area and to highlight interesting areas of research. The primary reason has not been to review this entire research area. However, this is an important area to address in this discussion. Coming from an academic environment from which several contributions in this area originate (e.g. Trygg, 1991), certain aspects of this issue might be taken for granted (such as the need to address technological as well as more sociological and managerial issues). However, this thesis will hopefully contribute to the local environment as well as the global academic community through its combination of technological (IT-based media), international (MNCs), and sociological and managerial aspects (Knowledge Management).

The second perspective in research originates from International and Strategic Management areas. Paterson and Brock (2002) summarize the foundations to four streams of multinational management literature, of which three are of distinct relevance for this thesis: The HQ-subsidiary relationship stream, the subsidiary role stream and the subsidiary development stream. No distinctions have been made in this thesis as regards the relationship between the studied units. One of the companies included in the study leading up to Paper V (company Alpha) displays a traditional HQ-subsidiary (as in a hierarchical) relationship, which most likely has a strong impact on knowledge dissemination in that company. Other companies display other behaviors that would be relevant to analyze using literature from the subsidiary role stream (companies Beta and Delta from Paper V and the main company studied in Papers I-II) or from the subsidiary development stream (company Gamma and the complementary company studied in Papers I-II). Thus, in the subsidiary role stream, the research on Centers of Excellence (e.g. Adenfelt and Lagerström, 2006) could be relevant to include for most of the companies involved since there are units within those companies that align to those characteristics. The effect of including those research streams into this framework could have meant that other influencing factors such as formal judicial aspects between units or intellectual property rights would have received greater interest.

The third and the fourth perspectives have been introduced in the introductory chapter, and touched upon when the research model was introduced, but have only been utilized to a limited extent this far, are the knowledge views and the interaction levels. The influencing factors presented in Paper V are interpreted from a Knowledge-as-a-Social-Contextual-Construct (or K-SCC) perspective. However, since these factors can be viewed from

alternative knowledge perspectives, it is of interest to revisit the original interpretations and discuss whether the presented factors can be utilized from other perspectives such as interaction levels and KT or KS classification in order to expand the validity of the classification. Since the number of factors that were dealt with in Paper V is high, an overview of each factor, current knowledge classification (KT and/or KS), and interaction levels studied in the original sources has been analyzed (this analysis can be found in Appendix B as previously mentioned). To summarize that analysis, most of the influencing factors mentioned have already been shown to be valid for other interactional levels as well as for the alternative labeling (KT instead of KS or vice versa). What these perspectives provide can be divided into practical implications and academic contributions.

Therefore, regarding the practical implications, these perspectives can enable better insights into what kind of measures that could be taken in order to utilize or minimize the effect of each influencing factor. If a factor is originally identified for a certain interaction level, and the table indicates that it can be valid for other levels, then measures on all relevant levels might have to be taken. If a factor, for example, is labeled KS and the conclusions presented in the table indicate that this factor is valid for the other label as well, KT mechanisms might be suitable to explore. However, such actions have not been tested thus far, and this is why caution should be exercised before implementing these guidelines on a broad scale.

Furthermore, regarding the possible academic contribution, the assessments of each factor's potential applicability on other interactional levels extends the current literature on influencing factors (e.g. Cummings and Teng, 2003; Riege, 2005; Riege, 2007; Liyanage *et al*, 2009; Duan *et al,* 2010). It does so by indicating that several of the identified factors can be relevant to address on multiple levels. Normally only one level is studied (sometimes two adjacent ones), which limits the possibilities for a holistic view. Some factors have been identified for multiple dimensions (cf. learning culture that has been identified for both actors (individual level) and as a contextual factor (higher level)), which is why this contribution can be seen as a logical extension. Another conclusion is that the use of knowledge dissemination as a summarizing concept encompassing both knowledge transfer and knowledge sharing is valid.

A final aspect of knowledge dissemination in MNCs that seems important to give special attention is the study by Pedersen *et al.* (2003) of the performance implications of fit between knowledge characteristics and transfer mechanism in Danish MNCs. If one-third of knowledge transfer activities are performed via inappropriate media (as is found in that

study), significant negative impact on overall knowledge dissemination within (or between) organizations can be expected. Paper IV addresses similar set-ups and some of the answers point strongly in the same direction. The respondents, in this case representatives for the source, answered that transfer mechanism were selected based on convenience more than on the fit in relation to the characteristics of the knowledge. This type of carelessness will most likely result in unnecessary resources being consumed in order to disseminate knowledge within the MNC.

6   Conclusions and implications

The purpose of this thesis was to *explore factors that influence knowledge dissemination in product realizing MNCs.* The outcome includes increased understanding regarding classification, quality and applicability of certain factors and also in theoretical contributions. The research model (Knowledge Dissemination Model) and the proposed classifications also open up for future research efforts in this area.

6.1   Main conclusions

The globalization of industry today has increased the importance for multinational corporations to utilize knowledge that is situated in different locations and in order to do so it is of the essence to understand underlying mechanisms and influencing factors. This thesis contributes to the possibilities for industrialists and academics alike to create a better understanding especially in the referred interface.

It has been shown that the use of IT-based media to disseminate knowledge influences the perception of the relationship between the actors concerned, at the same time as it has a mainly negative influence (directly or indirectly) on all phases of the knowledge transfer process (as defined in Paper II). Several of the factors that are associated with the KDM component Actors are found to have a negative influence on KD, which is mainly supported by previous findings regarding factors on an individual level. Deviations can be referred to the particular prerequisites that introductory phase implies. Furthermore, regarding the second component – Content - previous studies have shown ambiguous results and here mainly negative effects have been observed, especially regarding KD of tacit knowledge but also for more explicit knowledge and information, due to information overload effects. The observed effects for the third component – Media - are mixed. Positive effects, such as the use of common databases and communication via e-mail that enables actors to revisit and secure their original interpretations, have been observed. This is of particular relevance within time zone separated MNCs. Negative factors include the previously mentioned information overload aspect as well as de-contextualization. Moreover for Context, language distance has been in focus and here findings include that language distance exhibits the characters of an obstacle or an inhibitor depending of which level of IT-maturity the involved actors display. The mechanisms displayed when a common "computer"-language is introduced are similar to the one's displayed when bi-lingual intermediaries are used or when

intra-organizational boundaries are bridged thanks to temporary project constellations. However, for the final KDM component Activity, it is clear that the introduction enables companies to start the KD process earlier. The results for a local setting (as studied in Papers I and II) indicate that there is an inhibiting effect in the first four phases in the knowledge creation and transfer process. However in the MNC setting, this introduction seems to provide an opportunity for virtual socialization, which is positive for KD.

Therefore, regarding the effects of increased use of IT-based media in the Product Development - Production interface the conclusions are that IT-maturity is highly relevant for the Actors. Both Product Development and Production would benefit from increased IT-maturity. However, the obstacle-like character of IT-maturity (as previously mentioned) implicates that this aspect should be included in recruitment processes in order to secure a high IT-maturity in parts of MNCs where this is not obvious. The conclusions, as regards to the component Media, are that the increased use is positive, in other words it is a facilitator. This is especially clear in organizations where actors appear to have a lower degree of IT-maturity when the digital prototypes are supplemented by written reports. There is an indication that supplementing written reports has less positive influence than the more flexible and unarticulated digital prototypes. Moreover, for Context, the observations in Paper V that overarching organizational solutions (such as a boundary-bridging project) increase trust are positive for KD. It has also been shown that many of the prerequisites for product realization have changed. Several of the factors considered crucial in order to achieve efficiency in the product development / manufacturing interface are influenced. Early introduction of Production into Product Development, Continuous communication and improved cooperation is enabled by an increased use of IT-based media and they can provide even better prerequisites if time-related factors are managed to support them. But, on the other hand, the use of IT-based media has a distancing effect due to aggravated knowledge sharing and sufficient information, and learning aspects are affected in both positive and negative ways.

It has been shown that several factors that influence knowledge dissemination in the local - national and co-located - verification setting, such as the inhibiting influence by knowledge distance between actors are also present in the expanded multinational setting. There is also evidence that several factors are applicable on multiple interaction levels such as knowledge distance, which can be classified as an inhibitor on an individual level as well as on group

and intra-organizational levels. Also, in addition, the final table in chapter 5 (the analysis) summarizes the conclusions regarding influencing factors.

6.2 Contributions

Furthermore, in the quest to fulfill the objective of this thesis, several both empirical and theoretical contributions can be identified. Davis and Parker (1997) classify contributions in a thesis within the categories evidence, methodology, analysis and concepts, and theories. The contributions can either be new or improved. Their classification is used in the following sub-sections.

First, from the studies resulting in Papers I-II, early empirical observations of the use of IT-based media in verification activities are provided. These studies were performed within the automotive industry, which was among the early adopters of this technology. This contribution could have been classified as new evidence if this thesis had been presented at the time of the study. Now the assessment is complex. This would hardly be classified as a contribution within the automotive industry,. However, the studies performed in other industries have shown that solutions developed during, and conclusions drawn in, those early studies are of interest for these late adopters.

Second, an alternative categorization of factors influencing (FIOs) knowledge sharing in MNCs, in general and in product verification activities in particular is provided. The few existing categorizations available focus typically on interaction levels (individual/organizational) or technological dimensions (cf. Riege, 2005; ibid, 2007), or elements in the knowledge dissemination system (actors/context/content/media) (cf. Cummings and Teng, 2003; Duan *et al*., 2010). There are numerous studies that have addressed singular influencing factors and that have tried to determine their causality and relative strength. However, there are no previous compilations that have divided the factors based on their qualitative influence. Therefore, this contribution would be classified as improved theory.

Third, the research model proposed is built on both empirical observations and previously identified elements, and this is why it is categorized as an improved concept.

Fourth, the use of the term knowledge dissemination including both of the two established terms knowledge transfer and knowledge sharing would in itself be classified as a refined concept in this area.

Fifth, the final discussion indicates that the FIO-categorization has certain validity also for KT, and this is why this thesis can be regarded as expanding current theories on knowledge dissemination in the Product Development / Manufacturing interface. Chini (2005) and Barner-Rasmussen (2003) are two examples of researchers who have provided contributions regarding KT in MNCs and KS in MNCs. Their research contributions are impressive and have gained international recognition, which is why it is relevant to position this thesis in relation to those two. Chini (2005) adopts a strategic management perspective and includes KS in KT when she addresses the problem area. She studies intra-organizational KT between locally dispersed MNC units from what can be classified primarily as a "knowledge-as-an-object" view (even though she acknowledges the idea that knowledge cannot be regarded as a finite resource) without limitation to certain kinds of units, and her contributions provide solid support for strategic decision making in MNCs. Barner-Rasmussen (2003) studies KS from a social capital perspective and includes KT in KS when he addresses the problem area due to his knowledge view. He studies intra-organizational (actually inter-unit) KS in MNCs from more of a "knowledge-as-a-subjective-contextual-construction"-view and focuses on the role of language, identity, and feedback seeking behavior without limitation to certain kinds of units. Barner-Rasmussens findings imply that high levels of inter-unit social capital is considered desirable, which in turn implies that practitioners' actions in this area should be long term and enduring. This thesis is differentiated through its separate treatment of KT and KS, the way it encompasses several interactional levels, and since it focuses on one particular interface. Therefore, it can be classified as an improvement.

Like other innovations that often consist of two or more previously known items that are being combined into something new and fruitful, the conclusions and suggestions here are the results of a similar process. Like most of research today (Desouza, 2006), the addition from this thesis may be regarded as incremental but since it adds new pieces to the body of knowledge that is science, it is of high relevance. And since these two claims are true, then there is novelty in this thesis.

6.3 Implications for practitioners

Since the prerequisites for product realization identified by Säfsten et al, (2010) are found to be influenced by the use of IT-based media, it is relevant to highlight proposed measures to be taken to reap the benefits of this use.

Therefore, in order to decrease the negative effects of introduction of IT-based media, the recommendation is to keep other contextual factors as similar to previous situation as possible. Already in Paper I, the necessities to develop activities such as work methods that enable supplementary learning possibilities were addressed. Even though the general IT-maturity has increased in many parts of the world since the end of the last millennium, the later studies indicate that it is still of the essence to work with method development in order to reap the benefits of technology advancements and to keep up with technology development.

Language issues should be taken into account during recruitment, which is of particular relevance in areas of low IT-maturity and/or high staff turnover since the localized language has similar inhibiting effects as differences in national language.

Both the overall possibilities to transform tacit knowledge into explicit knowledge, and the possibilities to create new concepts are negatively influenced. This will have practical implications for both product development and production development within the product realization process.

Anyone who pursues KD in MNC's should try to analyze the degrees of tacit and explicit content in order to design or adapt the current KM system to facilitate the interplay between these forms. Additionally the use of media particularly suited for the different types of knowledge by using complementary media. This could also reduce the problems with information overload experienced both during introduction of IT-based media as well as during increased use.

An organizational measure that is recommended to be taken is to introduce, for example, temporary project constellations in order to bridge intra-organizational boundaries. This affects not only inhibiting factors related to the organization such as trust and power hierarchies, but also cultural differences and language distance.

Since the influencing factors are contextual, the conclusions and analytical framework should be considered with that in mind. However, as long as that is done, practitioners from Product Development, Manufacturing, as well as other functions in a MNC could utilize the proposed framework as well as tables containing influencing factors as guidelines in organizing knowledge dissemination.

6.4   Future research

There are several different directions - both theoretical and empirical – that are possible for future research.

The first direction is to include all actors in the empirical base since this study has focused on one actor at a time. During the initial studies, focus was on representatives from manufacturing and during the later studies most of the empirical material originated from the product development representatives. Studies on MNCs involve by definition individuals or organizations from different cultural backgrounds and perspectives, which is necessary to take into consideration when the study is designed, results are analyzed, and conclusions are drawn.

Empirical observations from Paper V indicate that factors that influence knowledge dissemination in the local - national and co-located - verification setting (such as the inhibiting influence by knowledge distance between actors discussed in Paper II) are present in the expanded multinational setting. However, how strongly these factors influence knowledge dissemination in the two respective settings is not clarified in this thesis, and this is why further studies are recommended.

Furthermore, other empirical directions include empirical studies to try to provide relative strengths of influencing factors from different contexts in order to provide a broader body of examples to compare and contrast future case studies with.

The final empirical direction is to extend to current studies to be able to include potential factors that can be perceived only after longitudinal studies. The current studies have, although they were performed during a 13-year period, still not addressed this kind of factors. One example would be to repeat either the studies for Paper I or the study on which Paper IV is based.

A theoretical contribution would be to deepen the theoretical studies in order to firstly try to identify additional influencing factors, and secondly to add each factors quantitative impact or relative strength to the model.

References

Adenfelt, M., & Lagerström, K. 2006. Knowledge development and sharing in multinational corporations: The case of a centre of excellence and a transnational team. *International Business Review*, 15(4): 381-400.

Ahmad, N., & Daghfous, A. 2010. Knowledge sharing through inter-organizational knowledge networks: Challenges and opportunities in the United Arab Emirates. *European Business Review*, 22(2): 153-174.

Alavi, M., & Leidner, D. E. 2001. Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, 25(1): 107-136.

Albino, V., Garavelli, A. C., Schiuma, G., 1998. Knowledge transfer and inter-firm relationships in industrial districts: the role of the leader firm. *Technovation*, 19(1): 53-63.

Allen, T. J. 1977. *Managing the Flow of Technology*. Cambridge, MA: MIT Press.

Ambos, T. C., & Ambos, B. 2009. The impact of distance on knowledge transfer effectiveness in multinational corporations. *Journal of International Management*, 15(1): 1-14.

Anantatmula, V. S., & Kanungo, S. 2010. Modeling enablers for successful KM implementation. *Journal of Knowledge Management*, 14(1): 100-113.

Appleyard, M. M. 1996. How does knowledge flow? Interfirm patterns in the semiconductor industry. *Strategic Management Journal*, 17: 137-154.

Argote, L. 1999. *Organizational Learning: Creating, Retaining and Transferring Knowledge*. Boston, MA: Kluwer Academic.

Aristotle. n.d. Nicomachean ethics. In R. Crisp (Ed.). Cambridge, U.K.: Cambridge University Press.

Attewell, P. 1992. Technology Diffusion and Organizational Learning - the Case of Business Computing. *Organization Science*, 3(1): 1-19.

Badaracco, J. L., Jr. 1991. Alliances Speed Knowledge Transfer. *Planning Review*, 19(2): 10-16.

Barner-Rasmussen, W. 2003. *Knowledge Sharing in Multinational Corporations - A Social Capital Perspective*. Ph.D. thesis, Swedish School of Economics and Business Administration, Helsinki.

Bartlett, C. A., & Ghoshal, S. 1986. Tap your subsidiaries for global reach. *Harvard Business Review*, 64(6): 87-94.

Bartlett, C. A., & Ghoshal, S. 1989. *Managing across borders: the transnational solution*. London: Huchinson Business.

Bartlett, C. A., & Ghoshal, S. 1988. Organizing For Worldwide Effectiveness: The Transnational Solution. *California Management Review*, 31(1): 54-74.

Bellgran, M. & Säfsten, K. 2010. *Production development: design and operation of production systems*. London & New York: Springer.

Birkinshaw, J. 1998. Corporate entrepreneurship in network organizations:: How subsidiary initiative drives internal market efficiency. *European Management Journal*, 16(3): 355-364.

Blomberg, J. & Werr, A. 2006. Boundaryless Management - creating, transforming and using knowledge in inter-organizational collaboration: A literature review. *SSE/EFI Working paper series in business administration* (Online), 1403-4433.

Bock, G.-W., Zmud, R. W., Kim, Y.-G., & Lee, J.-N. 2005. Behavioral Intention Formation in Knowledge Sharing: Examining the Roles of Extrinsic Motivators, Social-Psychological Forces, and Organizational Climate. *MIS Quarterly*, 29(1): 87-111.

Bryman, A., & Bell, E. 2007. *Business research methods* (2. ed.). Oxford: Oxford University Press.

Cabrera, Á., Collins, W. C., & Salgado, J. F. 2006. Determinants of individual engagement in knowledge sharing. *International Journal of Human Resource Management*, 17(2): 245-264.

Cabrera, E. F., & Cabrera, A. 2005. Fostering knowledge sharing through people management practices. *International Journal of Human Resource Management*, 16(5): 720-735.

Chini, T. C. 2005. Effective Knowledge Transfer in Multinational Corporations: 201. Gordonsville, VA: Palgrave Macmillan.

Choo, C. W., & Neto, R. A. 2010. Beyond the ba: managing enabling contexts in knowledge organizations. *Journal of Knowledge Management*, 14(4): 592-610.

CIRP Technical Scientific Committee 1990, Nomenclature and Definitions for Manufacturing Systems. *Annals of CIRP*, 39(2).

Clark, K. B., & Fujimoto, T. 1991. *Product development performance: strategy, organization, and management in the world auto industry*. Boston, MA: Harvard Business School Press.

Cummings, J. L. 2002. *Knowledge transfer across R&D units: An empirical investigation of the factors affecting successful knowledge transfer across intra- and inter-organizational units*. Unpublished Ph.D., The George Washington University, United States -- District of Columbia.

Cummings, J. L., & Teng, B.-S. 2003. Transferring R&D knowledge: the key factors affecting knowledge transfer success. *Journal of Engineering and Technology Management*, 20: 39-68.

Cummings, J. L., & Teng, B.-S. 2006. The keys to successful knowledge-sharing. *Journal of General Management*, 31(4): 1-18.

Cummings, J. N. 2004. Work Groups, Structural Diversity, and Knowledge Sharing in a Global Organization. *Management Science*, 50(3): 352-364.

Davenport, T. H., & Prusak, L. 1998. *Working Knowledge: How Organizations Manage What They Know*. Boston, MA: Harvard Business School Press.Davis, G. B. & Parker, C. A. 1997. *Writing the Doctoral Dissertation*. Hauppauge, NY: Barron's.

Davis, J. G., Subrahmanian, E., & Westerberg, A. W. 2005. The "global" and the "local" in knowledge management. *Journal of Knowledge Management*, 9(1): 101-112.

De Long, D. W., & Fahey, L. 2000. Diagnosing cultural barriers to knowledge management. *Academy of Management Executive*, 14(4): 113-127.

Denzin, N. K. & Lincoln, Y. S. (eds.) 1994. *Handbook of qualitative research*. Thousand Oaks, CA: Sage.

DeSouza, K. C. 2006. The Frontiers of Knowledge Management. **VINE**, 36(3): 284-288.

Dixon, N. M. 2000. Common knowledge: How companies thrive by sharing what they know Harvard Business Press.

Drucker, P. F. 2001. The Next Society: A survey of the near future. *The Economist*, 361(8246): 3-5.

Duan, Y. Q., Nie, W. Y., & Coakes, E. 2010. Identifying key factors affecting transnational knowledge transfer. *Information & Management*, 47(7-8): 356-363.

Duanmu, J.-L., & Fai, F. M. 2007. A processual analysis of knowledge transfer: From foreign MNEs to Chinese suppliers. *International Business Review*, 16: 449-473.

Dubois, A., & Gadde, L.-E. 2002. Systematic combining: An abductive approach to case research. *Journal of Business Research*, 55(7): 553-560.

Easterby-Smith, M., Lyles, M. A., & Tsang, E. W. K. 2008. Inter-organizational knowledge transfer: Current themes and future prospects. *Journal of Management Studies*, 45(4): 677-690.

Edwards, D., & Wolff, J. 2008. A Look At The Top 10 KM Challenges. *Knowledge Management Review*, 10(6): 24-27.

Ensign, P. C., & Hébert, L. 2010. How Reputation Affects Knowledge Sharing Among Colleagues. *MIT Sloan Management Review*, 51(2): 79-81.

Ettlie, J. E. 1995. Product-process development integration in manufacturing. *Management Science*, 41(7): 1224-1237.

Eurostat. China: EU bilateral trade and trade with the EU. [WWW document] http://trade.ec.europa.eu/doclib/docs/2006/september/tradoc_113366.pdf (accessed 15 January 2013).

Fernie, S., Green, S. D., Weller, S. J., & Newcombe, R. 2003. Knowledge sharing: context, confusion and controversy. *International Journal of Project Management*, 21(3): 177-187.

Forsgren, M., Holm, U., & Johanson, J. 1995. Division headquarters go abroad - A step in the internationalization of the multinational corporation *The Journal of Management Studies*, 32(4): 475-491.

Foss, N. J., & Pedersen, T. 2002. Transferring knowledge in MNCs: The role of sources of subsidiary knowledge and organizational context. *Journal of International Management*, 8(1): 49-67.

Foss, N. J., & Pedersen, T. 2004. Organizing knowledge processes in the multinational corporation: an introduction. *Journal of International Business Studies*, 35(5): 340-349.

Gabrielsson, Å. 2002. *Cross-functional Co-operation and Networking in Industrial Settings - with special focus on the Product Realization Process*. Ph.D. thesis, Royal Institute of Technology, Stockholm, Sweden.

Geiger, D. 2010. The Role of Argument and Narration in Knowledge Sharing: Coping with Context, Validity, and Coherence. *Schmalenbach Business Review (SBR)*, 62(3): 291-316.

Goh, S. C. 2002 Managing effective knowledge transfer: an integrative framework and some practice implications. *Journal of Knowledge Management*, 6(1): 23-30.

Gold, A. H., Malhotra, A., & Segars, A. H. 2001. Knowledge management: An organizational capabilities perspective. *Journal of Management Information Systems*, 18(1): 185-214.

Gomes de Sá, A. & Zachmann, G. 1999. Virtual reality as a tool for verification of assembly and maintenance processes. *Computers & Graphics*, 23: 389-403.

Gottschalk, P., & Khandelwal, V. 2002. Inter-organizational knowledge management: A comparison of law firms in Norway and Australia. *The Journal of Computer Information Systems*, 42(5): 50-62.

Grant, R. M. 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17: 109-122.

Gupta, A. K., & Govindarajan, V. 1994. Organizing for knowledge flows within MNCs. *International Business Review*, 3(4): 443-457.

Gupta, A. K., & Govindarajan, V. 2000. Knowledge Flows within Multinational Corporations. *Strategic Management Journal*, 21(4): 473-496.

Gupta, A. K., & Govindarajan, V. 2001. Converting global presence into global competitive advantage. *Academy of Management Executive*, 15(2): 45-56.

Haas, M. R., & Hansen, M. T. 2005. When Using Knowledge Can Hurt Performance: The Value of Organizational Capabilities in a Management Consulting Company. *Strategic Management Journal*, 26(1): 1-24.

Haas, M. R., & Hansen, M. T. 2007. Different knowledge, different benefits: toward a productivity perspective on knowledge sharing in organizations. *Strategic Management Journal*, 28(11): 1133-1153.

Hansen, M. T. 1999. The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly*, 44(1): 82-111.

Hansen, M. T. 2002. Knowledge Networks: Explaining Effective Knowledge Sharing in Multiunit Companies. *Organization science*, 13(3): 232-248.

Hansen, M. T., Mors, M. L., & Lövås, B. 2005. Knowledge Sharing in Organizations: Multiple Networks, Multiple Phases. *The Academy of Management Journal*, 48(5): 776-793.

Hedlund, G. 1986. The Hypermodern MNCA Heterarchy? *Human Resource Management*, 25(1): 9-35.

Hedlund, G. 1994. A Model of Knowledge Management and the N-form Corporation. *Strategic Management Journal*, 15: 73-90.

Holmqvist, T. 2004. *Managing product variety through product architecture*. Ph.D. thesis, Chalmers University of Technology, Göteborg.

Holste, J. S., & Fields, D. 2010. Trust and tacit knowledge sharing and use. *Journal of Knowledge Management*, 14(1): 128-140.

Huang, T.-T. A., Stewart, R. A., & Chen, L. 2010. Identifying key enablers to improve business performance in Taiwanese electronic manufacturing companies. *International Journal of Operations & Production Management*, 30(2): 155-180.

Hutchinson, J. R. & Huberman, M. 1994. Knowledge Dissemination and Use in Science and Mathematics Education: A Literature Review. *Journal of Science Education and Technology*, 3 (1): 27-47

Inkpen, A. C., & Dinur, A. 1998. Knowledge management processes and international joint ventures. *Organization Science*, 9(4): 454.

Ipe, M. 2003. Knowledge Sharing in Organizations: A Conceptual Framework. *Human Resource Development Review*, 2(4): 337-359.

Jang-Hwan, L., Young-Gul, K., & Min-Yong, K. 2006. Effects of Managerial Drivers and Climate Maturity on Knowledge-Management Performance: Empirical Validation. *Information Resources Management Journal*, 19(3): 48-60.

Jarvenpaa, S. L., & Staples, D. S. 2000. The use of collaborative electronic media for information sharing: an exploratory study of determinants. *The Journal of Strategic Information Systems*, 9(2-3): 129-154.

Johannesson, H., Persson, J.-G., & Pettersson, D. 2004. *Produktutveckling - Effektiva metoder för konstruktion och design*. Stockholm: Liber

Kalla, H. K. 2005. Integrated internal communications: a multidisciplinary perspective. *Corporate Communications*, 10(4): 302-314.

Kalling, T. 2003. Organizational-internal Transfer of Knowledge and the Role of Motivation: A Qualitative Case Study. *Knowledge and Process Management*, 10(2): 115-126.

Kang, J., Rhee, M., & Kang, K. H. 2010. Revisiting knowledge transfer: Effect of knowledge characteristics on organizational effort for knowledge transfer. *Expert Systems with Applications*, 37(12): 8155-8160.

Katz, R., & Allen, T. J. 1982. Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R & D Project Groups. *R & D Management*, 12(1): 7-20.

Kreis-Hoyer, P., & Gruenberg-Bochard, J. 2005. The use of knowledge in inter-organisational knowledge-networks: an empirical investigation. *International Journal of Technology Management*, 33(2-3): 196-213.

Kumar, J. A., & Ganesh, L. S. 2009. Research on knowledge transfer in organizations: a morphology. *Journal of Knowledge Management*, 13(4): 161-174.

Kwan, M. M., & Cheung, P.-K. 2006. The Knowledge Transfer Process: From Field Studies to Technology Development. *Journal of Database Management*, 17(1): 16-32.

Lawrence, P. R., & Lorsch, J. W. 1967. *Organization and environment; managing differentiation and integration*. Boston,: Division of Research, Graduate School of Business Administration, Harvard University.

Lawson, B., Petersen, K. J., Cousins, P. D., & Handfield, R. B. 2009. Knowledge Sharing in Interorganizational Product Development Teams: The Effect of Formal and Informal Socialization Mechanisms. *The Journal of Product Innovation Management*, 26(2): 156-172.

Lee, C. Y., & Wu, F. C. M. B. A. 2010. Factors Affecting Knowledge Transfer and Absorptive Capacity in Multinational Corporations. *Journal of International Management Studies*, 5(2): 118-126.

Liao, S. H., & Hu, T. C. 2007. Knowledge transfer and competitive advantage on environmental uncertainty: An empirical study of the Taiwan semiconductor industry. *Technovation*, 27(6-7): 402-411.

Lincoln, Y. S., & Guba, E. 1985. *Naturalistic Enquiry*. Beverly Hills, CA: Sage.

Lindkvist, B. 2001. *Kunskapöverföring mellan produktutvecklingsprojekt*. Ph.D. thesis, Stockholm School of Economics, Stockholm.

Liyanage, C., Elhag, T., Ballal, T., & Li, Q. P. 2009. Knowledge communication and translation - a knowledge transfer model. *Journal of Knowledge Management*, 13(3): 118-131.

MacNeil, C. M. 2003. Line managers: facilitators of knowledge sharing in teams. *Employee Relations*, 25(3): 294-307.

McEvily, S. K., & Chakravarthy, B. 2002. The Persistence of Knowledge-Based Advantage: An Empirical Test for Product Performance and Technological Knowledge *Strategic Management Journal*, 23(4): 285-305.

McNeish, J., & Mann, I. J. S. 2010. Knowledge Sharing and Trust in Organizations. *IUP Journal of Knowledge Management*, 8(1/2): 18-38.

Makido, T., Kimura, S. & Mourdoukoutas, P. 2003. IT and competitive advantage: The case of Japanese manufacturing companies. *European Business Review*, 15(5): 307-311.

Mentzas, G., Apostolou, D., Kafentzis, K., & Georgolios, P. 2006. Inter-organizational networks for knowledge sharing and trading. *Information Technology and Management*, 7(4): 259-276.

Michailova, S., & Husted, K. 2003. Knowledge-Sharing Hostility in Russian Firms *California Management Review*, 45(3): 59-77.

Miles, M. B. & Huberman, A. M. 1994. *Qualitative Data Analysis: An Expanded Sourcebook*. Thousand Oaks, CA: Sage

Milne, P. 2007. Motivation, incentives and organisational culture. *Journal of Knowledge Management*, 11(6): 28-38.

Minbaeva, D. B. 2007. Knowledge Transfer in Multinational Corporations. *Management International Review*, 47(4): 567-593.

Minbaeva, D. B., Pedersen, T., Björkman, I., Fey, C. F., & Park, H. J. 2003. MNC Knowledge Transfer, Subsidiary Absorptive Capacity, and HRM. *Journal of International Business Studies*, 34(6): 586-599.

Mohamed, M., Stankosky, M., & Mohamed, M. 2009. An empirical assessment of knowledge management criticality for sustainable development. *Journal of Knowledge Management*, 13(5): 271-286.

Morgan, J. M., & Liker, J. K. 2006. *The Toyota product development system: Integrating people, process, and technology*. New York: Productivity Press.

Mudambi, R. 2002. Knowledge management in multinational firms. *Journal of International Management*, 8(1): 1-9.

Mäkelä, K., Kalla, H. K., & Piekkari, R. 2007. Interpersonal similarity as a driver of knowledge sharing within multinational corporations. *International Business Review*, 16(1): 1-22.

Möller, K., & Svahn, S. 2004. Crossing East-West boundaries: Knowledge sharing in intercultural business networks. *Industrial Marketing Management*, 33(3): 219-228.

Nahapiet, J., & Ghoshal, S. 1998. SOCIAL CAPITAL, INTELLECTUAL CAPITAL, AND THE ORGANIZATIONAL ADVANTAGE. *Academy of Management Review*, 23(2): 242-266.

Napier, N. K. 2006. Cross Cultural Learning and the Role of Reverse Knowledge Flows in Vietnam. *International Journal of Cross Cultural Management*, 6(1): 57-74.

Nonaka, I. 1994. A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, 5(1): 14-37.

Nonaka, I. & Konno, N. 1998. The concept of "ba": Building a foundation for knowledge creation. *California Management Review*. 40(3): 40-54.

Nonaka, I., & Takeuchi, H. 1995. *The knowledge-creating company : how Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Noorderhaven, N., & Harzing, A.-w. 2009. Knowledge-sharing and social interaction within MNEs. *Journal of International Business Studies*, 40(5): 719-719-741.

O'Dell, C., & Grayson, J. 1998. If only we knew what we know: Identification and transfer of internal best practices. *California Management Review*, 40(3): 154-174.

Ottosson, S. 2004. Dynamic product development -- DPD. *Technovation*, 24(3): 207-217.

Palmqvist, J., & Paulin, D. 1998. *Utvärdering av inkörningsfasen, Volvo S80*. Master's thesis, Chalmers University of Technology, Göteborg.

Paterson, S. L., & Brock, D. M. 2002. The development of subsidiary-management research: review and theoretical analysis. *International Business Review*, 11(2): 139-163.

Patriotta, G. 2003. Sensemaking on the Shop Floor: Narratives of Knowledge in Organizations. *Journal of Management Studies*, 40(2): 349-375.

Paulin, D. 2002. *Virtual verification : Impact of a new work method on the final verification process*. Licentiate thesis, Chalmers University of Technology, Göteborg.

Paulin, D. 2006. The Effects on Knowledge Creation and Transfer in Production Process Verification due to Virtual Prototypes *The Electronic Journal of Knowledge Management* Vol. 4: 181-188: Academic Conferences Ltd

Paulin, D. & Almgren, H. 2001. Virtual Development and Verification of Products and Processes - Current Trends and Challenges in the Automotive Industry, **16th International Conference on Production Research (ICPR-16)**, Prague, Czech Republic.

Paulin, D., & Lindér, J. 2001. The Final Verification Process - Methods for Increased Efficiency, *12th Annual Conference of the Production and Operations Management Society (POM-2001)*. Orlando, FL, USA.

Paulin, D., & Suneson, K. 2011. Knowledge Transfer, Knowledge Sharing and Knowledge Barriers - Three Blurry Terms in KM. In F. Lehner, & K. Bredl (Eds.), *12th European Conference on Knowledge Management*: 752-760. Passau: Academic Conferences International.

Pedersen, T., Pedersen, B., & Sharma, D. 2003. Knowledge Transfer Performance of Multinational Companies. *Management International Review*, 3(Special Issue): 69-90.

Persson, M. 2004. *Managing the modularization of complex products*. Ph.D., Chalmers University of Technology, Göteborg.

Peters, A. J., Rooney, E. M., Rogerson, J. H., E., M. R., Spring, M., & Dale, B. G. 1999. New product design and development: a generic model. *The TQM Journal*, 11(3): 172.

Polanyi, M. 1958. *Personal knowledge; towards a post-critical philosophy*. Chicago,: University of Chicago Press.

Polanyi, M. 1966. *The Tacit Dimension* ([1st ed.). Garden City, N.Y.,: Doubleday.

Poli, C. 2001. *Design for Manufacturing: A Structured Approach*, Burlington, MA, Butterworth-Heinemann.

Postrel, S. 2002. Islands of Shared Knowledge: Specialization and Mutual Understanding in Problem-Solving Teams. *Organization science*, 13(3): 303-320.

Qin, C., Ramburuth, P., & Wang, Y. 2009. Cultural Distance and Knowledge Transfer within MNCs: The case of the IT industry in China. In K. Dalkir (Ed.), *The 6th International Conference on Intellectual Capital, Knowledge Management & Organizational Learning*: 221-230. McGill University, Montreal, Quebec, Canada: Academic Publishing Limited.

Renzl, B. 2008. Trust in management and knowledge sharing: The mediating effects of fear and knowledge documentation. *Omega*, 36(2): 206-220.

Rhodes, J., Hung, R., Lok, P., Lien, B. Y. –H. & Wu, C. –M. 2008 Factors influencing organizational knowledge transfer: implication for corporate performance. *Journal of Knowledge Management*, 12(3): 84-100.

Riege, A. 2005. Three-dozen knowledge-sharing barriers managers must consider. *Journal of Knowledge Management*, 9(3): 18-35.

Riege, A. 2007. Actions to overcome knowledge transfer barriers in MNCs. *Journal of Knowledge Management*, 11(1): 48-67.

Robertson, M., & O'Malley Hammersley, G. 2000. Knowledge management practices within a knowledge-intensive firm: the significance of the people management dimension. *Journal of European Industrial Training*, 24(2/3/4): 241-253.

Schepers, P., & Van Den Berg, P. T. 2007. Social factors of work-environment creativity. *Journal of Business and Psychology*, 21(3): 407-428.

Schlegelmilch, B. B., & Chini, T. C. 2003. Knowledge transfer between marketing functions in multinational companies: a conceptual model. *International Business Review*, 12(2): 215-232.

Schleimer, S., & Riege, A. 2009. Knowledge transfer between globally dispersed units at BMW. *Journal of Knowledge Management*, 13(1): 27-41.

Schomaker, M. S. 2006. *Knowledge transfer in multinational enterprises: A language and information processing view.* PhD Thesis, University of Minnesota, Minneapolis, MN.

Schulz, M. 2003. Pathways of Relevance: Exploring Inflows of Knowledge into Subunits of Multinational Corporations. *Organization Science*, 14(4): 440-459.

Schwartz, D. G. 2006. *Encyclopedia of Knowledge Management*: 945: IGI Global.

Shannon, C. E., & Weaver, W. 1949. *The mathematical theory of communication*. Urbana, IL: University of Illinois Press.

Shin, M., Holden, T., & Schmidt, R. A. 2001. From knowledge theory to management practice: towards an integrated approach. *Information Processing & Management*, 37(2): 335-355.

Simonin, B. L. 1999. Transfer of marketing know-how in international strategic alliances: An empirical investigation of the role and antecedents of knowledge ambiguity. *Journal of International Business Studies*, 30(3): 463-490.

Solberg, C. A. 2000. Educator insights: Standardization or adaptation of the international marketing mix: The role of the local subsidiary/representative. *Journal of International Marketing*, 8(1): 78-98.

Sorenson, O. 2003. Interdependence and adaptability: Organizational Learning and the Long-Term Effect of Integration. *Management Science*, 49(4): 446-463.

Sosa, M. E., Eppinger, S. D., Pich, M., McKendrick, D. G., & Stout, S. K. 2002. Factors that influence technical communication in distributed product development: an empirical study in the telecommunications industry. *IEEE Transactions on Engineering Management*, 49(1): 45-58.

Spender, J. C. 1996. Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal*, 17: 45-62.

Sundgren, N. 1998. *Product platform development: Managerial issues in manufacturing firms*. Ph.D. thesis, Chalmers University of Technology, Göteborg.

Sunesson, K., Allwood, C. M., Heldal, I., Paulin, D., Roupé, M., Johansson, M., & Westerdahl, B. 2008a. Virtual Reality supporting environmental planning processes: A case study of the city library in Gothenburg. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 5179 LNAI(Part 3): 481-490.

Sunesson, K., Allwood, C. M., Paulin, D., Heldal, I., Roupé, M., Johansson, M., & Westerdahl, B. 2008b. Virtual Reality as a New Tool in the City Planning Process. *Tsinghua Science and Technology*, 13(Suppl. 1): 255-260.

Susman, G. I. 1992. *Integrating design and manufacturing for competitive advantage*. New York: Oxford University Press.

Sveiby, K.-E., & Simons, R. 2002. Collaborative climate and effectiveness of knowledge work - an empirical study. *Journal of Knowledge Management*, 6(5): 420-433.

Sveiby, K. E. 2007. Disabling the context for knowledge work: the role of managers' behaviours. *Management Decision*, 45(10): 1636-1655.

Szulanski, G. 1995. *Appropriating rents from existing knowledge: Intra-firm transfer of best practice*. Unpublished Ph.D., INSEAD (France and Singapore), France.

Szulanski, G. 1996. Exploring Internal Stickiness: Impediments to the Transfer of Best Practice Within the Firm. *Strategic Management Journal*, 17(Winter Special Issue): 27-43.

Szulanski, G. 2000. The process of knowledge transfer. A diachronic analysis of stickiness. *Organizational Behavior and Human Decision Processes*, 81(1): 9-27.

Säfsten, K., Johansson, G., Lakemond, N., & Magnusson, T. 2010. *Effektiv produktframtagning: Analys och hantering av osäkerhet, komplexitet och spridning*. Lund: Studentlitteratur.

Søndergaard, S., Kerr, M., & Clegg, C. 2007. Sharing knowledge: contextualising socio-technical thinking and practice. *The Learning Organization*, 14(5): 423-435.

Taylor, W. A., & Wright, G. H. 2004. Organizational Readiness for Successful Knowledge Sharing: Challenges for Public Sector Managers. *Information Resources Management Journal*, 17(2): 22-37.

Teece, D. J. 1998. Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets. *California Management Review*, 40(3): 55-78.

Tell, F. 2001. What Do Organizations Know? Different Types of Knowledge and the Dynamics of Justification Contexts in R&D Activities, *Working paper*. Department of Management and Economics, Linköping University, Linköping.

Terwiesch, C., Bohn, R., & Chea, K. 2001. International product transfer and production ramp-up: a case study from the data storage industry. *R&D Management*, 31(4): 435-451.

Tezuka, S., & Niwa, K. 2004. Knowledge sharing in inter-organisational intelligence: R&D-based venture alliance community cases in Japan. *International Journal of Technology Management*, 28(7-8): 714-728.

Thomke, S. H. & Fujimoto, T. 2000. The Effect of "Front-Loading" Problem Solving on Product Development Performance, *Journal of Product Innovation Management*, 17(2): 128-142.

Trygg, L. 1991. *Engineering design: some aspects of product development efficiency*. Ph.D. thesis, Chalmers University of Technology, Göteborg.

Tsai, W. P. 2001. Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of Management Journal*, 44(5): 996-1004.

Tsang, E. W. K., Nguyen, D. T., & Erramilli, M. K. 2004. Knowledge Acquisition and Performance of International Joint Ventures in the Transition Economy of Vietnam. *Journal of International Marketing*, 12(2): 82-103.

Tsoukas, H. 2004. *Complex Knowledge: Studies in Organizational Epistemology* Oxford: Oxford University Press.

Ulrich, K. T., & Eppinger, S. D. 1995. *Product design and development*. New York: McGraw-Hill.

Vajna, S., & Burchardt, C. 1998. Dynamic development structures of integrated product development. *Journal of Engineering Design*, 9(1): 3-15.

van Wijk, R., Jansen, J. J. P., & Lyles, M. A. 2008. Inter- and Intra-Organizational Knowledge Transfer: A Meta-Analytic Review and Assessment of its Antecedents and Consequences. *Journal of Management Studies*, 45(4): 830-853.

Vandevelde, A., & Van Dierdonck, R. 2003. Managing the design-manufacturing interface. *International Journal of Operations and Production Management*, 23(11-12): 1326-1348.

Wang, S., & Noe, R. A. 2010. Knowledge sharing: A review and directions for future research. *Human Resource Management Review*, 20(2): 115-131.

Verona, G. 1999. A resource-based view of product development. *Academy of Management. The Academy of Management Review*, 24(1): 132-142.

Wheelwright, S. C. & Clark, K. B. 1992. *Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality*. New York, NY: Free Press.

Vithessonthi, C. 2008. Social Interaction and Knowledge Sharing Behaviours in Multinational Corporations. *The Business Review*, 10(2): 324-331.

Wolfe, C., & Loraas, T. 2008. Knowledge Sharing: The Effects of Incentives, Environment, and Person. *Journal of Information Systems*, 22(2): 53-53-76.

von Hippel, E. 1994. "Sticky information" and the locus of problem solving: Implications for innovation. *Management Science*, 40(4): 429-439.

Yao, L. J., Kam, T. H. Y., & Chan, S. H. 2007. Knowledge sharing in Asian public administration sector: the case of Hong Kong. *Journal of Enterprise Information Management*, 20(1): 51-60.

Yin, R. 1994. *Case Study Research Design and Methods*. New York, NY: Sage Publications.

Yin, R. 2009. **Case Study Research Design and Methods**. New York, NY: Sage Publications.

Zack, M. H. 1999. Developing a knowledge strategy. **California Management Review**, 41(3): 125-145.

Zahra, S. A., Ireland, R. D., & Hitt, M. A. 2000. International Expansion by New Venture Firms: International Diversity, Mode of Market Entry, Technological Learning, and Performance. **Academy of Management Journal**, 43(5): 925-950.

Zander, U., & Kogut, B. 1995. Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test. **Organization science**, 6(1): 76-92.

Appendix A – Expanded analysis of influencing factors

Component in the research model	Influencing factor	Authors	Type of influence	Comments
Actor, recipient	Learning culture	Cummings and Teng, 2003	(+)	Not significant, but indicative and/or theoretical evidence provided
Actor, recipient	Priority	Cummings and Teng, 2003	(+)	Not significant, but indicative and/or theoretical evidence provided
Actor, recipient	Absorptive capacity	Kayes et al, 2005 (in Duan et al, 2010); Szulanski, 1996; Mu et al, 2010	-	Szulanski address this factor as "lack of" and find that it has a positive influence
Actor, recipient	Knowledge level / Technical know-how	Attewell, 1992; Riege, 2005	|	Attewell provides empirical evidence for his claim

Component in the research model	Influencing factor	Authors	Type of influence	Comments
Actor, source	Articulability	Cummings and Teng, 2003; Riege, 2005	(-)	Not significant, but indicative and/or theoretical evidence provided
Actor, source	Embedded-ness	Cummings and Teng, 2003	-	The analysis concludes that that the influencing factor is significantly correlated, but with a weak influence
Actor, source	Protectionism / Knowledge hoarding	Riege, 2005; Michailova and Husted, 2003	-	Riege mentions it in general terms, while Michailova and Husted argue for it to be strong in certain cultures (the Russian)
Actor, source	Ability to share	Minbaeva and Michailova, 2004	+	Minbaeva & Michailova provide empirical evidence for their claim
Actors	Knowledge distance	Gupta & Govindarajan, 2000; Delios & Björkman, 2000 (both in Duan et al, 2010); Cummings & Teng, 2003; Riege, 2005	-	Cummings & Teng find a negative linear (rather than curvi-linear) relationship between knowledge distance and KT success. Gupta & Govindarajan use similarity in prior experience and knowledge and find a positive relation. Delios & Björkman discuss similar competence and find a positive relation. Riege refers to Sveiby (2003) and include differences in experience levels as a potential influencing factor.

II

Component in the research model	Influencing factor	Authors	Type of influence	Comments
Actors	Openness	Duan et al (2010)	(+)	Duan et al (2010) provide own empirical evidence to show this influence and supports their argument with other sources.
Actors	Trust	Gupta and Govindarajan, 2000 (in Duan et al, 2010); Goh, 2002; Riege, 2005		Goh argues strongly (but without empirical evidence) that "[a] high level of trust is therefore as essential condition for a willingness to cooperate" (ibid, pp. 25-26). Riege has a similar argument.
Actors	Motivation	Minbaeva et al, 2003; Osterloh and Frey, 2000; Szulanski, 2000 (all in Duan et al, 2010); Kalling, 2003; Riege, 2005	+	Duan et al (2010) provide own empirical evidence to show this influence and supports their argument with multiple other sources.
Actors	Age distance	Riege, 2005	(-)	Riege refers to Sveiby and Simons (2002) in order to include age difference in experience levels as a potential
Actors	Gender distance	Riege, 2005	(-)	Same as previous (Riege).
Actors	Leadership	Goh, 2002; Riege, 2005	+	Goh argues (without empirical support) for the important role of leaders to influence culture and to act as role models for the employees. Riege discusses lack of leadership as a barrier for KS and supports his argument with multiple theoretical sources.

III

Component in the research model	Influencing factor	Authors	Type of influence	Comments
Content	Causal ambiguity	Goh, 2002; Szulanski, 2000 (both in Duan et al, 2010); Szulanski, 1996; Riege, 2005	-	Szulanski provides empirical evidence for his claim. Duan et al (2010) provide own empirical evidence to show this influence and supports their argument with multiple other sources. Riege discusses the factors as part of trust, but adapt it to individual level and to KS.
Content	Type of knowledge	Goh, 2002; Riege, 2005	(+), (-)	Both Goh and Riege discuss this factor from a tacit/explicit perspective referring to Hansen et al (1999) and Nonaka and Takeuchi (1995) respectively, but no empirical evidence is provided.

Component in the research model	Influencing factor	Authors	Type of influence	Comments
Media	Linguistic distance	Kayes et al, 2005 (in Duan et al, 2010); Spring Schomaker, 2006; Ambos and Ambos, 2009	-	Both Spring Schomaker and Ambos and Ambos show empirical support for their respective claims that increased linguistic distance decrease KT
Media	IT systems	Davenport et al, 1998; Rhodes et al, 2008; Riege, 2005	+	Rhodes et al show empirical support for their claim that IT systems have strong significant impact on organizational KT. Riege addresses several parts of this factor and support his claims with no empirical evidence, but only with other sources.
Media	Communication channels	Pedersen et al, 2003	(+), (-)	Pedersen et al conclude that rich media communication supports tacit knowledge transfer and written media supports explicit knowledge transfer via an empirical study.
Media	Transfer channels	Duan et al, 2010	(+), (-)	Duan et al conclude that transfer channels are very important for KT and supports this conclusion with empirical support

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Component in the research model	Influencing factor	Authors	Type of influence	Comments
Context	Strength in ties between groups	Hansen, 1999	+	Hansen provides empirical evidence for his claim that weak interunit ties impede transfer of complex knowledge.
Context	Organiza-tional distance	Nonaka, 1994; Cummings and Teng, 2003; Albino et al, 1998; Riege, 2005	-	Albino et al (1998) use organizational similarity instead of distance and finds a positive relation
Context	Physical distance	Hansen and Løvås, 2004 (in Duan et al, 2010); Cummings and Teng, 2003; Ambos and Ambos, 2009	-	All three mentioned authors provide empirical evidence to support their claims.
Context	Distance between norms	Cummings and Teng, 2003	-	The analysis concludes that the influencing factor is significantly correlated
Context	Learning/ sharing culture	Riege, 2005	(+)	Riege refers to several sources to support his claim that when an existing corporate culture does not provide sufficient support for sharing practices it constitutes a KS barrier, but provides no empirical evidence.

Component in the research model	Influencing factor	Authors	Type of influence	Comments
Context	Cultural distance	Abou-Zeid, 2005; De Long and Fahey, 2000; Goh, 2002; Ipe, 2003; Schlegelmilch and Chini, 2004 (all in Duan et al, 2010); Ambos and Ambos, 2009; Riege, 2005	-	Duan et al provide own empirical evidence to show this influence and supports their argument with multiple other sources. Ambos and Ambos provide similar findings. Riege refer to numerous theoretical and empirical studies for support.
Context	Integration of KM strategy into company's goals and strategic approach	Riege, 2005	(+)	Riege refers to several sources to support his claim that when integration of KM strategy is lacking, it constitutes a KS barrier, but provides no own empirical evidence.
Context	Organiza-tion size	Gupta and Govindarajan, 2000; Riege, 2005	(+), (-)	Gupta and Govindarajan find that size of the organization has a positive influence on KT. This is disputed by van Wijk et al (2008), who find this inconclusive. Riege claim that the size of business unit often is not small enough to facilitate KS.

Component in the research model	Influencing factor	Authors	Type of influence	Comments
Context	Environ-mental uncertainty	Liao and Hu, 2007	-	Liao and Hu provide empirical evidence for their claim that environmental uncertainty and KT are negatively correlated.
Context	Relationship	Inkpen and Pien, 2006 (in Duan et al, 2010); Riege, 2005	(+), (-)	This multifaceted concept can be interpreted in many ways, why it is difficult to provide general support. However, Duan et al refer to respondents stating that relationship plays a critical role in KT (without conclusion about the effect) while Riege address several aspects of relationships without providing own evidence.
Context	Available/ suitable space	Riege, 2005	(+)	Riege refers to Gold et al (2001) and Probst et al (2000) to support his claim that shortage of formal and informal spaces to share, reflect, and generate knowledge constitutes a KS barrier.
Context	Available time	Goh, 2002; Riege, 2005	+	Goh argues (without empirical support) that organizations need to free up time for employees to involve in increased horizontal communication to support KT. Riege discuss general lack of time as a barrier for KS supported by several sources (e.g. O'Dell & Grayson, 1998; Michailova & Husted, 2003).

Component in the research model	Influencing factor	Authors	Type of influence	Comments
Activity	Frequency/ intensity in transfer activities	Cummings and Teng, 2003	+	The analysis concludes that the influencing factor is significantly correlated, but with a weak influence

Appendix B – Expanded discussion of interaction levels and labeling

Component in the research model	Influencing factor	Type of influence	Labeled KT or KS	Interaction level	Potential to be true for other label and/or interaction levels
Actor, recipient	Learning culture	(+)	KT	Inter- and intra-organizational	Yes, learning culture influence o group and individual levels too, which in turn affect KS
Actor, recipient	Priority	(+)	KT	Inter- and intra-organizational	Yes, related to knowledge hoarding on individual level and KS
Actor, recipient	Absorptive capacity	-	KT	Intra-organizational	Yes, is a term that primarily related to individuals
Actor, recipient	Knowledge level / Technical know-how	─	KT and KS	Intra-organizational and individual	Already shown
Actor, source	Articulability	(-)	KT and KS	Inter- and intra-organizational, and individual	Already shown

Component in the research model	Influencing factor	Type of influence	Labeled KT or KS	Interaction level	Potential to be true for other label and/or interaction levels
Actor, source	Embeddedness	-	KT	Inter-, intra-organizational, group, and individual	Cummings and Teng (2003) speak about KT, but in the theoretical support utilized, embeddedness in individuals as well as in organizational routines and in groups
Actor, source	Protectionism / Knowledge hoarding	-	KS	Individual	If protectionism is a part of the organizational culture, it could be applicable on other interaction levels. If an alternate knowledge view is adopted, it could be labeled KT.
Actor, source	Ability to share	+	KT and KS	Intra-organizational and individual	Minbaevas and Michailovas hypothesized model include expatriots willingness and ability to share knowledge and connect those two factors directly to degree of KT, so the labels are mixed.
Actors	Knowledge distance	-	KT and KS	Inter- and intra-organizational and individual	Already shown
Actors	Openness	(+)	KT	Individual	Yes, if openness is a part of organizational culture, this factor could be applied on all the other levels of interaction. Yes, depending on knowledge view it could be defined as KS.

Component in the research model	Influencing factor	Type of influence	Labeled KT or KS	Interaction level	Potential to be true for other label and/or interaction levels
Actors	Trust	—	KT and KS	Inter- and intra-organizational and individual	Already shown
Actors	Motivation	+	KT and KS	Transnational, inter-, intra-organizational, and individual	Already shown
Actors	Age distance	(-)	KS	Individual	Yes, there are studies on age distance on interaction levels such as groups and intra-organizational (ICICKM'10, Chinese space industry). Yes, depending on knowledge view, KT could be utilized.
Actors	Gender distance	(-)	KS	Individual	Lacks indications for both interaction level and label
Actors	Leadership	+	KT and KS	Inter- and intra-organizational and individual	Already shown

Component in the research model	Influencing factor	Type of influence	Labeled KT or KS	Interaction level	Potential to be true for other label and/or interaction levels
Content	Causal ambiguity	-	KT and KS	Inter- and intra-organizational and individual	Already shown
Content	Type of knowledge	(+), (-)	KT and KS	Inter- and intra-organizational and individual	Already shown

Component in the research model	Influencing factor	Type of influence	Labeled KT or KS	Interaction level	Potential to be true for other label and/or interaction levels
Media	Linguistic distance	-	KT	Inter-organizational	Yes, this factor would logically be applicable on other inter-action levels. Yes, depending on knowledge view it could be defined as KS
Media	IT systems	+	KT and KS	Intra-organizational	Yes, this factor would logically be applicable on other inter-action levels. Yes, depending on knowledge view it could be defined as KS
Media	Communication channels	(+), (-)	KT	Intra-organizational	Inconclusive regarding other interaction levels and labeling
Media	Transfer channels	(+), (-)	KT	Intra-organizational	Inconclusive regarding other interaction levels and labeling

Component in the research model	Influencing factor	Type of influence	Labeled KT or KS	Interaction level	Potential to be true for other label and/or interaction levels
Context	Strength in ties between groups	+	KS	Intra-organizational	Inconclusive regarding interaction levels. Yes, depending on knowledge view it could be defined as KT
Context	Organizational distance	-			
Context	Physical distance	-			
Context	Distance between norms	-	KT	Inter- and intra-organizational	Cummings and Teng discuss norm distance between knowledge transfer parties, not excluding individuals.
Context	Cultural distance	-	KT and KS	Inter- and intra-organizational and individual	Already shown
Context	Learning/sharing culture	(+)	KS	Intra-organizational	Yes, since culture can affect knowledge dissemination on multiple levels. Yes, depending on knowledge view it could be defined as KT.

Component in the research model	Influencing factor	Type of influence	Labeled KT or KS	Interaction level	Potential to be true for other label and/or interaction levels
Context	Integration of KM strategy into company's goals and strategic approach	(+)	KS	Intra-organizational	Inconclusive regarding interaction levels. Yes, depending on knowledge view it could be defined as KT
Context	Organization size	(+), (-)	KT and KS	Intra-organizational and group	Already shown
Context	Environmental uncertainty	-	KT	Inter-organizational	Lacks indications for both interaction level and label
Context	Relationship	(+), (-)	KT and KS	Inter- and intra-organizational, group, and individual	Already shown
Context	Available/suitable space	(+)	KS	Intra-organizational and individual	Inconclusive regarding other interaction levels. Yes, depending on knowledge view it could be defined as KT
Context	Available time	+	KT and KS	Intra-organizational and individual	Inconclusive regarding other interaction levels.

Component in the research model	Influencing factor	Type of influence	Labeled KT or KS	Interaction level	Potential to be true for other label and/or interaction levels
Activity	Frequence/intensity in transfer activities	+	KT	Inter- and intra-organizational	Yes and yes.