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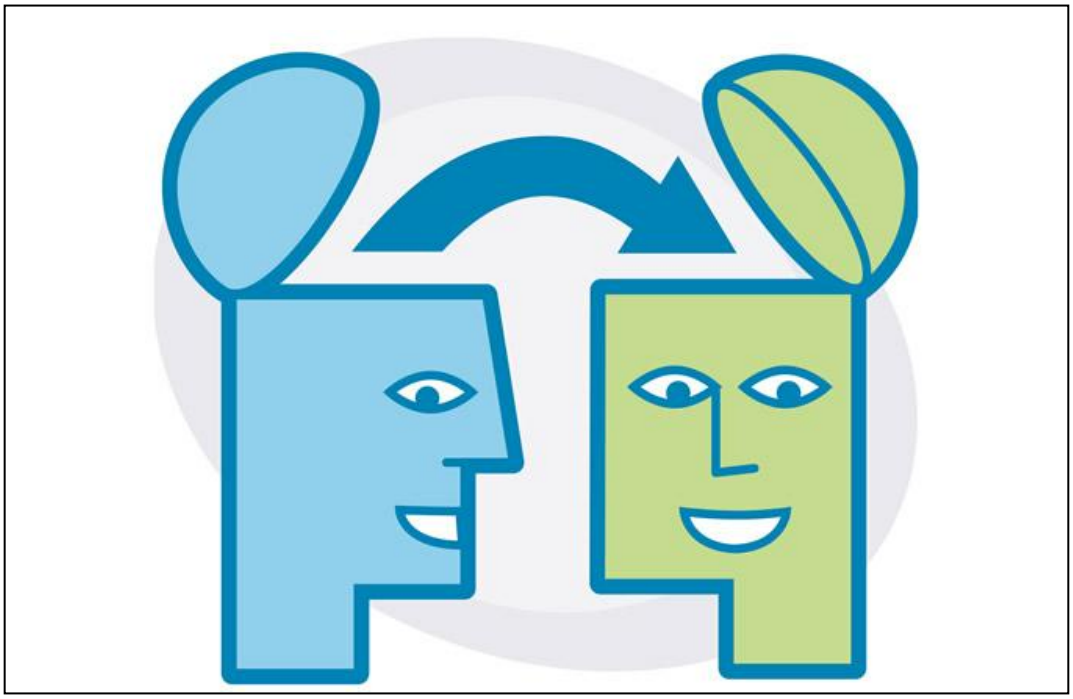

Knowledge Transfer in Global Product Development at Volvo Buses

Master of Science Thesis

in the Management and Economics of Innovation Programme

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Jesper Engberg and Anders Svensson

Abbreviations & Dictionary

CAD: Computer Aided Design

CATIA: Computer Aided Three-dimensional Interactive Application is a multi-platform CAD/commercial software suite developed by the French company Dassault Systemes.

DTL: Daily Team Lead, visual planning method used in LPD

G2P: Global Purchasing and Product Development within Volvo Bus

GDP: Global Development Process, Volvo Corporate Global Development Process is a product development process for most Volvo Business Areas/Business Units.

GBD: Global Body Development is a Functional Group of Volvo Buses' product development organization. A subdivision of G2P

KOLA: Konstruktionsdata Lastvagnar, KOLA is a Product Data Management System used by Volvo Group, mainly within Product Development, to document the product offering and design solutions.

LPD: Lean Product Development

NPD: New Product Development

PD: Product Development

PROTUS: Fault report feedback system used between Production and Product Development, often referred to as quality reports

VBC: Volvo Bus Corporation, a Business Area in the Volvo Group. The product range comprises city and intercity buses, coaches and chassis

Abstract

Knowledge transfer entail diffusion of existing knowledge, which provides an opportunity for exploitation of existing knowledge and learning from the experience of others (Wong et al., 2003). Knowledge transfer is a fuzzy concept and the reviewed literature contains a number of different definitions. Argote & Ingram (2000, p. 151) defines knowledge transfer as "*the process through which one unit (e.g. individual, group, department or division) is affected by the experiences of others*". Within product development organizations, knowledge transfer can therefore be regarded as a part of the organizational learning process (Smeds, Olivari, & Corso, 2001) and as a key dimension in a learning organization (Goh, 2002; Argote, McEvily, & Reagans, 2003).

It is important for innovative NPD organizations to make effective use of its existing knowledge regardless of where in the organization it resides. Understanding how knowledge transfer is organized in terms of what knowledge that is transferred, existing knowledge transfer activities and knowledge transfer barriers, is a first step towards setting knowledge into wider circulation in an organization (Cummings & Teng, 2003).

This study has been conducted at Volvo Buses with the purpose of investigating and analyzing how design engineers at the Global Body Development department exchanges skills and knowledge within and between its globally dispersed teams. Three research questions have been formulated: a) how does knowledge transfer take place in terms of formal and informal transfer activities at Global Body Development; b) What types of work-related knowledge do design engineers at Global Body Development perceive to be transferred, and see a need to be transferred; and 3) what are the difficulties that hinder knowledge transfer at Global Body Development? That is, factors that affect and hinder knowledge transfer and thereby determine the extent of knowledge transfer activity and the appropriate choice of transfer mechanisms. In order to answer these questions a qualitative case study has been conducted at Global Body Development, including 40 in-depth interviews with personnel across the Volvo Bus Corporation, several workshops and a questionnaire with 41 respondents.

The results showed that the knowledge that design engineers perceive as relevant to share and receive is largely tacit in its nature. The formal transfer activities are barely used at all; they are viewed as too complex and too time consuming to be useful. Instead it is the informal knowledge transfer activities, revolving around inter-personal interaction, that are used almost exclusively. These informal exchanges are mostly occurring at an ad hoc basis without any conscious and structured knowledge transfer strategy. In addition, the results showed that there exists a lack of established relationships between design engineers at the globally dispersed teams and with production. This leads to a situation where design engineers have difficulties identifying who to share knowledge with, and where it is difficult and time consuming from them to identify where knowledge resides within the organization.

Based on the context and conditions of VBC and GBD, they are recommended to formulate a knowledge transfer strategy following the personalization pattern. With clear processes and infrastructure that support inter-personal interaction, can experience-based and tacit knowledge succesfully be transferred to the right person at the right time. In some sense, this entails that knowledge transfer continues to occur at an ad hoc basis. However, this approach will ensure that this ad hoc based knowledge transfer is systematically supported and as a result becoms more

frequent. This means that GBD and VBC needs to systematically support relationship between employees to be established via strategic travelling, co-location and jobrotation. In addition, they need to set up a clear knowledge map of all the employees at different sites and functions, in terms of their expertise, skills and contact information.

Key words:

Knowledge transfer, organizational learning, lean product development, knowledge transfer mechanisms, barriers to knowledge transfer, knowledge transfer strategy

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Introduction

This master thesis report presents the findings of a case study conducted at Volvo Bus Corporation. The topic is knowledge transfer in a global product development organization, and more specifically within and between globally dispersed new product development teams. This introduction section presents a background of the topic and its relevance for research.

Background

In today's global environment characterized by ever-increasing complexity, shortened product life-cycles and constant threats of major discontinuities one of the few sources of sustainable competitive advantage is the ability of companies to innovate their product and services effectively. Consequently, the need of enhancing process of new product development (NPD) has become more and more frequent and strategically relevant. Companies all over the world are compelled to improve their efficiency in developing products and services of better quality, in a shorter time and with the use of fewer resources (Clark & Fujimoto, 1991; Schilling, 2011; Cooper, 2011).

The past ten years the concept of Lean Product Development (LPD) has gained an increasing amount of attention from academia as well as professionals. It extends the philosophies of Lean Thinking, which were introduced to the world as Womack et al. (1990) published *The Machine that Changed the World,* into the realm of product development. Like any 'Lean System' the main characteristics of LPD are shortened lead times reduced requirements for human and financial resources, as well as products and services that are a perfect match with customer requirements (Womack & Jones, 1996). In an extensive review of the current state of LPD research, however, Hoppman et al. (2011) acknowledges two fundamental weaknesses of LPD. First, thus far, the empirical foundation for LPD remains rather weak, and is primarily constituted of accounts from case studies and theoretical investigations that have strongly focused on practices at Toyota (and barely any other firms). Second, LPD is lacking a solid and consistent theory base; existing frameworks differ considerably in terms of constituent components and in their general philosophy (Hoppmann et al., 2011).

The product development organization of Volvo Bus Corporation (VBC) is currently undergoing large structural changes. They are currently introducing their Volvo Production System for their product development process, which constitutes ten cornerstones that are considered to be the locomotives in bringing their product development to world class performance. At the heart of this process lie the principles of Lean Product Development and a company-wide initiative called RnD30. This initiative revolves around doing the right things the right way with the right resources; and the name alludes to the initiative's over-arching goals of decreasing R&D/Product Development costs and lead-times by 30% while increasing quality by 30%. However, the initial pre-study revealed that much like the lack of theoretical and empirical foundation in academia there is a lack of understanding of what LPD really represents at Volvo Buses' product development organization.

The multi-sided confusion of LPD calls for a need to look for additional academic sources. One aspect that is deeply enrooted in the practices of any 'Lean System' is that of continuous improvements or *kaizen*, and in a literature review Baines et al. (2006) conclude that the creation, use and reuse of knowledge is one of the key pillars in the process of adopting LPD. In addition, Hines et al. (2004) points out that the evolution of the lean concepts over time has geared towards a focus on organizational learning. And Morgan and Liker (2006) similarly highlight both built-in

learning/continuous improvements and organizational learning as features of Toyota's prominent competitive advantages. Additionally, a plethora of authors emphasize the creation and transfer of knowledge as one of the key concepts of LPD (e.g. Kennedy 2003; Ward 2007).

The focus on organizational learning and continuous improvements in NPD thus provides a way of avoiding the shortcomings in the empirical and theoretical base of LPD, in the sense that it allows for integration of streams of research from neighboring bodies of literature. For example, Koners and Goffin (2005; 2011) draw on literature from project management-, R&D- and organizational learning literature in their research on individual and team learning from NPD projects. Similarly, Verganti, Bartezzaghi and Corso (1997) conducted their research on inter- and intra-project learning in NPD by applying continuous improvement and organizational learning research and literature on the NPD process.

Central to organizational learning and the process of continuous improvements is the object of making better use of the existing knowledge in the organization (Söderquist, 2006). A great number of researchers emphasize the importance of utilizing existing knowledge within PD organizations. Ward claim that "*the most important waste in development is waste of knowledge*" (2007, p. 30), and Browning state that "*lack of value stems less from doing unnecessary activities and more from doing necessary activities with the wrong information"* (2003, p. 52). Furthermore, Zack (2002) claim that a truly innovative organization needs to, not only explore new knowledge, but also exploit existing knowledge.

Knowledge transfer entail diffusion of existing knowledge, which provides an opportunity for exploitation of existing knowledge and learning from the experience of others (Wong et al., 2003). Knowledge transfer is a fuzzy concept and the reviewed literature contains a number of different definitions. Argote & Ingram (2000, p. 151) defines knowledge transfer as "*the process through which one unit (e.g. individual, group, department or division) is affected by the experiences of others*". Within PD organizations, knowledge transfer can therefore be regarded as a part of the organizational learning process (Smeds, Olivari, & Corso, 2001) and as a key dimension in a learning organization (Goh, 2002; Argote, McEvily, & Reagans, 2003).

This study is performed at Volvo Buses Global Body Development (GBD), a subdivision of VBC's global product development organization. GBD is a global department with teams spread across the world in Göteborg, Säffle, Poland, Mexico and India. Despite being globally dispersed, each of GBD's teams has traditionally been working primarily independent of the others. As of a couple of years ago, however, this has started to change. An organization-wide project aiming at formalizing the production of Volvo's buses into a one-bus concept, has forced the teams to leave their silos and start working as one.

The transformation into a global PD department, in combination with the pressures of the RnD30 initiative, presents a series of interesting challenges for GBD and makes it an interesting topic to study. Especially interesting is how they more efficiently can make use of and transferring the knowledge embedded in the globally dispersed teams, which are pointed out as both critical and difficult by a number of researchers (e.g. Cummings & Teng, 2003 and Subramaniam & Venkatraman, 2001). As opposed to the majority of the reviewed knowledge transfer literature, this thesis have a strong focus on investigating and analyzing knowledge transfer from the perspective of design engineers, who can be regarded to be the "blue collar workers" of product development. As far as

we are aware the existing literature on knowledge transfer in product development has paid little attention to what information individual design engineers find relevant to transfer and receive, and which tools and methods they prefer in doing so. Thus, this thesis aims to go beyond analyzing knowledge transfer from a managerial perspective and rather focus views and claims of design engineers and thereby adding a new perspective to the knowledge transfer within product development literature.

Purpose and Research Questions

In this section the purpose and the research questions of this study are presented. These were continuously developed during the research process.

Making effective use of knowledge has been pointed out as a basis for competitive advantage for innovative NPD organizations (Argote & Ingram, 2000), and in particular for organizations consisting of globally dispersed teams (Subramaniam & Venkatraman, 2001). Understanding how knowledge transfer is organized in terms of what knowledge that is transferred, existing knowledge transfer activities and barriers to knowledge transfers is a first step towards setting knowledge into wider circulation in an organization (Smith, 2001).

Thus, the purpose of this thesis is to investigate and analyze how design engineers at the Global Body Development department exchanges skills and knowledge within and between the globally dispersed teams. By establishing an understanding of how knowledge transfer is organized at GBD, the aim with the study is to analyze the knowledge transfer processes and to identify gaps and areas of improvement that could allow the developing of a learning organization.

The purpose is decomposed into three research questions, which are presented below. The first research question concerns knowledge transfer activities, formal and informal. It includes the mechanisms and media used to transfer knowledge but also the support structure in terms of knowledge transfer strategy.

- **RQ1**: How is knowledge formally and informally transferred at Global Body Development?

The second research question concerns the type of knowledge being transferred. This includes the nature of the knowledge in terms of being tacit or explicit, and where the knowledge is embedded.

- **RQ2:** What types of work-related knowledge do design engineers at Global Body Development perceive to be transferred, and see a need to be transferred?

The third research question relates to the factors that affect and hinder knowledge transfer and thereby determine the extent of knowledge transfer activity and the appropriate choice of transfer mechanisms. In the reviewed literature these are referred to as barriers to knowledge transfers, but also regarded as circumstances where the transaction costs involved are especially high.

- **RQ3:** What are the difficulties that hinder knowledge transfer at Global Body Development?

Literature Review

This section starts by presenting definitions of important concepts and explains different dimensions of knowledge transfer. Thereafter is a model for knowledge transfer in global product development presented. The model is based on a framework presented by Cummings & Teng (2003) and is divided into four sections, knowledge context, activity context, barriers to knowledge transfer and learning culture.

Knowledge in organizational settings can be described as being fuzzy and to be closely related to the individual who holds it (Ipe, 2003). There are multiple definitions of knowledge in the studied literature and often the term is used interchangeably with the concept of information. This thesis will not present a comprehensive review of the knowledge concepts, nor the difference between knowledge and information. However, a brief presentation of the concepts is relevant in order to understand the focus of the study.

Information can be regarded as a flow of messages and knowledge is created when the flow of messages is combined with the experience and commitments of holders of the information. (Nonaka & Takeuchi, 1995). Davenport & Prusak (2000) state that information can be described as a message that can be embedded in documents or be transferred through audible or visible communication. They further claim that knowledge derives from information and for information to become knowledge individuals needs to process and transform the information; individually and by interacting with others.

Davenport & Prusak (2000, p.5) defines *knowledge* as *"a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information"*. Knowledge is, unlike information, affected by beliefs and commitment of its holders (Nonaka & Takeuchi, 1995). In organizations, knowledge is not only held and used by individuals; it can also be embedded in documents, organizational routines, processes and norms (Davenport & Prusak, 2000; Bartol & Srivastava, 2002).

However, in the field of knowledge transfer, many researches claim to see no practical use of making a distinction between information and knowledge. Rather knowledge can be regarded as information held by individuals, including experiences, facts, interpretations and ideas relevant to individual, group and organizational performance (Wang & Noe, 2010). This thesis project adheres to this view of information and knowledge.

A widely used definition of *knowledge transfer*, is presented by Argote & Ingram (2000, p. 151) who state that *knowledge transfer* in organizations is *"the process through which one unit (e.g., individual, group, department, division) is affected by the experience of another"*. Szulanski (2000, p. 10) explains knowledge transfer as *"a process in which an organization recreates and maintains a complex, causally ambiguous set of routines in a new setting".* Others define knowledge transfer as a systematic and organized exchange of skills and knowledge between entities (Wong et al., 2003). Holding a constructive approach to learning, knowledge is not something that can be transferred or transmitted but something learners (recipients) has to create themselves. In this sense, the concept of knowledge transfer may be seen as a catalyst for learning that provides an opportunity for individuals to develop new knowledge (Biggs, 2003).

In the studied literature, *knowledge sharing* and knowledge transfer are often used as synonyms (Duan, Wanyan, & Coakes, 2010). Johansson (2008) argues that the difference between the two concepts it unclear, and hence uses the terms interchangeably. Knowledge transfer and sharing can be regarded as a part of the organizational learning process (Smeds, Olivari, & Corso, 2001) and as a key dimension in a learning organization (Goh, 2002). This thesis will not make a distinction between knowledge sharing and knowledge transfer, but use them interchangeably.

Dimensions of knowledge transfer

There are a large number of academic papers that aim to present models that explains the knowledge transfer process, key actors, transfer mechanisms and other influential factors, e.g. Cummings & Teng (2003), Szulanski (2000) and Ipe (2003). These models can be divided, in terms of their levels of analysis, into four different types; knowledge transfer at individual level, intra-organizational level, inter-organizational level, and transnational level (Duan, Wanyan, & Coakes, 2010). This can be regarded from the perspective of both the transmitter and recipient of knowledge. Since this study is limited to the Volvo Buses, inter-organizational knowledge transfer is not presented in this section.

Knowledge exists at multiple levels in an organization; however, at the most basic level knowledge cannot be created or transferred without individual involvement, alluding to the distinction between information and knowledge by Davenport & Prusak (2000). An organization's ability to transform knowledge into skills and capabilities is highly dependent on its people, who actually create, share and use the knowledge (Duan, Wanyan, & Coakes, 2010).

In organizations, transfer of knowledge occurs at individual level but also at intra-organizational level. That is, between groups, departments and divisions (Argote & Ingram, 2000). At inter-organizational level, knowledge transfer is regarded as *"the ability to transfer knowledge quickly and effectively from one part of the organization to others"* (Goh, 2002, p. 24).

At transnational level, the studied models offer a more dynamic view of knowledge transfer and much focus is on barriers hindering effective transfer and how these can be dealt with (Duan, Wanyan, & Coakes, 2010). In transnational intra-organizational knowledge transfer, the multinational corporation is regarded as the vehicle that transfers knowledge (Pedersen, Petersen, & Sharma, 2003). Transnational knowledge transfer is often referred to as global knowledge transfer (Subramaniam & Venkatraman, 2001). Several authors discuss the transnational aspects of knowledge transfer, emphasizing the virtually or globally dispersed units and teams (Rosen, Furst, & Blackburn, 2007).

When focusing on knowledge transfer in product development, two additional levels of analysis are discussed in the studied literature. Bartezzaghi, Corse & Verganti (1997) and Goffin & Koners (2011) discuss creation and transfer of knowledge in two dimensions, intra-project and inter-project learning.

Intra-project knowledge transfer refers to the sharing and use of experiences within the same project and project team and inter-project knowledge transfer refers to the sharing and use of experiences on different projects over a period of time (Bartezzaghi, Corse, & Verganti, 1997).

The Knowledge Transfer Framework

Knowledge transfer is an area that has attracted a lot of attention from researchers, during recent years and there are many different models and frameworks aiming to explain the knowledge transfer process (e.g. Goh, 2002; Ipe, 2003; Szulanski, 2000). The theoretical framework, used as a starting point for investigating and analyzing knowledge transfer at GBD, is based on the views of Cummings & Teng (2003), see figure 1 below. They use the perspective of knowledge transfer in product development and integrate a large number of factors in a more holistic view of knowledge transfer (Cummings & Teng, 2003). The framework divides the knowledge transfer process into four modules, each representing different factors that affect the process of knowledge transfer. The structure of the literature review is based on the model below, and presents knowledge context, activity context, barriers to knowledge transfer, and learning culture separately. The recipient context is not dealt with separately; instead it is integrated in the other four modules. The presented framework builds on the structure of the model presented by Cummings & Teng (2003), but is complemented by the views of a great number of other researchers.

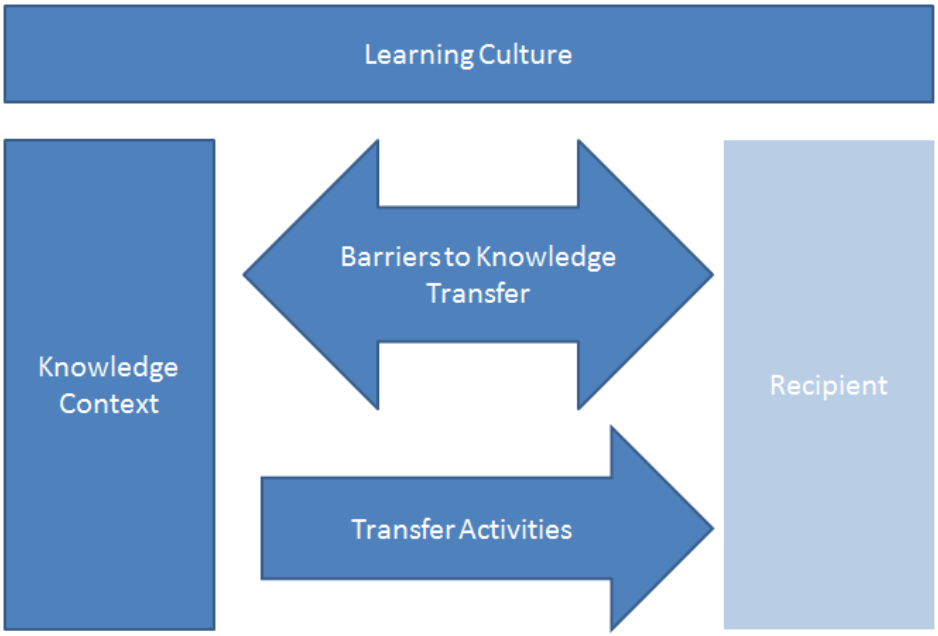

Figure 1 – Theoretical Model for Knowledge Transfer with Four Primary Modules

Knowledge Context

Understanding the knowledge context, to know where and how knowledge is stored, is positively correlated with the success of knowledge transfer (Cummings & Teng, 2003). In addition, the type of knowledge to be transferred affects the needs and conditions for the knowledge transfer process (Goh, 2002). A learning organization need to understand what type of local knowledge that exists within the walls of the company, and its characteristics. Thereafter it can be transferred and circulated among individuals and teams (Smith, 2001).

In the original model presented by Cummings & Teng (2003), two factors are presented and connected to knowledge context: articulability and embeddedness.

Knowledge Embeddedness

Cummings & Teng (2003) explain knowledge embeddedness as the characteristics of knowledge. Where it is captured and to which extent it demands transfer, absorption, adaption and adoption of multiple knowledge elements in order to allow the knowledge to be applied by the recipient. More deeply embedded knowledge has been found to be more difficult to transfer than less embedded knowledge (Cummings & Teng, 2003).

Argote & Ingram (2000) introduced the concept of knowledge reservoirs, where a reservoir denotes an element of knowledge that can be reused. They present a framework in which knowledge in organizations can be embedded in three different types of reservoirs; members, tools and tasks, or in combinations of these.

Knowledge held by people is experiences and specialized knowledge gathered from previous projects and other learning experiences. It always occurs at the individual level but can through an active strategy be used to improve the performance of units (Bartezzaghi, Corse, & Verganti, 1997). Knowledge held by members of an organization has been identified as critical in organizational knowledge transfer, transferring knowledge without involving the individual holding the knowledge often leads to a less successful outcome (Moreland, Argote, & Krishnan, 1996).

Knowledge embedded in tools, products or technology has been identified as critical in new product development (Söderquist, 2006). Knowledge embedded in a product is more than the final design. All the changes that was made leading up to a final design, contain useful knowledge that can help future projects (Ward et al., 1995), Examples of technological elements in which knowledge can be embedded in product development are structured CAD libraries, design rules and physical solutions to design problems (e.g. product platforms and off-the-shelf parts) (Bartezzaghi, Corse, & Verganti, 1997).

Knowledge can also be embedded in organizational tasks, routines and best practices. These include, for instance, procedures giving guidance to developers regarding sequences of activities to follow; tools and methods used by developers, the development process itself, and the organizational structure (Bartezzaghi, Corse, & Verganti, 1997).

Bartezzaghi, Corse & Verganti (1997) adds reports and databases as a fourth reservoir where knowledge can be embedded. Post-project reviews constitute an example, and they often come in the form of written reports or as data stored in electronic databases. However, the effectiveness of this type of reservoirs is questionable. Several authors have found that individual developers rarely take part of, use or consult the post-project reviews. The information is often unstructured and difficult to reach (Bartezzaghi, Corse, & Verganti, 1997).

Knowledge Articulability

Knowledge articulability can be explained as the extent to which knowledge can be written down, visualized, verbalized or articulated. People know more than they can explain, and research has shown that articulable knowledge is easier to transfer than less articulable knowledge (Cummings & Teng, 2003). A great number of researchers make the distinction between tacit and explicit knowledge (e.g. Polanyi, 1966), and claim that is constitutes a basis for analyzing and understanding knowledge transfer (e.g. Cummings & Teng, 2003; Nonaka & Takeuchi, 1995; Szulanski, 2000 and Ipe, 2003).

Tacit knowledge is connected to the individual holding the information. It is hard to formalize and hence difficult to communicate. Furthermore, it is deeply related to an individual's actions in specific contexts (Nonaka, 1991). Tacit knowledge can be described as know-how, acquired through personal experience. A commonly used example is that of riding a bike; something that is easy to do once you know it, but hard to explain to others using words (Ipe, 2003).

Explicit knowledge is easily codified, can be stored at a single location and can be transferred independently from specific individuals and holders of the knowledge (Ipe, 2003). Nonaka (1991) describes explicit information as formal and systematic. Through codification explicit knowledge can be easily shared and transferred in communication, product specifications, databases or documents (Smith, 2001).

The categorization of knowledge between tacit and explicit knowledge is a simplification in the sense that knowledge is rarely completely tacit or explicit. Rather, it often contains inseparable elements with different characteristics (Pedersen, 2003). However, the two types of knowledge demands different types of transfer mechanisms and support. Explicit knowledge holds an advantage to tacit knowledge regarding transferability (Ipe, 2003). However, authors have found also found negative aspects relating to the ease of transferability. Namely that easily transferred explicit knowledge does not give the same sustainable competitive advantage as tacit knowledge that is deeply embedded in organizational routines and processes (Argote & Ingram, 2000).

Knowledge in Global Product Development

Understanding what knowledge an organization and its members possess is the first, and a critical step to enhance effective knowledge transfer (Rulke, Zaheer, & Anderson, 2000; Williams, 2008). The process of product development creates a vast amount of knowledge, but so far few researchers have focused on understanding what type of knowledge that is actually created, i.e. what individuals learn from taking part of development projects (Goffin & Koners, 2011). However, a few studies have been made and findings from them are presented below.

In product development new information and technical knowledge of products are created as a part of the development process. However, the product development also contributes and enhances a firm's ability to exploit existing information. Cohen and Levinthal (1989) called this the dual role of innovation, the generation of not only technical knowledge but also knowledge on organizational processes. Bartezzaghi et al (1997) makes a similar distinction between systemic and specialized knowledge; where specialized knowledge concerns a single part of a product and systemic knowledge concerns interactions among parts of the product and among parts of the organization.

Goffin and Koners (2011) identified key lessons learned from development projects in a case study of five different organizations. Some have a strong focus on project management, e.g. project scope, planning, project budget and costs. While others were more connected to the designers work in the development process, e.g. technical problem solving, knowledge on organizational structure and complexity, technical knowledge on products and the ability to apply learning (Goffin & Koners, 2011).

Several authors also point knowledge that is required for effective R&D in global virtual teams, and product development for global markets. Subramaniam & Venkatraman (2001) discuss the impact of tacit overseas knowledge; others talk about location specific knowledge (Kogut & Zander, 1999).

Product development in a global perspective demands dealing with differences in overseas markets, and much of the location specific knowledge is claimed to have a connection to local market requirements. Location specific knowledge is to a large extent tacit by nature, and therefore difficult to transfer between globally dispersed teams (Subramaniam & Venkatraman, 2001).

Activity Context

In product development, a problem with learning from experience is largely connected to the space and time disjunction between the acquisition of new knowledge and its future application. Experienced gained from one project need to be captured and retained in the next project, which demands an efficient transfer mechanisms (Bartezzaghi, Corse, & Verganti, 1997). In global product development, the increased space disjunction further adds to the need for effective transfer mechanisms (Subramaniam & Venkatraman, 2001).

Cummings & Teng (2003) identifies three dimensions of knowledge transfer activities which are included in the activity context. Knowledge transformation that is focused on assessing the tacitness of the knowledge; knowledge transfer strategy that includes management activities and strategies focused on creating a supportive structure; and transfer mechanisms that are mechanisms focused on transferring the knowledge. Each dimension is of importance, and neglecting any one of them can lead to less successful knowledge transfer (Smith, 2001; Cummings & Teng, 2003).

Knowledge Transformation

For effective knowledge transfer, an organization needs to understand how tacit and explicit knowledge can be transferred and transformed (Williams, 2008). The SECI model, presented by Nonaka and Takeuchi (1995), describes four different conversion modes between tacit and explicit knowledge, as can be seen in figure 2 below. The model is based on the theory that new knowledge is created and expanded in the interaction between tacit and explicit knowledge – knowledge conversion – and explains theoretically how knowledge with different characteristics can be transformed and transferred. SECI as a basis for analysis has been widely used in studies of knowledge management and knowledge transfer in product development (e.g. Lindlöf, Söderberg, & Persson, 2012; Swan & Furuhjelm, 2010; Donnellan & Fitzgerald, 2003). An explanation is the importance of understanding and assessing the flow of tacit as well as explicit knowledge in a PD organization (Goffin & Koners, 2011).

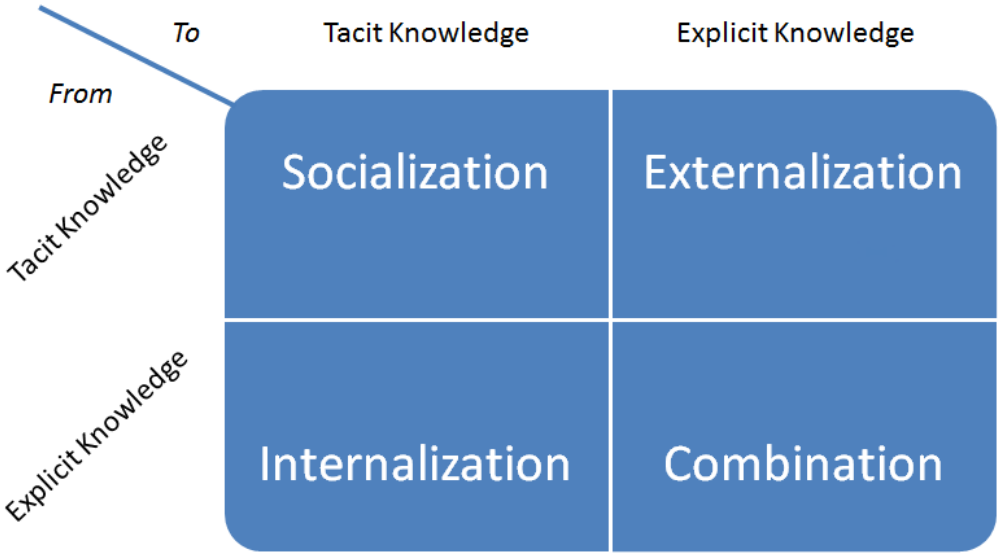

Figure 2 the SECI Model - Four Different Conversion Modes between Tacit and Explicit Knowledge

Socialization is the process of converting tacit to tacit knowledge. It concerns sharing knowledge, models and skills through shared experiences, from one person to one other where the interaction between people is essential (Swan & Furuhjelm, 2010). Apprenticeship, where a less experienced individual learns from an experienced master through observation, practice and interpersonal relationships is a common example (Lindlöf, Söderberg, & Persson, 2012).

Externalization is the process of converting tacit into explicit knowledge. It includes articulation of knowledge, transforming knowledge that is hard to codify into explicit knowledge that can be codified. Examples include A3 documents, trade-off curves and design models (Swan & Furuhjelm, 2010).

Combination is the process of converting explicit to explicit knowledge. The purpose is to structure, combine and add combinations of explicit knowledge; this is often done through meetings, training, documents, emails and telephone calls (Lindlöf, Söderberg, & Persson, 2012).

Internalization is the process of conversion of explicit knowledge into tacit knowledge. This is often explained as learning by doing. An example is to apply explicit knowledge from documents and checklists in the creation of a new design (Swan & Furuhjelm, 2010).

However, it should be noted that critics question whether knowledge can be transformed as described in the SECI model. Especially the transformation from tacit to explicit knowledge has been debated (Cook & Brown, 1999). The discussion is connected to different perspectives on knowledge and how to use the SECI mode. That is, whether knowledge is regarded as an object or if knowledge is regarded as a subjective social construction. In other words, if tacit knowledge can be transformed into explicit, or if tacit knowledge can be used to create explicit knowledge (Lindlöf, Söderberg, & Persson, 2012).

Knowledge Transfer Strategies

Knowledge transfer strategy, which is often referred to as knowledge management strategy, can be described as an ongoing process of managing efforts to find value and make use of existing

knowledge in an organization and to transfer it across organizational boundaries (Smith, 2001). A knowledge management strategy guides and defines processes and infrastructure in order to capture the value of knowledge (Zack, 2002). Two different strategies for knowledge transfer in organizations are codification and personalization strategy (Hansen, Nohria, & Tierney, 1999). These are connected to the distinction between tacit and explicit knowledge.

A *codification* strategy implies that knowledge is carefully codified, stored in databases and made available for anyone in the company; a "people-to-documents" approach is used. The knowledge is made independent of the individual and made available for reuse. With a *personalization* strategy, knowledge is rather linked to individuals that serve as holders of information. Focus is on dialogues and interpersonal interaction, which offers an opportunity to share tacit knowledge but demands organizational networks linking people together. Organizations aiming to excel at both strategies have experienced problems, and in the best-practice examples companies have focused on one of the strategies and used the other one as a supporting complement (Hansen, Nohria, & Tierney, 1999).

According to Hansen, Nohria, & Tierney (1999), the personalization strategy is mainly used by firms competing by creating highly customized solutions and unique problem solving; the person-to-person contact allows individuals to develop a deep understanding of the situation. Conversely, the codification strategy is used by firms dealing with similar and recurrent problems where re-use of specific knowledge creates value for customers through a faster and more reliable problem solving process. The use of computer systems differs substantially. In the codification strategy, databases and ICT systems are used as transfer mechanisms, whereas in the personalization strategy they are used to help people communicate knowledge rather than a way to store and transfer it (Hansen, Nohria, & Tierney, 1999).

Transfer Mechanisms

The transfer of knowledge implies a cost for the sender in terms of cost and effort spent to enable for others to understand and capture the knowledge. Individuals are offered a number of ways to transfer knowledge in an organization and the reason for using one mechanism and not the other can be explained by the ease of transfer as knowledge transfer tend follows the path of least resistance (Reagans & McEvily, 2003). Studies have shown that knowledge transfer success is positively correlated to the opportunities to share knowledge and amount of knowledge transfer activity (Cummings & Teng, 2003).

Knowledge transfer in organizations can occur through a variety of transfer mechanisms; e.g. staff rotation, formal training, face-to-face communication, observation, technology transfer, documents, visualization and presentations. The thesis does not present a review of all these mechanisms and how they affect knowledge transfer success. Rather, it focuses on the division of knowledge transfer activity into formal and informal transfer mechanisms. In addition, the impact of having a project based organization and the role of ICT systems is briefly discussed

Opportunities to transfer knowledge can be both purposive and relational (Ipe, 2003), corresponding to the distinction between formal and informal mechanisms. Formal transfer mechanisms constitute a structured environment for individuals to transfer knowledge and also the necessary tools to do so. Informal knowledge transfer is not as conscious; knowledge is rather transferred as an outcome of another activity. Informal transfer mechanisms have been proved to be effective for transfer of tacit

knowledge, but entail disadvantages when it comes to the spread and diffusion of knowledge as it is built on person-to-person interaction. Formal knowledge transfer is mainly suitable for explicit knowledge, but holds the advantage that it allows for knowledge transfer to a large number of individuals and fast knowledge diffusion (Ipe, 2003).

Informal transfer mechanisms build upon opportunities for face-to-face communication and information interaction which helps individuals to develop relationships (Ipe, 2003). Research has shown that informal transfer mechanisms accounts for a majority of the knowledge transferred in organizations. Individuals tend to transfer knowledge through informal relationship and communication even when clearly defined and formal transfer mechanisms are available (Stevenson & Gilly, 1991).

Knowledge transfer mechanisms can also be divided between communication media and written media. The problem with making both this distinction and the distinction between formal and informal mechanisms, is that knowledge transfer seldom occur in a in a single particular extreme. In most cases, the knowledge transfer process is a combination of both oral communication and written media, or a combination between formal or informal mechanisms (Pedersen, Petersen, & Sharma, 2003).

In product development, the dominating structure to organize the development process is project-based structure. Organizations often have a functional base but individuals are pulled from the line organization in projects and report to the project manager during the duration of the project. An underlying idea is that a project structure supports knowledge transfer between functional groups within the project organization (Söderquist, 2006). A method for capturing and transferring knowledge created in projects is post-project reviews where learning's from problems encountered are collected and discussed within the project team, and subsequently summarized in a document. Studies have shown that post-project reviews often are the only systematic method for knowledge transfer (Lindlöf, Söderberg, & Persson, 2012).

Within the field of knowledge transfer and knowledge management, much focus has been devoted to investigating the role of information communication technology (ICT), and how it enhances and supports the transfer of knowledge (Werger, 2004). Critics have raised the notion that it is too much focus on technology than the knowledge itself (Roberts, 2000). The development of ICT systems can be regarded to have had a double effect on knowledge transfer activities. Firstly, it has enabled collection, storage and dissemination of large amounts of data at a low cost. Secondly, it facilitates knowledge transfer through exchange and transfer of data with low transfer costs. However, the type of knowledge affected by these technological opportunities is often explicit in its nature, as it can be articulated and codified into documents and texts (Roberts, 2000).

The transfer activity, which strategy and mechanisms to use is a choice made by the sender of information (Reagans & McEvily, 2003). Pointing out a single way as the most effective is pointless as methods and means to transfer knowledge are highly dependent on the type of knowledge, objective, project and organization (Williams, 2008).

Barriers to Knowledge Transfer

The following section focuses on the relational context of the knowledge transfer. This largely revolves around a set of barriers that exists between and within the source and recipient in the

context of a knowledge transfer. Szulanski (1996, s. 30) defines barriers to knowledge transfers as factors that are likely to influence the difficulty of knowledge transfer. Based on the notion that knowledge transfer tend to follow the path of least resistance, barriers can also be seen as factors that affect the ultimate choice of knowledge transfer activities (Reagans & McEvily, 2003). Furthermore, Williamson (1981) regards the transaction cost as the central unit of analysis and that an understanding of transaction cost economizing is central in the study of organizations and their behaviour. Therefore, in the transaction cost approach, one can regard a barrier as a factor in a knowledge transfer process which has such a high transaction cost that it affects the ultimate choice of transferring knowledge, and which transfer mechanism that is chosen.

Cummings & Teng (2003) use the terminology of distances (organizational, physical, knowledge and norm) to elaborate on these barriers. By drawing on and building upon their model and other relevant authors in the knowledge management and NPD literature, the main barriers to successful knowledge transfers is outlined.

Relational Distance

What Cummings & Teng (2003) denote as organizational distance has been extended in this framework to emphasize the intra-organizational of knowledge transfer. While the semantics remains largely the same, relational distance is deemed to be a more appropriate name due to the emphasis on individual and team/department level transfers.

The shorter the organizational distance the greater the chance of successful knowledge transfers activities (Cummings & Teng, 2003). The organizational distance as a barrier to transfer boils down to that the weaker the social ties available are, the weaker will the opportunities to share knowledge and experiences, develop trust, and cooperate be (Baughn et al., 1997; Granovetter, 1985). Furthermore, Cummings & Teng (2003) argue that the strength of social ties, free-flow of communication, consistency in administrative controls and levels of trust between sources are all decreased as organizational distance increases, and consequently the likelihood of transfer success decreases.

Szulanski (1996) notes that knowledge transfers may require a good deal of interpersonal exchanges, and in particular when the transferred knowledge has tacit components. Such knowledge transfers depend greatly on the relationship between the source and recipient. And his research concluded that arduous relationships is one the most prominent barriers to successful transfers. Hansen (1999) instead discusses that it is the complexity of the knowledge that determines the need for relationships. He argues that weak social ties speeds up the development process when knowledge is less complex, but strong social ties are necessary when the transferred knowledge is highly complex.

Furthermore, in the literature there are also findings about barriers relating to a source's reluctance in sharing crucial knowledge. This lack of motivation can be related to factors such as fear of losing ownership, a position of privilege or superiority; the source may not anticipate sufficient rewards for sharing the knowledge; or it may be unwilling to devote the required time and resources to support the transfer (Szulanski, 1996; Rosen, Furst & Blackburn, 2007). Sun & Scott (2005) similarly notes that certain individuals are reluctant to transfer information, as the information constitutes an important component of their knowledge. They may feel that their importance to the organization will be undermined if the information is transferred. Likewise, in an organization in which an individual's knowledge is perceived to be the main source of value, knowledge sharing might diminish the value

of the individual and therefore decrease the motivation to participate in knowledge transfer activities (Ipe, 2003). Sun & Scott (2005) additionally elevate that a certain unit or team might not want to grant a certain individual more prominence than themselves by passing on too much information.

In addition, if the source is perceived as unreliable by its peers, the likelihood of the knowledge it attempts to transfer to be challenged and resisted increase (Szulanski, 1996). Barriers relating to lacking motivation to transfer knowledge exists at the recipient of knowledge as well. The well-documented *not invented here syndrome* (Hayes & Clark, 1985) is a well-known source of recipient's reluctance to accept outside knowledge. It is manifested by anything from foot dragging to outright rejection in implementing and using the new knowledge.

Physical distance

The difficulty, time requirements and expense of communicating and getting together face-to-face increases as physical distance is increased. Research has revealed that face-to-face meetings are superior to other meeting or transfer formats (Athanassiou & Nigh, 2000). Furthermore, as noted by Wheelwright & Clark (1992), the complexity of R&D knowledge and capabilities, which requires iterations of doing and learning, further demand a close proximity. In sum, the physical distance adds challenges to any knowledge transfers regardless of recent leaps in information and communication technology. The physical distance barrier also has a tendency of amplifying other barriers. That is, all else equal, the physical distance adds a dimension of hardship directly related to the fact that the transfer activities are not taking place in physical proximity.

Furthermore, in their article exploring barriers to knowledge sharing in global teams, Rosen, Furst, & Blackburn (2007) have found how important it is for indivudals spread globally to know each other's strengths or special knowledge, and how that information can be reached. A barrier to successful knowledge transfers is thus created when such knowledge is not readily available, e.g. via spreadsheets or other documents with each team member's knowledge profile and areas of expertise.

Knowledge distance

Knowledge distance refers to barriers that are created by differences in the knowledge base between the recipient and source of the transferred knowledge. Cummings & Teng (2003) have found that the shared interpretation of knowledge is essential for collaboration in R&D activities. And Hamel (1991) notes that the knowledge distance or gap cannot be too great in order for organizational learning to take place.

The concept of absorptive capacity is prevalent in the literature on inter-firm and intra-firm learning (Cohen & Levinthal, 1990). The concept refers to the recipient of knowledge's ability to exploit outside sources of knowledge. Research has shown (e.g. Szulanski, 1996) that a firm's ability to learn is related to the fit between the knowledge of the source and the knowledge of the recipient. That is, a large knowledge distance would be indicative of a low absorptive capacity, and when the gap is too large successful knowledge transfers cannot occur. The underlying logic is that without a shared knowledge-base, the recipient will not be able to understand and process the received knowledge. Similarly, as noted by several authors (e.g. Glaser et al., 1983; Szulanski, 1996), a knowledge transfer cannot be accurately deemed successful if the transferred knowledge is not retained. Thus, lacking abilities of the recipient of institutionalizing the utilization of knowledge is a barrier to transfer as it

reflects a lack of retentive capacity of the recipient. And the greater the distance in existing knowledge the greater likelihood difficulties during integration of received knowledge become an excuse for discontinuing its use and reverting to previous status quo.

Closely related to relational distances between individuals and teams, is the risk of asking for and sharing information. This is perhaps most evident in newly formed virtual teams where the least risky option for knowledge sharing may be not to ask for and not to offer information (Rosen, Furst, & Blackburn, 2007). This is often related to the fear of looking incompetent, or the fear of overloading virtual team mates with unwanted information (Rosen, Furst, & Blackburn, 2007). On a similar note, Sun & Scott (2005) found that certain team members may fear that their knowledge is inadequate or unimpressive, and are therefore afraid that transferring that information may display their ignorance or lack of knowledge. Lepak et al. (2007) also emphasize the individual characteristics as important in the sense that an individual may want to maintain the ability to capture the value he creates, and as a result he is unwilling to share that knowledge with co-workers or the company.

An additional concept that is mentioned in relation to the knowledge distance is that of staff turnover. Carley (1992) found that organizations typically learn slower and less the higher the turnover rate. This decrease in organizational learning is connected to the knowledge gaps, and subsequent knowledge distances, that are created as skillful and knowledgeable employees leave their positions. Moreover, her research also found that the higher the complexity of the task the organization is facing the less resilient they are in face of turnover. Thus, in R&D and NPD organizations with non-decomposable-consensual or high complexity tasks, staff turnover can work as a significant barrier to successful transfer (Carley, 1992).

Language is another knowledge-related aspect that surfaces in the literature on knowledge transfers within multi-national corporations. Marschan-Piekkari et. al (1999) presents data indicating that language acts as a barrier and a facilitator to inter-unit communication, and that those who possess relevant language competences may find themselves in more powerful positions than would normally be the case. And as noted in the relationship distance section above, unharmonious relationships act as a barrier to successful knowledge transfers. Furthermore, Rosen, Furst & Blackburn's (2007) research revealed how non-English speaking members tended to over time be left out from discussions as the language barrier were too time-consuming and tricky to overcome. Similarly, Sun & Scott (2005) elevate lacking skills in communication and persuasion as a critical barrier. This involves the skills in expressing effectively any thought or information in your mind. For an individual team member, this could mean that you find it difficult to draw the attention of the team to your point of view.

Norm distance

The norm distance relates to barriers stemming from differences in organizational culture and value systems. Similar culture and value systems allow for more smooth and effective knowledge transfer, and differences can significantly impair them (Allen, 1977). Without common norms, the predictability and understanding is decreased between parties and it hinders the adoption of a common approach in the transfer process (Cummings & Teng, 2003). As a consequence, the transfer success decreases as norm distance between source and recipient increases.

For MNC's with globally dispersed and virtual teams it has become reality with large norm distances within the same organizations. Rosen, Furst & Blackburn's (2007) note that cultural dissimilarities in

communication styles and knowledge sharing norms can fuel tensions and frustrations between virtual team members. In some occasions, team members may respond by excluding certain team members or teams from discussions by choosing to work around rather than with culturally diverse others. They also found that team members from certain cultures may be more hesitant to share ideas and to provide feedback of other's ideas. These issues of norm distances and similar will be covered in greater detail in the next section which deals with the importance of having a culture and environment that promote learning (Rosen, Furst, & Blackburn, 2007).

Priority

Another aspect that is frequently found in the literature on barriers to knowledge transfer is relating to relative priority of the knowledge transfer project. Cummings & Teng (2003), for instance, have found that when the recipient sees the knowledge transfer project as high priority it will have greater motivation to support the transfer than if the project is seen as less significant. Moreover, virtual projects and R&D projects are often of cross-functional nature and conflict with on-site responsibilities and deadlines of the line organization (Rosen, Furst, & Blackburn, 2007). That is, there is a general tendency for knowledge transfer activities to find themselves stacked under a pile of more highly prioritized tasks.

Learning Culture

Learning culture in an organization can be regarded as patterns of basic assumptions developed in a group while dealing with problems and developing solutions (Ipe, 2003). MacDermott & O'Dell (2001) state that organizations can be regarded as cultural entities. Therefore the culture of an organization will have an impact on all managerial attempts to manage the organizational knowledge. The learning culture of an organization determines individuals' perceptions of relevant knowledge and shape specific practices in terms of when to act and what to do (Ipe, 2003). Although it is acknowledged that there are inherent benefits to knowledge sharing, people are reluctant to share. Various reasons have been cited and among them scholars have consistently identified organizational culture as one of the main reasons (Argote, McEvily, & Reagans, 2003; Tannenbaum, 1997). Similarly, a plethora of authors have found and emphasized the need for a culture of learning in an organization in order to facilitate organizational learning and transfer of knowledge. The cultural dimension is present in most areas relating to motivations, attitudes, and value- and norm based aspects in inhibiting or supporting successful knowledge transfers from taking place (Cummings & Teng, 2003; Rosen, Furst & Blackburn, 2007; Aubrey and Cohen, 1995; Argote & Ingram, 2000; Glaser et al., 1983; Hamel, 1991).

A common source to unsuccessful knowledge transfer is an organizational culture and objectives that do not support learning; the organization is set in its ways and divergent ideas are not encouraged. Furthermore, the importance of openness to ideas stretches into the realm of teams and individuals as well, and the same applies if individuals are set in their way of thinking, and if it is difficult to get them to accept and adopt new ideas. Authors emphasize the importance of establishing an environment of learning, and thus avoiding situations where certain members find it difficult to transfer ideas and thoughts, as the team is reluctant to deviate from common trends of thought (Sun & Scott, 2005).

Tannenbaum (1997) found that there are facilitators and inhibitors of the environment that promotes and disrupts the process of organizational learning, continuous improvements and transfer of knowledge. The learning environment encompasses those salient aspects of the work environment that have the highest influence on whether learning occurs. According to Tannenbaum (1997) the following characteristics hold true in a positive learning environment:

- *Individuals are aware of the big picture.* They have a shared and clear understanding of the goals of the organization and what is the role of their unit in relation to the other parts of the organization. Having an awareness of the big pictures paves the way for individuals to align their personal goals with those of the organization. This enables them engage in appropriate learning experiences and knowledge sharing activities that contribute to both personal and organizational success (Senge, 1991).
- *Mistakes are tolerated during learning and early application, when individuals are trying new ideas and skills.* This relates to organizational aversion to risk, and how it can send messages that mistakes are unacceptable and that learning on the job and trying new ideas is viewed as a threat to one's career. This fear can inhibit learning, initiative and innovation. If handled correctly with a high degree of tolerance, however, mistakes can provide invaluable learning experiences (Tannenbaum, 1997).
- *Individuals are accountable for continuous learning and knowledge-sharing. The performance expectations are high and necessitate that learning and personal growth take place.* Does the

organization monitor how employees are learning new things and continuously develop their skills? Does the organization provide a playground for continuous learning to take place? Do employees believe that learning new skills will be essential for them to get ahead and grow in their professional career? Do employees believe learning and knowledge-sharing to be a part of their jobs? Accountability and high performance expectations are about sending the message that learning and sharing knowledge lie at the heart of being successful. Accountability is also about taking notice and commending individuals when they are applying new skills and ideas to solve problems (Rosow & Zager, 1988).

- *New ideas are valued and encouraged.* The thinking, problem-solving and offering of suggestions are seen as a part of everyone's role, and not solely something done by the management. It is, for example, acceptable to question why things are done in certain ways, and it is not seen as more safe to maintain the status quo than to try something new. It is important to establish an environment where everyone is encouraged to question what they are doing, how they are doing it, and how it can be done better (Tannenbaum, 1997).
- *Supervisors and coworkers are open to new ideas and support and encourage individuals to share and implement new ideas*. This is related to a having a culture of openness to new ideas and suggestions, where people are encouraged to try new ways of doing things. This goes hand in hand with new ideas being valued and encouraged, and how the employees can see personal and organizational benefits from learning new things and sharing these things with their co-workers. Are supervisors encouraging people to attend relevant training or engage in knowledge-transfer activities rather than acting as if it is an imposition for the department? The social support has been found to be an extremely strong influence in training, knowledge-transfer and learning effectiveness (Dubin, 1991; Tannenbaum, 1997).

A common denominator for all these characteristics is that they are all closely connected to the distances presented in the previous section, in the sense that they in many ways can provide an remedy, or works as amplifier, to common barriers to knowledge transfer. And Tannenbaum (1997) concludes that there is not one "best" way to enhance continuous learning – it depends on a variety of factors. However, his findings clearly indicate that ineffective learning environments hinder continuous learning and effective knowledge transfers. Thus, it is important that organizations periodically diagnose their learning environments.

Methodology

This section presents and discusses the methodology used in this study; it covers the research strategy, research design and research process and methods. The section is divided into four different parts where each of these is discussed. Thereafter follows a discussion on the research quality in terms of validity and reliability.

Research Strategy

In terms of research strategy, Bryman and Bell (2011) point out the distinction between qualitative and quantitative research as central in a methodological discussion. They represent distinct methods in business research and help classifying different methods, and they can be regarded as fundamental contrasts in terms of how data is collected and analyzed. In quantitative research, focus is on quantification in the collection and analysis of data. It is suitable when measures such as time are to be analyzed; and is often entailed by a demand for large samples to enable generalization and relevant conclusions (Bryman & Bell, 2011).

As for qualitative research, the focus is rather on words and their meaning instead of numbers and quantifiable measures. A qualitative approach can be applied when the sample is smaller, hard to measure and the investigated aspect has a softer focus (Creswell, 2009).

A third approach is mixed methods research, which combines and integrates aspects of both quantitative and qualitative research. It concerns research projects where research methods from the two distinct strategies are used as a combination to gather and analyze data (Bryman & Bell, 2011).

The focus of this study is to investigate and analyze the knowledge transfer process at GBD and Volvo Buses, which can be hard to codify and measure. The data collection and analysis is hence characterized by a qualitative research strategy. The data collection and analysis is focused on words, their context and meaning, and in this way creating and understanding of individuals' perceptions of the objectives. The underlying reason for this research strategy is two-folded. Firstly, in accordance with Creswell (2009), the study's soft focus makes the use of a qualitative approach more suitable. Secondly, due the relatively small sample size a qualitative approach enabled a deeper understanding of the studied object. However, during the research process, additional data collection methods were added to the research, including review of internal documents and databases, and a questionnaire. The use of quantitative research methods, in the form of a questionnaire, rather makes it a mixed methods research. The emphasis of the study, however, is on qualitative measures where quantitative methods have been used as complementary sources of information.

Research Design

A research design provides a framework for collection and analysis of data, and guidance for execution of research methods. Bryman and Bell (2011) argue that the choice of research design reflects the focus and priority of generalization. That is, the ability to make causal connections between variables, understanding behavior in specific contexts and drawing relevant conclusions over a period of time (Bryman & Bell, 2011). In the following section, the case study research design used in thesis is discussed.

Case study can be defined as *"an intensive analysis of an individual unit (as a person or community) stressing developmental factors in relation to environment"* (Flyvbjerg, 2011, p. 309). In business

research, the use of case study design is widespread. Often it concerns a single company or organization, a separate unit e.g. a factory, a person or a single project or event. The case study design builds upon detailed and intensive data collection and analysis of a single case. It aims to give an in-depth understanding of the studied object during a certain period of time (Bryman & Bell, 2011, p. 41). Case studies are often discussed as a qualitative approach, but a mixed methods research strategy can be used to collect and analyze data in order to create in depth understanding (Yin, 2009).

This thesis follows a single case study design focusing on the Global Body Development (GBD) department at Volvo Buses Corporation (VBC). Conducting the case study research design and focusing on one specific unit within VBC enables in-depth understanding of the given context and problems connected to the GBD department (Flyvbjerg, 2011).

This thesis focuses on a single department in a large organization, and that entails both positive and negative aspects. First off, it provides distinct boundaries for the study object, in an otherwise complex organizational structure, but still with the perspective of a global organization with all the complexity that brings. However, the negative aspects are connected to the fact that finding root-causes behind a specific phenomenon is problematic without leaving the given department. The implication is that some findings relevant for the organizations as a whole, particularly from the pre-study, has not been further investigated as they were perceived to be connected to other functional departments at VBC. That is, outside GBD and outside the scope of the study.

Research Process and Methods

This research project has been divided into five modules, each with different objectives and research methods in order to fulfill the overall purpose of the study. In this section, the modules are presented separately in order to give a detailed description of the research process, and argue for the choice of methods. The research process and methods as a whole are presented in the figure 3 below.

	Pre-Study	Situation Analysis	Data Collection	Problem Evaluation and Analysis	Discussion and Conclusions
Focus	The Volvo Context The Lean Product Development Context Problem Finding Audit	Knowledge transfer in product development Global knowledge transfer Creating structure for data collection	Assessing knowledge transfer within and between teams Assessing knowledge transfer activities between production and product development Assessing learning culture	Analysis of critical aspects affecting knowledge transfer	Provide general conclusions Discussion of knowledge transfer gaps and barriers at Volvo Buses Provide suggestions for further research
Research Methods	Semi-structured interviews	Semi-structured interviews Observation Review of documents and databases	Semi-structured interviews Observation Questionnaire	Workshop Applying framework Codification	Structuring and concluding the analytical findings
Sources of information	Department Managers, Project Managers, Coordinators, Internal Documents	Managers, Coordinators, Design Engineers, Daily Team Meetings, Internal Documents	Design Engineers, Coordinators Production Technicians Department Meetings Project Meetings	Management Team	

Figure 3 – Research Process

The pre-study served two main purposes. It aimed to create an understanding and contextualization of VBC, the GBD department, their product development process and the organizational change initiative that is the point of departure for this study, R&D30. Given that R&D30 is strongly influenced by LPD principles, the pre-study was extended to include LDP literature in order to create an understanding of important and relevant concepts.

Due to a broad initial scope of the project given by VBC, namely "*identify ways to improve the efficiency at GBD department*", an additional purpose of the pre-study was to use a problem focused analysis in order to narrow down the scope and identify a focus for the study. The design of the pre-study was inspired by the problem finding logic of a Problem Finding Innovation Audit (PFIA) as

proposed by Björkdahl and Holmén (2011). Given such a broad scope, the PFIA methodology was found useful as it stresses the importance of identifying problems, and using them as a base for further analysis and formulation of recommendations (Björkdahl & Holmén, 2011). To achieve this, six interviews were held with managers, project managers and coordinators, together with interviews with design engineers. Each interview lasted about one hour. The interviews were semi-structured with open-ended question in order to allow respondents to elaborate on their view on issues at VBC and GBD, and allowed the researchers to ask relevant follow-up questions.

The purpose with the interviews was to identify problems experienced by the interviewees and based on interpretations of their view create a tentative list of problems. The list was thereafter discussed, in a workshop-like manner, with managers of the GBD department and a top manager of the R&D30 program. These discussions lead to the choice of knowledge transfer the main focus of the research.

In the second module, situation analysis, the focus was narrowed down to knowledge transfer within product development. An extensive literature study was undertaken in order to develop a deep understanding of relevant concepts and methods for knowledge transfer in product development. This was done in combination with 8 semi-structured interviews managers and coordinators within GBD, as well as with managers and representatives of other functional departments at Volvo Buses. These included quality managers, after-market representatives and process-owners of the global development process. Each interview lasted for about one hour. The questions in these interviews were focused on what type of knowledge that is critical for design engineers, when they to receive it, and how they can/is receiving it presently. Semi-structured interview questions enabled the researchers to create an understanding of the respondents' view of relevant knowledge for design engineers at GBD, and the structure of current transfer activities. The underlying logic behind these interviews was based on idea that a "*lack of value stems less from doing unnecessary activities and more from doing necessary activities with the wrong information"* (Browning, 2003, p. 52). It thus served as a way to connect lean product development's focus on waste reduction to knowledge transfer.

Initially, attempts were made to map out the information flow at the Body department. This was done by participating during team and project meetings and by tracking internal written communication. However, these attempts were not fruitful due to the complexity of the information flows. Therefore the researches abandoned that approach and started looking at it from the perspective of individual design engineers instead.

In addition to the interviews, a large set of existing internal documentation was reviewed and analyzed; e.g. post-project reviews, existing information in databases and quality reports. The focus of the analysis was to triangulate the perceptions of the employees and looking directly at the embedded knowledge and its availability. Furthermore, during the situation analysis, the researchers participated as observers in both various formal and informal meetings, including department meetings and global project meetings. Review of documents and databases and observation and meetings served several purposes. Firstly, it gave an understanding of how meetings work as knowledge transfer activity and how these processes were applied at VBC and GBD. Secondly, it gave an understanding on the type of knowledge relevant for design engineers, since these meetings are

focused on discussing problems and possible solutions. Observing the transfer processes in-action allowed the researchers to develop a deeper understanding of knowledge transfer.

Despite initially limiting the study to the GBD department a choice was made during the second module to include production in the analysis of the knowledge transfer processes. Based on input from key personnel, and findings during the pre-study this choice was primarily based on the key characteristics of the production department in that they possess information directly related to the quality of the design engineer's design work. A manager in the PD organization pointed out the production department as their direct customers and therefore they hold knowledge valuable for design engineers.

Furthermore, the ongoing literature study revealed that knowledge transfer can be analyzed in several different dimensions; at individual level, at team level (globally and locally), at organizational level and at inter-organizational level. The focus of this study is on the level of GBD and its constituents design engineers. Therefore, a choice was made in limiting the research to certain dimensions of knowledge transfers as highlighted in figure 4 below. The limitations concern knowledge transfer *to* individual design engineers from the teams of GBD, locally and globally, and the production department. And *from* individual design engineers to the teams of GBD, locally and globally, and the production department.

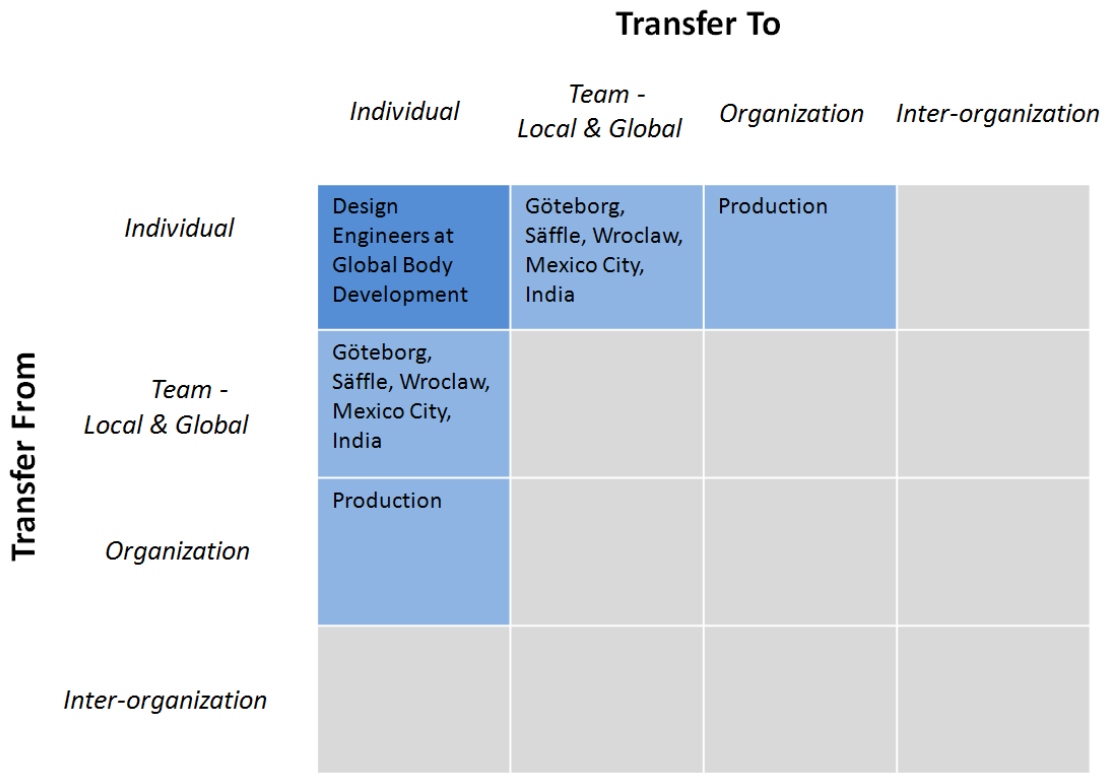

Figure 4 – Dimensions for Analysis of Knowledge Transfer

The third module represents the main data collection method of this study. Its structure is based on findings from the first two modules and the literature study. It consists of four main focus areas:

- Investigation of transfer activities between the production department and design engineers at GBD based on findings in module two – Related to RQ1

- Investigation of the knowledge transfer process within and between the globally dispersed teams of GBD – Related to RQ1
- Assessment of design engineers perception of work-relevant knowledge being transferred – Related to RQ2
- Assessment of barriers to knowledge transfer and learning culture at GBD – Related to RQ3

Data collection was done through, in total 15, semi-structured interviews with 9 design engineers and 2 team coordinators located at three of the GBD sites: Göteborg, Säffle and Wroclaw and 4 production technicians in Säffle and Wroclaw. The duration of the interviews was about one hour. Due to economic and time constraints, the sites in India and Mexico City were not included in this part of the research. In the interviews with design engineers, similar open-ended questions as in the second module was asked: What knowledge do design engineers receive and use from specific sources, to what extent the knowledge is useful, and what barriers exist that hinder them from receiving and using the knowledge. The intention with the semi-structured interviews was to keep interviews flexible and allow for follow-up questions as salient issues arose during interviews. The questions asked during interviews can be found in Appendix I.

The interview questions were tested during a pre-test interview at the Gothenburg site, which allowed for clarification of specific concepts and statements. An example was the particular concept "relevant knowledge", which was reformulated to be more specific following the pre-test interview, since the interviewee regarded it as difficult to understand. Furthermore, given the possibility of significant differences across the different sites, all questions were asked to at least one of the interviewees at each site.

The interviews with production technicians in Wroclaw and Säffle focused on conceptions about knowledge transfer between production and PD. These interviews partly took place in the production facilities with the ambition to allow the interviewees to point out specific examples of problems relating to knowledge transfer between production and PD. The sample of production technicians was chosen with help of the manager of GBD and local team manager is Säffle and Wroclaw. The only prerequisite was they were responsible for areas in production in which GBD employees are designing a significant amount of parts.

Furthermore, a questionnaire was sent out to all members of GBD, including those located in Mexico and India. The questionnaire was not part of the initial research design, however, during the research process it became relevant for two reasons. Firstly, the semi-structured interviews did not contain specific questions focused on the learning culture, which was identified as an important part of knowledge transfer in the literature review. During the research process and literature review, the researchers' view of knowledge changed from a transferrable object to the view of knowledge as a subjective contextual construction. By holding the view of knowledge transfer as a subjective social activity, the importance and impact of organizational learning culture became evident. A view supported by a large number of researchers (e.g. Cummings & Teng, 2003; Tannenbaum, 1997; Davenport & Prusak, 2000). Secondly, the questionnaire allowed for testing and triangulation of findings from the semi-structured interviews on a larger sample. The questionnaire will be more thoroughly described in next section.

In the fourth module; problem evaluation and analysis, the data collected from all interviews in module two and three were analyzed together with the results from the questionnaire. The data

analysis was performed by using the developed framework, presented in theory chapter**.** All interviews were summarized and thereafter color-coded in four different colors. Each of the colors was connected to the major parts of the framework; knowledge context, transfer activities, barriers and/or learning culture respectively. The data was compiled to a meta-text which was read with great care a number of times. The analysis was performed in a qualitative manner through thorough review of data given each specific context of knowledge transfer and thereafter the views and claims of the respondents could be summarized. When reading the text, salient issues were marked in order to create alignment of related claims and arguments, and by doing so themes and patterns in the data could be identified.

Questionnaire

To be able to assess the learning culture within VBC and the GBD department a web-based self-completion questionnaire was created and sent out to all members of the GBD organization, including Mexico City and India.

The questionnaire questions were based on a survey performed by Tannenbaum (1997) focusing on organizational learning and training. Drawing on an existing survey was seen as an advantage since already tested and used questions ensured a high research quality. However, the questionnaire was complemented with questions specific to the theoretical framework of this research, mainly consisting of questions dealing with global knowledge transfer. In addition, a few questions were added in order to test and triangulate previous findings form the interviews. The questions are presented in Appendix II**.**

Before being sent out, the questionnaire was pre-tested on a design engineer located at the Gothenburg site. After the design engineer had completed the questionnaire, he took part in a 30 minute interview in which each question was reviewed and discussed. In addition, the manager of the GBD department was sent the questions for review. A specific problem identified during the pre-test was that the word organization could be interpreted differently by different respondents, as VBC and GBD is a part of a large matrix organization the respondent claimed to see many meaning for "my organization". Therefore organization was changed to GBD, G2P[1] or VBC depending on the focus of the question. Besides that, some questions were rephrased as they were perceived as illogical and difficult to understand. In three questions the wording "VBC monitors" was changed to "VBC measures" as the respondent explained that the word monitors was too harsh, and made him think of police-like surveillance. The word measure was regarded as a better fit with reality of the respondents.

The sample of the questionnaire was all the design engineers at GBD, in total 50 employees**.** Out of those, 41 responded. 9 located in Gothenburg, 3 in Säffle, 6 in Mexico, 13 in Wroclaw and 9 in India. Which gave a response rate of 41/50, it should be noted, however, that the small number of respondents in Säffle should be put in relation to that there are only five members of GBD located there.

The weaknesses with the method is, according to Bryman & Bell (2010, p.233 - 234), that you do not know who answers; cannot control the order in which questions are answered; cannot collect additional data; difficult to ask a lot of questions; and low response rates. Some of these problems

[1] Global purchasing and product development

were not relevant in this case. Emails were sent out the all members of the GBD organization and the local team leaders were informed of the arrival. Members of the teams in Gothenburg, Säffle and Wroclaw were already informed about a coming questionnaire and to respondent in Mexico City and India an explanatory introduction was written in order to increase response rates. The questionnaire was structured so all questions for each theme had to be answered before moving on to the next page. This to allow the respondents the review all related questions before answering them the thereby understand the specific aspects separating the questions. In addition, to ensure that the respondents were not blindly filling in the questionnaire to get it over with, a couple of questions were reversed. The results revealed that the respondent had been paying attention as the reversed questions were answered in a reversed pattern.

Quality Criteria

While conducting this study, various aspects of validity of the reliability have been carefully considered. In this section these considerations and relevant actions concerning the quality of this study will be presented in detail.

Validity

Validity is concerned with the integrity of the conclusions that have been drawn from a certain study. That is, the level of trustworthiness the research displays (Bryman & Bell, 2011). In the sections that follow, the consideration regarding four types of validity types will be discussed. These are external validity, internal validity, construct validity and ecological validity. However, first follows a recount of how triangulation has been used in this study.

Triangulation

Triangulation is a concept that is very central in ensuring that the integrity of a research's findings is kept intact. Triangulation entails utilizing more than one method or source of data in the study of social phenomena. Common types of triangulation include having multiple observers, theoretical perspectives, sources of information and data collection methods. Triangulation allows for cross-checking of data and may open up for different levels of analysis and improve validity of findings (Bryman & Bell, 2011, p. 397).

Several features of triangulation are present in this study. Firstly, a simplistic description of knowledge transfer involves a sender and a receiver of knowledge, and multiple sources of information have been use in order to cross-check and understand the complex process of knowledge transfer. These sources include the sender and the receiver of knowledge, but also documents and databases. Secondly, a combination of different data collection methods has been used to obtain data from different perspectives and to cross-check findings. For example, questions in the quantitative questionnaire were based on (and cross-checked) findings from the qualitative interviews; and observations recorded during team, project and department meetings have been used to cross-check findings from other sources, and also as input in drafting interview guides and compiling the questions for the questionnaire. Thirdly, after each of the interviews both of researchers transcribed the notes and reflections independently. We then discussed our views, and in two instances where there was confusion or significant incongruences in our interpretations, they made sure to ask the interviewee for clarification.

The triangulation features have especially affected the first research question that addresses how knowledge transfer take place take place in terms of formal and informal transfer activities at Global

Body Development. The second and the third research questions have mostly been addressed via the interviews and the questionnaires in the later stages of the research, and not as heavily cross-checked as the first.

Internal Validity

In quantitative research, internal validity is concerned with setting up casual relationships where certain conditions lead to other conditions. It is about being confident that an independent variable is responsible for variations that are identified in a dependent one (Bryman & Bell, 2011, pp. 40-43). By providing thick descriptions of the setting, context and concepts and establishing how concepts are systematically related the internal validity of this research has been increased.

In qualitative research internal validity often is concerned with whether or not there is a good match between the researches' observations and the theoretical ideas being developed (Bryman & Bell, 2011, p. 395) Since we spent five months participating at GBD's working environment, during meetings, during lunch breaks, and being a part of their social context, we were allowed to ensure a high level of congruence between the concepts and our observations.

In addition, in qualitative research the concept *credibility* is often used instead of internal validity. There can be multiple accounts for a certain aspect of a social phenomenon, and credibility is about confirming that the investigator has properly understood the social world being studied. A way of increasing the credibility criterion is via respondent validation – the process whereby the researchers provide the people on whom the research was conducted with the findings and results. That is, it provides a way of confirming that that the findings and impressions are congruent with the views of those on whom the research was conducted (Bryman & Bell, 2011, p. 396). Through-out our research we have maintained high levels of respondent validation. Primarily this was done by asking the interviewees to comment on the notes and reflections that we compiled after completing each interview. Furthermore, as noted by Bryman & Bell (2011, p. 396), triangulation is another technique that helps increase credibility. And in those cases where immediate respondent validation was not possible, subsequent features of triangulation (for details see section on triangulation) were introduced to help confirm the findings. These considerations for internal validity have affected all the research questions equally.

External Validity

External validity is concerned with whether the results from a study can be generalized beyond the specific research context. It is thus important to clearly define this domain, outline the boundaries of what can be said and generate a representative sample (Bryman & Bell, 2011, pp. 42-43). In qualitative research one often talks about to which degree the findings can be generalized across social settings. And the concept of transferability is often used instead. To accomplish high transferability researchers are encouraged to produce what is called thick descriptions in order to provide a 'database' for others to use when assessing whether it is possible to transfer to other contexts and milieu (Bryman & Bell, 2011, pp. 395-398).

The domain of this study is quite narrow, given that we are based at single unit of a single company. However, the domain to which findings can be generalized has been extended due the use of thick descriptions of the context and the concepts involved, and by drawing on and connecting the research to prior theory. As a result, the findings have at least moderate levels generalizability in any context involving knowledge transfers, per our definitions, within and between PD teams that are

dispersed globally. In addition, GBD represent just one unit of one part of the entire Volvo Corporation, and there are similar product development departments finding themselves in similar context. And the transferability within the "Volvo" domain is deemed to be high. The first and second research questions are of perhaps the lowest external validity as they are very focused on exactly how things are done at GBD. Whereas the barriers to knowledge transfer findings could have higher external validity as many of them look at features of human beings rather than specific to the GBD/VBC organization and its context.

Construct Validity

Construct validity is concerned with whether a study is in fact measuring what it intends to measure (Bryman & Bell, 2011, p. 42). We have done several things in order to secure high construct validity. Firstly, via triangulation we have used multiple sources of evidence, and multiple data collection methods in answering the research questions of this study (for details see previous triangulation). Secondly, we have explicitly described our methods in detail, and provided a complete picture of the background and context of our research. Furthermore, the interviewees have been asked to review the notes and reflections from each interview. And finally, interview guides in all of the modules and the questionnaire were all pre-tested at least once before starting the actual interviews and data collection.

Ecological Validity

Ecological validity is related to the question whether the findings of empirical research are applicable to everyday reality of people and natural social settings. The logic is that the more the researchers intervenes in natural settings to create unnatural ones, the more likely is it that the research produces ecologically invalid findings (Bryman & Bell, 2011, p. 43). In order to keep the ecological validity as high as possible we have tried to create as thick descriptions as possible on the perceptions, settings and activities. And constantly done our best to make sure that these are based on how the personnel of GBD view reality. We have made sure that all the personnel have had their say, and allowed all interviewees to comment on summaries of our notes and reflections from the interviews. In addition, during frequent workshop-like meetings with the manager of GBD we have continuously presented our findings, and then received his feedback and comments on their validity. These considerations affect each of the research questions equally.

Reliability

Reliability is concerned with how accurate the study is – whether the results of the study are repeatable or not (Bryman & Bell, 2011, p. 41). In qualitative research external reliability can be hard to achieve; things are studied in a transient social setting that cannot be frozen and kept intact for replication of the research (Bryman & Bell, 2011, p. 395). However, various steps have been taken to improve the reliability of this study. Firstly, we have formulated clear research questions that have guided and shaped the features of the study. Secondly, we have documented the careful and systematic investigation of the study's different modules. Furthermore, relating to internal reliability, since we are two researchers, we have always ensured that we agree with what we saw and heard during observations and interviews. These considerations affect each of the research questions equally.

Results

In the results section, the qualitative data collected during the interviews with design engineers, managers, coordinators and process owners and quantitative data from the questionnaire is presented. The structure follows that of the theoretical framework: knowledge context, activity context, barriers to knowledge transfer and learning culture.

In the results section, a number of quotes collected during the interviews are presented. A coding scheme is used in order to uphold the privacy of the respondent. An explanation of the coding scheme is presented below.

- Location
    - S – Säffle
    - P – Poland
    - G - Gothenburg
- Position
    - DE – Design Engineer
    - PT – Production Technician
- Example
    - *GDE1 – Gothenburg, Design Engineer, interviewee number one*

Knowledge Context

In this section, what design engineers perceive to learn and the work-related knowledge identified as relevant to transfer within and between the globally dispersed teams of GBD is presented. The section starts with a presentation of how knowledge is embedded at VCB and is followed by a description of the type of knowledge identified within the dispersed team of GBD. In the table below, the results are summarized.

Table 1 – Summary of Results Knowledge Context

Knowledge Embedded in:	Knowledge in Global Product Development
People	Technical knowledge on product
CAD-models, Drawings	Knowledge of organizational processes - GDP, Administrative tasks, Networking knowledge
The development process, Checklists	Location specific knowledge - Market, Production, Suppliers, Customer adaptation
Quality report databases, Post-project reviews	

The interviewed design engineers state that what they learn, and the work-related knowledge they develop by taking part in the development process is mostly related to projects they have been involved in. New knowledge gained is based on personal experiences, in terms of problems encountered during projects, parts they have designed, suppliers they have been in contact with and so forth. This is specific technological knowledge on the product, e.g. design features, material selection, legal requirements, market demands, and demands from production. Design engineers also express that the knowledge they gain from taking part in projects is connected to organizational

processes, what requirements that need to be fulfilled but also on whom to contact in order to receive help and solve problems.

Knowledge Embeddedness

When being asked about where the knowledge is stored within the company, almost all design engineers state that they have most of the work-related knowledge stored in their own mind. A few interviewees mention that they have personal documents where they document important lessons learnt and new knowledge. However, they state that they rarely share that type of documents, one reason being that it is not general knowledge and rather connected to a specific problem. Another common reason is that it is hard to articulate and pin down on a piece of paper; it rather needs explanations during a conversation or demonstration.

"*Most of the work-related knowledge I have gained during my time at Volvo Buses is stored in my own head*" – GDE4

When being asked about what specific knowledge design engineer holds, it is explained as specific technical knowledge concerning manufacturing methods, materials, legal requirements and specific design features regarding for example mirrors and vision. In addition, the interviewees point out that they have knowledge connected the design work itself and the software used.

Tools & Models

A large part of the interviewed design engineers point out that they regard digital models, drawings and the final product as useful sources of re-usable knowledge. Most design engineers mention that they, before they start designing a new part, look at a similar or previous version of the part and use that as a starting point. The design of the "old" part is often reused and modified after new requirements and conditions which is perceived to save time, and helps them to avoid previously encountered problems.

Even though most interviewees claim to use digital models of previous designs, several interviewees point out that the digital model only contains information about the final product and final design. It does not contain information regarding the process through which the design was developed, problems encountered and solved and reasons explaining choices made. An interviewed design engineer explained that, in order to truly gain something from using previous designs, he always tries to contact the design engineer that previously developed and designed the part.

"*When looking at the model, I don't only want to see best practice and the final result, I want information explaining why it have its features*" – GDE5

A problem, mentioned by a few design engineers is that the digital model and the stored knowledge do not correspond to the design actually used in production. During the interviews a number examples comes up where a previous design has been re-used as a base for a new design, but previous modifications has not been registered in the digital model and therefore already known problems reoccur.

"*The models in the systems lacks information, it is often not the final version. Therefore they are useless, I don't look at the previous model, it's just crap*" – GDE4.

The tools, software and systems used for designing new products are also regarded as reservoirs of knowledge. None of the interviewed design engineers specifically states so. However, a few point out the usefulness of checklists and warning signals when designing and releasing parts. Some design engineers express that most of the feedback they receive is stemming from small mistakes that could be easily avoided with structured support from the systems and software used to design. Today, there are few checklists and warning systems available in the used software, several design engineers claim to see a need for development of new functions in order to prevent problems.

Tasks & Processes

Knowledge embedded in tasks, was something that barely was mentioned during the interviews with design engineers. However, t it came up during interviews with managers and process developers holding another perspective of the organization. The development process at Volvo Buses is structured after a model called Global Development Process (GDP), and is used by all companies in the Volvo Corporation. It contains detailed description of tasks that should be performed at each step of the development process. The GDP is described to be developed based on years of experience of product development within the Volvo corporation, and formulates structure and guidance for the development process.

Many of the interviewees express mistrust regarding rules and processes connected to the GDP. Several interviewees pointed out the great number of processes to be followed, forms to be filled in and administrative work to be done, as a design engineer in Gothenburg puts it:

"*At Volvo Buses we have a process for everything*" – GDE5

The formal tasks and processes were often described as too complicated and time consuming. The mistrust among design engineers does not come from the extent of rules and regulation in itself, rather several design engineers point out that the processes are not a good match with the Volvo Bus organization, in terms of the types of products produced and customer demands.

"Checklists are too detailed and are not adjusted after the Volvo Bus organization and development process. It is built for an organization that sells 150 000 vehicles per year, not 10 000" – SDE1

Although some of the respondents hold the view that the GDP and the processes connected to that is somewhat of a straightjacket, another group of respondents holds a different view. Their view is that the Volvo Bus organization is not structured enough, and needs more standardization to become a truly effective global product development organization. This is, specifically, pointed out as important during projects involving all globally dispersed sites. Following the GDP and its related processes is regarded to reduce quality issues and interface problems as it ensures that all required tasks, tests and administrative work is performed. However, this view is mostly represented by interviewed managers, project managers and process owners.

Reports and databases

At VBC, there is existing knowledge embedded in reports such as post-project reviews; and databases such as quality report systems. The interviews revealed that few design engineers perceive the quality reports as a useful source of knowledge, and that the post-project reviews focuses on project management issues that are not relevant to design engineers.

Instructions for how and when to perform post-project reviews is clearly stated in the GDP but the responsibility of evaluation and documentation lies at the project manager. Therefore the quality of review and report is claimed to be highly dependent of the interest of that individual. Some of the studied post-project reviews contain long and detailed descriptions of the project and problems in different phases; others are short and simply contain a list of positive and negative aspects of the project. Since the post-project reviews are performed by the project management team and design engineers rarely give input to the reviews, the knowledge stored in these are rather focused on management issues, such as planning and the formation of the project organization. A content analysis of existing white books at Volvo Buses was performed in 2011. Two main types of lessons learnt wasmore frequent than others and occurred in almost all post-project reviews. One that points out positive aspects of team work and coordination between teams, and one that points out negative aspects concerning the same subject.

- Good with dedicated resources and cooperation between all involved skills. Coordination. Conferences with all concerned parties. Experienced & joyful, hardworking team.

- Responsibility between the different departments/partners unclear. Poor/informal handover. Coordination & communication lacking. Difficult to ensure if each understands the others' needs.

Apart from post-project reviews, there are a number of databases and systems containing knowledge containing feedback regarding work performed by the product development departments. From production to PD there are at least three different systems and databases containing quality reports related to problems discovered in production. In addition, there are three other databases containing quality issues reported from the aftermarket department. When being asked about the knowledge and information stored in these systems and databases, all design engineers pointed out that the information is poor and they claimed that little could be learned from the systems as they are designed today.

"*There are too many different systems, I don't know where to look for information and often the data is poor and sometimes written in a local language*" – GDE4

The quality reports from production are written by production technicians who have identified a problem in production that needs a new solution from PD. The quality report is sent straight to the PD department and group responsible for the faulty part and it is also stored in a database together with all quality reports of that type.

The knowledge embedded in these systems is basically feedback regarding problems relating to specific parts. In the system, the report contains a short description of the problem and an evaluation of the impact of the problem together with a suggested solution by a production technician. The design engineer solving the issue is thereafter responsible for updating the information and documenting the solution. A large part of these reports are claimed to contain little knowledge useful for future work. Often the reports concerns missing details in the digital model or specific details e.g. too small holes. In addition to that, design engineers responsible for documenting the solution state that the level of documentation depends on the individual. Some design engineers write detailed descriptions of the cause and how the problem was solved. Others more or less leave the field blank as they claim that no one ever reads it anyway.

When being asked about the information and knowledge stored in these databases and systems, few design engineers regard them, or has used them, as an opportunity to learn or as a feedback function. More or less all respondents point out that the data within the systems is poor and hard to understand, and above all that it is very hard to search efficiently in the systems. In addition, several design engineers point out that they don't have access to the systems, have never been introduced to them and does not know what knowledge they contain.

"*The systems are not searchable, they lack useful keywords and the data is poor*" – PDE3

Knowledge in global product development

The knowledge base in the local GBD teams in Gothenburg, Säffle and Wroclaw is described to be focused on different areas of the bus. Each site are handling and developing parts related to the specific functional area they are responsible for. At VBC these are called function groups, which are division and breakdown of the whole bus. This can for example be mirrors, side hatches and driver's seat.

Within the teams, there are two different approaches to division of labor, in Wroclaw and Säffle each design engineer is responsible for a number of function groups whereas in Gothenburg the team instead shares the responsibility.

In Wroclaw and Säffle, several design engineers pointed out that they develop and have specific knowledge regarding the function group they are responsible for. Individual knowledge connected to a function group is explained as less dependent of personal project experiences, as function group owners are contacted and informed about problems, new discoveries and updates concerning their function group. In Gothenburg, design engineers claim, to a greater extent, that they have similar knowledge profiles within the local team and that knowledge rather is project bound.

Apart from specialized knowledge on a specific part or function, design engineers pointed out other types of knowledge gained from taking part in development projects. The nature of the knowledge gained is expressed to differ from site to site. However, a common claim by members of all three teams concerns organizational knowledge; whom to contact with specific questions, what routines that must be followed and what level of documentation that is needed.

Design engineers located in Gothenburg express that they experience that they develop new knowledge and learn much from being in contact with suppliers. They have close relationships with a large supplier in the area which gives knowledge concerning technical opportunities, costs, quality and performance of materials.

In Säffle and Wroclaw, production facilities are located in close proximity to the PD departments. Design engineers at these sites point out that they have and develop new knowledge concerning production methods. They explain this as an understanding of the whole product, the relation between parts and an understanding of the assembly process.

"*In production you are able to see the whole bus and see interactions among parts. When you are designing, you live in a single part world*" - PPT1

The Säffle and Wroclaw sites include an additional PD department called Customer Adaptation (CA). This department deals with specialized solutions for specific customers that according to design

engineers in Säffle and Wroclaw are needed for nearly all bus orders. Each interviewed design engineer at those two sites mentioned the importance of understanding CA and the gains that could be made by preparing for adaptations. They explain it as an understanding of the work process that ensues ones they have finished their part of the development.

A design engineer in Säffle exemplified the importance of the knowledge gained from working close to CA:

"*In Gothenburg, they don't understand that they must leave room for brackets when constructing a new front. Something that creates a lot of unnecessary extra work for CA later*" – SDE2

"*You should not be allowed to start with design until you have worked with CA*" – SDE1

Design engineers in Säffle further pointed out the positive aspects of being located at a site where customers and drivers actually come and pick up new buses. All interviewees in Säffle claimed to get valuable knowledge straight from customers and bus drivers. Knowledge that otherwise would not have reached them.

"*By meeting drivers, I get feedback concerning small issues of high importance to the customers, information that would never reach me otherwise*" - SDE3

Regarding the perceived need to transfer knowledge with GBD, figure 5 below illustrates design engineers' view of the impact of knowledge transfer within and between the globally dispersed teams. As can be seen, members from all sites regard knowledge transfer activities within and between teams as equally important.

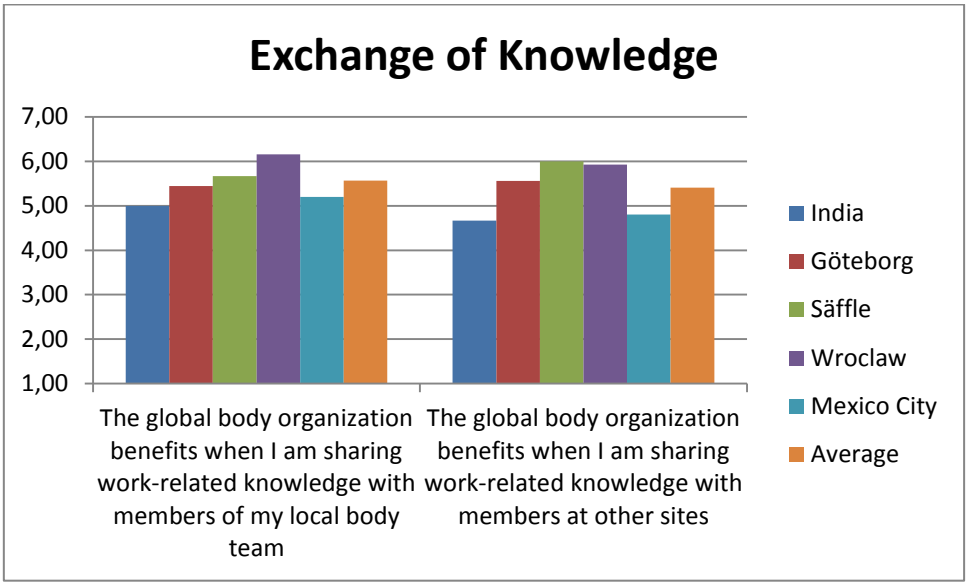

Figure 5 – Results from Questionnaire – Perception of Benefits in Exchanging Knowledge

Figure 6 below illustrates the design engineers' view on the extent of work-related knowledge they believe they can learn from other members of the GBD organization. As the figure shows, the design engineers within GBD believe that they have work-related knowledge to learn from primarily Gothenburg, Wroclaw and Säffle.

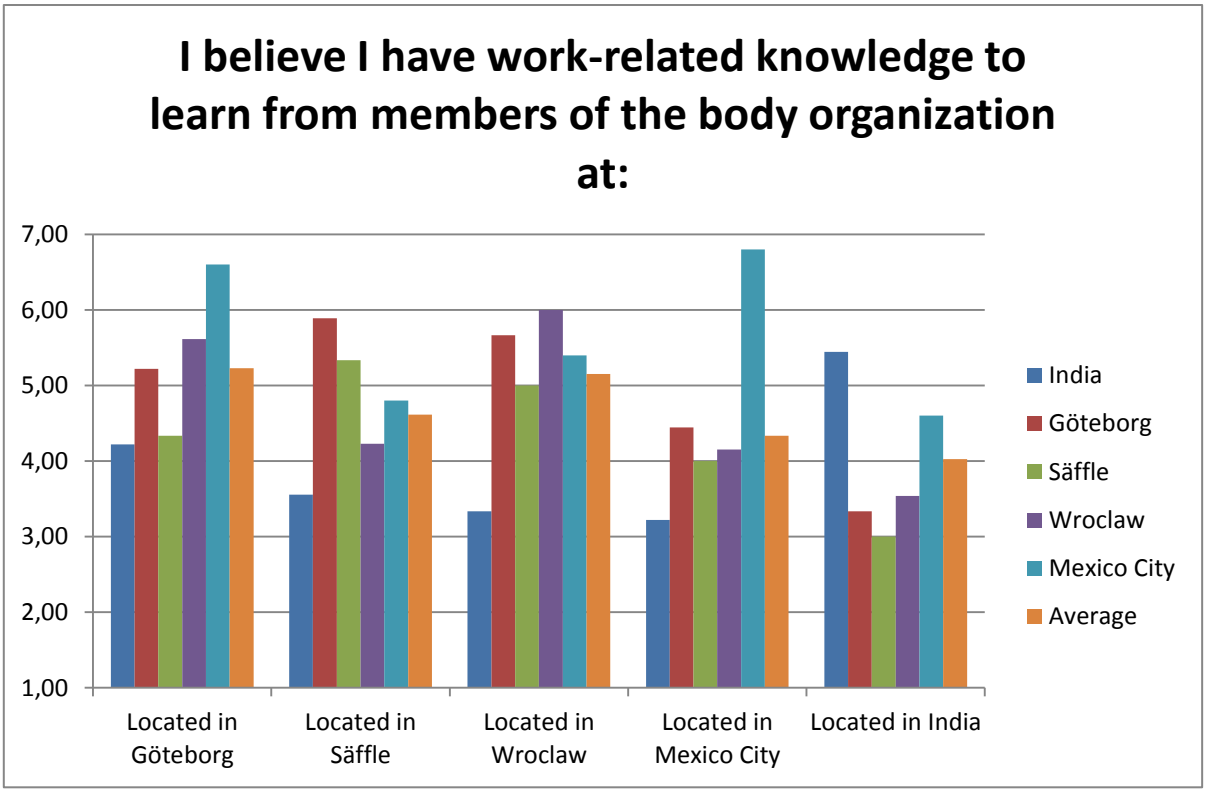

Figure 6 – Results from Questionnaire – The Employees' Belief in Having Knowledge to Learn from Respective Site

Activity Context

In this section, the knowledge transfer activities used to transfer knowledge within and between the globally dispersed teams of GBD and with production is presented, as perceived by managers, coordinator and design engineers. A summary of the empirical findings is presented in the **table x** below.

Table 2 – Summary of Results Activity Context

Activity Context	Formal Transfer Activities	Informal Transfer Activities
Within Teams	DTL, Department Meetings, Information Systems, Job Rotation	Face-to-interaction
Between Teams	Information Systems, Interface Communication, Communication Software, Co-location	Ad hoc interaction, Communication Software
With Production	Information Systems	Face-to-interaction, visiting production facilities (Säffle, Wroclaw), Ad hoc interaction (Gothenburg)

The interviewed design engineers in Gothenburg, Säffle and Wroclaw describe face-to-face meetings and interpersonal interaction as the most effective and used knowledge transfer activity. This goes for all three levels of analysis; within the teams, between teams, and with production. Members located at all three studied sites point out that they can always ask a colleague and expect an answer.

The identified formal transfer mechanisms: databases, reports, post-project reviews and digital models are by most design engineers claimed to lack information, be difficult to read and unsearchable. None of the respondent truly claims to use it for storing and sharing knowledge. The problem is often referred to as "information overflow", design engineers claim not to have time to search for information through these systems, databases or reports. Especially since there hardly exist a search function or keywords that enable effective filtering and searching.

Regarding the post-project review, no single respondent claimed to have read or seen a report; few had knowledge about where to find them and how to get access to them. One single respondent claimed to have contributed to one through reporting of a specific problem.

"*I have never seen a post-project review and I have no idea where to find one, I don't know what type of information it contains*" – SDE2

During interviews with design engineers, knowledge transfer at VBC was expressed to happen on a random basis. Numerous examples were given of how important knowledge has reached individuals by coincidence. It is described as a matter of talking to the right person at the coffee break or that an individual in your team just came back from a trip to another site and happened to see a specific problem in production. Several interviewees point out the need for a structured approach in order to take advantage of the complete knowledge in the organization.

"*You should be lucky and run in to the right person in order to get the right information*" – GDE4

"*Knowledge transfer at Volvo Buses is a system based on coincidence*" – PDE1

When being asked about training activities, the interviewed design engineers describe it as unsystematic or even non-existing at VBC. There is little formal training aiming to develop individuals and teams and the lack of introduction for new employees is mentioned frequently. Several respondents point out the lack of introduction as a problem. A view that representatives from other functional departments working closely with GBD e.g. production is adamant about. A common view among them is that the problems related to the GBD department are mainly caused by high staff turnover and that new employees lack sufficient knowledge on the development process at VBC.

Within teams

Within the local teams, all interviewed design engineers state that they find it easy to discuss problem and solutions with colleagues. Team members claim to have good knowledge on whom to ask for specific information and whom to share new knowledge with. At the sites, design engineers all sit close to each other in open office areas..

In Gothenburg and Säffle the interviewed design engineers claim to make little use of systems to transfer knowledge, instead most knowledge transfer goes through face-to-face interaction. All design engineers have their workplaces located closely to each other and find it easy to ask anyone in the group whenever needed. During interviews, coffee breaks are often pointed out as a good opportunity to share new knowledge in which new knowledge of relevant for the whole team can be shared easily.

"*Stuff that is important enough reach everyone in the group, informally, we are such as small team*" – GDE3

As a part of the R&D30 initiatives, a new type of team meetings was introduced at the Gothenburg site during spring 2012 and is soon to be introduced at the other sites. These are called daily team leadership (DTL) which is a visual planning method where the team meets in front of a whiteboard three times a week for 15 minutes and visually present each person's tasks the coming week. As stated in internal documents, one of the objectives with the meetings is to, by making all members of the team aware of tasks to be performed, use the complete knowledge of the group in the problem solving process. The interviewed design engineers in the Gothenburg team claimed during interviews that this has helped them to understand other team members' problems and has enabled more discussions within the team.

In Wroclaw, design engineers claim to transfer knowledge via informal face-to-face interaction in combination with more formal and structured knowledge transfer activities. These are built on the division of function group responsibilities. Updates, problems and new knowledge gained by all team members is shared and discussed with the relevant function group responsible, via informal and formal meetings and documentation sharing functions. A design engineer in Wroclaw claimed it to have a double effect. Knowledge is transferred from the function group owner who has extensive experience in the specific area and can thereby help other designers to solve problems. But knowledge is also transferred to the function group responsible who gathers new experiences in the specific area.

At the Wroclaw site and within the local GBD team, an initiative has been taken in late spring 2012 to start to store and make knowledge based on previous experiences available for future use on a design engineer level. This concerns e.g. technical solutions, regulations, material selection and has been structured so that the function group responsible is the owner of the design guidelines document which is to be constantly updated as new knowledge is gained. The document is thereafter stored on a public intranet page and reachable for all members of the team.

An additional transfer activity building on the functional group division in Wroclaw was pointed out by the manager of the GBD team in Wroclaw. Each function group has a primary and secondary responsible, the manager points out two underlying purpose for that structure; the primary responsible should be more experienced and therefore open up for knowledge transfer while working alongside a less experienced team member. In addition, it reduces the impact of knowledge loss if members of the team leave the organization.

In Wroclaw and Säffle job rotation occurs to some extent. It is not pointed out as planned and systematic by any of the two local team managers, but rather happens more randomly depending on the interests of individual design engineers. Interviewees with experience from exchanging roles see it as a great advantage, and something that has given them a better understanding of the whole development process. Examples of job rotation identified during interviews include both rotations within the teams - function groups owners and solvers of quality issues, but also with other PD departments such as CA.

Between teams

The communication and knowledge transfer activities between the dispersed teams are described as mostly interpersonal contact, building on established relations and dependent on common interests in specific projects. Almost all respondents point out that there are good technical solutions for communication with individuals at other sites; telephone, chatting tools and sharing of computer

screens to see virtual models, especially since headsets are available to all design engineers at all sites. However, almost all interviewed design engineers state that they almost exclusively interact with people they already know and have a relationship with.

Knowledge transfer activities between the globally dispersed teams within GBD are explained to be much less frequent than within the teams. Communication and knowledge transfer between different PD departments within a site is more common, especially in Wroclaw and Säffle where design engineers from different departments are mixed in the workplace.

"*I have more contact with design engineers from [other functional departments] in Gothenburg than with design engineers from my department in Wroclaw, Säffle, Mexico City and India*" – GDE5

This is further supported by the results from the questionnaire presented in figure 7 below.

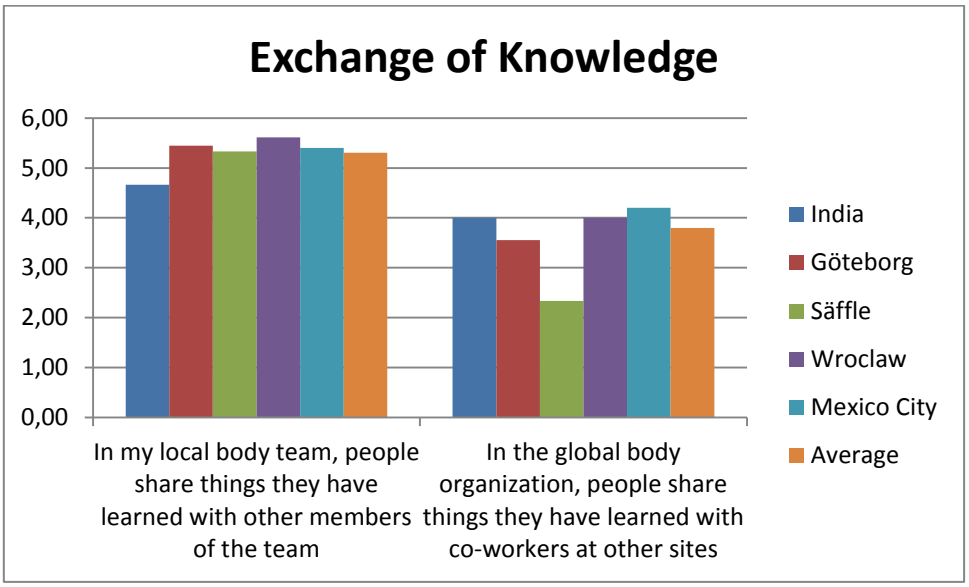

Figure 7 – Results from Questionnaire – Exchange of Knowledge

It is pointed out several times during the interviews, that there is not good structure to transfer knowledge between the sites today, and that there are no effective transfer mechanisms to store and share knowledge relevant for all members of GBD.

"*I don't know how to do it, there is no good channel I can use to share knowledge with members of GBD at other sites*" – SDE1

During projects, design engineers are often transferred to other sites in order to create efficient project teams. However, spending time at other sites is by all interviewed design engineers pointed out as important both when it comes to building relationship from a long-term perspective but also to exchange knowledge on the short-term. The data from the questionnaire show that 39 out of 41 respondents have visited at least one of the other sites.

"*After I went to Poland I have a contact there who can direct me to the right person if I have a question or a problem*" – GDE1

The importance of meeting in person and face-to-face communication was, with a few exceptions, mentioned by all interviewees. Respondent claimed that discussing problems and provide support is far more rewarding when being in the same room.

"By meeting people you understand the things that are never spoken out loud" – SDE1

Recently, a few members of the GBD organization from Mexico City were co-located in Gothenburg at a critical stage of a specific project. The co-located design engineers worked closely with the team in Gothenburg and the goal was to shorten decision-making and increase communication. During interviews, all the involved design engineers and managers pointed out this as very successful; the project could be completed within a short period of time and problems were avoided since to knowledge and experience of the whole group was combined.

A specific example of the latter was mentioned by a design engineer in Gothenburg; one of the co-located design engineers from Mexico City had previously worked with a quality report concerning a part critical for the project. Since he had knowledge concerning problems with a specific design he could help them and make sure the problem did not reoccur. This transfer of knowledge due to co-location was not intentional. Coincidentally he was involved in the current project; otherwise the knowledge would not have reached the right persons.

Communication and knowledge transfer between sites is explained by the respondents as dependent on individual initiatives. Members of different teams talk to each other when they are involved in the same project and the project forces them to communicate. However, a few examples are given during the interviews of how design engineers from different sites have started to set up weekly or monthly meetings to discuss common areas of interest in order to avoid problems and to share gained knowledge.

"*I and my counterpart in Poland and in purchasing have private meetings once a month to discuss and share recent news related to our function groups. This is our own initiative*" – SDE3

Production

The transfer activities regarding knowledge transfer from production to design engineers at the GBD department differs depending on the location. In Gothenburg, there are no production facilities, while Wroclaw and Säffle have production in the same buildings as PD is located, something that is expressed to have a significant impact on knowledge transfer activities.

The formal way of reporting feedback from production to PD is through existing quality reporting systems. Production technicians, who have identified a problem, describe it and provide a suggested solution in the system, in the form of a quality report. Thereafter the issue is sent to the responsible PD department to be solved. However, both production technicians and design engineers expressed great concerns regarding the system.

The interviewed representatives from production regard these systems as the only way of communication with design engineers, especially with the ones located at other sites. On the other hand, design engineers often point out that descriptions and data is often poor and it is hard to understand the nature of the problem by simply reading the report. Therefore the report is often combined with direct contact with the responsible from production.

"*It is the only method I can use to make people from PD to listen*" – PPT1

"*I rather go straight to production and talk to them instead of reading quality reports*" – SDE3

Personal contact and continuous discussions between PD and production s pointed out as important by representatives from both sides. From production, several examples are given of problems that could have been avoided if they would have been contacted at an early stage of the design process.

"*PD needs to build relationships with production, product technicians is a good person to know*" – SPT1

On the other hand, a large part of the interviewed design engineers in Wroclaw and Säffle point out that informal contact with production is not all good. They claim to see the advantages of talking straight to each other, and to see the problem in reality. A design engineer located at the Gothenburg site stated that:

"*In a dream world, I could ask production about everything"* - GDE3

And several point out that they would like to get more feedback from production. However, design engineers in Wroclaw and Säffle expressed that too much informal contact with production disrupts their workflow. A formal quality report gives them an opportunity to plan their work, while if a representative from production comes to their desk they have to leave what there are doing at the moment and focus on that.

"*When production come straight to my desk and ask for help, I cannot plan my work, therefore I prefer receiving quality reports*" –PDE2

"Production are so close that they disrupt the normal workflow" - PDE2

From the production side, they call for design engineers to visit production more often. Especially during prototype building which they regard as a great learning opportunity. A product technician located in Säffle, with many years of experiences, explained that design engineers previously have tried working in production for a day. Something he regarded as a great initiative, as it gives knowledge that is hard to transfer otherwise, it can concern the order something is assembled or how small details can cause a lot of extra work during assembly.

Barriers to Knowledge Transfers

The following will section will present the results regarding the barriers to knowledge transfer that exists at GBD. The barriers will be divided into five categories: Relational, Knowledge, Physical and Norm Distance, and Priority. These will be viewed from three perspectives, within teams, between teams and with production. A summary of the identified barriers is presented in **table x** below.

Table 3 - Summary of Results Barriers to Knowledge Transfers

Barriers	Relational Distance	Knowledge Distance	Physical Distance	Norm Distance	Priority
Within Teams	-	Staff turnover	-		Project-bound, Insufficient time, KPI's don't support Knowledge Transfer
Between Teams	Lack of personal contact	Lack of trust, Staff turnover, Language	Time zone, Lack of relational network, Geographical dispersion	Different views on problems	Project-bound, Insufficient time, KPI's don't support Knowledge Transfer
With Production	Lack of personal contact, Heated relationships	Lack of trust, Knowledge gap, Staff turnover, Language	Time zone, Lack of relational network, Geographical dispersion	Different views on problems	Insufficient time, KPI's don't support Knowledge Transfer

Relational Distance

This section will outline how relational distances within and between GBD's global teams, and between GBD and the production, to varying degrees work as barriers to successful knowledge transfers at GBD and VBC. The relational distance refers to a set of knowledge transfer barrier relating to the notion that the weaker the social ties available are, the weaker will the opportunities to share knowledge and experiences, develop trust, and cooperate become (Baughn et al., 1997; Granovetter, 1985).

The findings from the interviews with design engineers located at the different sites suggested varying levels of relational distance. As outlined in previous sections, within the teams of GBD the members have strong social ties and communication flows freely.

"Within VPI, I know basically everyone and have established a working relationship with each of them." -PDE3

"I know everyone well, and their door is always open when I need to exchange ideas or share knowledge." -SDE2

At the inter-site level with its increased organizational distance, however, the findings suggest weaker social ties. A majority of the interviewees emphasize how the lack personal contact and not working together on a daily basis hinder them from establishing working relationship with design engineers at different sites. As a consequence, a majority of the surveyed design engineers state that they often have difficulties exchanging ideas or asking for help globally.

"It is such a difference to work with Mexico or Poland in comparison to Sweden. I feel closer to other departments here in Gothenburg than my own department [GBD] in Mexico and Poland." -GDE5

However, a good deal of the design engineers has spent times at other sites during projects. These visits, they explain, have done a lot in decreasing the organizational distance and establishing working relationships with co-workers at these sites. They also explained how these relationships subsequently paved the way for more effective knowledge sharing and collaboration in future projects or assignments.

"Personal contact, getting a face behind the names, to have done stuff and solved problems together is so important." -GDE3

"When you know the person it gets easier. After having visited Poland it has improved. To have face behind the name makes such an extreme difference" -GDE1

The importance of relationships is further strengthen by the findings presented in figure 8 below. The image reveals how there is a near-linear correlation between how much design engineers feel they have to learn from other sites, with the extent of established relationships they have at those sites.

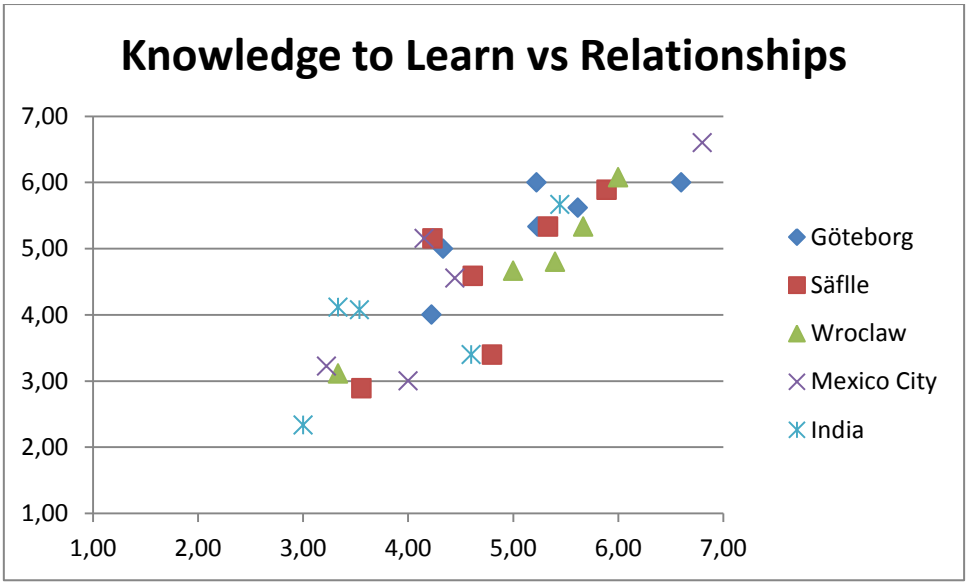

Figure 8 – Regression Analysis of Questionnaire Data – Perception of Knowledge to Learn vs. Extent of Relationships

Moving on to the relationship with production findings reveal a situation far more characterized by arduous relationships and lacking cooperation. All of the interviewees describe their relationship as messy and heated. And both sides are adamant about the other is the one to blame, in what best would be characterized as a blame game instead of collaborative relationship.

"Every time you contact design, they start to fight with you." -PPT1

"The communication between product development and production has gone to straight to hell." -SPT1

As previously mentioned, an information system that is used for reporting faults in production is considered to be the primary communication channel between the two. However, discrepancies in how production and GBD intend for it to be used presents evidence on their heated relationship. Both sides have different views on how the system should be used; and virtually all of the

interviewees share stories of how fault reports become political battles where people are trying to win rather than actually fixing the problems.

" [When using the system] it is more of a political battle about who is going to be right." -SPT1

"80% of my time is used to discuss and fight about problems [with product development]." -SPT2

Moreover, the findings from the interviews indicated that the relationship between production and GBD also have elements of lacking trust. For instance, rather than seeing it as a way to share knowledge of product, prototype or production faults for future learning, the fault reports are seen as a way to shift blame and responsibility.

"*Quality reports is proof that we have done what we can do – that we are 'clean'*." *-PPT2*

Furthermore, the data from the interviews revealed that there is a reluctance to share knowledge when the source does not anticipate sufficient rewards of doing so. In fact, a majority of the interviewees explain how they oftentimes find themselves looking for ways around the systems and routines just to avoid the battles with each other.

"It is easier to just fix yourself than trying to ask product development." -PPT2

In addition, in the questionnaire that was sent out, all the members of GBD were asked to what extent certain factors make it hard to transfer and receive knowledge. Two of those factors were related to relationships, and in figure 9 below the results of these are presented. In regards to uncooperative coworkers and/or poor relationships between people locally all the respondents disagreed. However, they disagreed to a varying extent, with the employees located at Säffle quite strongly disagreed, those in Gothenburg somewhat firmly disagreed, and with those of the remaining sites just disagreed to some extent. When the same question was asked on the level of the global body organization the level of agreement increased and averaged at a level of neither agreeing nor disagreeing. The results from all the sites but India's, which remained roughly the same, had increased. That is, they all deem uncooperative coworkers and poor relationships to be more of a problem at a global level than locally within their teams.

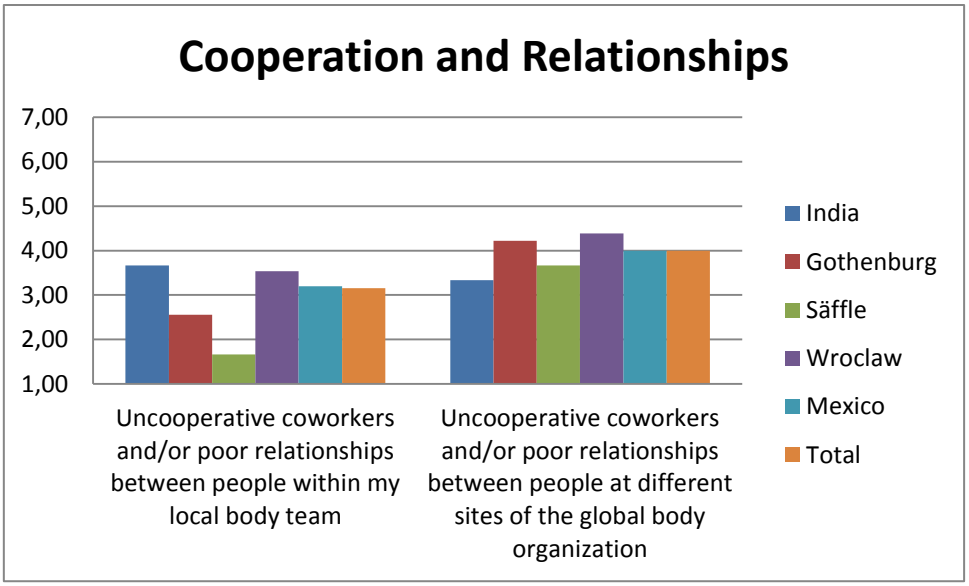

Figure 9 – Results from Questionnaire – Cooperation and Relationships as Barrier

Knowledge Distance

Knowledge distance refers to barriers that are created by differences in knowledge between the recipient and source of the transferred knowledge. And as noted by Hamel (1991) the knowledge distance or gap cannot be too great in order for organizational learning to take place. Between the local members of respective GBD sites the data from the interviews revealed little to no signs of barriers relating directly to distances in knowledge. The team members have similar knowledge bases and can understand each other during the informal exchanges that dominate their local environment. All interviewees find that their local co-workers are acknowledgeable engineers and that they them with any piece of work-related information.

However, the findings suggest that there is distrust of knowledge between the geographically dispersed teams of GBD, and especially so from Gothenburg vis-à-vis other sites. A majority of the design engineers at Gothenburg expressed concern regarding trusting the information and knowledge at the international sites of GBD.

"You do not trust the knowledge from primarily Mexico but also Poland – I rather Google than search for knowledge from Mexico." -GDE5

In figure 10 below are the results from the questionnaire, where the respondents were asked whether they agree to the statement that they trust the work-related knowledge held by people within their team, and by people at the teams in other locations. All the teams had higher level of trust locally than globally, and the level of agreement globally was ranging from slightly disagreeing to slightly agreeing.

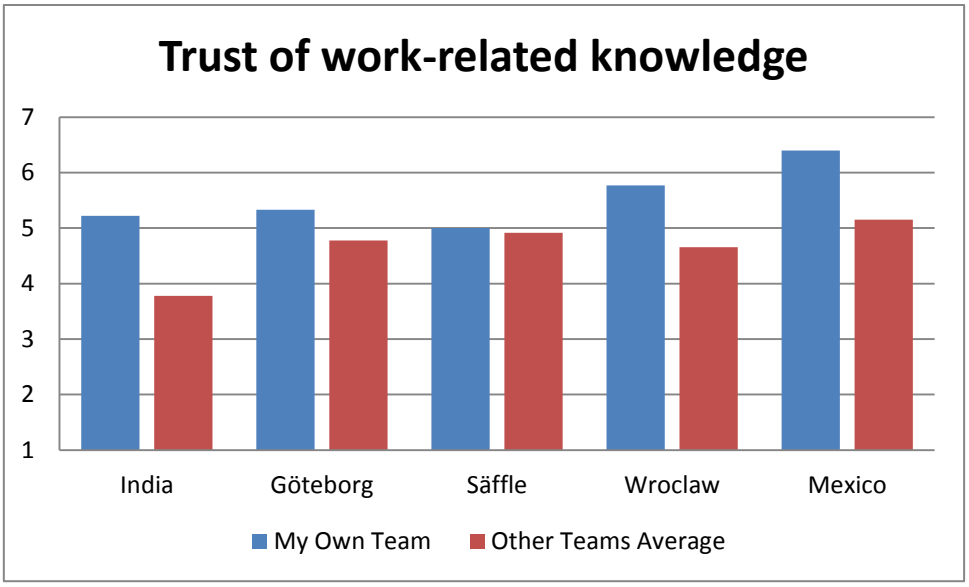

Figure 10 – Results from Questionnaire – Trust of Work-related Knowledge

Furthermore, in the connection between GBD and production, the interviewees from each of the departments pointed out that there are gaps and deficiencies in the other's knowledge. For example, the main output of the product development's development processes is CAD drawings/modules, and product development thinks production lack sufficient knowledge of CAD. However, at the same time production believes product development has inadequate knowledge of how the CAD modules translate into the physical world.

"CAD modules do not tell the whole story, and they think that they see reality on their computer screen." -SPT2

"Production lacks understanding of CAD software and CAD modules" -SDE2

"Product Development does not know how a bus looks like. -PPT1

Data from the interviews also revealed that product development and production have little knowledge and understanding of how the other operates. This distance in knowledge, they explain, hinders important knowledge and information to be transferred as the focus is shifted to fighting for opinions and politics, rather than the problem at hand. All of the interviewees from both sides stated that the majority of the personnel of the other side had insufficient knowledge of how the other operates, and that it have led to problems in communication of information.

"Product development does not really understand the order which things are done in production." -SPT1

"Production thinks that changing the size and type of screw is a simple task that would take 10 seconds, what they do not know is that it leads to a lot of changes of documents and more that would take countless hours" -SDE1

The interviewees also expressed a general distrust with the data in the fault reporting system, which works as a communication channel between production and product development.

"90% of all the fault reports from production are written in a way so that it is unclear what the problem is." -SDE1

Moreover, Gothenburg's situation is different since they are not located directly in conjunction with production facilities, whereas Säffle and Poland is. Interviewees at Säffle and Poland explain that the proximity to production allows for design engineers and production technicians of their sites to visit each other's facilities. Thus, the design engineers at these sites have it easier to gain an understanding of how production operates, and they have closer relationships with the production technicians at their respective locations. All the interviewed design engineers located in Sweden explained that they are not afforded that luxury, and that they oftentimes wish they had the option to see things directly in production, for instance when they are trying to solve a problem that was reported.

"It is great to be able to run down to production to see the design in reality." -SDE2

"The biggest problem with Sweden is that they do not see production, they do not know how it looks in reality. -PPT2

"It would have been awesome to be able to run down to production to check out some problem." -GDE4

In addition, virtually all interviewees stated that they experience knowledge related problems due to staff turnover. They explained that important knowledge that is stored in employees minds are often lost as people leave, and that it is hard to learn from past experiences when people are constantly changing jobs.

"When you are dealing with fault reports from production it is great to be able to ask the designer who created it for advice. The problem is that people changes job too often" -GDE1

"Staff turnover makes solving fault reports from production harder. Either is the person that created the detail not here to solve the problem, or he is not here to answer question if someone else is assigned to solve it." -GDE1

The findings also indicate a frustration on behalf of production as staff turnover and high amounts of consultants constantly replaces acknowledgeable employees with whom relationships and knowledge sharing had been established. All of the departments outside of GBD, that we interviewed members from, stated that the knowledge gap that is created by large number of consultants or high staff turnover in GBD causes problems with the inter-departmental collaboration and communication.

"There are too many consultants who have no production experience and just understand the virtual world." -SPT1

Furthermore, GBD is a globally dispersed department with English as primary business language. The results from the interviews reveal that, while the situation has improved, language do acts as a barrier in the communication between the different sites. And also that those who possess superior knowledge in English can find themselves in more powerful positions than would normally be the case.

"While it [the language situation] has improved compared to a few years ago it cannot be compared to talking Swedish with those around you." -GDE3

"Sometimes you have to yield in a discussion with Swedish people because you cannot speak English at the same level as them." -PPT1

Furthermore, since English is the primary language, all the information that is stored in information systems has to be in English. The interviewees from Poland explained how this creates a situation where Polish production technicians have to communicate in English with Polish design engineers, leading to two potential points of confusion.

"When they [Production] write a fault report, they have to translate in their head from Polish to English, and then as I receive the report I have to translate again from English to Polish in my head. -PDE1

In figure 11 below are the results from how the respondents of the questionnaire agreed to the statement that communication problems make it hard to send and receive information. In average, the responses at the all of the sites were at or close to the level of neither agreeing nor disagreeing.

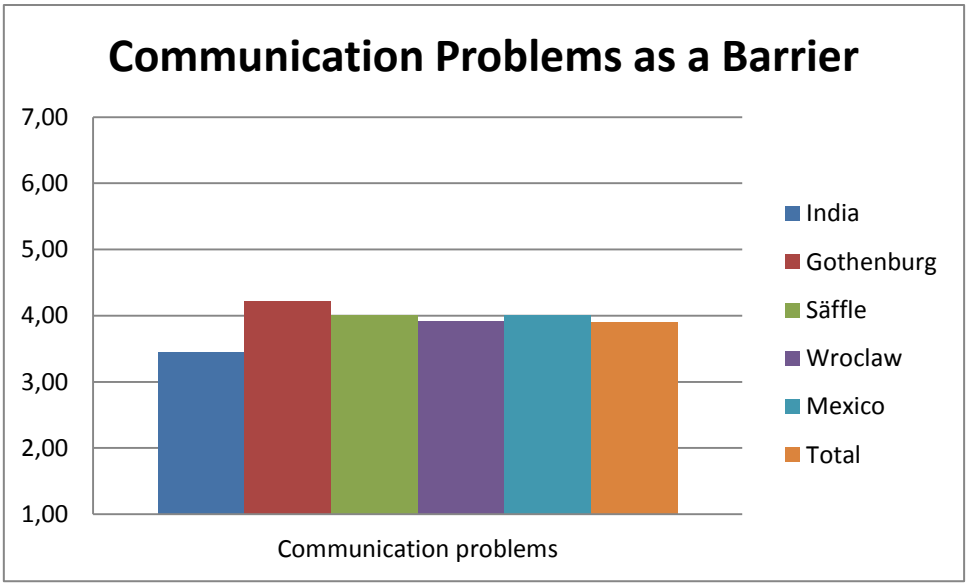

Figure 11 – Results Questionnaire – Communication Problems as a Barrier

Physical Distance

Up until this point, many of the findings that have been presented in the sections of relational and knowledge distances have had components relating to physical decision. The lines between them are often razor thin and it comes down to a judgment call. Physical distances refer to the difficulty, time requirements and expense of communicating without getting face-to-face. Research has revealed that face-to-face meetings are superior to other meeting or transfer formats (Cummings & Teng, 2003).

GBD is a global product development organization, and the findings show barriers relating to the physical and geographical dispersion this entails. In this section the results relating to these barriers will be presented.

All the interviewees agreed that however good a relationship or a communication tool may be, not being at the same location is always creating some kind of barrier to sharing knowledge, communicate ideas or ask questions.

"Regardless how well your relationship is, regardless if you use the convenient communicator tool – nothing compares to turning around and talking to the guy next to you the moment a question or thought pops into your head." -GDE2

Furthermore, since GBD has its units dispersed across the world in Europe, India and Mexico their collaboration entails time zone differences of up to 12 hours. The interviewees explain how this makes it very hard to arrange meetings with personnel from all sites present simultaneously. Additionally, a majority of the interviewees stated that the time zone difference was grounds for frustration as they often had to wait to receive knowledge or send confirmation until business hours of the non-European sites.

"Sometimes you really need a certain piece of information at 9:00 in the morning, but due to the time zone difference you have to wait till 15:00." -GDE3

"Trying to arrange a meeting with co-workers from India and Mexico simultaneously is nearly impossible." -GDE2

Another aspect which all interviewees deem as important in virtual and geographically dispersed teams is the importance of knowing whom to contact and when to contact them. All interviewees stated this as a problem that is especially pervasive where the physical distance was present, both between teams and across departments. And they all agreed that knowledge on whom to contact in a certain situation is very important, and how inconvenient it is when that knowledge is not readily available.

"Sometimes you do not know who does what, you do not know whom to ask or whom to talk to. And you don't have time to find out." -GDE5

"I do not know whom to contact when I need feedback from production on a matter. It can be frustrating." -GDE4

Within the teams and in instances where relational distances have been shortened, a majority of the interviewees agree that the situation is much better/improves quickly. That is, once they have established relationships with individuals across the different sites and functions they either know the relevant person, or have obtained a contact that quickly can direct them to the right person.

"Within my team [VPI], I know pretty much everyone and knows who does what, I have established some kind of relationship with each of them" - PDE3

"Once I had been to Poland I knew much more in regards to whom to ask and whom to talk to." - GDE1

"Now that I know Angel I will just call him and he will direct me to the right person in production." - GDE5

Furthermore, in the questionnaire all the members of GBD were asked to what extent certain factors make it hard to transfer and receive knowledge. One of these factors was lacking knowledge on whom to contact in order to get information. In figure 12 below it can be seen that the average response of the employees' at all of GBD's sites agree to the statement to some degree.

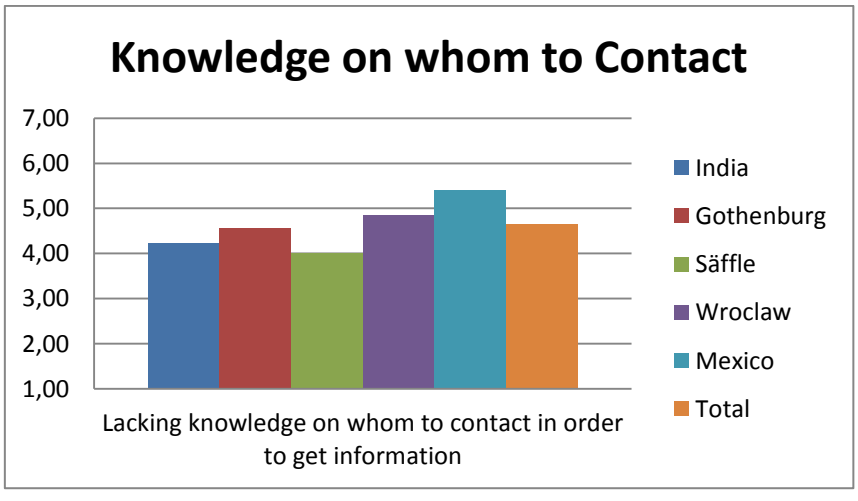

Figure 12 – Results from Questionnaire – Knowledge on Whom to Contact

It has been previously mentioned how Gothenburg, unlike Säffle and Poland, is not co-located with a VBC production facility, and the interviewees have explained how the physical distance have led to lacking or heated relationships and gaps in knowledge. However, during the interviewees with production technicians at the production facilities another aspect relating to the physical distance arose. A majority of the production technicians stated how they often think twice before sending a fault report to Gothenburg, and sometimes they chose do not do it all because it takes too much time. As a result, valuable knowledge about the product and production processes might not reach the design engineers in Gothenburg.

"We are hesitant to send quality reports to Gothenburg, it takes such a long time and we need solutions right." -PPT2

"You think twice before sending a quality report to Gothenburg." -PPT1

Though not being located in conjunction with production, Gothenburg is the site where the entire management headquarters of VBC is located, with the GBD manager included. And the interviews revealed how the lack of physical proximity leaves the other sites somewhat disconnected from, as one of them put it 'the place where big decisions are made'. A majority of the interviewed design engineers and project leaders at Säffle and Poland did raise concerns relating to this. They state, for instance, that it is usually one person that has a coordinator role at their site, and should that person miss a meeting (thus not receiving the information he is supposed to share with his team in the first place), there is no way for them to get that knowledge in any formal way.

"We do not get to know everything that happens in Gothenburg." -SDE2

"We get project and prerequisites, and that is it." -PDE2

"A lot of decisions are being made in Gothenburg affecting my parts that I am not aware." -SDE3

Norm Distance

In this section, results relating to differences in norms and values between the different sites of GBD. The norm distance refers to barriers stemming from differences in organizational culture and value systems. Similar culture and value systems allow for more smooth and effective knowledge transfer, and differences can significantly impair them (Allen, 1977). The focus is on the global perspective, both between GBD's dispersed teams, and the production facilities located abroad. When comparing results gathered from interviews and workshops with personnel located in Poland, including product development and production, with the findings from the Swedish sites, it is possible to distinguish differences in organizational culture and value systems. GBD has a matrix organization structure, where the personnel at Poland answer both to their local boss and to the head of GBD located in Gothenburg. The manager of the entire GBD organization has thus been able to provide insight on differences between the employees at the different sites. He explains that the employees in Poland want to be explicitly told what to do and takes much less initiative compared to their Swedish counterparts. The design engineers from Gothenburg agrees, and explain how problems can arise due to differences in views on what is a problem, and how to deal with it.

"We have completely different views on how to use the fault reporting system. They report the slightest bit of problem that could have been solved on site in 5 seconds." -GDE1

The production technicians who send the fault report agree that this is how things are done. However, in their view it is their duty to report any deviation or problem and highlights that this is because they want to avoid getting into trouble for doing otherwise.

"Quality reports are a proof that we have noticed error and reported it; it is proof that it is not on our table anymore." -PPT2

The design engineers in Sweden have a similar take on the situation. Since they are dealing with both the production facility located in Poland, and the one in Säffle, they could shed some light on what they state to be a lot of differences in the communication and knowledge exchange take place. However, while agreeing that Poland is very quick to report problems, they also explained the flipside of it all; in how Säffle often choosing to solve problems on their own can lead to that important knowledge not received.

"Production in Säffle sometimes solves issues in production on their own, and we never find out about it. Then x years later we get a fault report in another project because they are tired on fixing the problem on site. Had we known about it, we could have fixed it easily a long time ago." -GDE4

Furthermore, findings from the interviews with design engineers at the Gothenburg site revealed how they sometimes willingly take on additional workloads, since they deem it to be easier to work around the international sites rather than involving them.

"Sometimes I do it myself rather than trying to solve it together with Poland or Mexico – just to avoid all the cultural differences and language problems." -GDE5

Priority

Another aspect that is frequently found in the literature on barriers to knowledge transfer is relating to relative priority of the knowledge transfer project. Cummings & Teng (2003), for instance, have found that when the recipient sees the knowledge transfer project as high priority it will have greater motivation to support the transfer than if the project is seen as less significant. Moreover, virtual projects and R&D projects are often of cross-functional nature and conflict with on-site responsibilities and deadlines of the line organization (Rosen, Furst, & Blackburn, 2007).

In all of the interviews with design engineers and other personnel the aspect of relative priority of the knowledge transfer was brought up. VBC and GBD are run by project, and a majority of the interviewed design engineers mentioned how they ultimately are project bound. And the result is that the priorities of things such as exchange of ideas and knowledge are divided accordingly. In addition, they state how they often receive fault reports from projects that are in the later stages, at a time when they have already moved on to other projects. That is, a good deal of knowledge transfer activities between product development and production place when the priorities of the design engineers have shifted to a new project.

"It is closeness in project rather than closeness in a relational sense that dictates sharing." - GDE3

"Reports and errors are received at a late stage, when everyone else has other things on their plates." -GDE1

On a similar note, a few of the design engineer stated how even within teams, it is project involvement that truly dictates with whom they are sharing what.

"Knowledge sharing takes place mostly within projects – even within my local team." -GDE3

Moreover, with relation to the issue of priority, in the questionnaire employees at all of GBD's globally dispersed teams were asked to what extent insufficient time was a barrier to sharing of knowledge within and between the teams. The results, which can be found in figure 13 below, reveal that respondent at all of the sites agreed to some extent with the statement. The employees in India, Gothenburg and Wroclaw agreed only slightly, whereas those located in Säffle and Mexico agreed more firmly. In total, the average respondent agreed slightly to the statement.

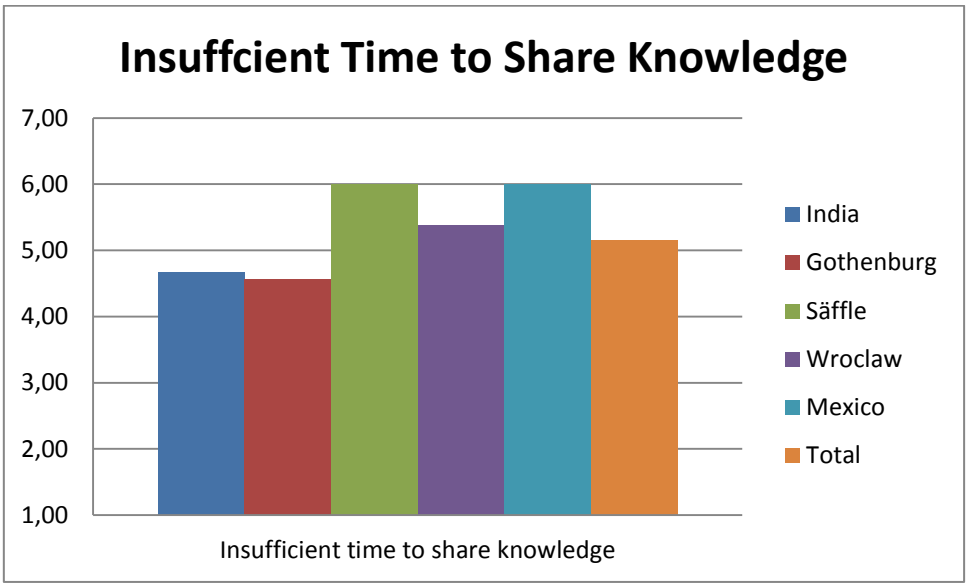

Figure 13 – Results from Questionnaire – Insufficient Time to Share Knowledge

Learning Culture

In this section the results from interviews and the learning culture questionnaire is presented. Learning culture in an organization can be regarded as patterns of basic assumptions developed in a group while dealing with problems and developing solutions (Ipe, 2003). Firstly, in figure 14 below are the questionnaire results from the questions relating to the individuals awareness of the big picture presented. In regards to having an understanding how one's job and unit relate and contribute to the entire G2P[2] organization the respondent did agree to some extent. However, when it comes to being clear about what G2P's goals are and having a sense of familiarity about G2P's purpose on direction the answers averaged closer to a level where the respondents neither agree nor disagree. Mexico is the only site that clearly deviated from the average, where the respondents agreed on all the statements.

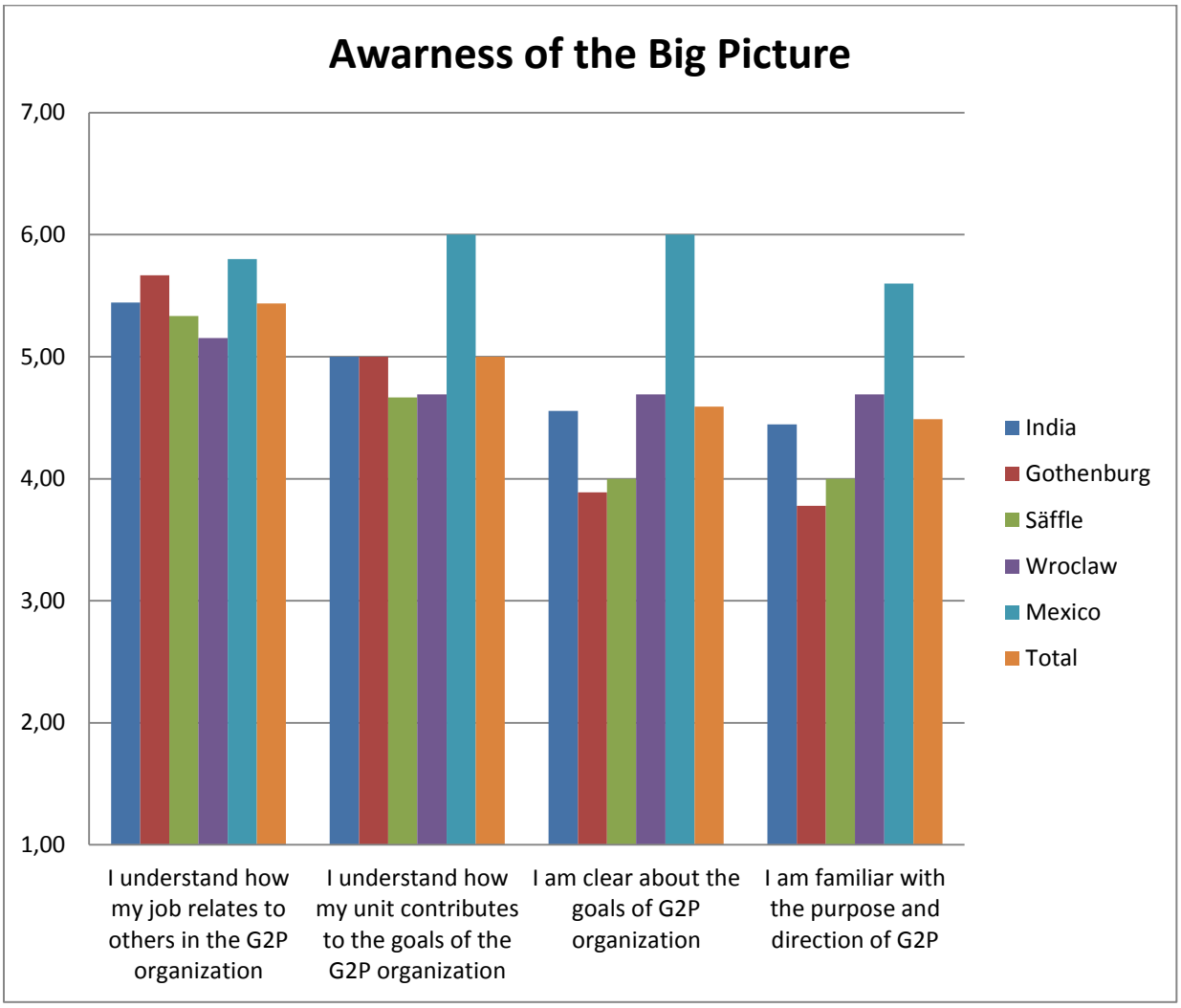

Figure 14 – Results from Questionnaire – Employees' Awareness of the Big Picture

[2] Global Purchasing and Product Development

In assessing how mistakes are tolerated as a part of learning and when individuals are trying new ideas and skills a series of questions were asked. The results can be found in figure 15 below.

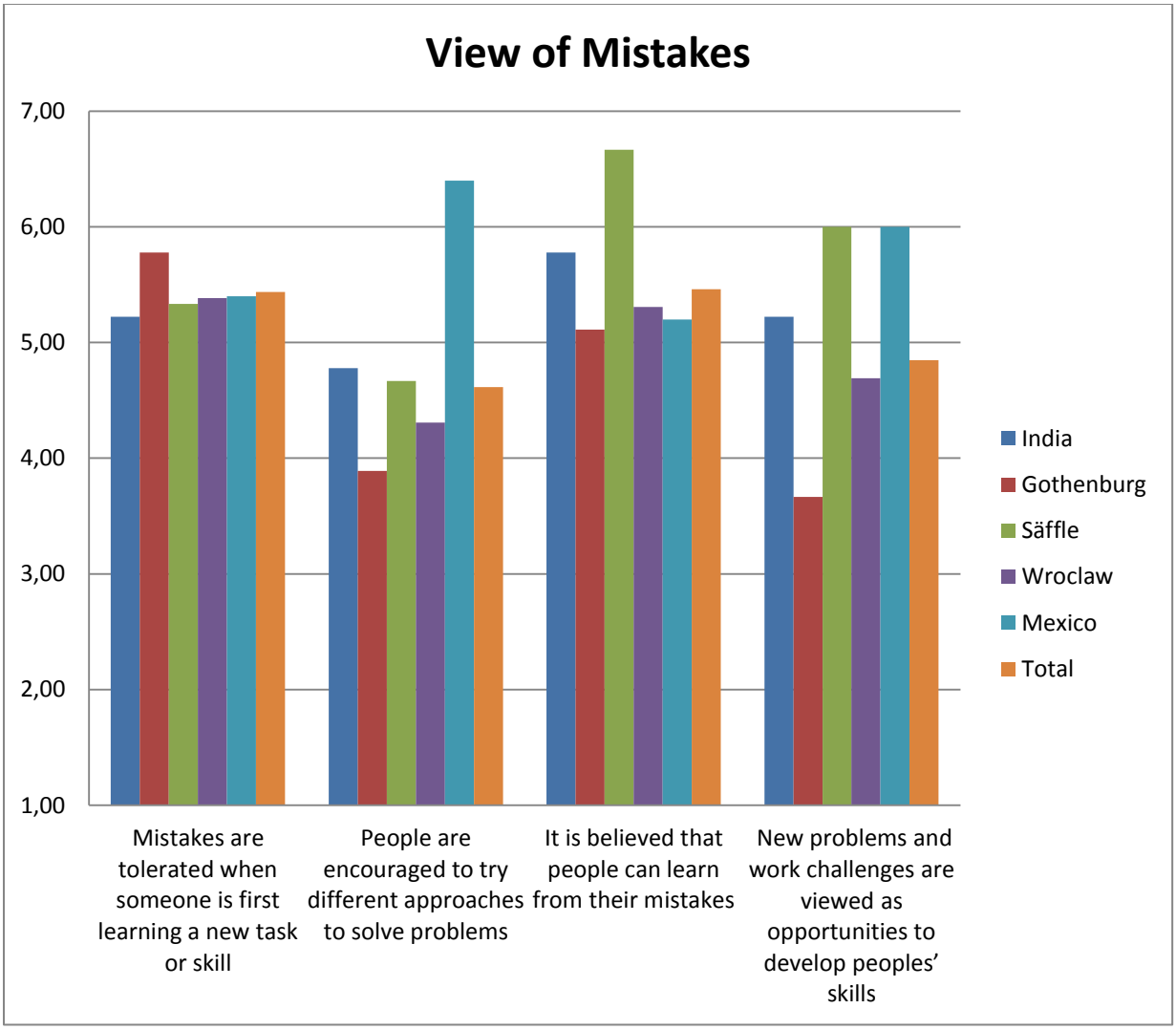

Figure 15 – Results from Questionnaire – Employees' View of Mistakes

The answers averaged between somewhat agreeing and agreeing in regards to how they believed mistakes to be tolerated in their organization as someone is learning new tasks or skills. The employees at Mexico agreed strongly to the statement that people are encouraged to try new and different approaches to solving problems, whereas the answers of the other sites landed between undecided to agreeing slightly. Furthermore, all the sites at least slightly agreed to the statement that the general organizational belief is that people can learn from their mistakes. The Säffle employees strongly agreed to the statement, thus helping to draw the total average closer to the level of agreeing.

The different sites agreed less when it came to their assessment of new problems and work challenges being views as opportunities to develop peoples' skills. The respondents in Gothenburg slightly disagreed, whereas those located in Mexico and Säffle firmly agreed to the statement. In the end, the average of the entire GBD organization was at a level between undecided and slightly agreeing.

Next, in testing how new ideas and changes are valued and encouraged within VBC, the respondents were presented with six statements, and the results are presented in figure 16 below.

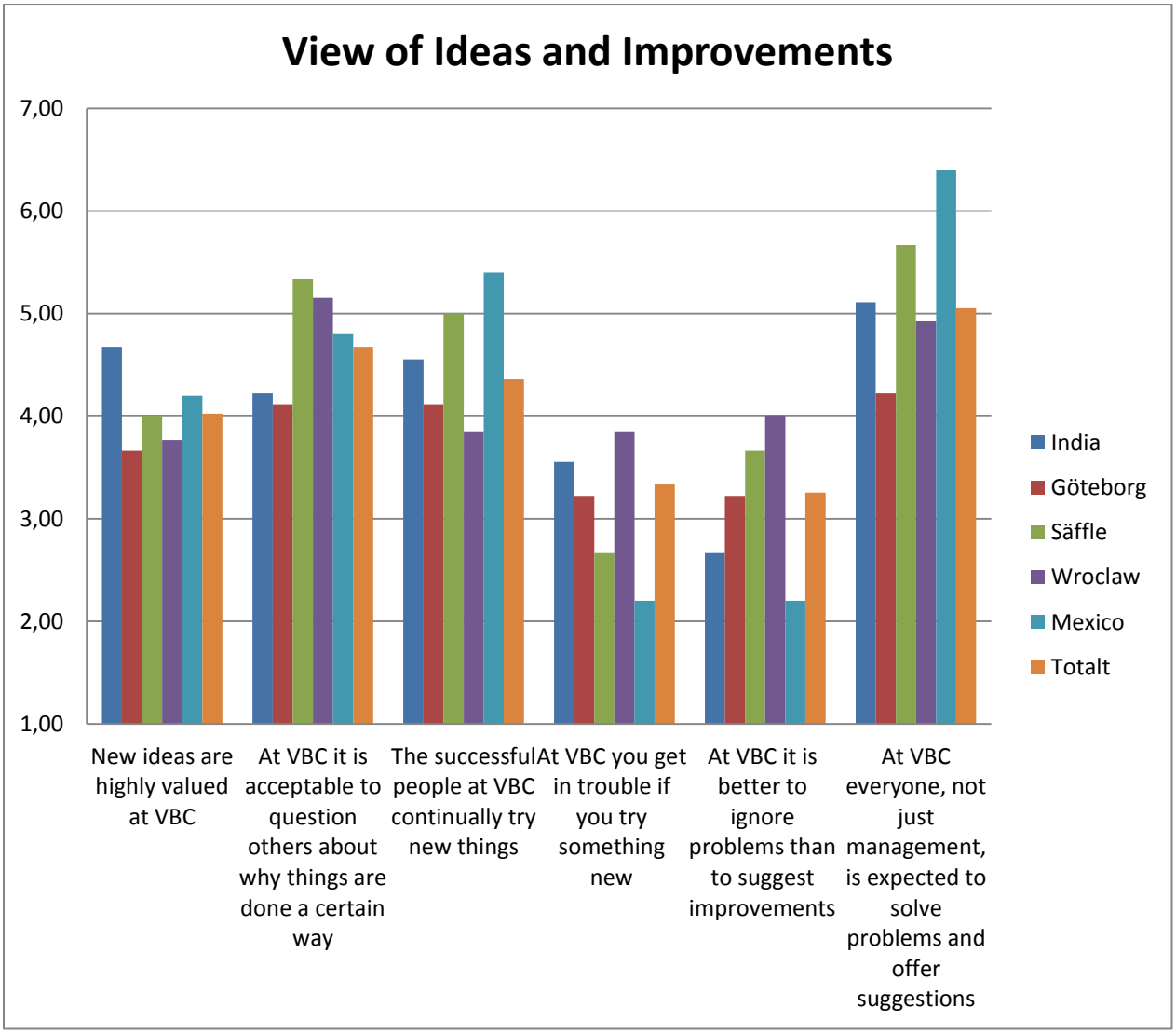

Figure 16 – Results from Questionnaire – Employees' View of Ideas and Improvements

As a whole, the entire GBD organization neither agreed nor disagreed to the statement that ideas were highly valued at VBC, and while agreeing slightly more they were also somewhat undecided when it came to assessing how acceptable it is to questioning the way things are done. In addition, while employees in Mexico did agree quite firmly, the total average of GBD were closer to neither agreeing nor disagreeing to the statement that the successful people of their organization continually try new things.

During the interviews an example was brought up that relates to the relatively low agreement on how new ideas are valued at VBC, and also to that some employees agreed with the statement that you can get into trouble if you try something new.

"It is no point to make the function group list public, it is not fully complete. Should we publish it now, we will get a lot shit from higher instances should it not be perfect." -SDE2

Furthermore, a majority of the respondents disagreed to some extent to the two reversed statements regarding getting into trouble for trying new things, and to it being better to ignore problems rather than suggesting improvements. However, the employees located in Wroclaw deviated a bit, and averaged closer to a level of un-decidedness. At last, the respondents somewhat agreed to the statement that everyone, not just management, is expected to solve problems and offer suggestions. There were some deviations, though, with Säffle, and especially Mexico, agreeing more firmly than the rest.

In figure 17 below, the results are presented to the series of question aimed at assessing the openness and social support to sharing of ideas and suggestions, to what extent knowledge sharing is deemed to be taking place locally and globally.

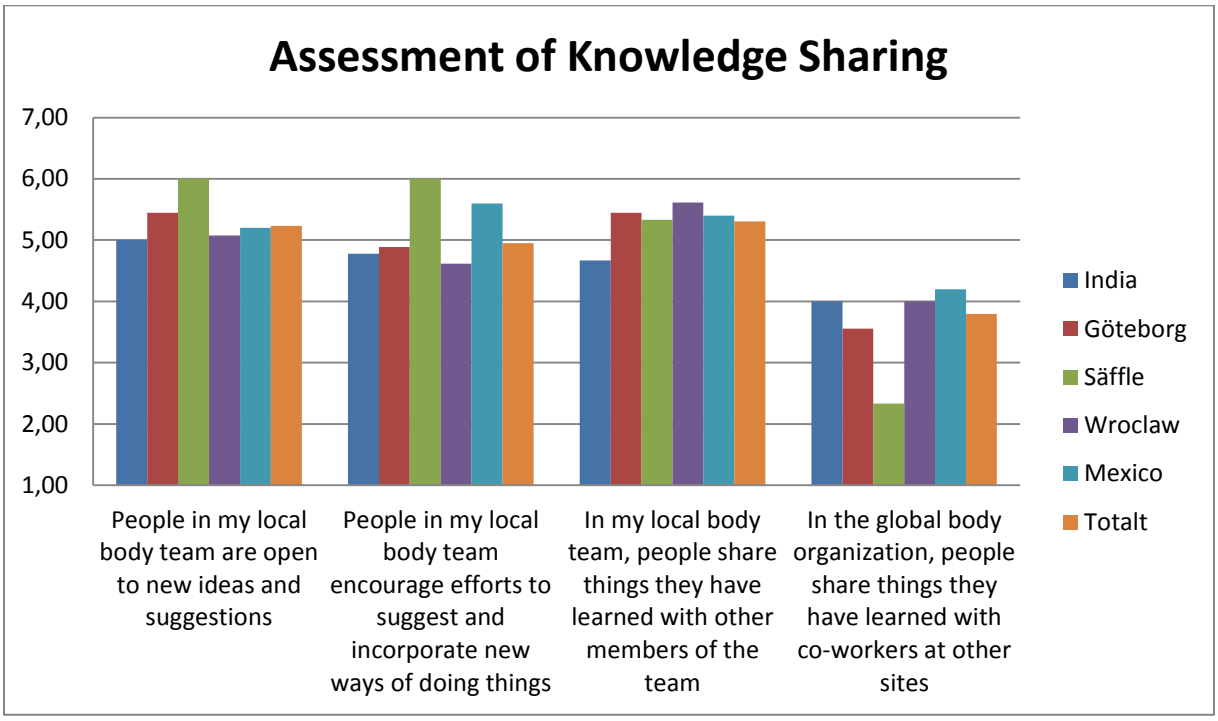

Figure 17 – Results from Questionnaire – Employees' Assessment of Knowledge Sharing

Employees at each of the sites somewhat agreed to that their co-workers are open to new ideas and suggestions, and that they feel encouraged to suggest and incorporate new solutions and ways of doing things. Furthermore, the results show how the employees quite firmly agree that they in their local environment people share knowledge with each other, however, they are slightly disagreeing to the statement that members of the global body organization are sharing things with co-workers at other sites.

Moving on, as can be seen in figure 18 below, the employees in Gothenburg and Säffle neither agree nor disagree to knowledge sharing being a part of their job description. The employees located in Wroclaw and India agrees to some extent, whereas those in Mexico firmly agree with the statement. In total, however, the majority of the respondents agree merely to a limited extent. Furthermore, in assessment of their personal and professional development the personnel in Mexico once again agreed more firmly than the other sites. In total, the employees somewhat agreed to the statements.

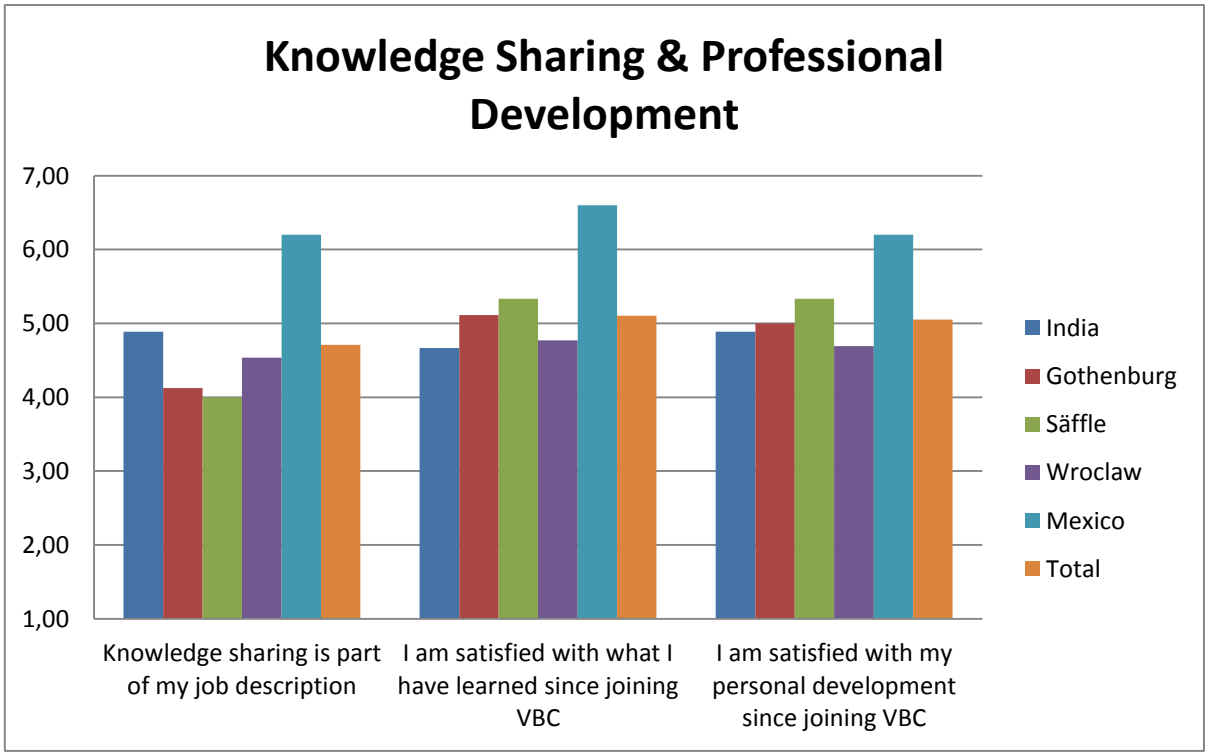

Figure 18 – Results from Questionnaire – Employees' view of Knowledge Sharing & Professional Development

Below, in figure 19, the results from the statements assessing the employees' view on the performance expectations are presented. All the sites, and especially Säffle and Mexico, agrees that the organization measures that people are performing in accordance to deadlines. When it comes to measuring that people are producing at high quality and that people continue to develop and learn throughout their career the sites agree significantly less. All the European sites slightly disagree, or remain undecided, when they are assessing these statements. Though, in India the employees slightly agree, and those in Mexico agree strongly with the former, and firmly with the latter.

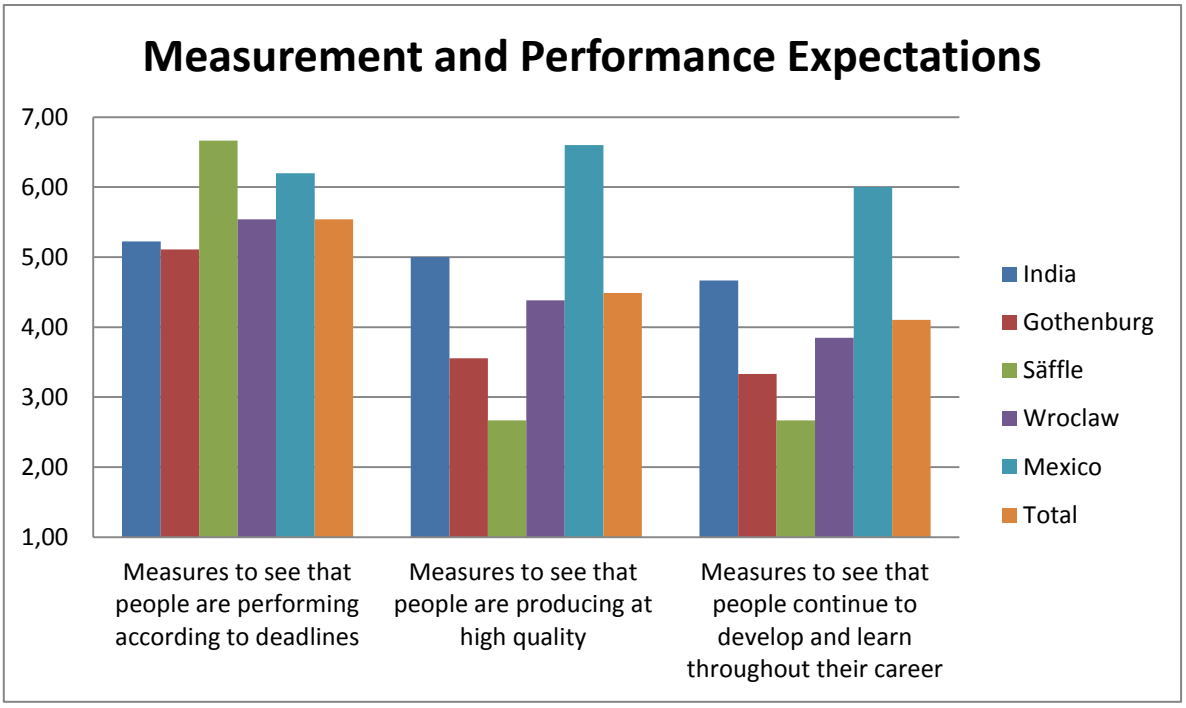

Figure 19 – Results from Questionnaire – Employees' View of Measurements and Performance Expectations

In addition, a majority of the design engineers where quick to point out how most of the measurements and KPI's of the organization seem to focus on leadtimes and deadlines rather than quality of products. This, they believe, inhibits learning as it oftentimes forces them to release drawings that are not up to par, and that fault reports that contain important information are being closed even though they are not resolved.

"The processes with their set deadlines forces us to relase weak designs." -GDE3

"You have to close fault reports even though they are not yet resolved." -GDE1

A production technician in Säffle also explain how, what he refers to as obsession with lead times, KPI's and gates, stifles learning and knowledge transfer to take place.

"It is simple too much prestige and fighting, it is no focus on the product, just on lead times, KPI's and Gates." -SPT1.

In stating this he joins a majority of the interviewees in defining the Volvo culture as one that is too focused on measuring lead times, adherence to deadlines and costs – at the expense of quality.

Analysis

In this section the empirical findings of the result section is analyzed and connected to the theoretical framework. First is a general analysis of GBD's knowledge transfer strategy is presented. Thereafter follows an analysis of the different parts of theoretical framework, focusing on those factors in each of the parts that are most important at GBD. These factors are finally synthesized and their relations are analyzed in a more detailed analysis of the strength and weaknesses of knowledge transfer at GBD.

Knowledge Transfer at GBD

First and foremost, while there is a good deal of knowledge transfer activity at GBD, they are lacking any kind of conscious and organized structure for knowledge transfer. This became evident during the extensive data collection. Many of the interviewees had not reflected on the need for knowledge transfer; and those who had thought about it, pointed out how it either was not done at all, or how VBC's current knowledge transfers efforts are poor. A large number of times knowledge transfer was described by interviewees as a system based on coincidence, that it is a matter of being lucky to receive the right information. As pointed out by Argote & Ingram (2000), knowledge transfer is a critical aspect in order to develop competitive advantage and effective development processes in knowledge-intensive PD organizations.

The only systematic and formal knowledge transfer that currently exists at GBD is post-project reviews, in accordance with the findings of Lindlöf, Söderberg, & Persson (2012). However, the study reveals that post-project reviews at are hardly used at VBC, and rather are documents collecting dust. The majority of knowledge transfer activities instead occurs at a coincidental level and is based on individual initiatives by employees and personal relationships. A supportive culture has been identified at VBC and GBD, and design engineers are good at helping each other when their co-workers have questions or issues. This is especially evident within the teams where the employees have strong social ties and the communication is flowing freely, however, it is also true between sites and with production in those instances where professional relationships have been established between specific employees at each of the sites/departments. However, the lack of a clear conscious structure for knowledge transfer has led to a situation where the employees, to a great extent, are lacking knowledge on what type of knowledge that exists, where that knowledge is located, and how that knowledge can be transferred.

Knowledge Context

The, for design engineers, work-relevant knowledge at VBC is to a large extent embedded in the minds of individual employees. Few design engineers state that they write down what they know; they seldom participate in post-project reviews, and the digital models & drawings are simple presentations of a final solution. As supported by the views of Moreland, Argote, & Krishnan (1996) members of the organization have been identified as the most critical reservoir of knowledge at GBD.

In databases and systems there is a great deal of knowledge embedded, but as design engineers point out, which also is supported by Bartezzaghi, Corse, & Verganti (1997), the knowledge is not utilized as it lacks structure, is difficult to reach and is rather lists of specific problems than lessons learnt. Even though quality reports are the single formal transfer activity of feedback from production to design engineers, no single respondent pointed it out as a learning tool. However, the

potential of the knowledge embedded in these quality reports is supported by the fact the several managers and design engineers believe it is a great learning experience to solve them.

Regarding reports and post-project reviews, there is not much to add to the abovementioned arguments. During the study, more than 25 design engineers have been asked about these and all claimed never to have seen one or participated in the creation of one. As they do not participate in creating it, the knowledge within the reports is rarely relevant when designing parts, and is more focused on managerial issues. In addition, interviews with managers, project managers and coordinator revealed that post-project reviews are regarded as a major inconvenience at the end of the projects. The purpose and structure of the current post-project reviews can therefore be questioned.

At VBC, the existing processes and the GDP is not regarded as reservoirs of knowledge. But as stated by Bartezzaghi, Corse, & Verganti (1997) the GDP can be regarded as knowledge embedded in organizational tasks, routines and best practices. The problem at VBC is, however, the great skepticism towards the GDP and other formal processes. Respondents claim that it is not useful in the VBC context, and that the most successful projects are carried out without following the guidelines and structure of the GDP.

Concerning type of knowledge, tacit or explicit, this has not been dealt with specifically in the results section. This is due to the fact that respondent were not asked directly about this issue, rather the analysis of tacitness of knowledge builds on the researchers interpretations of the results. During the interviews, most design engineers express that they find it hard to transfer knowledge by writing it in a document or explain it over a phone call. The knowledge transfer activity identified as most successful at GBD is within the team where individuals can have face-to-face conversations and directly show one another their views and ideas in drawings and 3D models.

Adding this to the finding that work-relevant knowledge is often explained as "*an understanding of the whole bus*", "*understanding interactions among parts*", "*you can only learn it by experience*" and "*understanding of the full picture*" leads to the conclusion that knowledge relevant when designing and developing new parts to a large extent is tacit in its nature. It is hard for respondents to explain specifically what they know, and they find it hard to transfer without personal meetings, demonstrations and long-term relationships.

Regarding knowledge that is specific for global product development, authors like Subramaniam & Venkatraman (2001), and Kogut & Zander (1999) discuss location specific knowledge. This is, in the literature often pointed out to be related to local market requirements and conditions. However, the results from the interviews reveals that what design engineers and managers perceive as location specific knowledge is rather connected to the specific features of each site. Being close to the headquarters and strong relationships with suppliers give design engineers in Gothenburg specific knowledge. Working closely with production, the customer adaptation department, and meeting customers who are picking up buses allows for design engineers in Wroclaw and Säffle to develop additional types of specific knowledge. An interesting aspect here is that, even though the dispersed teams all have well-defined areas of the bus as their responsibility there is knowledge within the teams the can be regarded as generalizable and relevant for all the design engineers GBD. To some extent design engineers seem to be aware of this, as can be seen in figure 20 below. The result from

the questionnaire shows that design engineers see knowledge transfer between team as less frequent than within the teams, but as equally important.

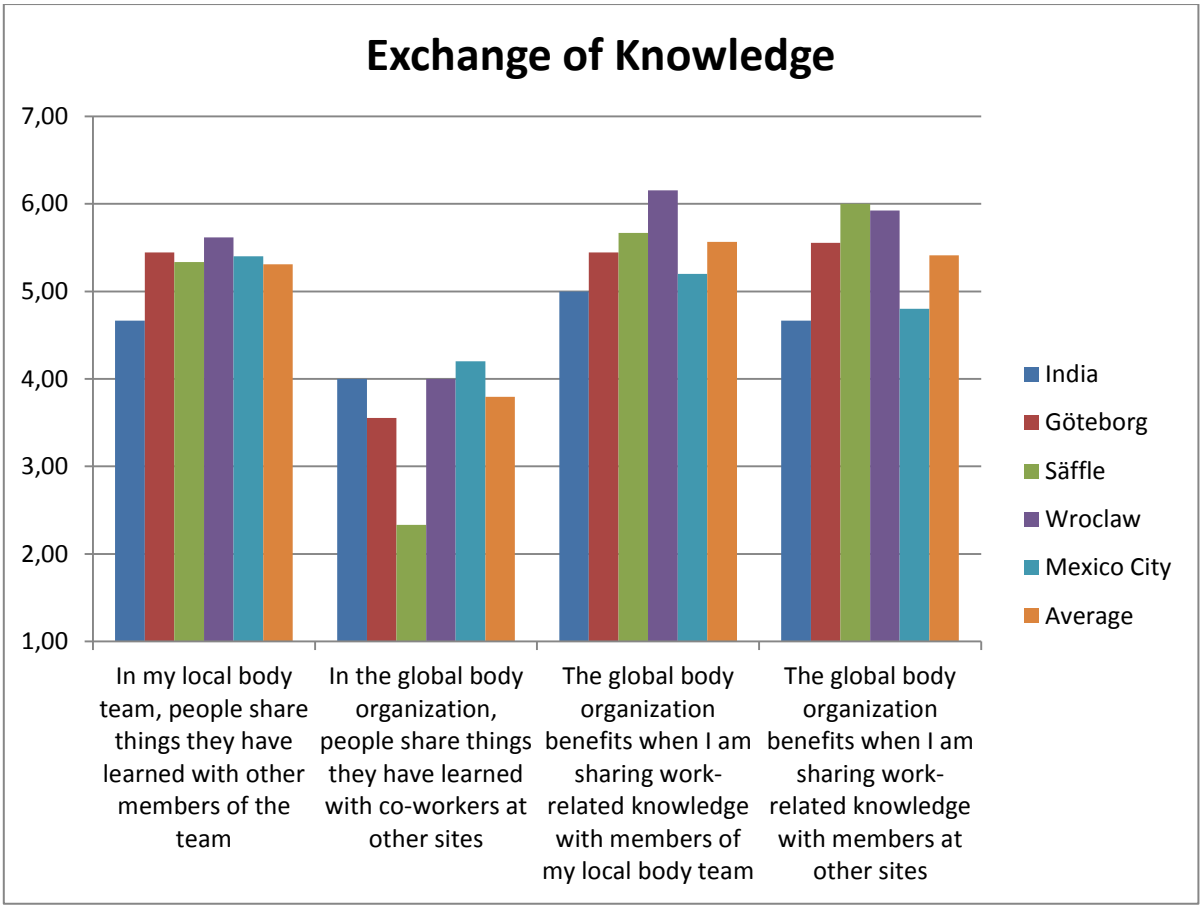

Figure 20 – Results from Questionnaire – View of Exchange of Knowledge

As pointed out by Smith (2001) it is important to understand what type of knowledge that exists within the walls of the company. The results from the questionnaire show that design engineers find it important to exchange knowledge within their team, between teams and with production. However, the interview result indicates that they, to some extent, lack awareness of what knowledge that is available within the organization and where they can find it. The findings of this report can be regarded as a first step in understanding the full knowledge of GBD, and the knowledge gaps of each of the sites.

Activity Context

Most knowledge transferring activities at VBC are based on informal interpersonal interactions. Design engineers ask each other and seek help when encountering problems. Compared to studied literature this is far from surprising, both Ipe (2003) and Stevenson & Gilly (1991) point out the importance of informal knowledge transfer activities and that they tend to be used even if there are structured and formal transfer mechanisms.

The findings shows that the formal knowledge transfer mechanisms are used less, and the information they contained are described to be of low quality. The formal transfer mechanisms seem to suffer from a moment 22 syndrome. The individuals documenting the knowledge do not put an effort in building detailed descriptions and lessons learnt as they believe no one will read them either

way. And the recipients do no search or review the existing knowledge since they believe it to be of low quality and difficult to find.

By using the division of transfer activities by Ipe (2003), formal and informal; and by Pedersen, Petersen, & Sharma (2003), written and communication media, the following **table** summarizes the available transfer activities at VBC.

Table 4 - Analysis of knowledge transfer activities

Transfer Activities	Written Media	Communication Media
Informal	Emails, Chat Software	Face-to-face interaction, telephone calls, video conference
Formal	Post-project reviews, Quality reports, Process charts, Drawings & 3D-models	DTL, Meetings (On project, team and department level)

GBD's strengths in knowledge transfer are mainly connected to the informal communication media, face-to-face meetings and discussions using chatting tools. However, there is a widespread reluctance to both creating and reading written documentation.

The problem with the existing structure is that knowledge transfer activities more or less builds on coincidence. Informal communication works great as a knowledge transfer tool, but it does not ensure that the right information reach the right person at the right time. This becomes especially critical in knowledge transfer between the sites where the amount of knowledge transfer activity is much lower.

Regarding knowledge transfer from production, most of the feedback comes through quality report systems. The quality report systems suffer from the poor communication between the two departments. Instead of transferring knowledge and containing high quality data the systems becomes a forum for non-yielding discussions, argumentation and conflicts.

An interesting aspect, not mentioned in the studied literature, was the claim of design engineers that too much direct contact with production disrupts the workflow and decreases work efficiency. Although design engineers seek personal contact, they express a desire that this contact is more planned. For example, formal meetings focused on discussing problems and receiving feedback. Both design engineers and production technicians claimed that visiting production and observing a problem "live" is a great way to provide better understanding. Interestingly design engineers claimed to be doing so often, whereas production technicians rather claimed that they hardly ever saw design engineers at the production facilities.

Barriers to Knowledge Transfer

There are large relational distances at VBC. Firstly, there is a lack of personal contact between the sites, and between product development and production. People do not have strong enough social

ties and there is a lack of systematic inter-personal exchanges. Secondly, in Poland and Säffle, which are located in conjunction with production, the relationship between the functions is arduous. The interaction is heated and focuses on politics and opinions rather than sharing of knowledge and information. The findings indicate that the lack of communication create misunderstandings and makes problems bigger than they need to be.

Several authors (e.g. Szulanski, 1996; Sun & Scott, 2007) have found that reluctance to sharing knowledge often stems from individuals' fear of losing ownership of that knowledge. However, at GBD, there was no evidence of such reluctance; rather, people are willing to devote time to transfer knowledge but lacking relationships with employees at the other sites and departments hinder them from doing so successfully.

The troublesome relationship between production and product development is further complicated by significant distances in knowledge. First off, there is substantial evidence showing that they do not fully understand each other. For instance, design engineers are working with CAD models that production personnel do not have technical knowledge of, and at the same time design engineers lack knowledge on how those CAD models are translated into the world of physical production. Furthermore, each of the departments lacks knowledge of the other's processes, and way and order of doing things. This lack of understanding often leads to heated discussions and politics about details that could have been easily solved had they had better understanding of each other.

Furthermore, lack of trust in the work-related knowledge held by people at other sites was identified as a strong barrier to the knowledge transfer activities between the globally dispersed GBD teams. As can be seen in figure 21 below, this lack of trust has been found to have a strong correlation to the level of established relationships. That is, the weaker the relationship between two specific sites, the lower is the trust of the knowledge at that site.

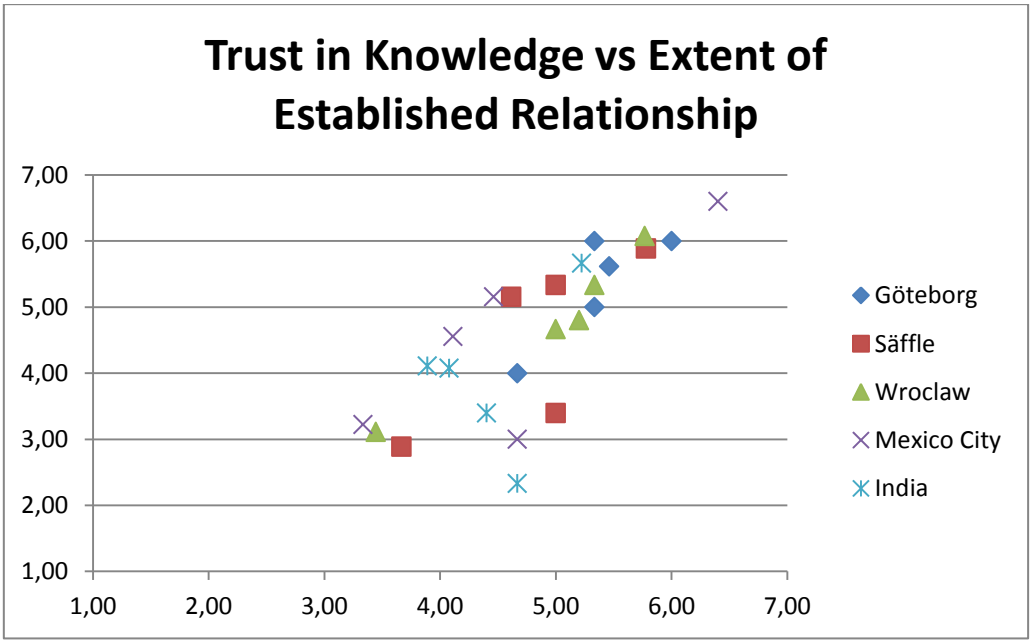

Figure 21 – Regressions Analysis of Questionnaire Data – Trust in Knowledge vs. Extent of Relationships

Moving on, while authors (e.g. Marschan-Piekkari, Welch, & Welch, 1999) and the managers at VBC and GBD anticipated differences in language skills to be a significant barrier to knowledge, the

findings suggest otherwise. Or rather, the interviewees do not believe it to be. Instead they emphasize that they do not trust the knowledge of their counterparts. However, even though not explicitly studied in this research, it could be very well be the other way around. That is, that difference in language skills creates or amplifies level of distrust.

With physical distance in mind, the most prominent barrier identified is related to lacking knowledge on who knows what and whom to contact when it comes to inter-site and inter-department communication. The interviews revealed how well-spread this issue is, and how design engineers have to spend a lot of time trying to find the right person when they need knowledge or have knowledge to share. This is connected to the lack of relationships between the sites and across functions, given that people who have established close work relationships have free-flowing communication and knowledge of each other's skills and expertise.

When it comes to the relative importance of, and priority of knowledge transfer activities the findings show that the VBC's project-focused way of working is a barrier to knowledge. This barrier works in two ways. Firstly, all the focus of VBC is on the new on-going projects, and when fault reports are received from older projects these are not prioritized, seen as inconveniences, and knowledge sharing neglected. Secondly, it was found that it is the projects you are bound to that dictates how knowledge transfer is taking place. Important knowledge is thus kept within the confines of a certain project and does not reach other personnel that possibly could benefit greatly from receiving it. These findings are slightly contradictive to existing literature. Rosen, Furst, & Blackburn (2007), for instance, found it to be the other way around, in the sense that knowledge transfer activities within projects often are neglected or ignored as they are conflicting with the duties of the line-organization. Finally, in terms of priority in general, the findings clearly show that knowledge sharing activities are low on the list of priorities across the GBD organization. The personnel simply think that there is not sufficient time and resources to devote time to transfer knowledge.

Learning Culture

With regard to the organizational aversion to risk in VBC, the findings revealed that the employees tend to agree that mistakes are tolerated and that people can learn from mistakes. However, employees at all sites but Mexico do not feel particularly encouraged to try different ideas to solve problems, which is regarded as an important part of a learning culture (Tannenbaum, 1997). Furthermore, the employees do not believe that new ideas are highly valued and encouraged; thinking, problem-solving and offering of suggestions is not seen as an integral part of everyone's role. VBC have in part failed to establish an environment where everyone is encouraged to question what they are doing, how they are doing it, and how it can be done better. The interviews revealed, for instance, that there is a culture of questioning things. However, this questioning is not constructive, and it leads to few improvements or development of new knowledge.

This lack of moving from questioning on how things are done into action could be connected to that most respondents were undecided or only slightly disagreed to the statements that you could get into trouble for trying new things, and that it is better to ignore problems rather than suggesting improvements. As a result situations have arisen where employees keep important knowledge and suggestions on improvements to themselves to avoid negative response from management. Thus,

the organizational culture and objectives do not fully support learning; leaving the organization set in its ways where divergent ideas are not encouraged.

In terms of feeling accountable for continuous learning and knowledge-sharing, the employees feel that the organization is primarily focused on measuring that people are performing according to deadlines. They feel that KPI's of the organization are overlooking the quality of the products, and that organization is not fully making sure that people continue to develop and learn throughout their career. These KPI's create an environment where knowledge transfer activities, and efforts to utilize existing knowledge in the organization, are inhibited because they are not in line with the performance expectations of the organization. As a consequence, the employees at GBD do not receive strong signals that continuous learning and knowledge sharing is a part of being a successful and appreciated employee of VBC.

Synthesis

In this section the four different modules of the theoretical framework is synthesized given the result from the study. This involves analyzing how modules are related and affects each other in the GBD context. Firstly, the relation between the type of knowledge and the transfer activities is analyzed, followed by an analysis of the relation between transfer activities and barriers to knowledge transfer and impact of learning culture.

Relation between types of knowledge and transfer activities

As the type of knowledge have a significant impact on the type of transfer activities that are useful, it is necessary to analyze the relation between the available knowledge at GBD and the used transfer mechanisms. A single transfer strategy or transfer activity cannot be pointed out as the most effective without understanding the type of knowledge needed to be transferred (Williams, 2008).

As previously stated, indications during interviews point at that much of the work-relevant knowledge for design engineers is tacit in its nature. This is in the literature review identified as more difficult to transfer than explicit knowledge as it highly connected to the individual who holds it, and hard to formulate in words (Argote & Ingram, 2000). In figure 22 below, the SECI framework is used to analyze the relationship between the type of available knowledge and used transfer activities at GBD. The orange-marked transfer activities represent opportunities to transfer knowledge within each site, including production. The green represent transfer activities that can be used no matter the location of involved actors.

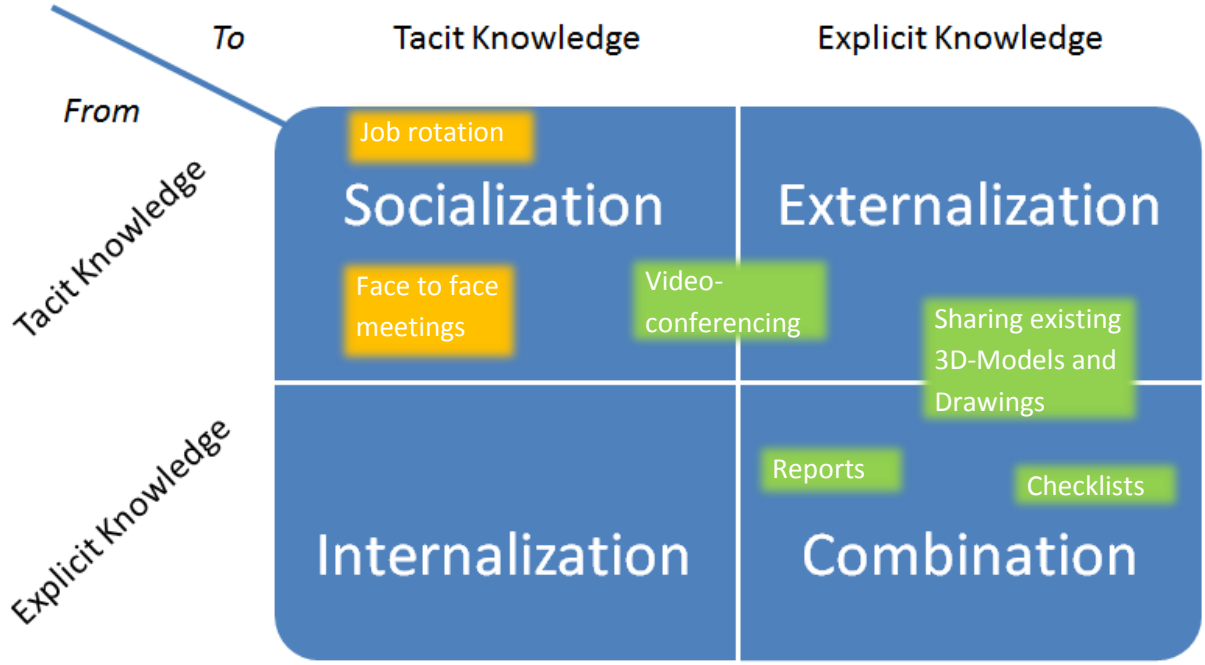

Figure 22 – Results of SECI Model Analysis – Mapping the activities at GBD to the different transformation modes

As can be seen in the figure, two transfer activities focused on *socialization,* the conversion of tacit to tacit knowledge are only available when being located at the same site. As presented in an article by Donnellan & Fitzgerald (2003) video-conferencing is a useful method to transfer tacit knowledge in global settings. However, few design engineers have talked about video-conferencing in this kind of terms. It was claimed to be useful, but far from as rewarding as face-to-face meetings or gaining experiences through job rotation and working closely with experienced colleagues.

Regarding the transfer activity of sharing 3D-models and drawings, it is in the literature seen as *transformation* of tacit to explicit knowledge (Donnellan & Fitzgerald, 2003). However, in the GBD context, design engineers often claimed that models and drawings lacked information about the process of creating the design and is rather a presentation of the final solution. Therefore the knowledge stored in 3D-models and drawings can rather be seen as explicit and leans more towards *combination.* Although, by expanding and developing processes for transferring knowledge through this activity by adding detailed descriptions about problems, solutions and lessons learnt. 3D models can be used to transform tacit knowledge into explicit knowledge.

Reports and checklists, which can be regarded as *combination,* are at GBD claimed to be of little use. One possible explanation is that the knowledge stored in them is of little use to design engineers. This can have two reasons; firstly the quality of the information and knowledge can be poor in itself. Secondly, the type of knowledge can be regarded as less relevant for design engineers due to its explicit nature and its focus on specific problems or situations. Interestingly, the only systematic and outspoken method for knowledge transfer identified at VBC are post-project reviews which this study reveals to have little success regarding knowledge transfer to and from design engineers at GBD.

As can be seen in figure 22 above, not all fields have a related knowledge transfer activity, and especially not a well-functioning transfer activity. This can be seen as a proof of the lack of systematic transfer of knowledge at GBD. A PD organization that wants to effectively utilize the knowledge

existing within its walls needs to have transfer activities for all conversion modes (Swan & Furuhjelm, 2010). Currently GBD have practices for internalization, meaning learning by doing, as design engineers naturally gain knowledge when designing new parts. However, the result shows little evidence that it is regarded as a specific learning experience to design a new part and in particular there is no structured support to enhance the transformation of explicit to tacit knowledge during design work. The reviewed literature discuss simulation software as a useful tool to gain tacit knowledge by trial and error exercises (Donnellan & Fitzgerald, 2003), and design reviews focused on creation and transfer of knowledge (Swan & Furuhjelm, 2010).

Relation between transfer activities, barriers and culture

There is no single best choice of transfer activities in an organization. The choice needs to be carefully weighed against barriers to knowledge transfers that may exist, and the learning culture of the organization. This has been found in existing literature (e.g. Tannenbaum, 1997; Cummings & Teng, 2003), and it has also been confirmed by the results from the research at GBD.

One thing that really works well at GBD is the informal face-to-face communication. The culture of VBC is open and suited for informal communication; people are willing to help each other and share knowledge. However, in order to make informal communication a conscious effort, GBD needs to create a support structure aimed at facilitating the required relationships.

Relational distances are the area with the most prominent barriers to knowledge transfers between the GBD teams. Lacking relationships have created a situation where people between sites and across functions do not know who knows what, whom to contact and how to contact them. Thus, conscious efforts of GBD to lower these relational distances is required. Co-location of employees from different sites during early phases of projects is an example that has worked well in alleviating the relational distances. Design engineers from the sites need to meet face to face, visit each other's sites, and get faces behind all the names. Once those relationships have been established it opens up for a plethora of informal written and communication media transfer activities to take place between individuals, e.g. emails, chat software, telephone calls or video conferencing.

Furthermore, at the heart of relying on informal communication as a transfer mechanism lies the finding that most of the knowledge of GBD's employees is stored in their minds. This, of course, can be problematic seeing that staff turnover was identified as a barrier to knowledge transfers. Essentially, it means that either the said support structure consciously works to minimize staff turnover, or that formal transfer activities using written media is a better choice as the knowledge then is independent of specific individuals

Daily Team Leadership (DTL) meeting is a transfer activity that has worked well within the teams. However, in accordance with the findings of Lindlöf & Söderberg (2011) our study has revealed that the primary drawback of the method is that you have to be physically present to take part in the knowledge transfer. Therefore, the challenge for GBD is to find complementing transfer activities that will allow for this local knowledge to be diffused between sites as well.

Moreover, in terms of the formal and written transfer activities such as post-project reviews, 3D models, and quality reports, GBD is stuck in a vicious cycle. GBD has failed in creating a culture where employees believe that new ideas are highly valued and encouraged; and they do not really believe knowledge sharing is a part of their job. Consequently, people do not devote time to document

knowledge in them, nor do they take the time to read them. For instance, the KPI's of the organization do not reward people for carefully handling quality reports; they only reward the speed of which they are solved. With a learning culture that does not promote long-term quality; the result is that employees quickly close the reports instead of carefully documenting important knowledge.

VBC's formal product development process (GDP) provides a great way of alleviating barriers relating to the physical distances between the sites. It can be regarded as a global model that disseminates best practices across the organization to ensure that guidance is provided to design engineers regarding activities to follow and tools and methods to use. The problem, however, is that there is a culture of distrust towards the model. It has been taken directly from VBC's sister organization Volvo Trucks, and the employees believe the model does not work at VBC, that it is not adapted to their way of working. The design engineers complain that is not flexible, however, whereas the findings have revealed that it is indeed adjustable locally. This makes it relevant to question whether the reluctance to accept the knowledge embedded in GDP is evidence of the not invented here syndrome.

Discussion

In this section theoretical implications are discussed, focusing on the concepts of knowledge and knowledge transfer, development of the used framework and finally implications for further research.

The theoretical model used as a framework to analyze knowledge transfer at GBD is based on the structure of a model presented by Cummings & Teng (2003) and is complemented by a great number of other researchers. This section discusses this model and to which extent it reflects and captures the critical factors in terms of knowledge transfer at GBD.

As a starting point of the thesis, the concepts of knowledge, information and knowledge transfer were introduced. In the field of knowledge transfer, some researchers claim that there is no point in making the distinction between information and knowledge (e.g. Wang & Noe, 2010). An argument supporting that view is that when studying organizational knowledge transfer the focus is rather on the result of the process of knowledge transfer than the actual process itself. However, there are two disctictive ways of looking at knowledge transfer, either knowledge is regarded as an object to be transferred or as a subjective contexutal construction (Paulin & Suneson, 2012). Based on an extensive litterature review and on the findings of this study the former seems to be too simplistic. And it does not provide a holistic view of the complex process of knowledge transfer. When discussing knowledge transfer, the learning culture needs to be adressed. Both in terms of understanding motviations and norms affecting willingsness to share knowledge but also how the organizational culture affects individual's opportunties to create knowledge for themselves. This risks to be excluded when discussing knowledge as an object that simply is transferred and received. Therefore, it is necessary to understand the difference in order to formulate models with a more holistic view of the knowledge transfer process.

The Knowledge Transfer Framework

The presented and used framework divides knowledge transfer into four modules that each will be discussed separately.

Regarding the knowledge context, the framework includes knowledge embeddedness and knowledge articulability as two distinct factors having an impact on knowledge transfer success. However, the findings from the study indicate that these two concepts to some extent relates to the same phenomenon. Knowledge stored, embedded, in individuals' minds can be, according to the results of the study, regarded to leaning towards being tacit in its nature. Whereas knowledge embedded, in documents, reports and databases is rather leaning towards being explicit by nature. Due to the relationship between the two concepts, it might not be interesting to discuss them separately in terms of their impact on knowledge transfer success. However, the two are relevant to analyze and discuss when formulating a knowledge transfer strategy as the appropriateness of specific strategies is dependent on both the type of knowledge and where it is stored in an organization.

Moreover, the discussion and distinction between tacit and explicit knowledge have been identified as useful in the sense that the two types of knowledge demands different types of transfer activities. However, putting too much focus on the distinction between tacit and explicit knowledge can be problematic. As stated by Pedersen (2003) it can be hard to characterize knowledge as one or the other, since knowledge rather contains inseparable elements with different characteristics. This thesis concludes that much of the knowledge relevant to transfer within and between teams of

design engineers is tacit by nature. However, this builds upon the researchers interpretations of claims of respondents and should rather be seen as a conclusion that work-relevant knowledge to a large extent contains tacit elements than being tacit by nature.

The literature review on knowledge in global product development revealed that much focus on the specific knowledge created in globally dispersed PD organizations is related to specific local market requirements. However, the findings from this study indicate that the knowledge unique for each globally dispersed team is connected to more than just the local market. Each site has unique features, in terms of proximity to other departments, existence of other departments and culture of knowledge sharing. This could mean that location specific knowledge is as much related to the specific features of each site as it is to the local market requirements.

Regarding knowledge transfer activities, the literature review revealed that knowledge transfer tends to be informal even when formal transfer mechanisms and infrastructure exist. The findings from the study strongly support this view. At GBD, the formal transfer mechanisms are hardly ever used and instead the knowledge transfer taking place mostly is informal face-to-face communication. As stated by Reagans & McEvily (2003), individuals chose to participate in knowledge transfer activities and the choice of transfer mechanisms is based on the path of least resistance.

The reviewed literature focusing on knowledge transfer activities is to a large extent focused on formal and written media communication; such as post-project reviews and lessons learnt books. Putting that in relation to the results of the study and the claims of researchers like Reagans & McEvily (2003) that knowledge transfer tends to be informal can be found interesting since much of the research is focused on discussing methods that seldom are found useful. And that little research is focused on what is actually used, in terms of findings ways to structure and improve performance of informal knowledge transfer.

Face-to-face interaction and proximity is pointed out as an advantage in almost all articles concerning knowledge transfer activities. However, the results from this study revealed it is not always an advantage to be closely located and have extensive communication with other departments as it can disrupt the workflow and hinder planning. This was pointed out as a factor by design engineers in Säffle and Poland when discussing knowledge transfer with the production department.

Regarding barriers to knowledge transfer, contrary to conventional wisdom that places primary blame on inherent characteristics of the recipient and sender of knowledge, e.g. motivational factors such as reluctance to share knowledge (Lepak, Smith, & Taylor, 2007), the major barriers to internal knowledge transfer at GBD were shown to be relationship-related factors (Szulanski, 1996; Cummings & Teng, 2003). That is, it boils down to the lack of relationships and arduous relationships between the source and the recipient. And based on the notion that the flow of knowledge follows the path of least resistance, these relationship-related factors cause and amplify a series of factors influencing how knowledge transfer takes place. At VBC, a good deal of the knowledge is transferred only via face-to-face interaction that takes place locally within the teams and globally during co-location activities and business trips between the sites. That is, knowledge transfer are not hindered by barriers per se, rather they are factors that affect the knowledge transfer related choices individuals within the organization take. In this sense barriers can be regarded as factors implying transaction costs with unique effects on each possible opportunity to transfer knowledge, thereby

affecting individuals' own perception of the path of least resistance. These factors primarily revolve around the aforementioned relational distances, but also physical and knowledge-related distances, that reward a certain set of knowledge transfer activities over others. As a result, we believe that using a terminology revolving around the word barrier can be a bit misleading, since these factors dictate the knowledge transfer activities that ultimately take place in the organization, rather than hindering them from taking place at all.

Learning culture is a fuzzy concept, and it is hard to make a distinction regarding what parts of the wider concept of organizational culture that it encompasses. Some authors (e.g. Tannenbaum, 1997) describe it as a barrier to knowledge transfer in its own right. Others (e.g. Ipe, 2003) treat it as more of a holistic entity that is reflected in the values, norms, and practices of the organization, where values are manifested in norms that in turn shape specific practices. All authors emphasize the importance of, and integrate the cultural aspects into their models for knowledge sharing but there lacks a consensus of what the concept should comprise.

We integrated learning culture quite late in the research via the questionnaire sent out to the design engineers across the different sites of GBD. It was not initially integrated into the conceptual model of knowledge transfers. Given the fuzzy nature of the concept, it is questionable whether it is suitable to use such a quantitative method for assessing it. And we believe our findings, as a result, cover an even smaller subset of culture. We describe the culture of VBC to be open where employees are open to help each, and that they actually are inclined to take the time to help each other. That is, the analysis was based on the assumption that the core of the concept boils down to a general will to devote time to share knowledge, and to see value in transferring knowledge with co-workers. However, it shall be noted that these insights also stem from our interpretations of what the interviewees said during the qualitative interviews, and observations during work-shops and meetings.

Implications for research

Despite conducting a practice-oriented case study research at a specific department of a specific company we believe there is an existing domain to which the findings of our study are generalizable. First and foremost, GBD is one of five global product development departments of VBC's product development organization. All of these share a good deal of characteristics, processes and systems. They are all working with the same quality/fault report systems, they are using the same tools and methods for designing products, they are all bound to the same global product development process, and they are all scattered across different regions around the world. Furthermore, they are also sharing processes, systems and routines with other companies within the entire Volvo AB Corporation.

As far as we are aware, this research has contributed with a new perspective on knowledge transfer in product development by using the perspective of design engineers as a starting point. In this sense, the findings from this research can be seen as a complement to existing literature. Much of the knowledge embedded in the PD organization at Volvo Buses is embedded in the minds of individual design engineers, therefore their perspective and interests are important to regard when evaluating the knowledge transfer process and formulating a knowledge transfer strategy. Since the holders of the knowledge need motivation and appropriate methods to transfer knowledge successfully. A strong focus on transferring knowledge on project management level has been

identified in both the studied literature but also in the Volvo Buses PD organization. In the studied case, the GBD organization this has led to a situation where individuals seldom are aware of the importance nor participate consciously in organizational knowledge transfer. For knowledge transfer to be successful, the holders of critical knowledge need to be involved actively in the knowledge transfer process.

Regarding recommendations for further research we have identified a couple of directions that constitute interesting areas of research:

- While organizational culture is receiving a lot of attention in academia, and is claimed to have a significant impact on knowledge transfer, little research have focused on which aspects that are especially salient to knowledge transfer success. Organizational culture is a broad and fuzzy area, and there is a lacking understanding which specific factors that actually influence the knowledge transfer process. In this study, for instance, a good deal of data relating to the cultural environment. However, it has been hard to draw any conclusions that can be specifically connected to learning culture. Especially it would be interesting to study learning culture from the perspective of design engineers as their motivational factors to share knowledge might differ from project managers.
- There is a lot of research on how relationship networks are created and maintained. However, this stream of research has not yet sufficiently been integrated in literature on knowledge transfer. Based on our finding that relationships are a key factor to the success of knowledge transfer activities, we believe that if the two areas are merged there is a lot of interesting topics and areas can be covered and dealt with more profoundly. Szulanski (2000) discussed the effect of strong and weak ties in R&D organizations on knowledge transfer. Relationship networks can be interpered to reduce transaction costs (barriers) when transferring knowledge. But what also should be further investigated is the extent of established relationships effect on individuals' motivation to share knowledge. Which in this research has been identified as a critical factor. In this sense, established relationships among design engineers might have a doubble effect, both decreasing transaction costs but also increasing the motivation to share knowledge.
- ICT systems have been found to have a great impact on the possibilities of knowledge transfer in a global environment, in terms of opening up for new ways of communicating more effectively. While the impact of these systems on knowledge transfer have been thoroughly examined, there lacks research on how these technological advancements affect the choices of knowledge transfer strategies. The distinction between codification and personalization as two extremes of knowledge transfer strategies was made by Hansen, Nohria, & Tierney in 1999. We believe that the development ICT systems that has underwent since this distinction could have decreased the fundamental requriement that organizations must focus on one of the two in order to be successful in knowledge transfer. This study mentiones, for instance, how VBC are using visualization techniques such as sharing 3D models and video conferencing. It would be interesting to further investigate how these and simlilar techniques have affected the validity of Hansen, Nohira & Tierney's model.

Conclusions and Recommendations

This section begins by presenting the conclusions that are related to the three research questions of the study. It is then followed by an open discussion, relating to the aim of the study, addressing how GBD can be allow to develop into a learning organization with help of knowledge transfer.

RQ1: How is knowledge formally and informally transferred at Global Body Development?

There are both formal and informal transfer activities in place at GBD. The formal includes post-project reviews, various information systems, 3D models and drawings, meetings, and product development process charts. However, most of the formal knowledge transfer activities are barely used at all. Some of them are viewed as too complex, containing weak data and are too time consuming to use, e.g. post-project reviews and information systems. Whereas others are not even considered to be knowledge transfer activities, and are not use as such accordingly, e.g. 3D models and product development process charts.

Rather, it is the informal knowledge transfer activities that are mostly used at GBD. These largely revolve around inter-personal interaction, e.g. face-to-face interaction locally or via communication software globally. These activities are occurring on more of an ad hoc basis and are dependent on individual initiatives of the involved design engineers. Although there is a lacking support structure for informal knowledge activities to take place, design engineer claim that it currently is the only successful form of knowledge transfer at GBD.

RQ2: What types of work-related knowledge do design engineers at Global Body Development perceive to be transferred, and see a need to be transferred?

The knowledge that design engineers perceive as relevant to share and receive are largely tacit in its nature. It revolves around knowledge gained from experience when working on specific projects. The explicit knowledge that is found in codified form in systems and reports are regarded as difficult to use and not applicable when designing new parts. Rather, design engineers believe that the relevant knowledge is stored in respective individual's mind, and its tacitness is supported by descriptions such as *"an understanding of the whole bus, and interactions among parts".* And this experience-based, tacit knowledge is almost exclusively transferred via face-to-face interaction.

RQ3: What are the difficulties that hinder knowledge transfer at Global Body Development?

The most successful knowledge transfer activities at GBD are based on interpersonal interaction. However, this study identifies a lack of established relationships between the design engineers at the globally dispersed teams and with production. This leads to a situation where design engineers do not know who to share knowledge with, and where to find knowledge.

Furthermore, knowledge transfer is considered to be low priority for design engineers. They do not believe that they have time to share knowledge, which could be related to how the organization and the employees are measured. The KPI's affecting design engineers are focused on time deadlines rather than quality and knowledge growth. Ultimately this means that the transaction cost of transferring knowledge is too high, and as a consequence neglected.

To conclude, relationships have been identified as the key factor affecting the success of knowledge transfer at GBD, primarily since informal inter-personal communication is the most frequent and successful transfer activity. There are three main reasons to this. Firstly, as pointed out by the design engineers, communication and knowledge transfer is perceived as significantly easier when having established relationships. Secondly, with established relationships come awareness in terms of who to share knowledge with, and where to seek knowledge. Finally, the results from the questionnaire reveals that when design engineers have established relationships, they both trust the knowledge and believe that they have knowledge learn from their counterparts. The near-linear relationships between these variables are presented in figure 23 and 24 below. This leads to the conclusion the relationship networks among design engineers has a double effect, it both decreases barriers to knowledge transfer but it also increases the motivation to share and seek knowledge from other members of the organization.

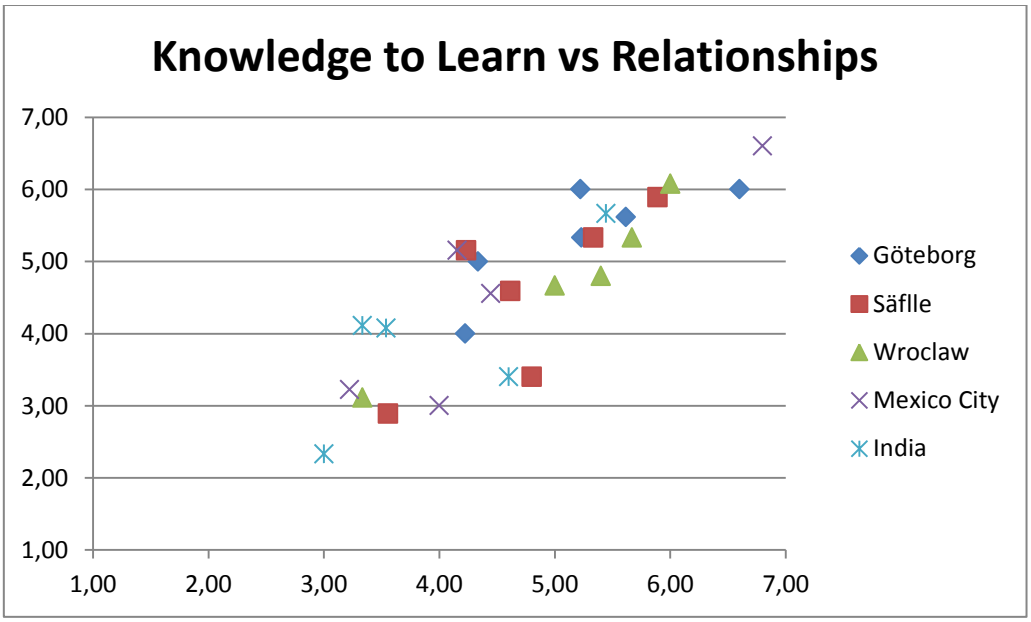

Figure 23 – Regression Analysis of Questionnaire Data – Perception of Knowledge to Learn vs. Extent of Relationships

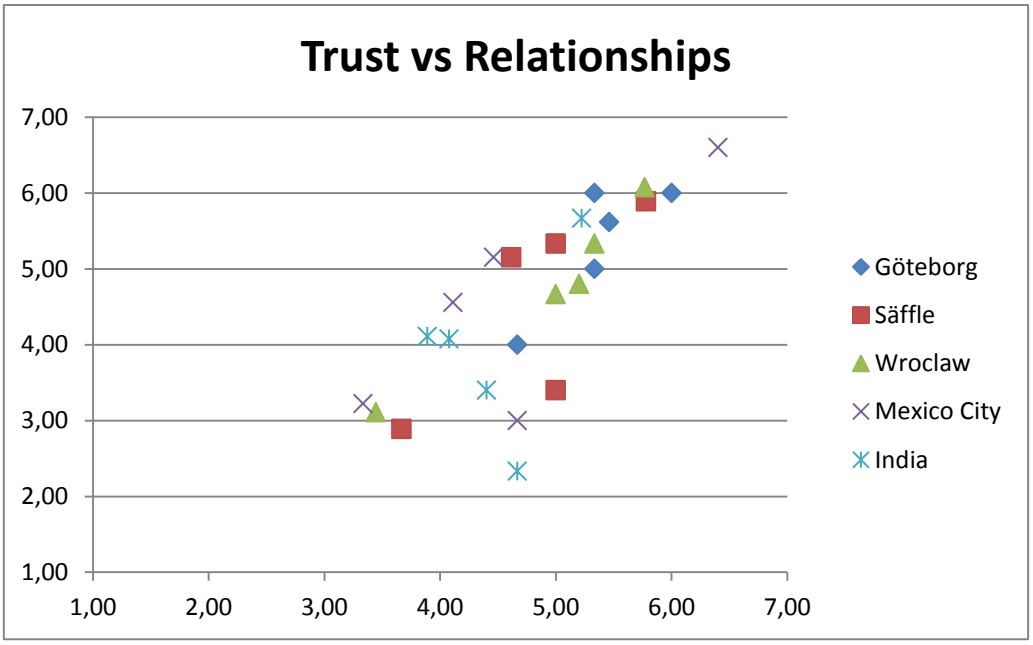

Figure 24 - Regressions Analysis of Questionnaire Data – Trust in Knowledge vs. Extent of Relationships

Formulating a Knowledge Strategy

In the beginning of the analysis section the notion that VBC and GBD is lacking a conscious and organized approach to knowledge transfer. And the analysis that followed has elaborated on this and showed how their current knowledge transfer activities can be described as a system based on coincidence and individual initiatives. Based on these findings we believe that the next step for VBC and GBD is to formulate a clear knowledge transfer strategy. That is, a strategy that guides and defines processes and infrastructure in order the capture the value of knowledge (Zack, 2002). And this must be strategy based on the context and prerequisites of VBC of GBD.

That is, we believe that a choice of knowledge strategy needs to ensure:

- That the knowledge transfer activities are adapted to the type of knowledge that needs to be transferred
- That the knowledge transfer activities are not hindered by existing barriers to knowledge transfers
- That the knowledge transfer activities are adjusted to the learning culture of the organization

While there currently is no conscious choice of strategy, it is still possible to analyze what type of strategy that best reflects the current knowledge transfer practices at GBD. In the figure below, the current transfer activities are connected to two knowledge transfer strategies described by Hansen, Nohria, & Tierney (1999).

Table 5 - Knowledge Transfer Strategy in Relation to Transfer Activities

Transfer Activities	Written Media	Communication Media
Informal	Emails, Chat Software	Face-to-face interaction, telephone calls, video conference
Formal	Post-project reviews, Quality reports, Process charts, Drawings & 3D-models	DTL, Meetings (On project, team and department level)

The emphasized field at the bottom left contain transfer activities that the findings have revealed to have little success at GBD. They have been identified to follow a codification strategy approach. The advantages of this approach are that knowledge stored in databases and reports can be made available by anyone in an organization. Knowledge is therefore independent of specific individuals, and available for reuse. A prerequisite when using this strategy is that knowledge is carefully codified with detailed descriptions (Smith, 2001). However, at GBD they have failed with the latter; people do not devote time and effort to provide high quality data, they do not trust existing data in the systems and they find it hard to locate relevant knowledge. For a codification strategy to become successful at GBD they have to address these shortcomings, and develop the quality of procedures and systems.

Correspondingly, the emphasized field at the top right contain transfer activities that the findings have revealed to be successful at GBD. They have been identified to follow a personalization strategy approach. The advantages of this approach are that the focus on interpersonal interaction offers opportunities to transfer tacit knowledge. However, this approach requires strong organizational networks linking people together (Hansen, Nohria, & Tierney, 1999). The findings of this study reveal the importance of organizational networks in terms of knowing who knows what, and which knowledge is relevant for whom. At GBD, however, there is no support structure that has helped creating such an organizational network. For a personalization strategy to be successful at GBD, they need to move away from ad hoc interaction, create more opportunities for employees to establish relationships, and make sure that all employees know each other's knowledge and areas of interest.

According to Hansen, Nohria, & Tierney (1999) an organization needs to make a choice and focus on one of the two strategies. This way they can develop knowledge transfer activities, an organizational learning culture and reduce barriers to knowledge transfer to support the specific strategy and use the other as a complement. Since no knowledge strategy exists at VBC, they have no focus on one of these extremes and can be regarded to be "stuck in the middle". Thereby they have not been able excel in and grasp the opportunities of knowledge transfer.

With that said, based on the context and conditions of VBC and GBD, we believe they are most likely to be successful with a personalization strategy. With clear processes and infrastructure that support

inter-personal interaction, can experience-based and tacit knowledge succesfully be transferred to the right person at the right time. In some sense, this entails that knowledge transfer continues to occur at an ad hoc basis. However, this approach will ensure that this ad hoc based knowledge transfer is systematically supported and as a result becoms more frequent. This means that GBD and VBC needs to systematically support relationship between employees to be established via strategic travelling, co-location and jobrotation. In addition, they need to set up a clear knowledge map of all the employees at different sites and functions, in terms of their expertise, skills and contact information. They need to conciously weigh the different existing barriers to their strategic choice. For example, the personalization strategy is dependent on a coherent work-force and low staff turnover.

However, one cannot ignore the fact that GBD and VBC is a global organization, making it necessary to support the personalization strategy with elements of codification. We believe the first step in that process is to start increasing the quality of the information stored in systems and documents. This means, for instance, adding detailed descriptions of the work process in 3D models, and making existing data in quality report systems searchable so they can be used as learning tools.

With a strategy that promotes knowledge transfer systematically can VBC and GBD better exploit exisiting knowledge within their organizatoin and develop as a learning organization.

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Appendix II – Interview Questions Module 3

Questions to Design Engineers

- *Definition - Information/Knowledge*
  - *Information/knowledge that if shared would*
    - *Avoid recurrence of problems*
    - *Avoid waste (unnecessary work, waiting time, re-work)*
- *General Questions:*
  - *Does [information source] contain useful information to you?*
    - *What information is useful?*
  - *Do you receive this information?*
    - *How do you receive this information today?*
    - *How could this information be received in a better way?*
    - *How would you like to receive it?*
- *Within Teams*
  - *What knowledge/information do you have that could be relevant to share with others in your team?*
    - *Do you have specific knowledge?*
    - *How do you share it?*
    - *Where is this information/knowledge stored?*
  - *What knowledge/information do others in your team have that could be relevant for you?*
  - *Transfer*
    - *How is information shared within the team today?*
    - *How would you like it to be transferred?*
    - *Barriers to transfer?*
- *Between Teams*
  - *What information/knowledge do you have that could be relevant to share with other sites?*
    - *Where is this information/knowledge stored?*
  - *What information/knowledge do others have that could be relevant for your team?*
  - *Transfer*
    - *How is information shared between the teams today?*
    - *How would you like it to be transferred?*
    - *Barriers to transfer?*
- *With production*
  - *What information/knowledge do you believe you can learn from experiences in production?*
    - *How do you receive this information/knowledge?*
  - *Transfer*
    - *How is knowledge shared between PD and production today?*
    - *How would you like it to be transferred?*
    - *Barriers to transfer?*

Questions to Production Technicians

- *How does communication work with the local PD and with other PD sites?*
  - *Are there any general problems?*
  - *Feedback mechanisms?*

    - *Protus?*
        - *How does the Protus system work in your opinion?*
- *Advantages and disadvantages of being close to the design engineers in Poland vis-à-vis design engineers on other sites?*
- *How do you think PD better could understand your reality?*
- *How do design engineers learn from experiences in production?*
- *How do you think design engineers should learn from experiences in production?*
- *What type of knowledge can be transferred to design engineers related to experiences in production?*

Appendix II - Questionnaire

Below, the questions asked in the self-completion questionnaire are presented. As stated in the methods section, the questionnaire builds upon an already used survey performed by Tannenbaum (1997). The re-used questions are emphasized in bold.

Note: All scales used a 7-point response format with 1=*strongly disagree;* 4=*neither agree nor disagree;* 7=*strongly agree,* unless otherwise noted.

Scale: Tolerates Mistakes as Part of Learning
At Global Body Development:

- **Mistakes are tolerated when someone is first learning a new task or skill**
- **People are encouraged to try different approaches to solve problems**
- **It is believed that people can learn from their mistakes**
- **New problems and work challenges are viewed as opportunities to develop peoples' skills**

Scale: Open to New Ideas/Change

- **New ideas are highly valued at VBC**
- **At VBC it is acceptable to question others about why things are done a certain way**
- **The successful people at VBC try new things**
- **At VBC you get in trouble if you try something new**
- **At VBC it is better to ignore problems than to suggest improvements**
- **At VBC everyone, not just management, is expected to solve problems and offer suggestions**

Scale: View of New Ideas

- **People in my local body team are open to new ideas and suggestions**
- **People in my local body team encourage efforts to suggest and incorporate new ways of doing things**
- In my local body team, people share things they have learned with other members of the group
- In the global body organization, people share things they have learned with co-workers at other sites
- I see personal benefits of sharing work-related knowledge with other members of my local body team
- I see personal benefits of sharing work-related knowledge with other members at other sites
- The global body organization benefits when I am sharing work-related knowledge with members of my local body team
- The global body organization benefits when I am sharing work-related knowledge with members at other sites
- Knowledge sharing is part of my job description

Scale: High Performance Expectations

- My organization (VBC) typically:
    - **Measures to see that people are performing according to deadlines**
    - **Measures to see that people are producing at high quality**
    - **Measures to see that people continue to develop and learn throughout their career**

Scale: Awareness of Big Picture

- **I understand how my job relates to others in the G2P organization**
- **I understand how my unit contributes to the goals of the G2P organization**
- **I am clear about the goals of the G2P organization**
- **I am familiar with the purpose and direction of G2P**

Scale: Satisfaction with Development

- **I am satisfied with what I have learned since VBC**
- **I am satisfied with my personal development since joining VBC**

Scale: Relations

- I believe I can learn work-related knowledge from members of the global body organization at:
    - Göteborg
    - Säffle
    - Wroclaw
    - Mexico City
    - India
- I believe I can trust work-related knowledge from members of the global body organization at:
    - Göteborg
    - Säffle
    - Wroclaw
    - Mexico City
    - India
- I feel that I have established good relationships with my coworkers:
    - Göteborg
    - Säffle
    - Wroclaw
    - Mexico City
    - India
- Please state the number of weeks you have visited: (*Leave your local site blank*)
    - Göteborg
    - Säffle
    - Wroclaw
    - Mexico City
    - India

Scale: Situational Constraints

(Note: this scale used a 7-point response format ranging from 1=*not at all;* 4=*to some extent;* 7=*to a great extent*)

- To what extent have the following made it hard for you to transfer and receive knowledge
    - Lacking knowledge on whom to contact in order to get information
    - Uncooperative coworkers and/or poor relationships between people within my local body team
    - Uncooperative coworkers and/or poor relationships between people at different sites of the global body organization
    - Insufficient time to share knowledge
    - Knowledge sharing is not a part of my job description
    - Communication problems

Scale: Background

- I have worked for Volvo Bus for ___ years
- I have worked in Global Body Development for ___ years
- I am located at GBG VPI VIM SÄF
- I am employed by:
    - Volvo
    - Consultancy firm