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THE MAJOR BARRIERS IN GLOBAL SOFTWARE PRODUCT DEVELOPMENT FOR FINNISH COMPANIES

Masters Thesis in
Information Systems Science
5.5.2005

University of Jyväskylä
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ABSTRACT

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The Major Barriers of Global Software Product Development for Finnish Companies / Milla Helén
Jyväskylä: University of Jyväskylä
126 p.
Masters Thesis

This study was undertaken due to the increasing importance of globally distributed software product development. This study investigated the global software product development process from the viewpoint of Finnish companies and it concentrated on the major barriers and solutions of the process. Despite the high importance of global software product development for Finnish companies, very limited research has been conducted on this topic and no research has yet been done on the barriers that Finnish companies face in the global development of software products. This research has been undertaken to make both theoretical and empirical contributions. This study has been conducted by: a) analyzing the cooperation and networks theories, b) reviewing literature concerning software business, globalization of software production, IT environment of Finnish software production, Finnish software market environment, global software product development of Finnish companies and barriers in global software product development, c) executing a qualitative case study, and d) analyzing data from a case company. This study introduces two conceptual models of global software product development process. This study also provides solutions to overcome the encountered barriers in globally distributed software product development.

Keywords: software business, global software product development, software team, co-operation, Finnish companies

ACKNOWLEDGEMENTS

I got the inspiration to conduct this study in 2004, when I was introduced to the issues of global outsourcing and global software product development in the lectures of Dr. Nazmun Nahar. The phenomenon of global software development and globally distributed software teams fascinated me and after conducting a seminar work concerning this issue, I decided that this topic was worth investigating more. After finishing my Bachelor thesis, I continued to investigate this issue in my Masters thesis.

The proactive support to my research work provided by Dr. Nazmun Nahar deserves special thanks. She provided systematic support and guidance throughout the whole process of completing this work. Furthermore, she was the person who initially introduced me the phenomenon investigated. I have been able to conduct rigorous theoretical and empirical research with the help of her comprehensive understanding of scientific research approaches and methods, and her knowledge in global software product development.

I would also like to thank Company x and everyone who participated in the empirical part of this study. I truly appreciate their positive attitude towards my research work and cooperation with me. I would like to thank all of them for sacrificing their time and effort, and for sharing their expertise.

CONTENTS

1 INTRODUCTION

The background of the study is discussed in section 1.1. In sections 1.2 and 1.3 the research problem and research questions and major objectives of the study are introduced. Section 1.4 discusses the motivations for the study and section 1.5 highlights the scope of the research. Structure of the thesis is introduced in section 1.6.

1.1 Background of the study

The importance of high-tech companies is increasing (Nahar, Lyytinen and Huda 1999; Nahar 2001) in highly developed countries when they are creating innovation and jobs with high incomes, driving for economic growth and maintaining the high standard of living. Many high-tech companies are in pressure to expand their businesses to foreign markets due to the rapid changes in technology, intense competition, shortening of product lifecycles, the increasing maturation of markets in the industrialized countries, to name a few. (Al-Obaidi 1999; Balachandra 1996; Nahar 2001; Chakrabarti and Lester 2002) Due to the increased liberalization that is occurring in major economies and regions, multinational companies are establishing and maintaining their existence in these liberalized economies and regions. This is happening through establishing subsidiaries or other business operation modes. (Nahar and Karmakar 2003) In order to survive in an intensely competitive and globalized business environment, rapid research and development (R&D), production and introduction of new products are important factors (Nahar and Karmakar 2003). According to Nahar et al. (2003), internationalization through distributed software product development is essential for most small software product business. The complementary innovations of small companies are also important for large companies in shaping their business webs and striving to become platform leaders.

Globally distributed software product development is a rapidly growing area in the field of information technology and it has become a major issue facing managers in today's business environment (Jurison 1995; Kern and Willcocks 2000). It has become almost necessary for software product companies to market their products to world markets and compete globally (Carmel 1999; Cusumano and Selby 1995). According to Carmel and Agarwal (2001), upwards of 50 nations – at least minimally- are currently participating in collaborative software development internationally. All in all, costs of software products development are increasing at the same time, as product lifecycles are shortening significantly and this enhances the globalization of software production even more. Research also indicates that the length of time that it takes to develop a new product from the product innovation to the initial sales of the product in major markets of the world needs to be shortened (Nahar et al. 2003). Organizations use global software teams in software product development and outsource their activities between different countries due to various reasons. The cost benefits, cheaper and well-educated workforce and the utilization of around the clock work attract even more companies into distributing their software development (Damian, Lanubile and Oppenheimer 2003).

During the 1990's, the globalization of software development became noticeable. Organizations started to outsource their activities and created flexible team structures. The co-located form of development changed into global software teams that collaborate across the world, working on the same software project (Carmel 1999). Globally distributed software development continues to grow and it is fuelled by factors such as access to highly educated, specialized work pool, cost-effectiveness, global presence and also the proximity of customers (Damian, Lanubile and Oppenheimer 2003).

Software development is a complex business even when it is conducted locally – but it becomes even harder when the software development is done in a

globally distributed environment. The global aspect brings in a major pool of different barriers. Without recognizing these barriers, the development of software and the business itself can very easily be threatened. Global software product development involves constant teamwork among people from different cultures and places, and the meaning of effective communication and collaboration becomes truly important. (Carmel 1999, 3-4) The parties of globally distributed software product development need to deal with the issues that affect the teamwork. It is important to ensure close relationship and two-way communication and collaboration that are essential for successful relationships (Barbosa and Vaidya 1995; Nahar 1999, 2001).

Finland has evolved from an agricultural nation to be one of the most networked nations in the world that has strong export positions in mobile phones, base stations and switches, and has recently created some successful software products. It can also be noticed that Finland has evolved from a peripheral European country that produces paper and timber into a nation with per capita IT production and use ranking among the highest in the world (Lyytinen and Goodman 1999). Finland suffered an economic crisis in the early 1990's but returned back to the positive growth track due to the fast growth in information and communication technologies based industries. Also a significant part of this positive development is due to the success of Finnish telecommunications company Nokia, which became in the 1990's one of the world's leading mobile phone suppliers. (Lemola 2001)

Researchers indicate that Finnish software product industry is booming and becoming an increasingly important part of the national economy (Elomaa 2002). This rapid growth of the industry is mainly due to the increase in venture capital investments, especially start-up investments. The number of software product companies has grown rapidly from 450 in 1999 to 700 in 2001. Actually, the growing number of science and technology centres around Finland has played an important role in supporting the development of software product

companies. These centres offer programmers and services support, and enable companies to work in closer co-operation with each other. (Elomaa 2002)

The globalization of software product development is an important issue also for Finnish software companies that already compete highly in their own domestic markets. This strong competition faced by companies in domestic markets increases the importance of developing software in a globally distributed environment (Nahar, Käkölä and Huda 2002b). Research shows that Finnish software production has also potential in the global markets and hence it should enter and try to compete in this field. This could easily lead to competitive advantage for Finnish software development and help to maintain their strengths (Autere, Lamberg and Tarjanne 1999; Greenson, Jacobsen and Paulin 2001).

To describe Finnish software markets, it can be mentioned that it is a small open economy with limited domestic markets and small-firm bases (Bell 1995). Finnish software market in its domestic environment is truly small and the competition has become very intense. Finnish companies are suffering from higher development costs and constant high competition. Going international is an important issue for software product development, because Finnish market is so small that companies need to expand their activities to abroad (Elomaa 2002). Companies usually begin their export activities through direct sales to Sweden, the Baltic countries, Germany and the US (Elomaa 2002). However, internationalization of Finnish software product development is still at very early stage and this is the greatest and most pressing challenge that the Finnish software product companies are facing at the moment. This is mainly due to the fact that high-tech entrepreneurship is a relatively young phenomenon in Finland and the Finnish companies do not have enough management teams, in particular in software product sector, which would have previous experience in managing the rapid international growth of a new venture. (Elomaa 2002)

How tempting the globalization of Finnish software product development may be, it also comes with great barriers that need to be dealt with. Research shows that many software projects fail due to various mistakes: people mistakes, process mistakes, product mistakes and technology mistakes (Nahar 2003). The risks faced in globally distributed software product development can be divided into three categories: project risks, technical risks and business risks (Nahar 2003). Researchers have also made several findings concerning the barriers in international software project management. These barriers include, for example, international distributed management, international project coordination, different time zones, different languages and cultures, problems in effective communication, different business strategies and different business regulations (Carmel 1999; Nahar et al. 2003; Nahar 2004b). Also other barriers can be recognized in globally distributed software development; for example, low quality of suppliers and sub-contractors, political instability and regulatory changes. The risk factors should be identified in order to create effective plans to reduce their impacts and reduce the risk of failure. (Marjanen 2003, 10; Nahar, Käkölä and Huda 2002b) It can also be mentioned that going abroad can be very difficult, especially for Finnish software companies that are small in size, because company needs a very focused product and to be very good at marketing at the same time (Elomaa 2002).

Despite the high importance of globally distributed software product development for Finnish companies, very limited research has only been conducted on general level barriers that Finnish companies face in the domestic markets. No research has yet been done on the barriers that Finnish companies face in the global development of software products. Therefore, this research has been undertaken to bridge this gap by studying the barriers in-depth that the Finnish companies face in globally distributed development of their software products for global markets and providing solutions to overcome the encountered barriers and enhance their efficiency.

1.2 Research problem and questions

This research has been undertaken due to the significance of barriers that Finnish companies face in the global software product development. Very limited literature exists that deals with the barriers that the Finnish companies are facing in the global development of software products and the previous literature mainly focuses on the challenges in a more general level. In fact, no empirical research has been done on the barriers that the Finnish companies face in globally distributed development of software products and providing solutions to overcome the encountered barriers.

The basic research question addressed in this study is: *what are the major barriers that the Finnish companies face in global software product development?*

In order to provide a comprehensive answer to the research question, the following sub-questions are formulated:

1. Which factors create barriers to Finnish companies in different phases of global software product development process and how?

2. Which measures should be taken to reduce the identified barriers in order to enhance the success of global software product development for Finnish companies?

These questions are answered by the following manner:

1. Analyzing cooperation and networks theory

2. Reviewing literature concerning software business, globalization of software production, IT environment of Finnish software production, Finnish software market environment, global software product development of Finnish companies and barriers in global software product development

3. Interviewing professionals in the field
4. Analyzing a case company
5. Validating the conceptual models through a case study

1.3 Major objectives of the study

These specific objectives have been created in order to undertake the research:

1. To investigate in-depth the global software product development of Finnish companies
2. To develop two conceptual models of global software product development
3. To identify the major barriers that Finnish companies face in each phase of the global software product development process
4. To provide solutions that reduce and prevent the identified barriers
5. To make a comparison with previous research findings of the literature and empirical data gathered by this research
6. To formulate possible future implications and propose research topics for future investigation

1.4 Motivations for the study

The main reason for undertaking this study is the growing importance of globally distributed software product development that is a constantly growing area of software business (Carmel 1999; Damian 2002). The barriers associated with different cultures and languages, distance and several other factors that

rise from the globally distributed software development make the issue interesting, relevant and useful for both practitioners and academies.

The fact is that the global competition is a major concern for Finnish software companies that already compete intensely in their own domestic market and it gives importance to the research question to be investigated. This strong competition faced in domestic market creates the importance of globalization of software companies (Nahar, Käkölä and Huda 2002a). Increasing need to compete globally in the software development market also brings up the question of encountered barriers in globally distributed software development. The possibility to investigate Finnish software product development gives motivation for this study and also the possibility to propose solutions for the barriers discovered is an interesting issue for me.

My personal interest of this issue began when participating lectures of software business program. The importance of global activities in software business and the global environment for software production became fascinating issues for me. To investigate virtual team interactions and global co-operation in general created motivation for me to conduct this study.

The purpose of this study is to investigate global software product development for Finnish companies and to identify the major barriers that exist in this field. Another important purpose of this study is to provide solutions for the identified barriers in order for Finnish software product development companies to reduce and overcome these identified barriers. This study deals with various important issues that can provide guidelines to Finnish software and other high-tech companies, and these guidelines can help companies to take pre-empted measures in order to avoid various encountered barriers.

This study does not only provide information of the barriers of global software production and the solutions for them, but it also provides useful insights to Finnish software markets and to Finnish software product development in

general. The results of this study will be useful for both companies that have already tapped into global software production markets or for those companies who are considering this possibility.

1.5 Scope of the research

The study will be conducted by following the next defined boundaries:

- The main focus of this research is to study the global software product development of Finnish companies
- This research deals with the barriers that the companies face in each phase of global software product development. The focus is not on the phases themselves and this is why, the phases are explained only briefly
- This study does not deal with customized global software development
- This study does not deal with software service firms that provide consultancy
- This study also does not investigate the barriers that Finnish software product development faces while the software development is confined in the Finnish domestic environment

1.6 Structure of the study

Chapter 1 presents the background of the study, formulates the research problem and questions, provides the major objectives of the study, highlights the motivation for conducting the study, describes the scope of the study, and also outlines the structure of the thesis.

Chapter 2 presents a great variety of issues concerning earlier literature focusing on the research problem formulated in this study. The main topics

covered in this chapter are the following: global software business, global software product development for Finnish companies, the major barriers that are faced by Finnish companies conducting in global software product development and solutions for the barriers. The literature concerning these topics are thoroughly investigated and evaluated and the main issues concerning these matters are explained in great detail.

In Chapter 3, two conceptual models of global software product development are developed and described. These models consist of five major issues:

- Software product
- Characteristics of globally distributed software product development project
- Software company
- Software production sites/countries in which the development teams operate, or country level factors of software producing companies
- Software markets where the customers are located and software is marketed

The conceptual models describe these major issues and their relations.

In Chapter 4, the research method used to conduct this study is presented. Research method applied in this study is a qualitative single case study method. This chapter consists of a description of the selected case study, the criteria for the selection of the case company used in this study, the procedures for collecting the data, and the technique for analyzing the data collected. In order to get the most reliable results, also the reliability and validity are taken into consideration.

In Chapter 5, the empirical data of the selected case company is presented. This chapter deals with the global software product development for Finnish companies, the global markets for Finnish software production, the major barriers in this development and the solutions for reduction and prevention of these barriers. The empirical results are thoroughly evaluated against the chosen background theories and also against the earlier research. The chapter concludes with in an overall summary that gathers all the key aspects dealt with the study.

Chapter 6 presents the findings and results of the whole study. The chapter also provides an evaluation of the findings, implications for Finnish software product development companies and also provides suggestions for future research.

2 LITERATURE REVIEW

The sub-sections of this literature review consist of several issues. Section 2.1 discusses relevant issues concerning information technology, software business, software industry and global software product development. Section 2.2 discusses the major barriers in global software product development, investigating the barriers associated with communication, distance and culture. The Finnish environment for global software product development and the Finnish software market environment are investigated in sections 2.3 and 2.4. Section 2.5 discusses the cooperation and networks theories and section 2.6 summarises the literature review.

2.1 Information technology

2.1.1 Definition of information technology

It can be stated that information technology is one of the most dynamic and frequently changing and evolving technologies.
The concept of information technology is complex and therefore in past research several unambiguous definitions have been made in order to define it. In this study the definition given by Nahar (2001, 42) is used. "Modern computing with multimedia capability, computing networks and communications technologies; their development, implementation and provision of technical support; and their application for data processing, storage, sharing, and transmission. All information may be in the same place, or different places, within the same time frame or different time frames. The major components of IT are hardware, software, and services".

Companies are increasingly utilizing information technology in their efforts to internationalize in order to maintain competitiveness in the marketplace (Nahar 2001).

2.1.2 Definition of software

Software is "A generic term for those components of a computer system that are intangible rather than physical. It is most commonly used to refer to the programs executed by a computer system as distinct from the physical hardware of that computer system, and to encompass both symbolic and executable forms for such programs" (Dictionary of Computing 1996).

Researchers indicate that software is a constantly growing industry that requires a relatively low capital investment. It is also an industry that various nations have identified to be an essential factor to their successful participation in the future global economy and world markets. (Barr and Tessler 1997)

2.1.3 Definition of software business

The basic division of software business is to divide it into three main categories: a) professional software service, b) enterprise solutions, and c) packaged mass-market software (Käkölä 2002; Nahar 2003).

Professional software services are usually highly customized products, expensive and developed in close contact with the actual customer. Building trust, focusing on one domain and in-depth knowledge of the customer are important features in professional software services. (Nahar 2003)

In enterprise solutions, the companies are developing enterprise solutions usually for business users and the products are not made in particular to one customer but can be adapted to meet specific needs. (Nahar 2003)

Packaged mass-market software is developed for both business and private users and they are designed for compatibility over several platforms in order to maximize the amount of software product users. Packaged mass-market products are user-distant and they are developed under great a deal of time-to-market pressure. (Hoch et al. 2000; Nahar 2003)

Research also indicates that intense marketing efforts and investments are needed in product business. Conducting global software business can be very expensive as a variety of highly specialized tasks need to be performed. (Nahar, 2003) It has also been indicated that software businesses tend to be challenging to manage (Nahar et al. 2003). Market share (installed base) is truly vital in product software business (Hoch et al. 2000). Software businesses in small locations have the tendency to spread their resources too thinly and success in the international markets typically requires a focused, product-based business model (Nahar et al. 2003).

2.1.4 Software industry

Software industry produces software and related services and it is one of the most important parts of information technology. The major segments of software industry are the following: a) standardized software products, b) customized software products/services, c) In-house software development, and d) embedded software. (Nahar 2003)

Software industry is a growing field, and one that requires relatively low capital investment. It is also an industry that a number of nations have identified as essential to their successful participation in the future global economy. (Barr and Tessler 1997)

The demand for the products of the information processing industry – hardware, software, and services- has shown considerable growth globally. The software industry in particular has been noticed to boom. (Fujii, Guerdat and Sullo 1991)

2.1.5 Global software industry

According to Nahar (2004a), "Global software industry refers to the worldwide software production activities such as designing, programming, testing,

maintenance, documentation, and selling of software products and related services".

The trend of global software industry is constantly growing and the main reason for this growth is that software development industry is itself changing. First, the supply and demand of software industry are growing. The demand for the products of the information processing industry, such as hardware, software and services has shown incredible growth and the software industry especially is booming (Fujii, Guerdat and Sullo 1991). Another industry driver is the shift from US dominance to a global market. Research shows that the market for software development will increase at a greater pace outside the US than within the US. The shift to global software industry is also occurring because of certain business arrangements. For example, strategic partnerships and joint ventures are these types of arrangements. Therefore, more global companies have chosen to synergize their diverse capital and human assets. (Karolak 2002, 2-10)

According to Bell (1995, 60) internationalization could be explained as following: "A firm's engagement in a specific foreign market develops according to an establishment chain, i.e. at the start no export activities are performed in the market, the export takes place via independent representatives, later through a sales subsidiary, and, eventually manufacturing may flow".

According to Carmel and Agarwal (2001), many countries are in the process of a radical push to send their key software processes offshore, and critical centers of software R&D are growing outside the traditional centers. Previous research also indicates that finally, the marketplace is responding to the increased demand for IT labor through the construction of new commercial mechanism.

2.1.6 Global software product

Software products can be seen as non-physical information products (Rajala et al. 2001). The division of software products can be the following: a) real time programs, b) scientific programs, c) administrative-business programs, d) embedded programs, e) personal programs and f) expert systems (Koskinen, Paakki and Sakkinen 2001).

Software products and services market can be divided into five major industry segments that consist of the following: a) professional software services, b) enterprise solutions, c) packaged mass-market software, d) Internet-based applications rented by Application Service Providers and e) embedded software including services. (Nahar et al. 2003)

Researchers also point out several success factors for the development of appropriate software products. These success factors include the following: a) building the right product portfolio, b) cannibalistic new product development, c) succeeding in partner networks, d) high customer involvement in product development and e) getting the customers to try the products. (Nahar et al. 2003)

2.1.7 Global software product development

Global software development can be considered as a phenomenon that refers to developing software in temporally and geographically distributed organizations, which creates solutions to meet business needs, community needs, human, moral and ethical needs (Damian 2002).

Different policies mentioned below can be pursued when developing products that are marketed in international markets (Nahar 2003):

1) National development = Product is developed individually for each national market

2) Domestic development = Product is developed for a specific national market and exported/produced elsewhere without changes

3) Sequential development = Product is being developed to fit one national market and modified to suit conditions of foreign market situation

4) Global development = A standardized product is being developed from the outset for world markets

Global software product development means the division of assets. This division of assets can be fuelled and driven by one or a combination of business relationships, software development phases, architectural considerations, relative knowledge and experience, staffing concerns, tools, investments and leadership skills. (Karolak 2002, 35) Global software development continues to be a phenomenon that is fuelled also by several other factors, such as access to vast and specialized pool of labour, reduction in developing costs, proximity to the actual customers and, of course, global presence (Carmel 1999; Damian, Lanubile and Oppenheimer 2003).

Global software developments are mostly done through international projects that involve stakeholders from different national and organizational cultures and time zones (Damian 2002). This diversity creates various barriers to global software product development. This study especially investigates the barriers that the Finnish companies are facing in their global software product development and proposes solutions to encountered barriers.

2.1.7.1 Why global software product development?

Carmel (1999, 3-11) explains six different factors behind the reasons for creating global software teams. The catalyst factors are reasons for starting the

utilization of global software teams. First of these six factors is specialized talent. The amount of software professionals can be very scarce and that is why, it is useful to obtain workforce also outside your own organization or country. The second catalyst factor (i.e. acquisitions) creates the possibility for software companies to fill in their gaps and expand their product families. Reduction in development costs is the third catalyst factor presented by Carmel (1999) and it refers to the low costs in the emerging countries. This allows more flexibility in development cycles and it also enhances meeting the customer demands better. Other catalyst factors are globalized presence that is provided through working across nations and the proximity to the customer provided by the dispersion of the business. This creates greater possibilities for collecting the needed requirements and also maintaining good customer relations. The catalyst factor of reduction in time-to-market means utilizing around the clock work to create competitive advantage.

Carmel (1999, 3-11) also presents the sustaining factors of global software teams. First of these is the development rigor that creates greater formalism and hence increases the quality of the products. Other sustaining factors are internal freshness due to new creativity and inspiration, distance from distractions and experience received from different countries. The last of the sustaining factors is professional cadre of software specialists that is created by combining the talent gathered from different countries.

2.1.7.2 Phases in the development process

According to Nahar et al. (2003), the development process of global software product (GSP) is evaluated against the eleven phases mentioned below.

Phase 1: Product concept creation

The product conceptualization team of the home country generates the preliminary product idea during this phase. This is done by consulting with the

board of advisors who are experts of the particular industry sector, by joining telecom conferences, trade shows, seminars, and also by communicating with present and future clients and partners.

Phase 2: Product concept evaluation

During the second phase of GSP development process, the product concept idea is sent from the home country to host country team. Resources and other relevant matters are discussed between vice president (VP) of product and technology development, and VP of operations and project manager at the site of the host country.

Phase 3: Requirements analysis

In GSP development process, the requirement analysis is done onshore. In standardized software development process, the user remains distant and is not involved in this phase. The documents for requirements are created by the project business analyst and the requirements are discussed internally with the VP of product and technology development, VP of operations, project manager, and other experts in order to get an in-depth and comprehensive view of the requirements.

Phase 4: Designing

During this phase, the high-level design is done onshore and detailed design is done offshore. In order to maximize the amount of users of global software products (i.e. mass market software), they are designed for compatibility over several platforms.

Phase 5: Coding

In GSP development process, coding is done offshore and the code developed is being reviewed by experienced software professionals on a continuous basis.

Phase 6: Testing

Also the testing phase is conducted offshore. This phase can consist of several different testing activities including, for example, user-interface testing.

Phase 7: Localization

In GSP development process, the standardized products, especially mass-market products, are localized to different languages. In order to develop software products for global markets, a two-step internationalization and localization process is followed. Internationalization is the process in which software is separated into two different components: a) a culture-independent and b) a culture-dependent component. The culture-independent component does not contain culture-sensitive elements and is called as the generic code. The culture-sensitive elements, such as, dialogue messages and error messages are translated/localized and stored in a message file.

Phase 8: Commercialization

Country specific marketing (i.e. pricing, promotion, and distribution) is performed for standardized products during the commercialization process.

Phase 9: Installation/implementation

Installation service is not provided for standardized software products (mass market). Installation service is provided for both standardized software product (enterprise solutions) and customized IS.

Phase 10: Post implementation

The post implementation phase (i.e. application support, training, and bug fixing services) is not done in standardized software product (mass market) development process. Due to high complexities of software, the post

implementation phase is conducted for both standardized software product (enterprise solutions) and customized IS.

Phase 11: Developing new versions

New releases of standardized products are developed on a continuous basis in software development process. New releases replace older ones and so called cannibalistic product creation is common for mass-market products.

2.1.7.3 Global software teams

Virtual teams are a relatively new phenomenon and they can be defined as temporary, culturally diverse, geographically dispersed, electronically communicating workgroups (Potter, Balthazard and Cooke 2000). These teams have an increasingly important role in organizational life and they offer the flexibility in order to maintain competitiveness (Pauleen and Yoong 2001). The virtual teams can interact and collaborate via groupware though separated by distance and time. This ability enhances the organizations increased flexibility and responsiveness, allowing them to rapidly form dispersed and disparate experts into a virtual team. However, managers and virtual team members typically have to deal with a number of issues that are related to working in this unit, including training and proficiency with the support technology, potential cultural and organizational differences and goal sharing. (Potter, Balthazard and Cooke 2000)

2.1.7.4 Global coordination

When measuring global software teams, focusing on the construct of coordination is needed, because it is at the root of effective functioning of a dispersed team. However, measuring coordination is complicated. Coordination indices need to take "snapshots" from different angles (different operationalizations) that together, form a picture of coordination. (Carmel 1999,

183) According to Carmel (1999, 184-185), the following indices and measures deal directly with issues of dispersed development:

Indices of collaborative technology use:

- Time using collaborative technologies.
- Quantity of sessions/messages using collaborative technologies.

Indices of meetings, face-to-face time, and travel:

- Amount of time per person for formal face-to-face meetings.
- Team-building index. Number of days that individuals of one site spend at other sites.
- Travel days.

Measures of hand off and transition efficiency:

- Delay. The number of times site work was delayed because of wait for dependent tasks from other sites.
- Gain. The number of times activities resulted in overnight gain.
- Blocking counts. A block occurs when one site or individual compensates for time loss on one task by working on another one.

Measures and indices of issue management:

- Issues rose. An issue is a problem of some kind.
- Number of open issues.
- Issue closure index.

Measures of costs those are significant to global teams:

- Cost of telecommunications infrastructure.
- Cost of travel.
- Cost of labor.

Effective utilization of cross-border IT-support allows organizations to coordinate their business, R&D and production in distant locations between the parent company and its subsidiaries and offer competitive advantage in a global market place (Nahar 2003).

2.1.7.5 Global project management

Global software development projects include stakeholders from different national and organizational time zones and cultures. By stakeholders, it is referred to individuals, groups or organizations that are involved or affected by a business action. The diverse factors create specific challenges to the software development process and management. (Damian 2002) When a team is dispersed, the whole team must be tasked and coordinated via formal mechanisms which are called *project management techniques*. The six fundamental project management techniques are the following: creating a statement of work; using consistent techniques for estimating costs and task times; using consistent techniques for task decomposition and building a work breakdown structure; creating a project timeline of tasks taking into account task dependencies and critical path; creating a project budget; and conducting proper risk management. It is also recommended that the project manager and team leaders agree verbally, during face-to-face planning meetings, to project milestones and deliverables that are created as output from the project management software package. (Carmel 1999, 181-182)

According to Jurison (1995, 241), "Risk, defined most generally, refers to the chance or probability that some unfavourable event or outcome will occur. Risk is broadly defined to include uncertainty and the results of uncertainty because this definition appears to reflect the way managers consider risk in decisions regarding cost and benefit issues". Although, risk is often considered to have a negative impact, it can also bear an upside-potential that reflects the positive impact of events (Bhattacharya, Behara and Gundersen 2003). Risks that affect project work can be, for example, technical risks that have effect on programs and platforms.

First of all, risk management involves identifying risks of all kinds and evaluating each of them. Then, all risks should be prioritized and the project manager typically focuses attention, daily, on the "top 10 most important risks." Each risk has to be actively mitigated, prevented, or even eliminated. All in all, risk management is a process that needs continuous management attention. (Carmel 1999, 181-182)

2.1.7.6 Global training

The training provided at remote sites can be considered important for the success of IT project implementation (Hersleb and Mockus 2001). According to Nahar (2003; 2004a), the increase of the development of IT based training tools and powerful computers and computer networks, various training tools have become more beneficial and also the usage of them has become easier. Interactive multimedia training with multimedia Extranet, video conferencing, computer-based simulation software, DVD and CD make the training more efficient, reduce the need for face-to-face contacts, increase training capacity and enable synchronous training (Nahar 2001).

2.1.7.7 Global know-how sharing and know-how management

The knowledge sharing between the parties conducting globally distributed software development is seen as one of the major objectives of the partnership. It must be noticed that knowledge sharing between different organizations is not easy. Research shows that knowledge sharing is based on organizational context, and thus that knowledge cannot easily be transferred among organizations with different structures, goals and cultural backgrounds. (Lee 2001)

Knowledge management is the process of capturing, storing, sharing and utilizing knowledge. The major issue in knowledge management is how to change individual knowledge into organizational knowledge, since organizational knowledge is inherently created and stays with individuals. (Lee 2001) Information sharing about corporate and subsidiary strategies, new products, product development strategies, competitors and customer needs, etc. is essential in global business environment (Nahar 2001).

Managing knowledge as an asset is considered to be difficult and the hardest task is to try to manage the knowledge that employees carry in their brains. Previous research indicates that in the future companies will concentrate on managing people rather than managing physical assets (Cairncross 2002).

Internet technologies also provide new opportunities for companies in order to manage people and their knowledge which can be considered as a huge competitive advantage (Cairncross 2002). However, the communication revolution presents new opportunities for managing people and, at the same time it also presents some new challenges. For example, Internet technologies help to spread and share knowledge. They also allow ideas to move easily beyond a company, creating a need for protection. A balance between openness and protection is needed. (Cairncross 2002)

2.2 The major barriers in global software product development

The global aspect in software product development brings in the issues of distance, culture, language and time-zone differences. Without having in-depth understanding of these barriers, the development of software products and the business itself can very easily become threatened. Global software product development involves constant teamwork among people from different cultures and places, and the importance of effective communication and collaboration becomes noticeable. (Carmel 1999, 3-4)

2.2.1 Barriers concerning communication

2.2.1.1 Loss of communication richness

Potentially, the largest source of problems in global software product development is issues related to communication across sites (Hersleb and Mockus 2001; Damian 2002). When working environment becomes global, the amount of different communication channels diminishes. The lack of face-to-face meetings and the great use of electronic channels make the communication different from the one that happens in the co-located working environments. (Carmel and Agarwal 2001) The communication is mainly conducted via electronic channels that may cause a great deal of misunderstandings, mainly due to the lack of the actual physical contact, including face-to-face and non-verbal communication (Pauleen and Yoong 2001). Despite today's asynchronous technologies for dispersed work – e-mail, voice mail, online discussion groups, project management tools and Software Configuration Management -there are still powerful reasons for synchronous communications. (Carmel 1999; Carmel, and Agarwal 2001)

When working in an environment that demands a great deal of communication from people, also richer medias are preferred. Any task that demands intense

cooperation requires rich communication. When considering the challenging environment of software development, also the tasks are demanding. The lack of rich communication channels (i.e. two-way interaction involving more than one sensory channel) (Carmel 1999, 48), can create frustration in conducting any kind of communication and also diminish the motivation directed to the work itself. An actual problem that has to be tackled with is the initiating of conversation. When distance becomes huge and channels for conducting communication diminish, also the frustration and the anticipation in the working environment grow. People also need unplanned communication and informal contact with other workers (Damian, Lanubile and Oppenheimer 2003). Research also indicates that without the rich source of information cues, team members are vulnerable to cascading misunderstandings and miscommunications that can derail project efforts (Dodson 2001).

2.2.1.2 Lack of informal communication

All in all, team members must communicate whenever necessary in order to make the team work efficient (Ebert and De Neve 2001). The importance of informal communication can not be too stressed. The lack of informal communication and knowledge about the local working context is the one distinguishing factor of distributed groups. (Damian 2002; Hersleb et al. 2001; Pauleen and Yoong 2001) It should not be so that the distributed teams only build relationships through electronic media and in that way not being able to know each other properly. Building relationships require test and negotiate expectations and traditionally, face-to-face communication emerges as a critical factor at this point by the ability to easily share emotional bonding, values, principles and work practices (Pauleen and Yoong 2001). This is why, distributed software development teams easily face difficulties in establishing trust and respect for each other, as well as in achieving an understanding of work practices across distributed locations. When considering the

aforementioned challenges, the obvious need for informal conversation becomes noticeable. (Damian 2002) When different cultures come together, also the lack of trust and willingness to communicate openly become a huge problem (Damien, Lanubile and Oppenheimer 2003).

2.2.1.3 Barriers concerning electronic communication channels

E-mail as a communication channel has become extremely popular (Pauleen and Yoong 2001). The advantages of e-mail include the ability to explain the details of requirement, and to provide a written record and history of issues related to requirements, together with an increased communication ability for non-fluent English speakers, particularly the customers. However, it also allows to covert communication which leads to challenges in managing conflicts. E-mail can also be found weak in managing ambiguous information, mainly due to its lack of interactivity. E-mail also provides no indication of when the electronic answer will be returned. (Damian, Lanubile and Oppenheimer 2003) The written word can not convey the full meaning of what has been said, for example, to the disagreement and the range of emotions. (Dodson 2001)

Another electronic media that cause barriers in communication are conference calls that make the communication particularly difficult for speakers who speak English as a second language (ESL). (Dodson 2001)

Even though some communication channels remain for the use of globally distributed software teams, the effectiveness of communication is not guaranteed (Hersleb and Mockus 2001; Pauleen and Yoong 2001). People might be willing to use the communication channels, but they actually do not know how to use them efficiently or even the right way. For example, different groupware application platform, like Lotus Notes, can offer a great place for communicating and sharing information. However, the lack of adequate training and supervision of use may destroy the possibilities that groupware

could offer. Also hostile attitude towards different electronic communication channels could easily lead to the same result.

2.2.2 Barriers concerning distance

2.2.2.1 Physical distance and the development speed

Physical distance is unavoidable when working in globally dispersed teams. It becomes nearly impossible to gather the entire team together at the same time and that has an effect on the quality of communication. (Battin et al. 2001) Also the factors of development speed and delay must be taken into account.

Speed is often considered to be perhaps the most important success factor in modern high technology business. The research concerning the work of physically dispersed teams suggests that the multi-site development may also increase the development cycle time (Hersleb and Mockus 2001). It is interesting to investigate the extent of this delay in multi-site software development organization, and also explore several possible reasons for this delay. The term delay is understood as the additional time that it takes to resolve an issue when more than one site is involved in the matter. It is essential to notice that cross-site work demands a much longer time-period and it also requires more people for work with equal size and complexity. A strong relationship between delay in cross-site work and the degree to which remote colleagues are perceived to help out when workloads become heavy is also noticeable. Research done previously also suggests that multi-site communication and coordination challenges can easily cause a substantial loss of development speed. This is why, the relationships among delay, communication, coordination, and geographic distribution of work should be thoroughly investigated and their affects to delay time should be discovered. (Hersleb and Mockus 2001; Hersleb et al. 2001)

The research by Hersleb and Mockus (2001) indicates that the dropdown of communication that happens when teams no longer are co-located affects the speed of software development. Therefore, the organizations with rapidly changing environments and "unstable" projects, demand quite high degree of informal conversation, particularly lateral communication across sites. The most frequent consequence of this lack of communication and distance is the delay in the resolution of work issues. The issues concerning work tasks, times, partners and managers can become unclear when distance becomes an important factor. Particularly, these delays in resolving work issues can slow the development process considerably. (Hersleb and Mockus 2001)

According to Hersleb e al. (2001), the reasons for that the cross-site work includes more delays than the same-site work seams to be due to the multi-site communication, coordination and/or social networks that may differ from their single-site counterparts in a way that requires more people to participate, thereby introducing the delays. Several differences among the forms of communication are noticed, including the size of communication network, the difficulty of finding people, the reduced likelihood of getting timely information, the clarity of plans and the reduced likelihood of receiving help with heavy workloads. Lower level employees not receiving adequate help with heavy workloads has the greatest effect on the length of the delays. (Hersleb et al. 2001)

2.2.2.2 Time zone disparity

Time zone differences can be considered as a benefit for the software development, because of the around the clock work that is made possible, but it can also be considered as a possible challenge (Palvia 1996). The time zone differences can prevent people from concurrent communication that can be conducted vie electronic channels. That means that the possibility of utilizing electronic conference meetings and groupware application become useless.

People can receive the messages too late and the effective use of information flow can be destroyed. (Damian 2002)

2.2.2.3 Coordination breakdown

Communication and coordination processes are the aspects that are mostly affected by geographical distance (Damian 2002; Carmel and Agarwal 2001).

Coordination breakdown can easily become an issue in globally dispersed software product development when the management of teams and differences between technologies occur. New technologies can create problems in the working environment and when the new team structure is also added to the situation, the problem of coordination loss becomes even bigger. It is no longer possible to have face-to-face meetings when needed and things can remain unclear for a longer period of time. Carmel (1999, 45) also emphasizes the distance from the management level can create confusions in the given work tasks.

People also can get confused when the contact persons concerning different issues, for example, management issues, are not known. When working in different locations, the coordination of experts of different tasks can easily get confusing (Damian, Lanubile and Oppenheimer 2003).

In global teams, the workforce is collected from different sites of business. When utilizing workforce outside your own country and organization, also the quality and level of domain expertise can vary (Battin and Crocker 2001).

Teams that work within globally distributed software development demand coordination around the clock with close attention paid to the personal, professional and culture demands of the individual team members. This effort naturally requires also features from the project leader who has to be sensitive

to the values of other cultures, technologically savvy and own excellent negotiation skills. (Dodson 2001)

2.2.2.4 Geographical dispersion and the loss of "teamness"

Co-located teams have the advantage of shorter communication lines and the ability to give feedback whenever necessary. These factors result to ability to create shorter project time-lines, because the coordination of projects is more efficient. Carmel (1999, 41-43) also describes about the fewer management resources and less organizational support that global software teams easily receive. Being away from other group members creates also the possibility of miscommunication and lack of trust. People, who can not get to know each other properly, also create certain assumptions of each other. These assumptions can easily turn out to be false.

Dodson (2001) stresses three challenges in his article that are created due to geographical dispersion. First of these is the isolation from the events of other team members and from the centre of decision making. The second challenge is the sense of personal isolation that is caused by working in a foreign country that is not familiar for the worker. The third challenge is the fractures in team relationships that occur when team members do not respect the cultural differences between one another.

Carmel (1999, 54-55) also points out the possibility of oversized teams that are likely to take place in globally distributed software development.

The geographical distribution also represents a significant barrier to interactions between development and systems users, affecting the developers' involvement in gathering, analysis, prototyping and the validation of the requirements.

Carmel (1999, 52-54) also presents the problem of lost cohesion and lost trust. Cohesion is being prevented when people are not able to create bonds between

each other. Reasons for the lost cohesion are misunderstandings in communication, alertness when working with different cultures and also the differences between linguistic and cultural messages. Building trust also becomes an issue. It is hard to trust other people when meetings are done infrequently and communication is conducted mainly asynchronously. The loss of the sense of a team becomes noticeable. Carmel (1999, 54) also emphasizes on the problem of the team creation stages that also global teams should follow. The stages of forming, storming, norming and performing can be hard to obtain when locations are different. Formation of teams can happen easily when decisions are made in upper level, but the storming phase, meaning the roles, objectives and task allocations, need more time and continuous communication. Also the norming-stage of creating norms, roles and protocols can be hard when working in multi-cultural teams. While the team is performing, the common goals and possible conflicts must be taken care of.

2.2.2.5 Technological barriers

Issues of appropriateness of tools and technologies for global collaboration, and the processes and methodologies for distributed software development are important factors. A clear need for tools and methodologies that appoint to the issues of information and knowledge management, clear identification of roles, accountabilities and authorities, and relationships based on common processes is recognizable. These factors are important, particularly in the early stages of development, when distributed teams are more frequently involved with each other. (Damian 2002)

The need for devising the requirements engineering processes that define stakeholders' roles and responsibilities in requirements communication and development in distributed structures must be identified (Damian and Zowghi 2003). It should also be noticed that the more recent development methodologies such as agile methodologies create additional challenges to

globally distributed software development. Other challenges are posed by physical separation, the concept of pair programming, as well as establishing personal and working relationships. (Damian 2002) It is noticed that computer technologies create opportunities for disseminating information to big audiences and recording information. These benefits however come with barriers. A plethora of information in the form of priorities, strategies, key decisions, critical risks, currently projects and web sites can be available on intranet that links the different sites. Difficulties exist in linking these separate pieces of information together and identifying relationships between different people's work. The balance in capturing information and providing it in a meaningful way is the greatest challenge. The information should also be addressed in a way that gives easy access and reduces the overhead. (Damian 2002)

In global working environment, the architectures being used might not be familiar to all of the members of the team. This creates the need for additional education that may be extremely hard to organize within different countries and even continents. (Battin et al. 2001)

A problem can also be caused by the unsuitable architectures. For example, the features of the systems being used may not be compatible or adoptable for globally managed working environment. (Damian, Lanubile and Oppenheimer 2003)

Global software development is usually divided into a large number of independent teams that have their own parts of the product under manufacture. The various teams located in various places make it difficult to coordinate the modules and parts manufactured, and this also increases the effort required to integrate the parts. This could lead to multiple levels of integration like shared-library, subsystem, cluster and system levels (Battin et al. 2001). Software Configuration Management is itself a very demanding field

of software development and it becomes even more challenging if it is conducted in globally distributed project. This means the problems caused by multiple versions of modules and parts used in multiple builds by multiple developers. (Battin et al. 2001)

2.2.2.6 Development process related barriers

The software development process can easily become a challenge when different organizations and working places follow different processes. It becomes hard to coordinate each unique set of named deliverables with an expected content.

At this point, it is important to rise up the question of requirements engineering and see how the global distribution affects this important phase of the development. This phase of the development is emphasized, because it is the phase that has most impacts on the success of software development. The challenges that this phase encounters have serious effects also in the next phases of software development. (Hersleb and Mockus 2001; Damian and Zowghi 2003)

Remote communication and knowledge management, cultural diversity and time differences negatively affect the requirements gathering, negotiations and specification. It should be emphasized how the major problems in communication and coordination are extremely important and they should be considered as activities that are critical during the early phases of strategic planning, requirements gathering, analysis and negotiation. (Damian and Zowghi 2003)

The lack of common understanding of requirements, together with a reduced awareness of working local context, the level of trust and the ability to share work artefacts challenge the collaboration of remote stakeholders when the negotiation of the requirements is taking place. Global organizations face the

challenges in enabling effective communication between headquarters and remote development sites. The distance may also create fundamental problems such as poor communication among stakeholders, as well as problems due to factors of political, organizational and social nature. The knowledge management is also a challenge that is related to the requirements engineering. It often happens that the great amount of information gathered through the requirements analysis from multiple sources at remote customer sites is not appropriately shared with the teams. (Damian 2003)

In order to take a look at the risks in whole software development, the term of global Software Development Lifecycle (SDLC) comes into question. The global SDLC includes three phases: 1) design that incorporates internationalization and localization, 2) implementation, and 3) usability evaluation. Barriers in these phases are that guidelines and factors provided are too general and not specific enough considering the variations of cultures. Issues relating to deeper levels of culture are omitted. In addition to these problems mentioned, the lack of knowledge casts doubts on the efficacy of the global SDLC. (Yeo 2001)

2.2.3 Barriers concerning culture

2.2.3.1 What is culture?

Carmel (1999, 58) gives a definition for the term culture.

> [Culture] provides members with images of their basic concerns, principles, ethics, and bodies of manners, rituals, ideologies, strategies, and tactics of self-survival including certain notions of good deeds and bad, various forms of folklore and legends… The way we give logic to the world begins at birth with the gestures, words, tone of voice, noises, colours, smells, and body contact we experience…Our culture is what is familiar, recognizable, habitual.

Some cultures are situated within national boundary while other cultures, for example, Arab or Latin cultures cross the boundaries. Some nations may also

have strong internal cultural differences such as India which has 14 official languages and hundreds of dialects.

Culture is something that we are usually unconsciously part of and something that is hard to define. Culture as a term is very wide and it covers more or less everything. Culture exists on various levels: everyday objects, arts and artefacts, norms and values and basic assumptions. The first level of everyday objects is the one everyone can see and appreciate and this level is easier to identify. Second level is harder to get at because it includes the norms and values that underlie the behaviour in any culture. For example, some cultures value individualism while other cultures value group harmony. The third level, basic assumptions, is completely hidden and that is why it is, problematic to deal with. Questioning these basic assumptions can often lead to conflicts between people from different cultures. (Bartlett and Davidsson 2003, 15)

Culture has different levels and forms of presenting itself. First of these levels is the organizational culture that is more commonly known as the *corporate culture* (Carmel and Agarwal 2001). Research shows that cultural differences have greater effect among foreign employees working within a multinational corporation. However, organizational culture may be strong for the group but weak for the individuals. Organizational culture is influenced by whole range of things: nationality, geographical location, government regulation, industry, founders, strong leaders, administrative heritage, and stages of development and nature of the product. (Bartlett and Davidsson 2003, 65) National culture, on the other hand, encompasses an ethnic group's norms, values and spoken language, often delineated by political boundaries of the nation (Carmel and Agarwal 2001). Another cultural level is *professional culture* that different professions, for example, programmers have. This form of culture is strong because a person chooses one's profession for life and also because professional cultures cross over national culture. *Functional cultures* can also be found within organizations. A functional culture is created through the norms and habits that

are associated with functional roles within organization, for example, marketing and sales. Finally, also teams create their own *team culture* which emerges from bonding through common work experiences. All in all, it should be noticed that each individual is a member of multiple cultures: one or more national/ethnic cultures; one or more professional cultures; perhaps a functional culture; perhaps a corporate culture; and perhaps a team culture. (Carmel 1999, 59-61)

Culture and cultural differences are often sensitive topics for discussions. When people deal with cultural differences, also some negative terms, for example, stereotyping comes into the picture. Prejudice is a key concern in this field. The worst teams and team leaders are the ones that deny having any stereotypes and those who strictly rely on the stereotypes. We should not consider different cultures or cultural features as stereotypes, but as an "archetype" or "mental file". The most effective teams are those that use these cultural mental files as starting points and keep on updating them constantly with new information. (Bartlett and Davidsson 2003, 65)

2.2.3.2 Key cultural dimensions

Managing different cultures can be a hard task for organizations, because it can not be conducted without serious effort. It can only be achieved by an awareness and knowledge of the fundamentals of cultural differences. Looking at different cultural dimensions gives a good overview of general cultural differences that affect the globally distributed software development.

Hofstede's dimensions of national culture present five factors that affect the work in global environment: revering hierarchy, individualism/collectivism, taking care of business, risk avoidance and long term orientation. The first of these dimensions, *revering hierarchy*, refers to the relationships between superiors and subordinates. In some cultures, large gaps can be found between

levels of organizational hierarchy while other cultures do not revere hierarchy as much. This can cause problems among the team members and managers when people are used to different organizational hierarchies. The second dimension is *individualism versus collectivism* and it refers to the extent to which person sees himself as an individual rather than part of a group. Individualistic persons are more concerned with the personal achievements, with individual rights and with independence. In collectivist cultures, the groups' goals and the group membership become more important factors. This can cause trouble among the team and disrupt the team harmony. *Taking care of business*, the third of Hofstede's dimensions, refers to the toughness versus the softer values. There are great differences between countries in how they see the business. For example, taking care of business ranks highest in Japan, while the softer values, like relationships in work place, are more important in Scandinavian countries. The *risk avoidance* as the fourth level has to do with people's attitudes towards risks, ambiguous behaviour, predictability and control. Some cultures may be more willing to take risks while others look for more secure attitude towards work. The fifth dimension, *long term orientation*, refers to the way people consider the future. Some cultures look more far away to the future than others and this may cause confusion when creating common goals and visions for the teams. (Hofstede 1994 cf. Carmel 1999, 63-68)

Hofstede, after concentrating on national culture, also dealt with six dimensions along which organizations differ. The first dimension is the *Process-oriented versus task-oriented* where the different lies in the fact that process-oriented organizations focus on technical and bureaucratical issues while task oriented ones focus on outcomes. The second dimension makes the difference between *job-oriented* organizations that view employees just another resource versus *employee-oriented* which take a much wider responsibility of their employees' well-being. In the dimension of *professional versus parochial* the difference is that in professional cultures people who can do their jobs are valued and whereas

parochial culture outsiders are not trusted. In the fourth dimension, *open systems* communicate freely both internationally and externally while *closed systems* do not welcome newcomers that easily. In the fifth dimension, the *tightly controlled* cultures are more formal and *loosely controlled* cultures are more flexible. The sixth dimension of organizational cultures presents the *pragmatic versus normative*. The pragmatic companies have more flexible ways of dealing with the environment while normative ones do not. (Hofstede 1994 cf. Bartlett and Davidsson 2003, 79-80)

The way people use language and communicate can also be formed into dimensions: *High-context versus Low-context communication*. These dimensions present the ways people communicate, how they see the language. The communication in high-context cultures is emotional and implicit and in the low-context cultures neutral and explicit. This can cause problems between team members and the ways they conduct the communication. (Carmel 1999, 70-71)

A distinction can also be made between *universalist cultures* and *particularistic cultures*. Universalistic people see the achieved rules as common rules that everyone must follow in every situation. Particularistic people see situations as made up of particular persons, unique relationships and special circumstances. It has been recognized that low-context cultures, such as the United States, were rated highest in universalism, while high-context countries, such as the Latins, rated higher in particularism. (Carmel 1999, 70-71)

2.2.3.3 Governmental issues

In different countries and cultures, also vary the governmental issues and policies. This refers to the procedures and legislations that are created and used in different countries. The problem is making the different governmental issues compatible with each other in global software development. The problems with

immigration work laws, visas, import and export rules and regulations and also the inadequate support received from government become challenges. (Battin et al. 2001) It is also difficult to understand different country's import and export rules and regulations and procedures (Battin et al. 2001).

Other factors that affect the global software development are nation's physical and financial infrastructures, its piracy rates and governmental policies. Government-created technology policies are difficult to keep up-to-date mainly because of the mismatch between the rapid rate of technology change and the more deliberate pace of government bureaucracy. Also the inadequate telecommunications infrastructure may have a serious impact on the collaboration between countries. The problem with inadequate governmental programs can cause barriers. Governmental organizations and execution can prevent the industry from keeping up with the rapid rate of changes in hardware and software technologies, as well as with market demands. Other counter-productive government policies that prevent the effective utilization of global teams include protective tariffs and import restrictions. Also the censorship, especially restrictions on Internet access, is shaping up as the key counter-productive government policy. (Barr and Tessler 1997) Also for software publishers, piracy is a major issue. (Bartlett and Davidsson 2003) These factors should be most thoroughly investigated when the question is about development and emerging countries.

2.2.3.4 Cultural diversity in business

Diversity in group members' culture, including ethical, functional or organizational differences, can easily bring challenges into globally distributed software development. When conducting global software development, teams are involved in strategic decision making, defining requirements, creating designs, sharing code and testing software in distributed project environment. However, creating a synergy that normally exists in co-located teams based on

common goals is extremely hard to establish in distributed teams. (Damian 2002) Research indicates that it is least problematic to build IT and R&D work teams domestically and inside the firm. At the other extreme, cultural distance is naturally greatest when a foreign outsourcing or contracting company performs the work. (Carmel and Agarwal 2001)

Also the diversity in customer culture and business creates challenges for globally distributed software development. Firstly, the customers' language is an important factor that has a direct impact on activities such as requirements engineering process, since language barriers affect the transfer of knowledge of requirements to personnel and developers. Additional challenges rise at several levels of business: market trends that may differ by market segment; differences in national culture often lead to information being meaningful only in the context of certain cultural beliefs and values. (Bartlett and Davidsson 2003)

Communicating in international environment may cause problems. Language is one of the most obvious elements of culture and this is why, it is a central aspect in intercultural communication. In an environment where people have different mother-tongues and where some languages become the dominant ones it is often difficult to avoid situations of dominance and the resulting frustration experienced by people who are not able to use the chosen languages for interpersonal communication fluently. English is often an issue since it is most commonly used in international business. However, using English as the main language can cause challenges. Some of the difficulties that may rise from the use of English as the common language are speed, articulation, accent, repetition, confirmation and idiomatic expressions. All these factors can have different forms in different countries and that is why they can cause confusion and misunderstandings between people with different cultural backgrounds. (Bartlett and Davidsson 2003, 59-63)

Many sources of potential communication problems may appear in diverse teams. High misunderstanding, high exclusion of others from the discussions, high divergence from other's communication patterns, suppression of divergent opinions and general negative evaluations are clear sources of communication problems. Communication styles, language problems, body language and the actual meaning that is behind the words vary in different cultures. People often evaluate unknown things negatively and this can cause serious damage for teams that is consisted of different cultures. (Bartlett and Davidsson 2003, 109-110)

According to Carmel and Agarwal (2001), building and maintaining a culture that stresses values and beliefs associated with entrepreneurship, organizational learning and innovativeness leads to increased performance within specific organizational functions such as global sourcing as well as the increased overall business performance.

2.3 The Finnish environment for global software product development

2.3.1 Description of Finland

The key facts concerning Finland are presented in TABLE 1.

TABLE 1 Key facts: Republic of Finland (Ratnathicam 2002)

Key facts	
Population	5,176,00
Rural population (% of total population) 1999	33.28%

GDP per capita (PPP)	US$24,864
Global Competitiveness Index Ranking, 2001-2002	1
UNDP Human Development Index Ranking, 2001 (adjusted to GITR sample)	10
Main telephone lines per 100 inhabitants	54.69
Telephone faults per 100 main telephone lines	8.40
Internet hosts per 10,000 inhabitants	1022.53
Personal computers per 100 inhabitants	39.61
Piracy rate	29.00%
Per cent of PCs connected to Internet	25.82%
Internet users per host	3.64
Internet users per 100 inhabitants	37.23
Cell phone subscribers per 100 inhabitants	72.64
Average monthly cost for 20 hours of Internet access	US$7.26

Finland's strengths are its well-developed information infrastructure, high quality workforce, efficient policy environment, and the well-developed usage of ICTs. The high development level of information infrastructure in Finland is partly due to the fact that Finland had been obliged to connect its geographically dispersed population. Finland is also a leader in e-commerce (Ranking in e-Commerce micro-index: 2nd). (Ratnathicam 2002)

2.3.2 The economic environment of Finland

The Finnish economy has grown as it changed its industrial base significantly and became a leader in wireless communications. Studies in regional economics show that proximity to university is often associated with recent growth of

high-tech industries in these regions. Technical universities in Finland, mainly the Helsinki University of Technology and the Technical University in Tampere contributed to the growth of the mobile communications industry. (Chakrabarti and Lester 2002) It is noticed that the Finnish educational system all in all has actively promoted IT skills. Also the research activity in IT has been steadily growing and it has achieved world-class results in neural computing, computational theories, cryptography, digital signal processing, programming languages and compilers, telecommunication protocols, databases, operating systems, and software engineering. (Lyytinen and Goodman 1999)

The Finnish R&D system changed when the Technology Center of Finland (TEKES) was established in 1983. TEKES has played an important role in fostering industry-oriented R&D. (Lyytinen, and Goodman 1999) Investments in R&D and education, and other policy instruments have gradually created conditions for favourable structural modifications in the Finnish economy and industry, and paved the way to the growth and success of Nokia and other Finnish high-tech companies (Lemola 2001).

It has been stated that Finnish SMEs are very active in the field of development and utilization of innovations. It is considered to be promising that large amount of Finnish companies are able to finance new product development by internal funds. (Lehtimäki 1991)

2.4 The Finnish software market environment

2.4.1 Software market in Finland

To describe Finnish software markets, it can be said that it is a small open economy with limited domestic market and small-firm bases (Bell 1995). Finnish software market in its domestic environment is truly small and the competition has become very intense. Finnish companies are suffering from

higher development costs and constant high competition. Due to the size of domestic markets and business, the window of opportunity is open for only a short period of time, thus small companies need to exploit their new ideas quickly. In small economies, such as Finland, the domestic market will be saturated quickly, which forces the companies to target small global segments, e.g., ecological niches already at an early stage (Uusitalo 1999). This is why, the possibility of globalization of the software product development had become a necessity.

2.5 Cooperation and networks theories

When conducting globally distributed software product development, the cooperation of different organizations becomes an important issue. Very close cooperation happens between the software development teams and other stakeholders. This appropriately introduces the concepts of cooperation and relationship theories.

According to cooperation theory, developed by Axelrod and others (Axelrod 1984; Axelrod and Keohane 1986; Axelrod and Doug 1988), cooperation among individuals, companies, or nations depends greatly on the existence of sufficiently long future rewards of all actors. According to network theory, an inter-organizational network is a number of connected business relationships between companies (Bradach and Eccles 1989; Cooke and Morgan 1993; Easton 1992; Jarillo 1988; Johanson and Mattson 1987; Lorenz 1988, 1992; Powell 1987, 1990, 1996; Powell and DiMaggio 1991; Powell and Brantley 1992; Richardson 1972; Thorelli 1986). Inter-organizational network means the external cooperation as opposed to intra-organizational cooperation. According to Ford, Håkansson and Johansson (1986), basically every organization conducts business in business networks. Researchers (Al-Obaidi 1999; Grosse 1996) have used cooperation and network theories often in organizational studies. Network can also be prescribed as a web of relationships that include actors,

activities and resources (Håkansson and Johanson 1992). The network is also defined as a model or metaphor linking, sometimes a large number of entities (Easton 1992). According to Easton (1992), relationships in business networks are comprised of four elements: a) mutual orientation between companies, b) a dependence on one another, c) links of various types (economic, social, technological, informational, and legal), and d) the investments each makes in the report/ratio.

Companies have been strongly affected by the globalization and intense competition in software markets. New approaches and possibility to survive have been enhanced for small and medium sized enterprises (SMEs) by inter-organizational cooperation and networking. The advance in communication technology has made it easier for companies to communicate efficiently and form strategic alliances and partner networks. (Huhtinen and Virolainen 1998)

SMEs can form partnering network and collaborate due to the evolved IT capabilities. Larger companies can also utilize networking in their business by, for example, moving non-crucial tasks to other firms and gain resources that way. (Vahtera 2002)

This study deals with the major barriers in global software product development for Finnish companies. This issue is influenced by a great deal of cooperation, relationships and networks.

2.5.1 Defining networking key concepts

Actors

Network contains different actors – e.g. individuals, parts of companies, whole companies, and groups of companies. These actors determine what activities are performed in the network, how and by whom. Developing relationships is

also an important part of actors collaborating in the network environment. (Håkansson and Johanson 1992)

Activities

The actions are developed through exchange processes between different actors. The processes are activities between actors and they take place when one or several organizations combine, develop, exchange or create resources by using others' resources. Depending on the nature of the company, activities can be divided in to two groups: "transformation activities" and "transfer activities". Through "transformation activities" resources change in some manner. One actor usually controls activity of this type. On the other hand, more than one actor always controls the "transfer activities" that link information activities of different actors together. (Håkansson and Johanson 1992)

Resources

Knowledge and experience are the most important resources that a company has. The value of a resource depends on the usage and the manner that is combined with other resources. By combining different resources that a company possesses, it is possible to learn new and possibly create innovations. All resources that an organization has are controlled by actors – by single actors or by many joint actors. (Håkansson and Johanson 1992)

Three different forms of resources needed to create value to the customer are identified by Håkansson and Johanson (1992). These include 1) tangible, 2) intangible and 3) human assets. Tangible resources refer to physical properties like equipment and intangible assets refer to non-concrete resources such as brands. For example, in software business resources like platform, software programs and knowledge are important and have essential meaning and purpose (Nahar 2003). The third kind of resource is in great value for all

organizations' human resources. By choosing right kind of tangible and intangible resources and combine them with right people, valuable products can be created for customers (Osterwalder and Pigneur 2002).

2.5.2 Networking and inter-organizational relations

Organizations exchange resources through a specific relationship. These relationships can evolve over time, and it is important to notice that these relationships also need to be managed and developed (Wilkinson and Young 1994). In globally distributed software product development the work is conducted in globally dispersed, virtually acting teams.

2.5.3 Virtual teams and collaboration

Virtual teams are a relatively new phenomenon and they can be defined as temporary, culturally diverse, geographically dispersed, electronically communicating workgroups (Potter, Balthazard and Cooke 2000). These teams have an increasingly important role in organizational life and they offer the flexibility in order to maintain competitiveness.

According to Andriessen, Hettinga and Wulf (2003), virtual teams with comparable start-up conditions evolve in different ways. The evolvement of a virtual team can be evaluated by People Capability Maturity model (P-CMM) developed by the Software Engineering Institute (SEI) (Carmel 1999, 168-169). The model helps software organizations to integrate team development with software process improvement (TABLE 2).

TABLE 2 The five stages of people Capability Maturity Model (Carmel 1999, 168)

	Abbreviated description
Level 1: Initial	These are ad hoc, inconsistently performed practices.
Level 2: Repeatable	Instill basic disciplines into team activities, including training, communication, and compensation.
Level 3: Defined	Identify the primary competencies and align the activities around them, including creating a participatory culture.
Level 4: Managed	Begin to manage quantitatively and engage in teambuilding
Level 5: Optimizing	Continuously improve methods for personal and team competence

Another model for evaluating team evolvement is from US-based consulting firm Management Strategies, Inc., which specializes in distributed teams. The model is derived from the CMM but it is applied to any dispersed work team (TABLE 3)

TABLE 3 The four stages of the Maturity Model for Distributed teams (Carmel 1999, 169)

	Abbreviated description
Level 1: Ad hoc	Effective work is performed only in co-located site.

Level 2: Basic	Written documents are developed for project and mission; reliable communications are put in place.
Level 3: Standardized	Organizational memory is built; detailed project specs and team member objectives are in place.
Level 4: Optimizing	Business processes are defined, aligned, and regularly reviewed; new members are easily integrated.

2.5.3.1 Designing the team structure

According to Carmel (1999, 174), the traditional team structure suitable for co-located work is no longer applicable for globally dispersed team work. The companies that are transitioning to the stage 3- Globally integrated, (see FIGURE 1) need a more flexible team structure in order to support dispersed modes of work and effective decision-making. The stages presented in Figure 1 consist of three stages. In stage 1 (one location) all the development is co-located at headquarters. In stage 2 (central coordination) distant development sites are added, but all are largely controlled from headquarters. In stage 3 (globally integrated), a globally dispersed organization, resembling a network organization is created.

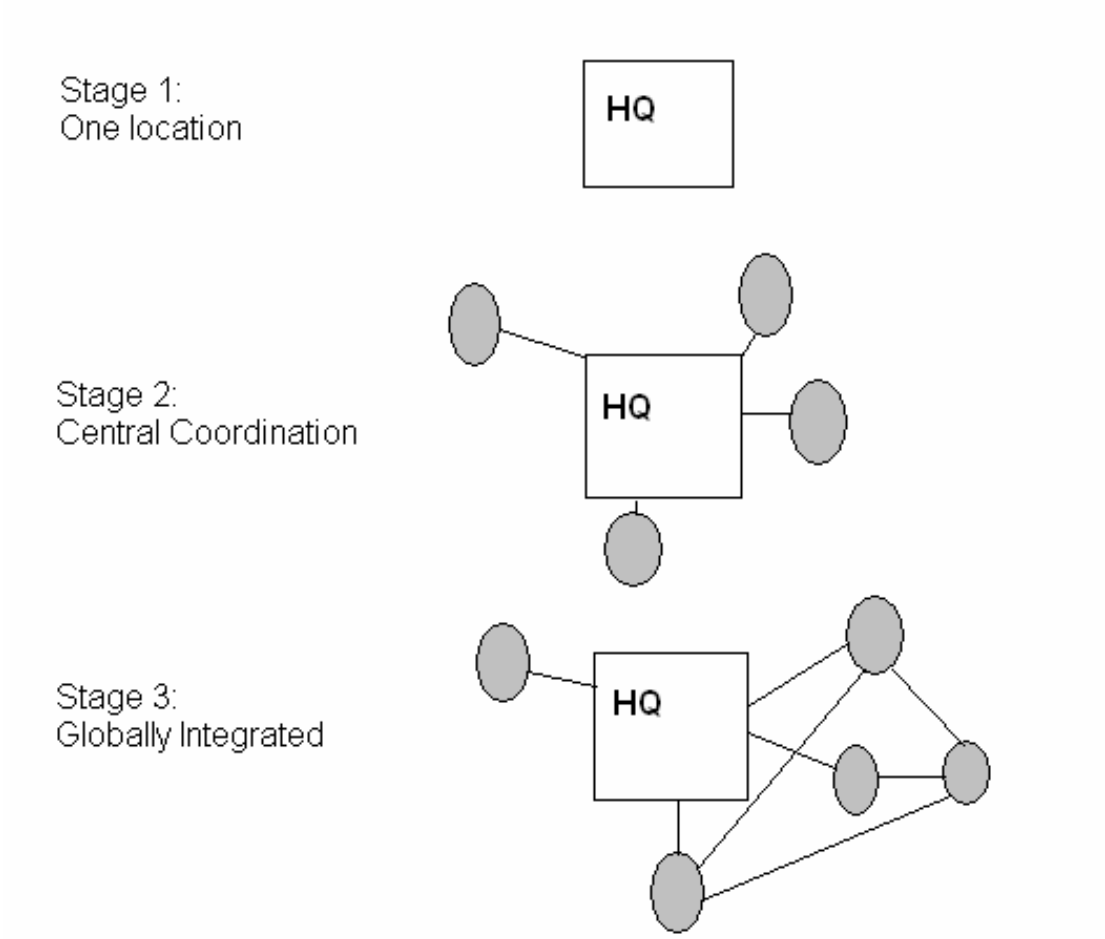

Figure 1: The stage model of global software teams (Carmel 1999, 175)

Global software team should be formed following a certain structure that provides the flexible foundation for efficient modular work, effective communication, and clear decision making. It is important to notice that a clear team structure, depicted by an organizational chart, is an important step towards transparency. The generic team structure is based on design principles. First, it represents balance between a centralized and decentralized structure. Second, some vital roles are preserved, such as architecture, planning and budget. Third, some level of hierarchy should be reserved, for example, in the form of project manager. Finally, the structure should allow various committee

functions and individual functions to be collapsed if necessary. A global software team also requires an executive committee acting in oversight capacity. At the team's center, there are three committee roles: project management, technical and process. The project management committee is a coordinating body including project manager and the leads from each site. (Carmel 1999, 176-177)

The flexible team structures are an essential part of the success of collaboration in global software product development process (Carmel 1999).

2.5.4 Technology as a resource for enhancing relationships and creating dependencies between companies in the networks

Individuals, communities, groups or organizations are enabled to perform different activities and processes due to IT support and the diverse range of information tools makes the performance of different tasks easier (Nahar 2001). IT enables the increase in capacity and decrease in the costs of information technology, information sharing, information processing and communication (Bakopuolos 1995). Teamwork can now be conducted despite the distance, geographic location and time differences because IT overcomes distance and time barriers, significantly decreases the costs of communication and business processes, makes the information sharing and collaboration easier and increases global connectivity (Nahar 1998, 1999, 2001; Nahar, Lyytinen and Huda 1999; Nahar and Savolainen 1997).

Previous research indicates that the presence of a network is dynamic and powerful entity that serves to regulate the transfer of information and knowledge (Madon and Sahay 2001). According to Nahar (2001), Intranet, Extranet and Internet have created a global, electronic environment where companies, foreign customers, suppliers and partners are interconnected. The increasing importance of Internet technology and of several other powerful, cheaper and easier to use information and communication technologies are

giving more opportunities to use IT technology implementation in conducting international business (Nahar and Karmakar 2003).

According to previous research, web-based education and training programs are becoming widely offered at companies today. This new electronic learning, or e-learning, systems employed by these programs may also be utilized by work teams at companies for facilitating creative energy in a virtual climate in order to increase team performance. Discussion boards, virtual classrooms, digital drop boxes, task lists, calendars and other various features of the e-learning systems can help teams work and allow more efficient communication. (Alstete 2001)

Previous research indicates that significant progress has been achieved in global communications, mainly due to judicious R&D and timely application of the resulting technology. It has been noticed that the telecommunications industry has taken advantage of it in several areas. (Davis, Dinn and Falconer 1992)

International and multinational companies are attempting to implement advanced global information systems (GISs) at increasing amount. This way they want to provide support to their international business operations and also to participate in intra- and inter-firm collaboration. In order to achieve the competitive status in the markets, highly functional global information system supported coordination is needed that crosses the national, organizational, and cultural boundaries. (Nahar and Karmakar 2003)

2.6 Summary

The literature review first took a thorough look at the issues concerning global software product development and global software industry. Second major section explained the major barriers in global software product development including barriers concerning communication, distance, technology and culture.

The Finnish environment for global software product development and the Finnish software market environment were also discussed. The last major part of the literature review consisted of the presentation of cooperation and networks theories. In this section, issues concerning networking key concepts, networking and interorganizational relations, virtual teams and collaboration, and technology improving relationships were presented.

3 CONCEPTUAL MODELS OF GLOBAL SOFTWARE DEVELOPMENT

Chapter 3 presents two conceptual models of global software development. In section 3.1 the cooperation and networks based conceptual model of the phases of global software product development process is presented. In section 3.2, the conceptual model of the phase specific barriers of global software product development process is presented and in section 3.3, a summary of the conceptual model part is presented.

3.1 The cooperation and networks based conceptual model of the phases of global software product development process

The way in which this model is developed will be explained below. Figure 2 below demonstrates the conceptual model of global software product development process. It is based on:

a) Key constructs as offered by cooperation and networks theories

b) Relationships among the key constructs

c) Issues to be examined in this research

The eleven different phases of global software product development are presented in Figure 2. The phases are: 1. product concept creation, 2. product concept evaluation, 3. requirements analysis, 4. designing, 5. coding, 6. testing, 7. localization, 8. commercialization, 9. installation/implementation, 10. post implementation, and 11. developing new versions. The thick black arrows between the phases refer to the order of them. In the global software development, some activities need to be done in chronological order, others need to be done in parallel, for example, in order to quicken the development process (Nahar et al. 2003). Different software teams are involved in different phases and this is presented by arrows from different software teams to

different phases. The software team in Finland is in charge of the phases 1, 2, 3, 11 and partly 4. Software team 1 is in charge of phase 4. Software team 2 is in charge of phases 5 and 6 and software team 3 in charge of phases 7, 8, 9 and 10.

The key actors who participate in global software product development process are the different software teams. Figure 2 presents four global software product development teams. Software team in Finland represents the home country and consist of several subteams. Software teams 1, 2 and 3 represents the offshore teams and they consist as well of several subteams. Each software team collaborates and cooperates with each other. All the three offshore software teams will interact with Finnish team. The construct of cooperation originates from the cooperation and network relationship-based theories. In order to utilize the software technology efficiently and to produce software products, a long-term relationship and cooperation is required to exist between the teams.

Figure 2 also presents how information and know-how flows between the teams and this is presented with two-headed arrows between the teams. Generic IT tools, collaborative tools, software engineering tools and also the technical support is provided from the software team in Finland and this is shown by one-headed arrows directed to software teams 1, 2 and 3.

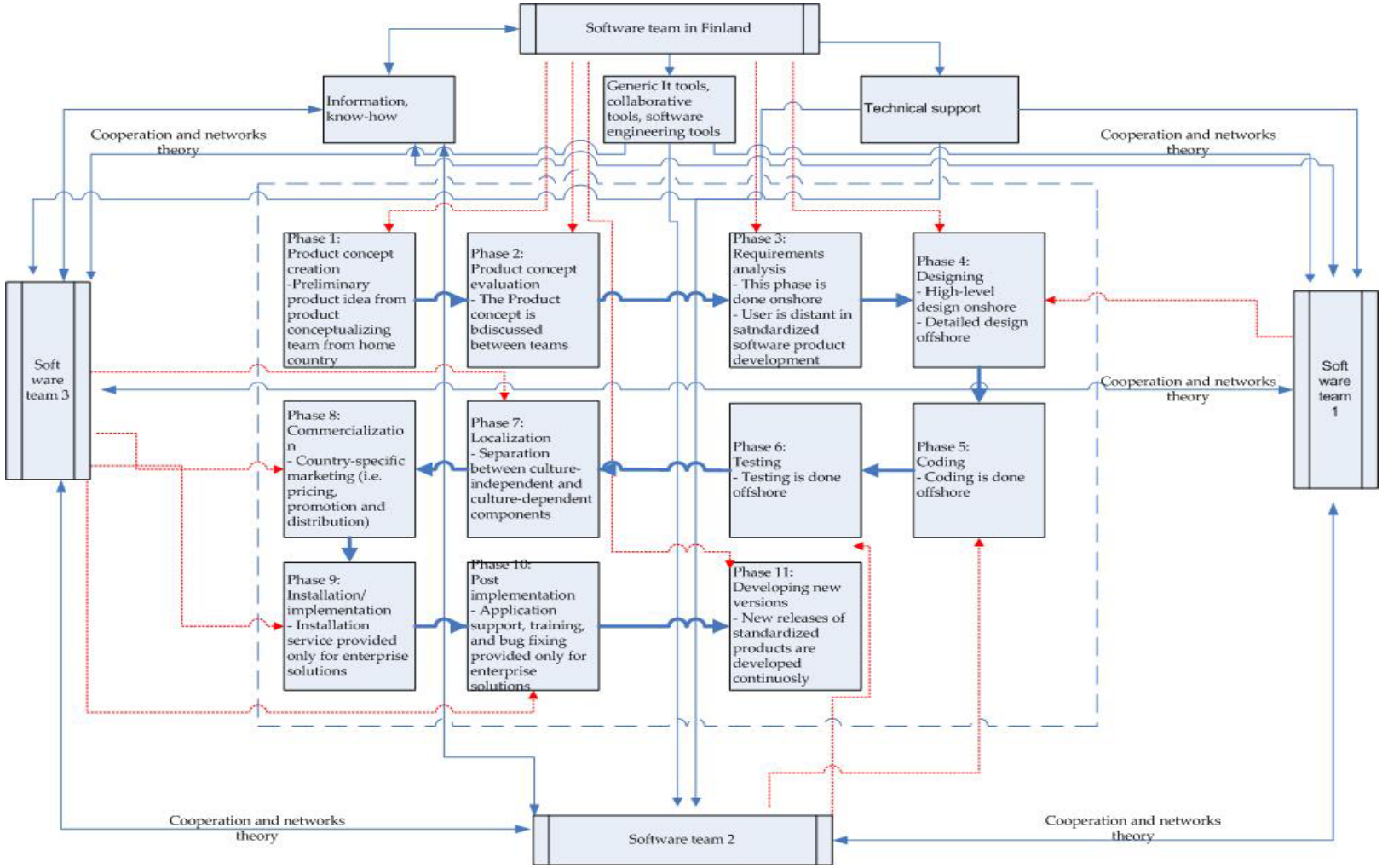

Figure 2: The model of the phases of GSP development process

3.2 A conceptual model of the phase specific barriers of global software product development process

The way in which this model is developed will be explained below. Figure 3 below demonstrates the conceptual model of global software product development process and the barriers encountered during it. It is based on:

a) Key constructs as offered by cooperation and networks theories

b) Relationships among the key constructs

c) Issues to be examined in this research

Figure 3 presents the different phases of GSP development and the specific barriers of each phase. The boxes of software company and software markets present specific barriers concerning the company and markets and the relevance to different phases of GSP development is shown by arrows.

Four different software teams are presented in the Figure 3. Each team collaborates and cooperates with each other and this is shown by presenting the relevance of cooperation and networks theories to each team by an arrow.

Different teams are involved in different phases and this is presented by arrows from different software teams to different phases. The software team in Finland is in charge of the phases 1, 2, 3, 11 and partly 4. Software team 1 is in charge of phase 4. Software team 2 is in charge of phases 5 and 6 and software team 3 in charge of phases 7, 8, 9 and 10. All the software teams are cooperating with each other.

3.2.1 Phase specific barriers of global software product development process

Figure 3 presents the phase specific barriers of the GSP development process. Each phase consists of different barriers and some of the barriers can occur in

various phases or throughout the whole development process. The barriers faced in product concept creation are misunderstandings of goals, motivational problems, loss of communication richness and loss of "teamness". Misunderstandings, cultural problems, language problems, physical distance and challenge of electronic channels can cause problems in product concept evaluation. The barriers of requirements analysis are misunderstandings, diversity of cultures, coordination breakdown, challenge of electronic channels and geographical dispersion. Unclear requirements, delays in development speed, differences in tools and technologies, complexity of software and time zone disparity can cause problems in the designing phase. In the phase of coding, differences in tools and technologies, delays in development speed and complexity of software can be considered as barriers. Problems with software configuration, complexity of software and problems in the development process can be faced in testing. Localization can consist of barriers such as loss of communication, language differences, cultural differences and governmental differences. In the 8th phase, "commercialization", cultural barriers, language barriers, governmental/national boundaries and lack of communication can be faced. In installation/implementation phase, cultural barriers, language barriers and governmental/national boundaries can be encountered and the same barriers can be faced also in the post implementation phase. When developing new versions, lack of communication, unclear requirements, lack of cultural knowledge and too intense competition can cause problems. The severity of each barrier can vary between different companies and teams and also some barriers can be non-existent.

Software company related barriers can be found at a separate box, as well as the barriers related to the software markets. The barriers concerning software company consist of misunderstandings of goals, lack of corporate culture, geographical dispersion, ineffective project/risk management and inadequate skills of personnel. The software markets related barriers introduce the

challenges of too intense competition, governmental/national boundaries and diversity in customer culture.

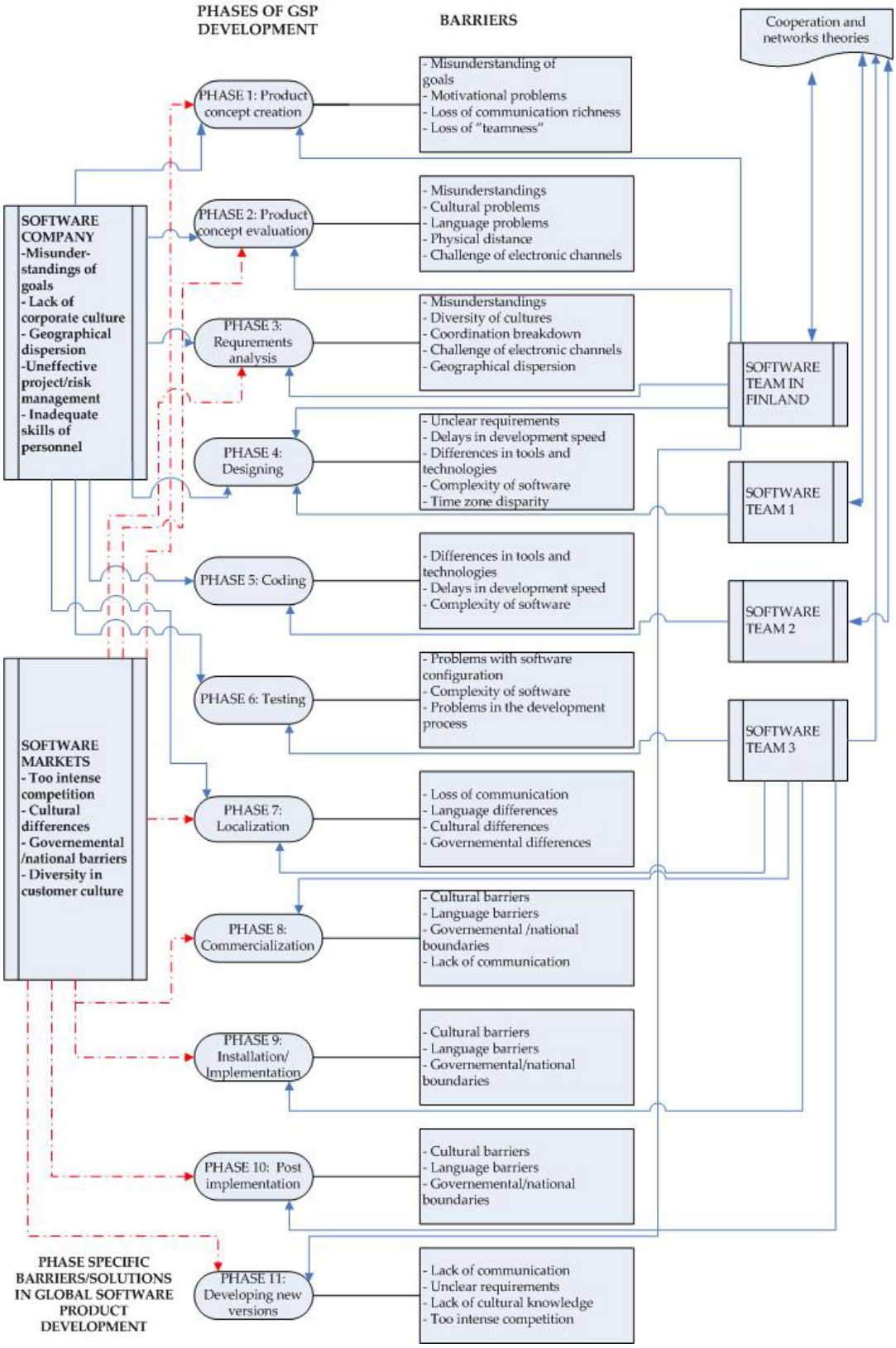

Figure 3: The conceptual model of the phase specific barriers of global software product development process

3.2.2 Cooperation between the development teams at remote sites

The cooperation between different organizations becomes important when conducting globally distributed software product development. The concepts of cooperation and networks theories are introduced by the cooperation occurring between the company and its various teams.

In order to achieve global software product development goals, long-term cooperation between all software teams is essential. Global software product development can be characterized by long-term cooperation.

The cooperation and network theories view technology as a resource to be utilized for enhancing relationships and creating dependencies between companies (Buckley and Casson 1988). IT enhances cooperation between organizations (Baker 1997). Internet-based networks and services are developed by international organizations thus forging connections with many countries and employees, and sharing information with relatively low investment. Various organizations are being brought close together, bridging the gaps through the use of Internet and IT. (Nahar 1999; Nahar, Huda and Tepandi 1999) IT improves the collaboration between employees, as well as with other project partners (Nahar 1999).

Successful virtual teams often use different technologies to enhance the breath and depth of their communication (Pauleen and Yoong 2001). Successful virtual team facilitators have to be able to manage the whole spectrum of communication strategies via new technologies, as well as human and social processes, and often do it cross-culturally. Developing personal relationships is considered to be an important factor enhancing effective working relationships among members of both co-located and virtual teams. The link between team effectiveness and team member relationship is an important factor to study virtual teams. According to previous research, stronger relational links have been associated with higher task performance and the effectiveness of

information exchange. The key to successful virtual teams lies in effective communication. (Pauleen and Yoong 2001; Potter, Balthazard and Cooke 2000) The innovative use of groupware for supporting the communication is also important, because it leads to changing work processes and practices (Andriessen, Hettinga and Wulf 2003).

3.2.3 Knowledge transfer between development sites

In order to succeed in knowledge sharing in global software development, all teams should have a common vision and goals. Another issue that is essential for successful knowledge sharing is an organizational ability to learn or acquire the needed knowledge from the other organization. (Lee 2001) Internet, with its open standards, makes collaboration even easier than before. This online collaboration can enormously reduce paperwork, limit the scope of error, and enable companies with many different skills to cooperate without problems. (Cairncross 2002) There are also some other assets that information technology can provide for globally distributed software development. The development of sophisticated databases and Intranets give organizations new opportunities to build a core knowledge that is easily accessed globally. Internet technologies create enormous capacity that makes it possible to store vast amounts of information.

3.3 Summary

This chapter presented two conceptual models based on the cooperation and networks theories and literature of global software product development. The first model presented the phases of GSD process and the role of teams in it. Also the flow of information, tools and technical support was presented. The second model presented the phase-specific barriers, identified different barriers in different phases and also the barriers general for several phases. The roles of

software teams, software company and markets were also presented in this model. The cooperation between remote sites and the knowledge transfer between different development teams were also discussed.

4 RESEARCH METHOD

This chapter describes the selection of a suitable research method and its utilization in this study. In section 4.1 a comparison between the suitability of qualitative and quantitative research approaches is conducted based on the research questions of this study, and the research method is included in section 4.2. Research design is outlined in section 4.3, and in section 4.4 the setting for interviews and data analysis are introduced. Limitations of the research method have been examined and analyzed in section 4.5. Finally, validity and reliability measures of the study are described in section 4.6.

4.1 Selection of the research approach

It is very important to select a suitable research approach in order to attain right kind of information about the phenomenon under investigation. There are two main research approaches, qualitative and quantitative. These two approaches differ significantly in characteristics of the research data (Alkula, Pöntinen and Ylöstalo 1995; Creswell 1997; Nahar 2001). Both of these approaches generate different kinds of data and the selection of the most suitable approach depends on the research questions and objectives of the research (Creswell 1997). Several factors need to be considered before choosing an approach for the research. These include the nature of phenomenon, state of existing knowledge, and the questions to be asked (Creswell 1997; Yin 1994; Al-Obaidi 1999; Nahar 2001). The qualitative approach focuses on unstructured, thorough interviews and investigations that will focus, at least in this study, on one case company. Creswell (1997, 15) gives the following definition of this research approach: "Qualitative research is an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting".

Creswell (1997) also makes the distinction between the quantitative research and qualitative research and the key difference is that quantitative researchers work with a few variables and many cases, whereas researchers using qualitative approach rely on a few cases and many variables.

This study describes real-life situations through conducting an in-depth empirical study and tries to make a holistic conception of "major barriers in global software product development process". No previous empirical research on the topic of "major barriers in global software product development for Finnish companies" has been done. Also very limited literature exists on this topic. When only limited research has been done and very limited literature exists on the problems the qualitative method is suitable for investigating the problem.

The qualitative study is commonly used in the field of IT and several researchers have resolved relevant research questions utilizing it (Al-Obaidi 1999; Earl 1993; Nahar 1999, 2001). Creswell (1997) also gives a good list of the research features that support the qualitative research. Creswell claims that qualitative inquiry is for the researcher who is willing to do the following: a) commit to extensive time in the field, b) engage in complex, time-consuming process of data analysis, c) write long passages, because the evidence must substantiate claims and the writer needs to show multiple perspectives and d) participate in a form of social and human science research that does not have firm guidelines or specific procedures and is evolving and changing constantly. These characteristics mentioned by Creswell (1997) will support well the purpose and research of this particular study. Due to aforementioned reasons this study uses a qualitative research approach.

4.2 Research method

In order to attain the research objectives and to adequately answer the research questions, it is very important to choose a suitable research method (Creswell 1997). Because this field of research is new, only very limited amount of knowledge is available about the phenomenon of global software product development. The key objective of this research is to investigate what are the major barriers that Finnish companies face in global software product development.

A qualitative case study provides an in-depth analysis of the current research problem, based on vast and relevant source of material and the objective of a case in the empirical environment (i.e. the case company) that is a part of a larger environment (all relevant companies) (Creswell 1997). In a case study, a real-life environment is investigated when the boundaries between new phenomenon and the real-life situation are not clear. The qualitative approach can be divided into a single case study and a multiple case study (Yin 1984). The single case study means a thorough investigation of a one case unit in order to reduce the possibilities of incorrect presentation and to enhance the access needed to collect the empirical data. The multiple case study method contains more cases and also allows greater generalization when compared to a single case study (Yin 1984).

This study focused on identifying the major barriers of global software product development for Finnish companies. The case study fits well to this purpose, because the earlier research had mainly been done based on general challenges and little research has been done concerning the challenges that Finnish companies face. Considering the characteristics of this study, the case study approach is suitable for this research. The purpose of this study was to make an in-depth investigation of the case company. The time was limited for conducting a Masters level thesis, therefore this study dealt with a single case

study method. This Masters thesis has a wide scope and therefore a high amount of data was needed from the case company in order to investigate the research topic thoroughly. The single case study approach gave a holistic view to research area and provided an in-depth analysis of the research problem. This study utilized an exploratory single case study method (Yin 1984) due to the aforementioned reasons.

4.3 Research design

Before implementing a research, it is important that it is well-designed. Through research design it is possible to guarantee that the study has an adequate level of quality.

According to Yin (1994), the following five components of a research design are especially important:

- study questions,
- study propositions, if any,
- unit of analysis,
- logic linking the data to the propositions, and
- criteria for interpreting the findings.

The research design of this study includes: the arrangement of research questions, selection of the case company, data collection procedures, data analysis, inspection of research validity and reliability.

In order to select the case company for this research, the following criteria were applied:

- The case company is Finnish and uses IT in order to conduct their business
- The case company is strongly involved in global software product development
- The case company and its employees were willing to participate in this research by giving useful information

There were also criteria for selecting the interviewees for this study. Every interviewee has been selected on the basis of their experience. The following professionals were interviewed:

- managers who have in-depth knowledge regarding global software product development process
- employees who have participated in the process of global software product development
- external experts who have in-depth knowledge from the field of the study

Questionnaire (see appendix 1) in use was constructed on the basis of literature review and background theories. The questionnaire was reviewed by the supervisor of the thesis to ensure high quality of the questionnaire. The same questions were asked to all interviewees in order to create comparable and relevant results.

4.4 Data analysis

In-depth interviews were conducted to support the framework and synthesize practical application. The same questions based on the questionnaire (see appendix 1) were asked to all the interviewees. In order to get a thorough

picture of the issues, different people from the case company were interviewed. The interviews covered management level and also employees from different functional areas of software product development, marketing and sales. In addition to this, e-mail and telephone interviews were used extensively in collecting additional data.

Interviews were conducted in the form of discussions. Although interviews were quite informal, the questions of the questionnaire guide gave some structure to the interviews. Immediately after each interview, informal data analysis (Nahar 2001) was performed. During and after the interviews all ideas and references to the theory and framework were written down. Preliminary findings were also identified. Each interview was also recorded and the tapes were thoroughly listened and further transcribed literally. Texts were carefully edited and forwarded to the interviewees for reading, correcting possible misunderstandings and approving. It was also made possible for the interviewees to make additional comments based on the edited interviews. Adjustments were made to the texts accordingly to the interviewees' comments and feedback.

Data was analyzed using different phases described by Creswell (1997):

- Data managing
- Reading, memoing
- Describing
- Classifying
- Interpreting
- Representing, visualizing

4.5 Limitations of the research method

A single case study can have several problems that need to be taken into consideration in the research. According to Lee (1989), there are four problems associated with the single case study:

1. **Control observations.** In a single case study method, controlling different factors or events and also the usage of these findings can become problematic.

2. **Control deductions.** The availability of making controlled deductions might be decreased, since the validity of the acquired data cannot be verified by using some mathematical algebra.

3. **Replicability.** Because a single case study is conducted in a unique environment and includes various variables, it is difficult to replicate same study again (Yin 1994).

4. **Generalizability.** Findings of a single case study can be often considered as unique and non-replicable.

According to Yin (1994), selection of a case company is critical and the type of the case company affects the quality of the results of the research. Yin (1994) also emphasizes the usage of multiple sources of evidence, explanation building and usage of case study protocol. According to Yin (1994), one major limitation in case study approach is that researchers fail to develop a sufficient operational set of measures and that "subjective" judgements are used to collect this data. In this study these issues are considered by defining a strict scope for the thesis.

In the case study approach, interviews are performed to gather inputs for the research. Thus, data collection procedures and questions need to be well defined in order to gather relevant data for the research.

Multiple procedures have been taken in order to overcome aforementioned weaknesses of the single case study method (see section 4.6). This study also utilizes questionnaire guide in order to maintain the focus on the data collection procedure and reduce the amount of material to be handled.

4.6 Validity and reliability

In order to ensure the validity and reliability of this study the following measures were used:

- The sources of data were multiple and covering all the important factors of the issue in order to increase the validity of the research
- The questionnaire guide was verified by both the advisor and the case company
- The total number interviewees was comprehensive and all the data collected was presented to them afterwards for checking the errors and evaluating the validity of the data (Yin 1994)
- In order to obtain as much information as possible, employees interviewed presented different functional cultures of the case company
- The case analysis report was checked and verified by the advisor and the case company.
- The research path has been documented to ensure reproducibility (Yin 1994).

5 CASE DESCRIPTION, ANALYSIS AND RESEARCH RESULTS

In this chapter, a case analysis has been performed. This case study analysis has been conducted on the basis of two conceptual models and cooperation and networks theories. The following issues have been investigated and analyzed: a) the main reasons for conducting globally distributed software development, b) the global software development process and its phases, c) general barriers of global software product development and general solutions to enhance the activities, and d) phase-specific barriers and actions to alleviate the encountered barriers of the process. In this section, an analysis on the basis of the cooperation and networks based conceptual model of the phases of GSP process (see section 3.1) has been performed. In section 5.2, an analysis on the basis of the conceptual model of the phase specific barriers of global software product development process (see section 3.2) has been performed. In section 5.3, the key aspects of this chapter are being discussed.

5.1 Global software product development process by Company x

5.1.1 The background of Company x

Company x is a leading developer of software and services for implementing communication and collaboration solutions. The company has a long history of working in product development of web-based and workgroup solutions and in planning and executing customer solutions. Today, Company x focuses on the full-fledged use of enterprise information systems in mobile environments, enabled by the 20 years of experience in development. The continuity of development is guaranteed by stable owners, i.e. an international investor and an international information technology enterprise. The head office is situated in Finland. The regional units are located in Sweden, UK, The Netherlands, and US. Company x's product development units are located in Finland, UK,

Iceland and Japan. The main products of the company include: groupware applications, websites and mobile services. Company x is medium-sized enterprise and the number of employees is 70, including the people from abroad. The number of employees working with mobile services is approximately 20, with groupware applications 5 and with website activities 15. Rest are working in the administrative side and several persons are also working with multiple products. Most part of teams belongs to company's own subsidiary, but a few employees are, mainly from validation and development also from an outsourcing company.

Distribution of software product development has not happened intentionally, but it has become a part of the activities based on the historical development and cooperation with different partners. Company x has spread its activities to several countries. The development activities have spread also besides Finland to Sweden, United Kingdom, Iceland and Japan. Japan has been involved in developing the core product for groupware applications in cooperation with the Finnish software team. Iceland, as the newest acquisition happened approximately one year ago, brings in new specialized talent and technology. In addition to these, several countries are engaged in selling and marketing the products.

The major part of the persons interviewed for this research work within the mobile product team with the newest groupware product developed at Company x. The interviews included people from all the phases of the development process.

5.1.2 Phases of the global software product development process of Company x

In this research, the phases of global software product development are presented in the "the conceptual model of the phase specific barriers of global software product development process (see section 3.1)"including the following

eleven phases: 1. product concept creation, 2. product concept evaluation, 3. requirements analysis, 4. designing, 5. coding, 6. testing, 7. localization, 8. commercialization, 9. installation/implementation, 10. post implementation and 11. developing new versions. Based on the interviews, it became evident that the division of the GSP development into these extremely accurate eleven phases works basically just in theory. In practice and in the development process at Company x, the division is not this steep and many of the phases take place concurrently. For example, requirements analysis and design often happened concurrently. Also the significance of iteration in the beginning of the development became evident. The importance of concurrent activities and iteration was not stressed in the conceptual model of the phase specific barriers of global software product development process presented in this study. However, according to the interviews, all the eleven phases identified in the model were included in the development of global software products and this validates the given conceptual model. One of the interviewees gave the following definition of the development process:

> "All the phases are somehow built inside the development process, but the division of them is not this accurate as presented in this research" (Test Manager, Finland 2004).

5.1.2.1 Reasons for conducting globally distributed software product development by Company x

As Company x is a result of a long historical development starting from the days of working in cooperation with a significant information technology enterprise, the international history of the company is explained by great deal by that fact. One interviewee explained this in the following manner:

> "Company x has been basically taken into global activities, first by a one large company and then evolving its way to function under other company. It can be said that globally distributed software development is not by biggest part due to the company itself" (Test Manager Finland 2004).

Acquisitions in order to expand activities were addressed as an important factor for starting to conduct globally distributed software product development, due to the most part of the aforementioned historical background.

Specialized talent was also pointed out as a vital factor from the viewpoint of all the nine interviewees. Company x received specialized talent, and in addition to that technology by bringing software team from Iceland into cooperation.

Other reasons for conducting globally distributed software product development provided by several interviewees were globalized presence, market growth, desire to increase the market share and proximity to the customer. The usability of the product can increase when the development is distributed to several countries, because the proximity to different customers is increased at the same time. This of course, demands the willingness and know-how from the developers to develop the product as user-centric in order to get the benefits from the proximity to the customer. One interviewee mentioned the importance of globalized presence, market growth and desire to increase the market share as the reasons for conducting global software product development in the following way:

> "Gaining globalized presence, market growth and increase in the market share can be seen as trivial assets for all the companies. The product itself is easier to be sold, if a company has a reference in several countries" (SW Developer, Finland 2005).

Also new creativity and experience received from other countries and the small size of Finnish market were considered as important factors. Some interviewees also addressed the importance of reductions in development costs, reduction in time-to-market and development rigor. Finnish markets were seen as quite small and it became evident that it is hard to find needed technology from Finland. Although, it was easiest to first bring products into Finnish markets, but the goal was always to expand activities into global markets. Because the team interviewed for this research works in the field of global software product

development of mobile products, it also became clear that mobile markets in Finland are relatively small. At one point of Company x's history, also the reduction in development costs had been a vital factor. At that point, the company gained more capacity from a country where software development was relatively cheap. One interviewee also explained the importance of reduction in time-to-market in the following way:

> "The product can be introduced into markets faster when development of the product is done at different places" (Product Manager, Finland 2005)

One interviewee also explained the following reason behind starting to conduct globally distributed software product development:

> "Global distribution of activities creates credibility towards investors and analysts. Also acting in hot spots that are vital considering markets increases the credibility" (VP Business Development, Finland 2005).

The empirically discovered reasons for conducting globally distributed software product development supports the findings of Carmel (1999, 3-11) to most extent. Carmel (1999, 3-11) presents six catalyst factors behind this activity including: specialized talent, acquisitions, reduction in the development costs, globalized presence, proximity to the customer and reduction in time-to-market. All the six catalysts factors were pointed out by the interviewees, stressing the factors of acquisitions, specialized talent, globalized presence and the proximity to the customer. Some of the sustaining factors that Carmel (1999, 3-11) presented were also discovered, including new creativity and experience received from another countries as well as development rigor. Some additional reasons, including the small size of Finnish market, market growth and desire to increase market share were pointed out by the empirical research.

5.2 Analysis on the basis of the conceptual model of the phase specific barriers of global software product development process

The conceptual models presented earlier in this study, exhibit the different phases of global software product development, the cooperation between teams in these phases and also the barriers occurred during the development process. The findings of the empirical research support the earlier presented conceptual models by identifying the phases of the GSP development process, some general barriers and phase-specific barriers of the development process and also emphasizing the importance of cooperation and knowledge transfer between the globally distributed software development teams.

5.2.1 General barriers and solutions of global software product development

During this research, it has become evident that certain barriers exist throughout the whole global software product development process. As it is explained in the second model "the conceptual model of the phase specific barriers of global software product development" (see section 3.2), some general barriers are also related to factors concerning software markets and software company itself. Software company related risks presented in the model include: misunderstandings of goals, lack of corporate culture, geographical dispersion, uneffective risk/project management and inadequate skills of personnel. Barriers related to software markets are presented in the model to include the following: too intense competition, cultural differences, governmental/national barriers and diversity in customer culture. The risk of facing these barriers is big when it is question about globally distributed software teams with different cultural backgrounds cooperating from several parts of the world with the software team in Finland.

During the interviews, several general barriers concerning all the phases of global software development process and some actions to alleviate the barriers

of the process were discovered. The most relevant barriers according to several interviewees were the following: miscommunication, problems with electronic media, very different culture and very different business culture and business practices. Miscommunication was found as a problem for several reasons. To name a few, different language, multiple communication channels, different working methods and different cultural backgrounds can be considered as factors creating miscommunication during cooperation. Different language, i.e. working in English can cause difficulties, for example, in documenting the activities. These findings somewhat support the general barriers presented in the second conceptual model. The barriers of different culture, different language, different working methods and business practices can be discovered from the model also from several phases of global software product development process. These barriers can exist throughout the whole development process, but to be more relevant to some particular phases. The problems with electronic media were explained mostly based on the great number of communication channels being used. This is why, the information is spread into several locations and the relevant information can be hard to find. According to the literature presented in this research (Damian, Lanubile and Oppenheimer 2003; Dodson 2001; Pauleen and Yoong 2001), the problems related to electronic media usually deal with problems of wrong usage and delays and not with the too large amount of different electronic medias. One interviewee stated the following:

> "Electronic communication channels in a distributed environment do not create the best possibilities for communication. Different people have different preferences about what communication channel to use. It has not been firmly decided which communication channel is used for which purpose" (Software Architect, Finland 2004).

Problems with electronic media also included the slow and non-interactive communication through email and newsgroups and the lack of gestures and other non-verbal elements, as it was also already discovered in the literature

part of this research (Carmel and Agarwal 2001; Dodson 2001; Pauleen and Yoong 2001). Also the risk of loosing vital information from the vast information flow was considered problematic. Very different culture, business culture and business practices were also found as relevant barriers throughout the whole development process. These problems were also pointed out in the literature part of the study (Bartlett and Davidsson 2003; Carmel and Agarwal 2001; Damian 2002) For example, different cultural backgrounds can lead to misunderstandings and lack of trust. Different business practices came in question when different working habits collide. For example, the cultural differences between Finnish and English people were discussed several times during the interviews. Also the cultures of Japanese and American people vary a great deal from the Finnish culture.

The next important barriers encountered in the global software product development process included: coordination breakdown, different language, lack of face-to-face communication and lack of informal communication. English is being used as the main language of activities and that poses its own barriers, because it is always easier to communicate with your own language (Dodson 2001). Also the factors of long distance, time zone differences, increase in the development cycle time and distance from the management level were pointed out by some of the interviewees (Battin et al. 2001; Carmel 1999; Hersleb and Mockus; Hersleb et al. 2001; Karolak 2002). Where the management is being situated has its own effect, because overlapping activities are easily happened when management is situated in a different country. The barriers of coordination breakdown and long distance support the conceptual model of the phase specific barriers of global software product development by emphasizing the barrier of geographical dispersion. Also the importance of highly competitive market was pointed out in the interview, as it was also discovered in the model as a barrier of too intense competition. One of the reasons of

coordination breakdown was explained by one interviewee in the following manner:

> "The coordination between different parts of the product is hard. Also the management of documentation is a demanding task considering the coordination" (Project manager, Finland 2005).

One of the interviewees also pointed out the following barrier:

> "In a longer run, hiring new employees can be considered as a challenge, because it is conducted by small local teams from different countries" (Director of Mobile Solutions, Finland 2004).

Some general actions to overcome the barriers of global software product development were also discovered. The most relevant ones were: effective communication strategies, enhancing coordination, effective use of groupware and communication technologies. The importance of coordination is also very much stressed in the literature part of this study (Cairncross 2002; Carmel 1999), because it is at the root of effective activities of a distributed software team. As Company x is a developer of groupware, communication technologies and the use of groupware are essential parts of company's activities. The use of email and groupware systems was also considered to be effective. For example, the company has in use its own groupware system, including calendar and discussion possibilities and also its own Intranet website used as an information channel. The importance of email was stressed mostly when cooperating with people from distant time zones, for example from Japan, when the time of synchronous communication is very short. The advantages of using IT as a factor increasing the capacity of information sharing and communication was also stressed in the literature review part (Bakopoulos 1995; Nahar 2003). One of the interviewees stated the benefits of using electronic communication in the following way:

> "On a longer run, electronic communication has a better quality and it records all the communication history" (Director of Mobile Solutions, Finland 2004).

The communication and the understanding of issues were enhanced also over coffee and in info-meetings and the information was being distributed in a hierarchical way from the top of the organization to the bottom. Every country had its own team leader that is responsible for effective communication and that person sees to that things get done on schedule and this enhanced the coordination of global software product development process. In the projects, it had been well-defined what was needed and the conversation was being held up all the time. Other issues important concerning effective coordination were adequate documentation and systematic activities in general. Different document guides have also been developed in order to give information about, for example, general coding practices and the places for reserving information.

Also the following actions in order to reduce the barriers encountered came up in several interviews: effective use of databases, for example, a database for gathering information concerning the product, common understanding of goals, training to support the technologies, effective project management, global know-how sharing and know-how management, creating mutual needs and right attitude and creating common organizational culture. In order to gain common understanding of goals and to create cohesion, group letter to the people of development had been taken to use in order to spread the information effectively. The training to support the technologies was mainly organized as self-studying and self-improvement and the information was passed to others. The global know-how sharing had taken place, for example, by moving people from Finland to work in Japan thus spreading the knowledge. This skill-transfer with Japanese employees is related to another product than mobile solutions and it can be considered as an example of experience of the company's international activities. Also the gathering of architects from different countries enhanced the know-how sharing between software teams. These findings support the conceptual model of the phases of global software product development by emphasizing the flow of information and know-how and

technical support between the software team in Finland and other software teams. The usage of generic IT tools and collaborative tools were also discovered from the empirical research that supports the conceptual model (see Figure 3).

These findings support the second conceptual model, "the conceptual model of the phase specific barriers of global software product development" by finding some general barriers concerning the whole process of global software product development. Some of these factors, like coordination breakdown, are software company related. On the other hand, also the importance of software markets, in the form of too intense competition was discovered.

5.2.2 The conceptual model of the phase specific barriers of the global software product development process

As it is presented in the second model, "the conceptual model of the phase specific barriers of global software product development process" (see section 3.2), some phase-specific barriers can be discovered from the process. Also some activities in order to enhance the activities of particular phases have been found.

5.2.2.1 Product concept creation

Product concept creation and product concept evaluation were considered as phases that go hand in hand. The most severe barriers recognized in these phases included very different culture and very different business culture and business practices (Bartlett and Davidsson 2003; Damian 2002). The way people with different cultural backgrounds handled and developed thoughts was considered to be very different. These different viewpoints could also lead to lack of cohesion and increase in the development cycle time. People often tended to reject ideas that are not invented in their own countries and this

supports the Not Invented Here (NIH) –phenomenon. Also barriers in interaction between system users and system developers and unclear requirements were addressed by several interviewees as particular barriers of product concept creation and evaluation. Often, only few customers were being interviewed during the product concept creation and evaluation and this often leads to the fact that information gathered is not that comprehensive. It was also considered challenging to form the requirements based on the information gathered from the customers. As it was also mentioned in the literature research, inadequate communication and cultural diversity can negatively affect the gathering of requirements (Damian and Zogwhi 2003). The developers often were more interested in the technology itself rather than people and this could have caused damage to the practicability of the product. Lack of face-to-face communication, long distance, distance from the management level and different language were also being mentioned. Management level often concentrated mainly on the sales and was not that involved in the long-term product concept creation. In the creation process, the management has a great role in which direction to go and if the opinions differ, the final solution can be risked. The role of project manager was pointed out in the following way:

> "Incompetent project managers are not considered as a barrier rather than a critical factor in this phase. The success of the project is dependent on the activities of project managers" (VP Business Development, Finland 2005).

One interviewee also pointed out the importance of iteration:

> "There is no time or will to iterate sufficiently. The geographical distribution makes it even harder when interactive communication is missing" (Software Architect, Finland 2004).

The barriers concerning the phases of product concept creation and evaluation found in the empirical research support the model to some extent. Misunderstanding of issues, loss of communication richness, cultural and language problems and also physical distance were considered as barriers both

from the theoretical and empirical viewpoints. The empirical findings also add the barriers in interaction between system users and system developers and unclear requirements as important findings.

Effective communication strategies and common understanding of goals were seen as the most important activities that have helped to overcome the barriers encountered in this phase. More focus had been put on the listening to customers' need from the beginning of the development, also utilizing the effectiveness of face-to-face communication. The common understanding of goals was seen to be enhanced by organizing events that different teams from different countries participate in. Making different scenarios of different product concepts had given more practical view on the product concept creation. One interviewee also mentioned the richness of having different cultures this way:

> "When the barriers of cultural differences are overcome, the product will be more dynamic. This is because of having knowledge of other cultures and having the possibility to get straight feedback from different cultures" (System Specialist Support, Finland 2005).

5.2.2.2 Product concept evaluation

The barriers in product concept evaluation were similar to the challenges in product concept creation at Company x, because these two phases are seen as non-separate part of software product development process.

5.2.2.3 Requirements analysis

Requirements analysis was seen as a phase that included several barriers due to distribution of software development (Battin et al. 2001; Hersleb and Mockus 2001). The most relevant barriers found in this phase were unclear requirements and problems during requirements engineering. Different countries prioritized different requirements and this caused confusion. Also the requirements

themselves were often received in an unsystematic form. Also lack of face-to-face communication, long distance, very different culture and very different business culture and business practices had caused difficulties. One interviewee explained the barrier of long distance in the following manner:

> "Customers remain far and the information from them come through several people and this can lead to unclear requirements" (Product Manager, Finland 2005).

The requirements are often being discussed in meetings and in urgent cases, foreign people are not able to join those meetings. This pointed out the lack of face-o-face communication and the absence of people from important decision making process. Problems caused by electronic media and barriers in interaction between system users and developers were also valid in this phase. The requirements that came to the developer did not always come straight from the user but through several persons and this can hinder the message. There is also always some risk to be found when communicating and making decisions through email and other electronic communication channels. This problem was also discussed in the literature review by pointing out that distance can also create serious problems such as poor communication among stakeholders (Damian 2003).

The empirical findings support the barriers identified in the model. The barriers of geographical dispersion, diversity of cultures, misunderstandings, coordination breakdown and challenge of electronic channels were discovered from both theoretical (Battin et al. 2001; Damian 2002; Carmel and Agarwal 2001; Pauleen and Yoong 2001) and empirical research. According to the empirical research, the problem of unclear requirements and problems during requirements engineering were found to affect the development process from quite early on.

Training to support the technologies, developing personal relationships and enhancing coordination were seen as activities improving the success of

completion of this phase. The effort to make the mobile solutions very compact and to use common interfaces was also pointed out. Global know-how transfer had been enhanced by transferring knowledge, for example, from Finland to Japan by sending few employees there for a certain period of time. As it has been already mentioned, this happened when developing other product than mobile solutions.

5.2.2.4 Designing

The problems of this phase were mainly based on the activities and outputs of the requirements analysis. The most relevant barriers of designing were very different culture, miscommunication, problems with electronic media, coordination breakdown and very different business culture and business practices. The role of miscommunication was described by one interviewee in the following way:

> "The development of the product can suffer serious damages if people do not understand things correctly and design happens wrong or overlapping activities are being done" (Project Manager, Finland 2005).

The influences of the communication channels being used were stressed in this phase. It was considered to be difficult to manage communication in the development team, mainly due to the fact that there were too many communication channels in use. Coordination breakdown was considered to be a risk factor during the whole development phase, but its significance was highlighted in the development phase. The way the project is divided affected the barriers of project management and coordination breakdown. Different national mentalities also affected this phase, because people were not always willing to accept feedback or simply did not understand it. Also lack of face-to-face communication, long distance and different language were considered as important barriers of this phase. The quality of design reviews was lowered

because the electronic communication channels lack interactive communication and are also slower.

According to the empirical research, different culture, miscommunication, problems with electronic media, coordination breakdown and very different business culture and business practices were stressed as the most severe problems of the design phase. The barriers presented in the model, including differences in tools and technologies, complexity of software and delays in development speed (Battin et al. 2001; Damian 2002; Hersleb and Mockus 2001), are more technical than the barriers discovered in the empirical research.

Creating common organizational culture, effective use of groupware, effective use of databases and enhancing coordination were seen as the most successful activities to prevent the influence of the encountered barriers. The board of architects also had meetings where people from different teams were able to come together. Also some guidelines had been developed in order to increase the quality and management of designing. In enhancing coordination, the importance of project managers was stressed. The effective usage of databases was seen when different modules were put in version management system database and this way the information was easy for everyone to see.

5.2.2.5 Coding

Increase in the development cycle time, appropriateness of tools, technologies and methods and software configuration management were considered as the most relevant barriers faced in coding. Also miscommunication, time zone differences and coordination breakdown received concern from more than one interviewee. The barrier of time zone differences was stressed mainly at the end of coding. The isolation from other teams and the lack of information often lead to overlapping work and that was why important resources could be lost. It was also considered to be a problem that thought did not travel well from one

country to another and that was why it was often considered to be hard to find a common tune in cooperation. Because different product development teams also had other product development projects at hand, the priorities in the development varied and this can often lead to delays in the development process. The tools and working methods also varied and this affected the maintenance of the product. Putting the pieces together was also a challenge and it is increased due to globalization of activities.

Differences in tools and technologies and delays in the development speed were seen as barriers according to the model as well as the empirical research (Battin et al. 2001; Damian 2002; Hersleb et al. 2001). The empirical research also pointed out less technical barriers, such as miscommunication, isolation from other teams and loss of cohesion.

Coding was seen as a phase that often succeeded well if the previous steps were done properly. Enhancing coordination was the most important activity in order to prevent the effects of the encountered barriers. Every subteam had its own specific part so it would have been easier to agree on interfaces. One interviewee stated it in the following:

> "The coordination of coding is most likely to succeed if the product is divided into adequately small pieces" (System Specialist Support, Finland 2005).

5.2.2.6 Testing

Testing was discovered as a problematic phase of the global software development process. It was harder to distribute across different countries and at the moment, testing was mainly done in Finland. Miscommunication, lack of face-o-face communication and appropriateness of tools, technologies and methods influenced this part of development. It was considered problematic as it was not always clear at which state the product was in and to get the pieces into testing on time. This supports the findings of the model by pointing out the

problems in the development process that can have an impact on the success of the testing phase and also the problems of software configuration. The literature review of this research also points out the problem of software configuration. In globally distributed environment, it is difficult to coordinate the modules and parts manufactured and this can increase the effort required to integrate the parts (Battin et al. 2001). It had also been hard for the persons testing the product to get the information how to act in different situations if the developer was not present and the communication became slower when using electronic communication channels. The differences between the customers should also have been taken under consideration when writing different test cases.

In order to improve this phase of software product development, some additional resources had been added in order to succeed better in testing. One interviewee also pointed out this issue in the following:

> "The phase of testing has become easier, because the schedule is more flexible and there are no specific deadlines" (SW Developer, 2004).

5.2.2.7 Localization

Localization has mainly been conducted through subcontractors at Company x. The phase of localization has been influenced mainly by barriers such as very different culture, miscommunication and coordination breakdown. Also long distance and very different business culture and business practices have had an effect on this part of the development process. The subcontractors were also very often not familiar with the product in question. If the cultural knowledge had been too low, the product lacked properties or had properties not fitting to the culture in question. The timing of localization was also found problematic, because it is not wise to make the localization when the product itself is still developing. These findings support the model by emphasizing the loss of communication, language differences and cultural differences (Carmel and

Agarwal 2001; Damian 2002; Hersleb and Mockus 2001). The governmental/national boundaries identified in the model (Battin et al. 2001; Bartlett and Davidsson 2003) in the phases of localization, commercialization, installation/implementation and post implementation were not supported by the empirical research. The governmental issues were not seen as relevant problems in Company x and the effect of the formation of the European Union was seen to have improved the situation even more.

The product has been developed from the start in such a way that it can be easily localized. Also certain flexibility towards changes had been considered important.

5.2.2.8 Commercialization

As the interviews were conducted with people from the mobile product development group, it became evident that the complexity of the product itself affected the commercialization. Also very different business culture and business practices and different and complex market structure had an effect on this phase. These cultural problems were also pointed out in the second conceptual model (Carmel and Agarwal 2001; Battin et al. 2001). Company x does not have specialized marketing people in different countries and the marketing is often done by salespersons or subcontractors. It was considered as a goal to enter markets that were ready. Going to USA market, the risk to fail was pointed out to be bigger than in Nordic countries. This somewhat supports the possibility of governmental/national barriers that were also mentioned in "the conceptual model of the phase specific barriers of global software product development process."

The way to improve the activities in this phase was to enhance the coordination. The marketing of the product started before the product itself was even ready. This was how the customers were already waiting for the product. The

European Union had also made the activities of commercialization easier. When conducting business in USA, many practical barriers, for example, payments were much harder to manage. Also the former history with a large, recognizable enterprise helped to create credibility and good reputation. It can also be considered as richness to have marketing in different countries.

5.2.2.9 Installation/implementation

Long distance, appropriateness of tools, technologies and methods and unsuitable architectures were considered as barriers in installation of the product. The information did not always get well to the person handling implementation, because of unsystematic activities. If the product had been sold to countries that did not have support units, it was considered problematic to conduct the implementation and it also increased the need to travel. Different countries often have different platforms and the product can be hard to implement. These empirical findings are more technical than the findings of the model, which include cultural, and language barriers, and governmental/national boundaries (Battin et al. 2001; Carmel and Agarwal 2001; Damian 2002).

These barriers were being alleviated by enhancing the coordination of installation and by sending a person to the place where implementation takes place. Being local was considered to be an important factor in several countries and mostly in Middle- and South-Europe.

5.2.2.10 Post implementation

Post implementation consisted of barriers such as problems with electronic media, time zone differences and very different culture. Also miscommunication, long distance and appropriateness of tools, technologies and methods were seen as problems. For example, email was seen to cause

unnecessary delays in support activities. The barrier of cultural differences was also emphasized in the second conceptual model.

Utilization of different networks, rigorous maintenance, enhancing coordination and effective communication strategies were seen as alleviating factors. When problems were encountered, the information from the customers was first sent to the partners and then if it was not solved, the problem followed a certain support chain in Finland. Customers were able to give feedback and complain straight to system on the Internet, and from there Support handled the information. The development teams in other countries also used this channel in order to solve problems and that is why, real documents were left behind. Finnish software teams were able take the problems straight to development. This was of course faster, but on the other hand, no written document was left behind. This system is currently being under continuous improvement. It can be considered as a positive thing that the closest support responsibility was at the place in question and that the post implementation was distributed neatly and efficiently. Interaction with field personnel was stressed in weeklong Expert Seminars where people from different countries meet.

5.2.2.11 Developing new versions

Developing new versions included the similar barriers as creating the product to begin with. Unclear requirements and barriers between system users and developers were considered as major barriers, as these were also found in the development of product concept and requirements analysis. Adding too much functionality to the new version was also seen as a barrier. The empirical findings were quite similar as the findings of the model, including unclear requirements and lack of communication.

In order to enhance the development of new versions, system for managing the different versions was being used. Also more accurate prioritization was being applied in order to improve this phase. A road map was often done when designing the actual product and this is how the versions were also scheduled.

5.3 Summary

This chapter analyzed the empirical part of this study and reflected it on the two conceptual models. First, the main reasons for conducting globally distributed software product development from the viewpoint of Company x were presented. The cooperation and networks based conceptual model of the phases of GSP development process (see section 3.1) was validated to some extent by investigating the phases and co-operation at Company x. Both the empirical and theoretical researches include all the eleven phases of the development process, but the empirical research pointed out also the importance of iteration and flexibility. Some general barriers and phase-specific barriers were also found to support the second conceptual model (see section 3.2) and also some actions were discovered in order to alleviate the encountered barriers.

6 CONCLUSIONS AND IMPLICATIONS

This chapter presents the conclusions of this study by explaining its contributions and implications. Section 6.1 introduces the conclusions of this study. Section 6.2 describes the major contributions of this study and recommendations for further research are suggested in section 6.3.

6.1 Conclusions

The importance of globalization of software product development has increased due to the higher costs of the software product development and the ever shortening software product lifecycles. The importance of increased competition that software companies face in both domestic and international markets must also be noticed. The small size of Finnish market and the increasing competition in domestic market make the globalization of activities important for Finnish companies. Many positive issues have risen to conduct the globally distributed software product development, such as gaining specialized talent and proximity to the customer. However, the importance of the barriers identified in this globally distributed software product development must also be analyzed. The earlier research discussing the major barriers in global software product development has been limited and no research has been done on the barriers specified for the Finnish companies. This study tried to contribute to this field by studying: a) the phases of global software product development process, b) the general barriers of the process, c) the phase-specific barriers of the process, and d) actions to alleviate the encountered barriers.

This research has discussed the major barriers in global software product development for Finnish companies. Two conceptual models have been developed to support the research. The "cooperation and networks based conceptual model of the phases of global software product development

process" has been developed and it has been tested empirically. Companies can use this model when they examine their software product development process and the cooperation that takes place in that process. The second conceptual model "the conceptual model of the phase specific barriers of global software product development process" was also developed and validated empirically. This conceptual model can be used for identifying phase-specific barriers and general barriers from the global software product development process. Besides the barriers identified in the process, this study also provides suggestions to reduce the influences of these barriers.

6.2 Major contributions of the study

The fact that, no previous research concerning the barriers of global software product development for Finnish companies had been done was proven with an in-depth literature review.

This research has investigated the research problem by: a) using a specific scientific method, b) analyzing the cooperation and networks theories, c) reviewing literature concerning software business, globalization of software production, IT environment of Finnish software production, Finnish software market environment, global software product development of Finnish companies and barriers in global software product development, d) interviewing of researchers and practitioners, and e) analyzing empirical data of the case company.

The investigation of the previous research and background theories has validated the phases of global software development process, the major barriers of global software product development and the actions to alleviate the barriers. This literature review helped also understanding the importance of cooperation and knowledge transfer in this process. This study has been performed using a qualitative research method. A variety of measures have been performed by

following the suggestions of various research methodologists in order to improve the validity and reliability of this study (see section 4.6).

The empirical part of this study examines the global software product development process and its phases, reasons for starting to conduct the global software product development, major barriers of this process and actions to alleviate the impact of the barriers. These empirical research findings are evaluated by using two conceptual models that were developed in this study, as well as utilizing the cooperation and networks theories and previous research. Through a highly systematic process this study identifies that the main reasons for conducting globally distributed software product development were: a) specialized talent, b) acquisitions in order to expand the activities, c) globalized presence, d) market growth, e) desire to increase market share, and f) proximity to the customer. In this study, the identified major barriers in globally distributed software product development include: a) miscommunication, b) problems with electronic media, c) very different culture, d) very different business culture and business practices, e) coordination breakdown, and f) different language. The research also identifies several actions that were seen as to alleviate the encountered barriers. The major ones were: a) effective communication strategies, b) enhancing coordination, c) effective use of groupware, d) communication technologies, e) effective use of databases, f) common understanding of goals, g) effective project management, and h) global know-how sharing and know-how management.

6.3 Implications for managers and policy makers

Applications in business:

- Companies will get a better understanding of global software product development and management and factors influencing and enhancing it

- Companies will get a better understanding of the barriers of global software product development process and of the solutions to reduce and prevent them
- Companies considering globalization will get an insight into global software product development
- Companies will get a better understanding of Finnish software market

Implications for policy makers:

- The results of this study will provide guidelines concerning the major barriers of global software product development for Finnish companies and the solutions for them. With the provided guidelines, policy makers can provide more support to Finnish software companies in their global software product development
- The barriers identified in this study and the solutions provided for them, will help policy makers to develop strategies to reduce the influences and consequences of these barriers.

6.4 Recommendations for further research

The major barriers of global software product development for Finnish companies and the solutions found in order to reduce and prevent the barriers will give several benefits for future research.

The barriers and solutions introduced in this study through conceptual model will be useful in conducting the future research in the following areas:

- Global software product development process
- The barriers that were identified in global software product development

REFERENCES

Alkula, T., Pöntinen, S. & Ylöstalo, P. 1995. Sosiaalitutkimuksen Kvantitatiiviset Menetelmät. 1.-2. edition. Juva: WSOY.

Al-Obaidi, Z. 1999. International Technology Transfer Control: A Case Study of Joint Ventures in Develping Countries. Helsinki School of Economics, Series A-151. Helsinki: HeSE Print.

Alstete, J.W. 2001. Alternative Uses of Electronic Learning Systems for Enhancing Team Performance. Team Performance Management: An International Journal 7(3/4), 48-52.

Andriessen J.H., Hettinga, M. & Wulf, V. 2003. Introduction to Special Issue on Evolving Use of Groupware. Computer Supported Cooperative Work 12, 367-380.

Autere, J., Lamberg, I. & Tarjanne, A. 1999. Ohjelmistotuotteilla Kansainväliseen Menestykseen – Toimialan Kehittämistarpeet ja Toimenpide-ehdotukset. Teknologiakatsaus 74/99, TEKES, Finland.

Axelrod, R. 1984. The Evolution of Cooperation. New York: Publisher-Basic Books.

Axelrod, R. & Keohane, R.O. 1986. Achieving Cooperation under Anarchy. In O. Kenneth (Ed.) Strategies and Institutions: Cooperation under Anarchy. Princeton: Princeton University Press, 226-254.

Axelrod, R. & Doug, D. 1988. The Further Evolution of Cooperation. Science 242, 1385-1390.

Baker, H.R. 1997. EXTRANETS: Complete Guide to Business to Business Electronic Commerce. New York: McGraw-Hill.

Bakopoulus, J.Y. 1995. Toward a More Concept of Information Technology Center for Information Systems Research. MIT Sloan School of Management, Cambridge, Massachusetts.

Balachandra, R. 1996. International Technology Transfer in Small Businesses: A New Paradigm. International Journal of Technology Management, Special Issue 12(5/6), 625-638.

Barbosa, F. & Vaidya, K. 1995. Developing Technological Capabilities: The Case of a Brazilian Steel Company. Technological Innovation and Global Challenges: Proceedings of the European Conference on Management Technology, Aston Business School, Birmingham.

Barr, A. & Tessler, S. 1996. The Globalization of Software R&D: The Search for Talent. Standford Computer Industry Project.

Barr, A. & Tessler, S. 1997. Software R&D Strategies of Development Countries. Standford Computer Industry Project.

Bartlett, C. & Davidsson, A. 2003. Improve Your Global Competence. Helsinki: Multiprint Oy.

Battin, R.C., Crocker, R., Kreidler, J. & Subramanian, K. 2001. Leveraging Resources in Global Software Development. IEEE SOFTWARE 18(2), 70-77.

Bell, J. 1995. The Internationalization of Small Computer Software Firms. European Journal of Marketing 29(8), 60-75.

Bhattacharya, S., Behara, R.S. & Gundersen, D.E. 2003. Business Risk Perspectives on Information Systems Outsourcing. International Journal of Accounting Information Systems 51, 1-18.

Bradach, J. & Eccles, R. 1989. Price, Authority, and Trust: From Ideal Types to Plural Forms. Annual Review of Sociology 15, 97-118.

Buckley, P.J. & Casson, M. 1988. A Theory of Cooperation in International Business. In F.J. Contractor & P. Lorange (Eds.) Cooperative Strategies in International Business: Lexington, 31-53.

Cairncross F. 2002. The Company of the Future: How the Communications Revolution is Changing Management. Ubiguity, an ACM IT Magazine and Forum.

Carmel, E. 1999. Global Software Teams: Collaborating Across Borders and Time Zones. New York: Prentice Hall.

Carmel, E. & Agarval, R. 2001. Tactical Approaches for Alleviating Distance in Global Software Development. IEEE SOFTWARE 3(4), 22-29.

Chakrabarti, A.K. & Lester, R.K. 2002. Regional Economic Development: Comparative Case Studies in the US and Finland. IEEE International 2, 635-642.

Cooke, P. & Morgan, K. 1993. The Network Paradigm: New Departures in Corporate and Regional Development. Environment and Planning: Society and Space 11, 543-564.

Creswell, J.W. 1997. Qualitative Inquiry and Research Design: Choosing Among Five Traditions. Thousand Oaks: Sage Publications.

Cusumano, M.A. & Selby, R.W. 1995. Microsoft Secrets. New York: The Free Press.

Damian, D. 2002. Workshop on Global Software Development. University of Sydney, Department of Software Engineering, Australia. ICSE.

Damian, D. 2003. Research Engineering Challenges in Multi-site Software Development Organizations. Requirements Engineering 8(3), 149-160.

Damian, D. & Zowghi, D. 2003. Requirements Engineering Challenges in Multi-sit Software Development Organizations. Requirements Engineering 8, 149-160.

Damian, D., Lanubile, F. & Oppenheimer, H. 2003. Global Software Development: Technical, Organizational, and Social Challenges. ACM Sigsoft Software Engineering Notes 28(6), 1-4.

Davis J.H, Dinn, N.F. & Falconer, W.E. 1992. Technologies for Global Communications. IEEE Communications Magazine 10, 35-43.

Dictionary of Computing. 1996. Oxford University Press, Oxford Reference Online. Oxford University Press. [online], [date of reference 8.9.2004]. Available in http://oxfordreference.com/views/ENTRY.html?subview=Main&entry=t11.002572

Dodson, W. 2001. Virtually International: How to Manage Globalized Teams. Silk Road Communications Consulting Unit.

Earl, M.J. 1993. Experiences in Strategic Information Systems Planning. MIS Quarterly 17(1), 1-24.

Easton, G. 1992. Industrial Networks: A Review in Industrial Networks. In B. Axelsson & G. Easton (Eds.) A New View of Reality. London: Routledge.

Ebert, C. & De Neve, P.D. 2001. Surviving Global Software Development. IEEE SOFTWARE 18(2), 62-69.

Elomaa, T. 2002. Huge growth in Software Business. R&D Articles, Published by TEKES, July, Helsinki, Finland.

Ford, D., Håkansson, H. & Johansson, J. 1986. How do Companies Interact? Industrial Marketing and Purchasing 1(1), 26-41.

Fujii, R., Guerdat, C. & Sullo, P. 1991. International Software Engineering Standards: Facing the Challenge. IEEE SOFTWARE 7, 44-48.

Greenson, O., Jacobsen, K. & Paulin, B. 2001. The New Global Economy. In K. Jacobsen (Ed.) Launcing Your Software Business in America: A Handbook for Finnish Entrepreneurs, TEKES, Helsinki, Finland.

Grosse, R. 1996. International Technology Transfer in Services. Journal of International Business Studies 27(4), 781-800.

Hersleb, J. & Mockus, A. 2001. Challenges of Global Software Development. IEEE SOFTWARE, 182-184.

Hersleb, J., Mockus, A., Finholt, T. & Grinter, R. 2001. An Empirical Study of Global Software Development: Distance and Speed. IEEE SOFTWARE, 81-90.

Hoch, D., Lindner, S., Müller, R., Purkert, G. & Roeding, C. 2000. Secrets of Software Success: Management Insights from 100 Software Firms around the World. Harvard Business School Press. USA: McKinsey & Co.

Hofstede, G. 1994. Cultures and Organizations. Software of the Mind. Intercultural Cooperation and Its Importance for Survival. London: HarperCollins Publishers.

Huhtinen, H. & Virolainen, V. 2002. Studying Network Management from the Communication Perspective – A Literature Review. The 18th IMP-Conference in Dijon, France.

Håkansson, H. & Johansson, J. 1992. A Model of Industrial Networks: A New View of Reality. Routledge, London, 28-34.

Jarillo, J.C. 1988. On Strategic Networks. Journal of Strategic Management 9, 31-41.

Johanson, J. & Mattsson, L.G. 1987. Interorganizational Relations in Industrial Systems: A Network Approach Compared with a Transaction Cost Approach. International Studies of Management Organization 17(1), 34-48.

Jurison, J. 1995. The Role of Risk and Return in Information Technology Outsourcing Decisions. Journal of Information Technology 10, 239-247.

Karolak, D.W. 2002. Global Software Development: Managing Virtual Teams and Environments. IEEE Computer Society.

Kern, T. & Willcocks, L. 2000. Exploring Information Technology Outsourcing Relationships: Theory and Practice. Journal of Strategic Information Systems 9, 321-350.

Koskinen, J., Paakki, J. & Sakkinen, M. 2001. Ohjelmistotekniikka. Teaching Material OM-10.2. Department of Computer Science and Information systems. University of Jyväskylä.

Käkölä, T. 2002. Basics of Software Business. Lecture Notes. University of Jyväskylä, Department of Computer Science and Information Systems, Software Business Program.

Lee, A.S. 1989. A Scientific Mehodology for MIS Case Studies. MIS Quarterly 3, 33-50.

Lee, J. 2001. The Impact of Knowledge Sharing, Organizational Capability and Partnership Quality on IS Outsourcing Success. Information & Management 38, 323-335.

Lehtimäki, A. 1991. Management of the Innovation Process in Small Companies in Finland. IEEE Transactions on Engineering Management 38(2), May.

Lemola, T. 2001. The Role of Science and Technology Policy in Finland's Economic Development. Management of Engineering and Technology 1, 483.

Lorenz, E. 1988. Neither Friends nor Strangers: Informal Networks of Subcontracting in French Industry. In D. Gambetta (Ed.) Trust: Making and Breaking Cooperative Relations. Oxford, Basil Blackwell, New York.

Lorenz, E. 1992. The Search for Flexibility: Subcontracting Networks in British and Frech Engineering. In M. Storper & A. Scott (Eds.) Pathways to Industrialization and Regional Development. Routledge, New York, 122-123.

Lyytinen, K. & Goodman, S. 1999. Finland : The Unknown Soldier on the IT Front. Communications of the ACM, 42(3), 13-17.

Madon, S. & Sahay, S. 2001. Cities in the Developing World. Linking Global and Local Networks. Information Technology & People 14(3), 273-286.

Marjanen, V. 2003. Information Technology Supported Technology Transfer to China: Factors Influencing Information Technology Projects Implementation. University of Jyväskylä, Masters Thesis in Computer Science and Information Technologies.

Nahar, N. & Savolainen, V. 1997. Information and Communication Technologies for Global Productivity Increase. In M. Bazewicz (Ed.) Proceedings of the 19th Information Systems' Architecture and Technology (ISAT '97), October, Wroclaw, Poland, 220-230.

Nahar, N. 1998. Risk Assesment of IT-enabled International Technology Transfer. Case of Globalization of SMEs. In S. Munari, G. Krarup & L.B. Rasmussen (Eds.) Proceedings of the 5th World Conference on Human

Choise and Computers on Computers and Networks in the Age of Globalization, August, Geneva, Switzerland, 407-418.

Nahar, N. 1999. IT-enabled Effective and Efficient International Technology Transfer for SMEs. In J. Zupancic, W. Wotjkowski, W.G. Wotjkowski & S. Wrycza (Eds.) Evolution and Challenges in System Development. New York: Kluwer Academic/Plenum Publishers, 85-98.

Nahar, N., Lyytinen, K. & Huda, N. 1999. It-enabled International Market Research for Technology Transfer: A New Paradigm, In D.F. Kocaoglu & T.R. Anderson (Eds.) Technology and Innovation Management. IEEE and PICMET, Oregon, 515-522.

Nahar, N., Huda, N. & Tepandi, J. 1999. Managing IT Project through Global Networking Systems: A New Approach. In K.A. Artto, K. Kähkönen & K. Koskinen (Eds.) Managing Business by Projects, 2. PMA Finland and NORDNET, Helsinki, 1198-1212.

Nahar, N. 2001. Information Technology Supported Technology Transfer Process: A Multi-site Case Study of High-Tech Enterprises. University of Jyväskylä. Jyväskylä Studies in Computing 9.

Nahar, N., Käkölä, T. & Huda, N. 2001. E-Supply Chain for International Technology Transfer. In D.F. Kocaoglu, T.R. Anderson, D.Z. Milosevic, T.U. Daim, K. Niwa, T.R. Gulledge, C. Kim & H. Tschirky (Eds.) Technology Management in the Knowledge Era (on CD-ROM). IEEE and PICMET, Oregon.

Nahar, N., Käkölä, T. & Huda, N. 2002a. Diffusion of Software Technology Innovations in the Global Context. Proceedings of the Hawaii International Conference on System Sciences. Big Island, Hawaii, January 7-10. IEEE.

Nahar, N., Käkölä, T. & Huda, N. 2002b. Software Production in Developing and Emerging Countries through International Outsourcing. In S. Krishna & S. Madon (Eds.) Proceedings of the Information and Communication Technologies and Development: New Opportunities, Perspectives & Challenges. 7th International Working Conference of IFIP, WG 9.4. Indian Institute of Management Bangalore, Bangalore, India, May 29-31. 292-310.

Nahar, N. 2003. Global Software and Systems Development. Lecture Notes. University of Jyväskylä, Department of Computer Science and Information Systems, Software Business Program.

Nahar, N. & Karmakar, N.L. 2003. Challenges in the Implementation of Global Information Systems. Proceedings of the Technology Management for Reshaping the World, Ch.20: Information Technology (IT) Management, Portland International Conference on Management of Engineering and Technology, July, 1-8.

Nahar, N. Käkölä, T., Huda, N. & Deo, P.S. 2003. International Software Product Development for World Markets in a Software Start-up. 1st Annual Conference on Systems Integration, Stevens Institute of Technology Campus, Hoboken, New Jersey, March 12-14.

Nahar, N. 2004a. ITKB52 Global Software Industry and International Outsourcing. Lecture Notes. University of Jyväskylä, Department of Computer Science and Information Systems, Software Business Program.

Nahar, N. 2004b. ITKB55 – Globalization of High-tech Enterprises through IT Support. Lecture Notes. University of Jyväskylä, Department of Computer Science and Information Systems, Software Business Program.

Nahar, N., Huda, N. & Deo, P.S. 2004. The Development Processes of Global Software Poducts and Information Systems: A Comparative Analysis. Proceedings of the Innovation Management in the Technology-Driven

World, PICMET'04 (Portland International Conference on Management of Engineering and Technology) Symposium in Korea, July 31 - August 4.

Osterwalder, W. & Pigneur, Y. 2002. An e-Business Model Ontology for Modeling e-Business. 15th Bled Electronic Commerce Conference, e-Reality: Constructing the e-Economy, Bled, Slovenia, June 17-19.

Palvia, P.C. 1996. Strategic Applications of Information Technology in Global Business: Using the "GLITS" Model and Instrument. In P.C Palvia, S.C. Palvia & E.M. Roche (Eds.) Global Information Technology and Systems Management. Key Issues and Trends, 510-532.

Pauleen D.J. & Yoong, P. 2001. Facilitating Virtual Team Relationships via Internet and Conventional Communication Channels. Internet Research: Electronic Networking Applications and Policy 11(3), 190-202.

Potter R.E., Balthazard, P.A. & Cooke, R.A. 2000. Virtual Team Interaction: Assesment, Consequences, and Management. Team Performance Management: An International Journal 6(7/8), 131-137.

Powell, W. 1987. Hybrid Organizational Arrangements: New Form of Transitional Development? California Management Review, Fall, 67-87.

Powell, W.W. 1990. Neither Market nor Hierarchy: Network Forms of Organization. Research in Organizational Behavior 12, 295-336.

Powell, W.W. 1996. Neither Market nor Hierarchy: Network Forms of Organization. In G. Thompson (Ed.) Markets, Hierarchies and Networks: The Coordination of Social Life. London: Sage Publications.

Powell, W.W. & Brantley, P. 1992. Competitive Cooperation in Biotechnology: Learning through Networks? In N. Nohria & R.G. Eccless (Eds.) Networks and Organizations: Structure, Form and Action. Boston: HBS Press, 366-394.

Powell, W.W. & DiMaggio, P. 1991. The New Institutionalism in Organizational Analysis. University of Chicago Press, Chicago.

Rajala, R., Rossi, M., Tuunainen, V. & Korri, S. 2001. Software Business Models: A Framework for Analyzing Software Industry. Technoly Review 108/2001, TEKES, Helsinki.

Ratnathicam, I. 2002. IT Country Profiles: Finland. Available at: http://www.cid.harvard.edu/cr/profiles/Finland.pdf

Richardson, G. 1972. The Organization Industry. The Economic Journal 84, 883-896.

Robinson, R.D. 1988. The International Transfer of Technology: Theory, Issues and Practice. Cambridge: Ballinger Publishing Company.

Thorelli, H. 1986. Networks: Between Markets and Hierarchies. Strategic Management Journal 7, 177-202.

Uusitalo, O. 1999. Entrepreneurship in Global Business. Management of Engineering and Technology 1, 89.

Vahtera, H. 2002. The Roles of Information Systems in a Value Net. University of Jyväskylä, Masters Thesis in Computer Science and Information Technologies.

Wilkinson, I. & Young, L. 1994. Business Dancing – the Nature and Role of Interfirm Relations in Business Strategy. Asia-Australia Journal of Marketing 2(1), 67-79.

Wolfe, R.A. 1994. Organizational Innovation: Review, Critique and Suggested Research Directions. Journal of Management Studies 31(3).

Yeo, A. 2001. Global Software Development Lifecycle: An Exploratory Study. Journal of ACM 3(1), 104-111.

Yin, R. 1984. Case Study Research: Design and Methods. Beverly Hills: Sage Publishing.

Yin, R. 1994. Case Study Research: Design and Methods. Thousand Oaks: Sage Publications.

Appendix 1. The interview questionnaire guide

1 General background regarding the company

- Name of the interviewee:
- Position:
- Contact details:
- Company / organizational background:
- Name of the company and contact information:
- Year of establishment:
- Main products:
- Company experience in globally distributed software product development:

2 Reasons for conducting globally distributed software product development

2.1 Why did you start conducting globally distributed software product development? Please select and explain those factors (mentioned below) that are suitable from your viewpoint.

1. Specialized talent
2. Acquisitions in order to expand activities
3. Reduction in development costs
4. Globalized presence
5. Market growth
6. Desire to increase market share
7. Small size of the Finnish market
8. Increasing competition in the Finnish market

9. Increasing competition in the world market
10. Proximity to the customer
11. Desire to follow competitors
12. Monitor acts of competitors
13. Reduction in time-to-market
14. Development rigor
15. New creativity and inspiration
16. Experience received from other countries
17. Others, please mention

3 Barriers in globally distributed software product development

3.1 A list of potential barriers for answering the below questions:

1. Highly competitive market
2. High cost of marketing
3. Lack of communication channels
4. Miscommunication
5. Lack of face-to-face communication
6. Lack of informal communication
7. Problems with electronic media (e-mail, conference calls, etc.)
8. Lack of training and supervision of IT tools
9. Lost of trust and cohesion
10. Increase in the development cycle time
11. Time zone differences
12. Long distance

13. Coordination breakdown
14. Oversized teams
15. Distance from the management level
16. Variance in quality of domain expertise
17. Availability of IT skilled employees
18. Incompetent project managers
19. Inadequate organizational support
20. Problems in team relationships
21. Barriers in interaction between developers and system users
22. Appropriateness of tools, technologies and methods
23. Unsuitable architectures
24. Software Configuration Management
25. Problems during requirements engineering
26. Unclear requirements
27. Very different culture
28. Very different business culture and business practices
29. Different language
30. Different and complex market structure
31. Political bureaucracy
32. Unstable political environment
33. Unstable economic environment
34. Complex taxation
35. Complex intellectual property protection
36. Complex laws associated with product regulations
37. Currency exchange regulations

38. Others, please mention

3.2 phases of the global software product development process:

Phase 1. Product concept creation

Phase 2. Product concept evaluation

Phase 3. Requirements analysis

Phase 4. Designing

Phase 5. Coding

Phase 6. Testing

Phase 7. Localization

Phase 8. Commercialization

Phase 9. Installation/implementation

Phase 10. Post implementation

Phase 11. Developing new versions

3.2.1 a) Which barriers (see the list of potential barriers above) have you encountered in Phase 1. Product concept creation:

Please say the name of your phase 1, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.2 a) Which barriers (see the list of potential barriers) have you encountered in Phase 2. Product concept evaluation

Please say the name of your phase 2, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.3 a) Which barriers (see the list of potential barriers) have you encountered in Phase 3. Requirements analysis:

Please say the name of your phase 3, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.4 a) Which barriers (see the list of potential barriers) have you encountered in Phase 4. Designing:

Please say the name of your phase 4, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.5 a) Which barriers (see the list of potential barriers) have you encountered in Phase 5. Coding:

Please say the name of your phase 5, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.6 a) Which barriers (see the list of potential barriers) have you encountered in Phase 6. Testing:

Please say the name of your phase 6, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.7 a) Which barriers (see the list of potential barriers) have you encountered in Phase 7. Localization:

Please say the name of your phase 7, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.8 a) Which barriers (see the list of potential barriers) have you encountered in Phase 8. Commercialization:

Please say the name of your phase 8, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.9 a) Which barriers (see the list of potential barriers) have you encountered in Phase 9. Installation/implementation:

Please say the name of your phase 9, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.10 a) Which barriers (see the list of potential barriers) have you encountered in Phase 10. Post implementation:

Please say the name of your phase 10, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

3.2.11 a) Which barriers (see the list of potential barriers) have you encountered in Phase 11. Developing new versions:

Please say the name of your phase 11, if it is different from the phase name of this study.

b) Please arrange factors in the order of severity of problem.

c) Please explain how these factors created barriers to this phase.

4 Actions to overcome the barriers

Which actions have you taken to reduce and/or overcome the encountered barriers?

4.1 List of potential actions to reduce and/or overcome the encountered barriers:

1. Effective use of groupware
2. Training to support the technologies
3. Communication technologies
4. Utilization of different networks (Internet, Intranet, Extranet)
5. Effective use of databases
6. Adequate technical skills
7. Rigorous maintenance
8. Web-based education and training programs
9. Effective communication strategies
10. Developing personal relationships

11. Enhancing coordination
12. Effective project management
13. Effective risk management
14. Global know-how sharing and know-how management
15. Common understanding of goals
16. Creating mutual needs and right attitude
17. Creating common organizational culture
18. Frequent interaction with field personnel
19. Others, please mention

4.1.1 a) Which actions (see the list of potential actions above) have you taken to reduce and/or overcome the encountered barriers in Phase 1. Product concept creation:

b) Please explain how you executed/performed these actions.

4.1.2 a) Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 2. Product concept evaluation:

b) Please explain how you executed/performed these actions.

4.1.3 a) Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 3. Requirements analysis:

b) Please explain how you executed/performed these actions.

4.1.4 a) Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 4. Designing:

b) Please explain how you executed/performed these actions.

4.1.5 a). Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 5. Coding:

b) Please explain how you executed/performed these actions.

4.1.6 a). a) Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 6. Testing:

b) Please explain how you executed/performed these actions.

4.1.7 a). Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 7. Localization:

b) Please explain how you executed/performed these actions.

4.1.8 a) Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 8. Commercialization:

b) Please explain how you executed/performed these actions.

4.1.9 a) Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 9. Installation/implementation:

b) Please explain how you executed/performed these actions.

4.1.10 a) Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 10. Post implementation:

b) Please explain how you executed/performed these actions.

4.1.11 a) Which actions (see the list of potential actions) have you taken to reduce and/or overcome the encountered barriers in Phase 11. Developing new versions:

b) Please explain how you executed/performed these actions.