Dynamic distributed knowledge work – Collaboration and productivity factors in the context of global software development

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Abstract

This master's thesis examines factors that influence on collaboration and productivity in dynamically distributed knowledge work with a case in global software development (GSD). The topic is studied by the methods of a literature review, case study approach, qualitative semi-structured interviews and content analysis of the collected interview material. The thesis contributes to and was conducted in collaboration with a TEKES-funded joint research program, DD-SCALE (2014-2016).

The theoretical frame of the thesis was constructed based on a literature review of previous GSD research on team collaboration and productivity. This frame was used as a basis for the empirical part of the study with the aim to complement, strengthen and expand the findings of previous research.

The interviews were conducted in India with managerial level information and communication technology (ICT) research and development (R&D) professionals of a case company that has multiple software R&D locations around the globe. As a result, a set of 217 factors in 16 categories and seven higher level viewpoints that concern issues of cross-boundary collaboration, competence and knowledge, improving practices and processes, socio-cultural aspects, human capabilities and characteristics, management and leadership, and tools and infrastructure was gathered.

The findings are in line with previous GSD research, and they indicate that factors impacting collaboration and productivity of distributed teams are interdependent, embedded in different organizational layers, and especially linked to the areas of human related, management practices and technical factors in organizations.

Moreover, the findings point to the importance of enabling maturity, evolution and continuum in teams to support the accumulation of capabilities and (intellectual) capital in a dynamic and fast changing business environment. It is thereby suggested that the dimension of continuity as an enabler for accumulating competency, growing team relations, team and organizational evolution and maturity should be further addressed in GSD research to support enhanced collaboration and productivity.

Keywords: distributed, knowledge work, team work, collaboration, productivity, global software development, interview study, India, continuity

Table of contents

List of abbreviations

BPO	Business Process Outsourcing
BRIC	Brazil, Russia, India and China
CCC	Cost Competitive Country
DDSD	Dynamic Distributed Software Development
DSD	Distributed Software Development
GSD	Global Software Development
GSE	Global Software Engineering
ICT	Information and Communication Technologies
IT	Information Technology
ITO	Information Technology Outsourcing
KW	Knowledge Work
R&D	Research and Development
RDI	Research, Development and Innovation

1. Introduction and research objectives

This master's thesis examines factors that influence on collaboration and productivity in dynamically distributed knowledge work with a case in global software development (GSD). The topic is studied by the methods of a literature review, case study approach, qualitative semi-structured interviews and qualitative content analysis of the collected interview material. The empirical research data was collected in a case company that operates globally at multiple sites in research and development (R&D) of complex software intensive products.

The thesis contributes to a TEKES-funded joint research program, DD-SCALE (2014-2016), which is conducted by three Finnish research institutions and four globally operating case companies. The program investigates new frameworks, tools, practices and operations evaluation solutions for managing dynamic distributed software development work (DDSD) in global value networks. [Ruohonen *et al*., 2014] This study approaches these issues by examining the various factors that influence collaboration and productivity in distributed software development (DSD) teams. The practical aim is to uncover which factors exist and how they get manifested in the context of the case company, and thus the DD-SCALE -project, in the mix of elements that influence the success of collaboration and productivity in teams within dynamically and globally networked DSD work.

In a broader context, the thesis aims at increasing understanding of factors that affect the success of geographically distributed collaboration especially at individual, team and inter-team levels. Since global partnerships with emerging economies are evolving in quantity, depth and quality, India as a prominent offshoring country is a topical research location. This thesis approaches the topic in the context of globalized, networked business environment, where frequent, unrestricted collaboration across various boundaries, such as teams, organizations and countries, is a requisite.

The research question is twofold:

> *What are the factors, which affect collaboration and productivity in teams that work in distributed software development…*
>
> *a) …according to the previous research in the field of global software development?*

b) *…according to the empirical findings of interviews at a global software development centre operating in a dynamically and globally networked business environment?*

The core research problem of collaboration and productivity factors in globally networked, distributed software development is hereby viewed from two angles: The first specifying question, *a*, aims to examine and synthesize the previous research in the field by the method of a literature review. The second specifying question, *b*, then, aims to complement, strengthen and expand the findings of previous research by means of empirical data collection conducted by semi-structured interviews. Further, the aim of the empirical part is to identify these factors at a low level, to make them visible, in order to gain a detailed, up-to-date and contextually sound view to the relevant issues, recognize potentially uncovered areas in managing DSD activities, and thus to enhance the manageability and even measurability of those factors.

This study was conducted in collaboration with the case company, the research group CIRCMI at the School of Information Sciences, University of Tampere and Haaga-Helia University of Applied Sciences. The results are utilized as a component in consolidated research data that is being developed during the DD-SCALE project. The role of the thesis worker entailed acting as the primary researcher in planning and implementation of this thesis study. The other collaborators provided guidance and advice throughout the work as well as the scope in which to conduct the empirical data collection. These collaborators could also be seen as clients, or (internal) customers, who would utilize the thesis results.

1.1. Rationale

Developing software in globally distributed teams has gained footing since the 1990's. The practice has been accelerated by increasing globalization, advancement in information technology, and the growing global demand for software products. [Sengupta *et al.*, 2006, 731] Since then, global software development has become a usual business practice and even the "mainstream" [Šmite and Wohlin, 2011, 15; Bonn, 2012]. The driving forces behind going global include cheaper workforce in the cost competitive countries (CCCs) [Ruohonen, *et al.*, 2014, 2], such as Brazil, Russia, India and China (the BRICs) [Oshri *et al.*, 2009, 192] as well as accessing a wider market area and proximity to global customers and the talent pool of the target country [Jaakkola *et al*., 2010, 1; Niazi *et al*., 2012; Marques *et al*., 2012, 1]. Building agile global networks that can reach high quality, sunrise-

to-sunrise production, reduced response times, dispersed risk, as well as flexible information technology (IT) staffing are named among the many benefits sought in offshoring IT work [Rottman and Lacity, 2006].

However, the benefits of GSD often remain uncertain: global collaboration is deemed risky by previous research, and the benefits may not be fully realized [Šmite and Wohlin, 2011, 15]. The various temporal, cultural and geographical challenges often hinder the success of GSD work [Šmite and Wohlin, 2011, 18]. Many challenges result from the geographical distribution of team members, and thus the processes in a distributed setting differ from those of traditional, co-located software development [Marques *et al.,* 2012, 134]. Studies have shown that up to a half of the companies engaging in GSD activities have not achieved the expected outcomes. Poor global relationships, misunderstandings of projects' requirements, high costs and poor services are said to have resulted from these failures. [Niazi *et al.,* 2012] Further, due to how information systems today relate to organizations' strategies, it is important to understand the risks, challenges and good practices of GSD environment [Marques *et al.,* 2012, 135]. The challenges in DSD may lead to "heavy penalties", such as increased coordination costs and lengthened completion times of software applications. Additionally, risks in distributed software projects are likely to be less visible than in collocated projects, and thus more difficult to tackle. [Sengupta *et al.,* 2006, 732, 737] It can be concluded that there is "enormous promise and enormous challenge" [Herbsleb *et al.,* 2005, 524] in the field of global sourcing and GSD.

Outsourcing information technology (ITO) and other business and knowledge processes (BPO/KPO) continues to be a growing trend. Today software development companies aim at a successful combination of on-shoring, nearshoring and offshoring settings in their research, development and innovation (RDI) operations. The traditional, one-directional, offshore outsourcing relationships are changing towards more strategic and bi-directional processes between the sourcing partners. [Ruohonen *et al.,* 2014, 3] This "highly dynamic set of possibilities" [Willcocks *et al.,* 2009 cited in Oshri *et al.,* 2009, 193] in the global sourcing arena adds complexity to the subject [Oshri *et al.,* 2009]. Therefore, new ways of managing dynamic distributed software development activities – including competencies, skills and resources – are required [Ruohonen *et al.,* 2014, 2].

1.2. Work division and structure of the study

The study winds around the DD-SCALE research project. Thus collaboration in the research planning and implementation took place with the research group CIRCMI at the School of Information Sciences of the University of Tampere, Haaga-Helia University of Applied Sciences and the case company. In practice, the thesis worker was the primary researcher in planning, designing and conducting the study presented in this dissertation, but so that the decisions and progression were frequently reviewed in consultation with the collaborating parties including the supervisor and other senior researchers.

The thesis evolves around three publications in which the work has been developed and discussed in conjunction with writing the dissertation, as itemized in Table 1. I, as the thesis writer, have been the primary author with the main responsibility of planning, writing, revising and presenting the work in the listed forums. The second author acted in an advisory role providing consultation, guidance and revision support.

Table 1. The related publications

No.	Time	Title (type)	Forum	Authors
1	08/2015	Factors Impacting Successful Collaboration and Productivity of Distributed Software Development Teams: A Proposed Multidimensional Concept Map (seminar paper)	The 38th Information Systems Research Seminar in Scandinavia (IRIS38) in Oulu, Finland	Löytty, Katriina and Ingalsuo, Timo
2	11/2015	Factors affecting collaboration and productivity of teams working in globally distributed software R&D – Summary of interviews in India (report)	Internally in the DD-SCALE project case company	Löytty, Katriina and Ingalsuo, Timo
3	08/2016 (to be published)	Mapping the Collaboration and Productivity Factors in Distributed Software Development Teams – An Interview Study in India (seminar paper)	The 39th Information Systems Research Seminar in Scandinavia (IRIS39) in Ljungskile, Sweden	Löytty, Katriina and Ingalsuo, Timo

The publications discuss the following areas of the dissertation:

- No. 1: The Literature review (section 2)
- No. 2: The Findings (section 5)
- No. 3: The whole work, in a summarized and preliminary form (sections 1 through 7)

The dissertation is structured as follows: Next, the key concepts are defined and the evolution of global sourcing as well as the context of India in the industry and in this study are discussed. The section two presents the theoretical frame of the study, a literature review including its method, findings and conclusions. The discussion then moves on to the introduction of the case study approach and data collection method in the section three. The section four examines the analysis process. The

findings are presented in detail in the section five followed by discussion in the section six. The latter answers the research questions, evaluates the methodology, validity and limitations of the study together with considerations on cultural distances and ethical matters. The concluding remarks are then made in the section seven.

1.3. Defining the key concepts

The following paragraphs define and discuss the key concepts that the work evolves around.

Knowledge work. Bosch-Sijtsema *et al.* [2009, 534] define *knowledge work (KW*) in a composite way, based on literature: KW is *"relatively unstructured"* and *reflective of the changing demands of organizations* rather than of predefined rules and practices [Scarbrough, 1999 cited in ibid]. It is cited as *"non-routine, complex and situation-specific"* [Antikainen and Lönnqvist, 2005, Davenport *et al.*, 1996, Quinn, 2005 and Scott, 2005 cited in ibid]. It is also referred to as *"opportunistic, non-linear and improvisational"* [Heerwagen *et al.*, 2004 cited in ibid]. Finally, *"the use of new technologies"* is typical of KW – as is the work being *"autonomous and unpredictable"* [Pyöriä *et al.*, 2005 cited in ibid].

Software development work encompasses many of the elements that are used in defining the concept of knowledge work: It reflects the dynamically changing requirements of an organization and requires improvisation. It inherently utilizes (new) information technologies as well as deals with unpredictable, often complex situations. In sum, software work, and even more so software R&D, stand as excellent examples of knowledge intensive effort, which today is commonly conducted in a distributed, global setting [Lambgrets *et al.*, 2016, 1]. GSD thus provides an ideal scope and framing for examining the topic of distributed knowledge work.

Distributed software development. *Distributed software development (DSD)* is a scenario, where geographically dispersed teams collaborate in order to develop a product [Marques *et al.*, 2012, 134], such as a software application or component. This scenario often takes place due to global sourcing decisions made by a company. In literature, the terms *global software development (GSD)* and *global software engineering (GSE)* [e.g. Herbsleb *et al.*, 2001; Šmite and Wohlin, 2011] are also used. In this dissertation I mostly use the first two terms, DSD and GSD, depending on whether the emphasis is on the distribution element or the global nature of work.

Global sourcing. Šmite and Wohlin [2011, 17] explain sourcing and shoring types of GSE as follows: The term *sourcing* refers to two types of collaboration forms, *insourcing* and *outsourcing*. Insourcing means company-internal and outsourcing involves external, third-party collaboration. *Shoring* then denotes the distance or location of the collaborating site. *Onshoring* happens in the same country, *offshoring* in a different country, *nearshoring* in a neighbouring, near-by country and farshoring in a distant country. The two dimensions of terms can be combined, as we see in the next paragraph. [ibid]

In the theory gathering phase of the study no explicit distinction was made between *offshore outsourcing*[1] and *offshore insourcing*/*internal offshoring*[2]. This was due to two reasons: first, the main focus was on distribution of employees and the challenges presented by it, and secondly, the challenges between offshore outsourcing and internal offshoring *"have important similarities"*, although their emphasis may differ [Prikladnicki and Audy, 2012, 228] from case to case.

For the sake of simplicity, comprehensiveness and in acknowledgement of the recent evolution of global sourcing trends in IT and other professional services (which are discussed in the section *1.4. The evolution of global Information Technology and Business Process Outsourcing*), in this dissertation I opt for the term *global sourcing*, when referring to any form of the above defined sourcing activities, unless it is necessary to specify the form in more detail due to the context of the discussion.

Collaboration. *Collaboration* is defined as action, where two or more people, making a team, work together on an "*intellectual endeavour*" [Webster, 1992 cited in Kotlarsky and Oshri, 2005, 40]. Collaboration is successful, when the desired outcome, such as accomplishing project objectives or social gratification, is achieved through group effort [Kotlarsky and Oshri, 2005, 40].

Productivity. *Productivity*, another central concept in the study, is a complex term and it is being used in various, sometimes confused, meanings at work places, in the media and by people in general. Tangen [2005] has made a rich analysis on the use of this term and its neighbouring concepts of efficiency, effectiveness and performance in research. There are numerous ways of defining productivity. Seemingly, one of the most straightforward formulas is:

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[1] i.e. contracting services with an external organization located in another country [Prikladnicki and Audy, 2012, 216]

[2] i.e. contracting with a wholly-owned subsidiary located in another country [Prikladnicki and Audy, 2012, 216]

units of input / units of output [Chew, 1988 in Tangen, 2005, 36]

Productivity has also been defined as *"the ratio of the actual output to the expected resources used"* [Sink and Tuttle, 1989 in ibid] and as *"the ratio of the total income to the sum of cost and goal profit"* [Fisher, 1990 in ibid]. The term can also be defined in a more qualitative way, as *"the quality or state of bringing forth, of generating, of causing to exist, of yielding large result or yielding abundantly"* [Koss and Lewis, 1993 in ibid].

The above examples illustrate how the definition of productivity varies depending on the perspective and context of the speaker. In KW, we can rarely point the direct relation of input and output due to the numerous intervening, intangible, variables [Bosch-Sijtsema *et al.*, 2009, 536]. Thus, in this study productivity is understood as follows:

> *"Productivity means how much and how well we produce from the resources used. If we produce more or better goods from the same resources, we increase productivity. Or if we produce the same goods from lesser resources, we also increase productivity. By "resources", we mean all human and physical resources, i.e. the people who produce the goods or provide the services, and the assets with which the people can produce the goods or provide the services" [Bernolak, 1997 cited in Tangen, 2005, 36]*.

Based on an empirical examination of data from completed projects, it has been suggested that work dispersion has a significant effect on productivity and a secondary effect on quality [Ramasubbu and Balan, 2008 cited in Šmite and Wohlin, 2011, 17]. These effects may be difficult to specify, as KW itself is hard to measure with the traditional productivity measures, let alone when conducted in a distributed, networked team setting [Bosch-Sijtsema, *et al.*, 2009].

Dynamism. The *dynamic* aspect of GSD essentially means flexibly sourcing software development work through multiple sites, and scaling up operational excellence and innovativeness in the changing global work settings, sourcing environment and value networks in order to attain sustainable competitive advantage [see Ruohonen *et al*., 2014; Kamaja *et al.*, 2015]. Also knowledge itself, and the process with which a company creates, maintains and exploits knowledge to sustain that competitive

advantage can be seen as dynamic, where new knowledge is being created from existing knowledge in organizations [Nonaka *et al.*, 2000].

Dynamism can thus be seen at individual, team, organizational and operating environment levels: For example, dynamism is relevant at work and task level, where people change from one job to another as a result of job rotation or other production requirements. The jobs change and new knowledge needs to be acquired and existing knowledge disseminated to and by team members. At the same time, in the other end of the continuum, the whole operating environment and the sourcing network can be dynamically changing in terms of sourcing partners and market conditions for instance, which means that organizational practices need to be effectively and actively re-coordinated, re-integrated and re-reconciled time and time again.

1.4. The evolution of global Information Technology and Business Process Outsourcing

In order to provide a broader societal context and background for the study, this section briefly looks at the evolution and current discussion that is ongoing in the arena of global outsourcing and offshoring of knowledge intensive work. The question is no longer about shipping away some *"low-end IT functions"* from the United States to India [Lambgrets *et al.*, 2016, 1] with hopes of cost savings. Instead, the flow is now referred to as a *"large scale migration of multi-various service production activities from advanced to emerging economies"* [ibid].

The important advances in information and communication technologies (ICTs), such as digitization of business processes and the related services, have greatly impacted on the increased tradability of service products, which in turn has significantly contributed to this change in services production. The more and more skilled and educated work force of the Global South and the reduced trade barriers further enable this progression. [Lambgrets *et al.*, 2016, 1]

This change in the composition of outsourcing and offshoring activities is turning the western-lead production relocation process towards more intricate relationships of production partnering in South and Southeast Asia [Lambgrets *et al.*, 2016, 6]. This requires a more refined division of competent resources [ibid] as well as sophisticated and in-depth collaboration between partners and other stakeholders. Furthermore, along with the expansion and growing maturity of the industry, increasingly efficient allocation of resources is sought for [ibid], which emphasises the importance of dynamicity in the equation.

Heinz-Paul Bonn, the vice president of BITCOM, Germany's digital association in software, IT and telecommunications industries sees that *"the role of professional services within the IT industry has both changed in its structure and at the same time continuously increases its relevance"*. As the globally distributed delivery model has become the mainstream in the industry of professional services, new and stronger relationships not only between companies but also between national bodies can be expected to form. [Bonn, 2012]

In a similar manner, Som Mittal, the president of NASSCOM, the National Association of Software and Services Companies, a trade association of Indian IT and BPO industry, notes that while global sourcing is still driven by objectives, such as cost competitiveness, faster time to market and access to specialized talent, the industry is also going through a transformation. The transformation shows in reduced deal sizes, emergence of small and medium customers, mergers and acquisitions and alternate business models. [Mittal, 2012] These forms of transformation can be seen as signs of more dynamic global sourcing as the mainstream, deeper partnering and collaboration in the face of increased global competition, and availing of business opportunities opened by digitalization [for the latter see e.g. Ingalsuo, 2015; Ruohonen *et al.*, 2016].

1.5. The context of India

Today India is a competitive exporter of software services, and it is said to lead the developing countries in knowledge intensive software R&D activities [Kumar, 2014, 143]. India is also quoted as one of the world's most important locations for globally sourced IT-intensive services production [Asian Development Bank, 2012, Dossani and Kenney, 2007, 2009, World Bank, 2007 cited in Lambgrets, *et al.*, 2016, 5]. NASSCOM names India as the *"leading global sourcing hub"* of IT, BPO and engineering service providers and the in-house centres of multinational companies. The service provider industry of India is considered as matured, which is reflected by their *"focus on innovation, domain skills, global delivery model, and operational excellence"*. [Mittal, 2012] Kumar [2014, 147] writes that India's software industry *"has come of age"* what comes to its level of capabilities, sophistication, range of global reach and offered services. Therefore, India as a case location is well-grounded and relevant. The following paragraphs provide brief information of the country as a background for the field work, data collection setting.

India is a country of colours and contrasts. The country has a mind-boggling number of citizens at approximately 1,295 billion [The World bank, 2014]. It has 27 states and 15 official languages. Hindi is the most widely spoken and the primary language of approximately 41% of the people. English

has a well-established standing and is a subsidiary official language. It is also the most important language for the national, political and commercial communication. Additionally, a huge number of regional dialects are spoken. The main religion in India is Hinduism with 79,8% of the population, followed by Islam with 14,2%, Christianity with 2,3% and Sikhism with 1,7% of the people. Additionally, 2% of the population practice other or unspecified religions. India seceded from the British rule in 1947. [Central Intelligence Agency, 2016]

India's economy is likewise varied with traditional village farming, modern agriculture, handicrafts, and a wide range of modern industries and services. Approximately half of the workforce is in agriculture. However, two thirds of India's output come from the services sector. It is a major source of the country's economic growth, and India is a significant global player in the export of IT and business services as well as software workers. [Central Intelligence Agency, 2016] In 2014 the software industry still covered only a marginal share of India's Gross National Product (GDP), but the share is constantly growing [Kumar, 2014, 146]. Despite the on-going societal development and economic growth, still close to 30% of the population lives below the poverty line. [Central Intelligence Agency, 2016]

Historically, as a business environment India is known to have heavy bureaucracy, which severely hindered entrepreneurial investment until the 1990s. Also, developing the physical infrastructure of the country was not in the focus of national and local governments, which still shows in the quality of the country's roads, power grids and airports. [Engardio, 2006, 9] During the recent years the infrastructure has improved, however, and for example the airports in big cities such as Delhi and Bengaluru, have been modernized. Also a large number of business and software technology parks (STPs) specializing in providing office spaces and communication links [Kumar, 2014, 148] for the needs of multinational corporations have risen in the outskirts of cities like Mumbai, Bengaluru, Delhi and Hyderabad [cf. Kumar, 2014, 179].

The Indian government has made large investments in building local and enterprise-level technological capability and human resources development infrastructure especially in the fields of engineering and science technology [Kumar, 2014, 161, 166]. Consequently, the country possesses a large resource of talented and English speaking scientists and engineers educated from organizations such as Indian Institutes of Technologies (IITs) and Indian Institute of Science (IISc). Workforce-wise India

is also cited to have a "*top-notch, globally minded managerial talent"* educated in institutions such as Indian Institutes of Management (IIMs). [Engardio, 2006, 9; Kumar, 2014, 161]

Finally, from a research perspective as a data collection location, India is relatively distant from Finland both geographically and socio-culturally speaking. By utilizing Geert Hofstede's well-known framework of cultural dimensions [The Hofstede Centre], we can get an overview of the general differences between the cultural approaches in these two societies. The scores for six cultural dimensions, *power distance, individualism, masculinity, uncertainty avoidance, long term orientation* and *indulgence,* in India and Finland are portrayed in Figure 1.

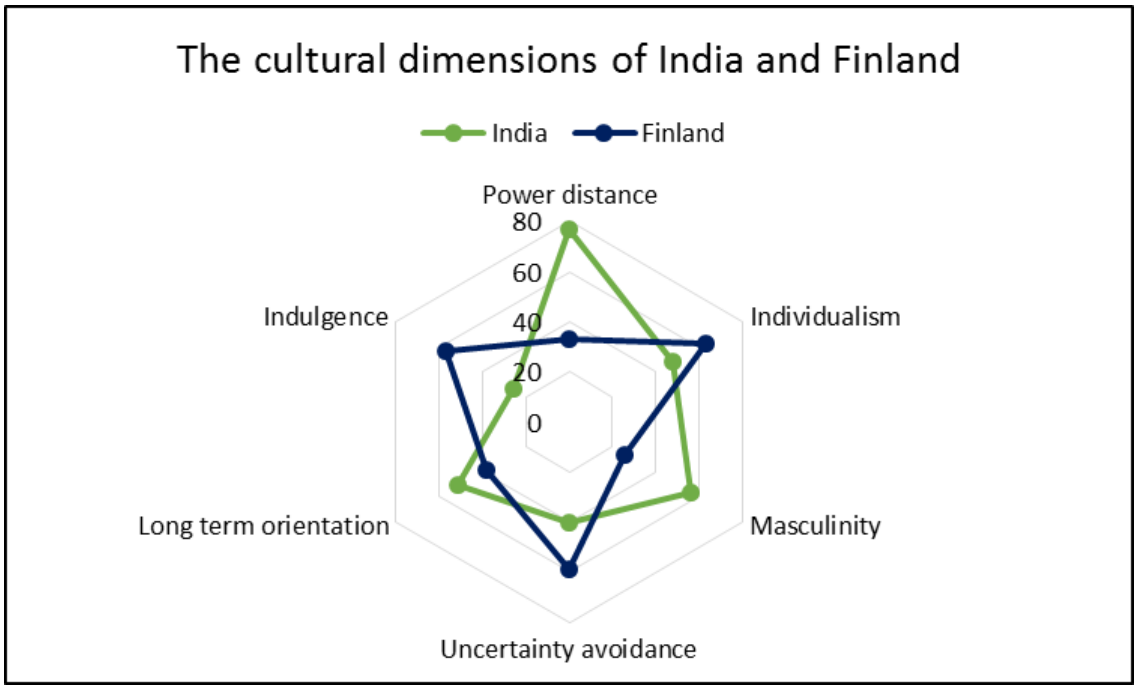

Fig. 1. The cultural dimensions of India and Finland [applied from The Hofstede Centre].

At this time, I will not go deeper into discussing the dimensions nor analysing the differences between the two societies. Instead, the purpose for addressing the matter here is in acknowledgement of the fact that there *are* various cultural distances present, when conducting research in an international, inter-continental environment, and that these distances should be prepared for, when collecting, analysing and interpreting data. The socio-cultural distances manifest both as an area of inquiry of the thesis and as an integral element within the study itself. The topic of socio-cultural distances from the DSD work point of view is discussed in the literature review section *2.1.2. Socio-cultural distance*. Additionally, the India-Finland axis will be addressed towards the end of the dissertation in the *Discussion,* section *6.4. Revisiting the India-Finland axis.*

2. Literature review

The value of a literature review is in increasing the understanding about the topic under investigation, synthetizing previous studies as well as providing a view of the present state of research while exposing areas where further inquiry is required, as is noted by a number of authors [Järvinen, 2008, 13; Rowe, 2014, 242-243; Webster and Watson, 2002, xix]. This sets the overall objective also in this literature review.

The context specific goal of the review was to gain enough understanding of the topic in order to draft a comprehensive interview structure with a suited scope to meet the information needs of the study, DD-SCALE research project and case company. The scope and objectives of the literature review are set in the first research question, a):

> *What are the factors, which affect collaboration and productivity in teams that work in distributed software development…*
>
> *a) …according to the previous research in the field of global software development?*

Thus team related issues and collaboration among parties within the discipline of DSD were in the centre of the review.

The issues discussed in this section were initially examined in a working seminar paper entitled *Factors Impacting Successful Collaboration and Productivity of Distributed Software Development Teams: A Proposed Multidimensional Concept Map* [Löytty and Ingalsuo, 2015]. The paper was presented in the 38th Information Systems Research Seminar in Scandinavia (IRIS38) in Oulu, Finland in August 2015. This section presents the refined and revisited contents of that paper.

The literature review was conducted by following the below steps:

1. *Source*: Literature was searched by using the Nelli Portal of University of Tampere Library. The combined search included the EBSCOHost Academic Search Premier, Emerald, ACM Digital Library and IEEE/IET Electronic Library -databases.

2. *Search terms*: Keywords such as “distributed software development”, “distributed software”, “global software” and “distributed teams” were used for the search. The keywords were chosen in order to get an overall view of the problem domain within the scope of DSD work.
3. *Selection*: The resulting papers were overviewed. The papers discussing collaboration in distributed teams were selected for further analysis.
4. *Additional literature*: Additionally, the reference lists of the most relevant papers were studied to identify potentially important sources that may have not appeared in the database searches.
5. *Analysis*: The selected papers were investigated to identify the factors impacting the distributed software development team collaboration.

The following sections present the findings of the analysis by first examining the influence of physical, temporal and socio-cultural distances, as has been learnt from the literature. After that the different influencing factors identified to stem from the team, organization and operating environment levels are discussed. The review is concluded with a concept map that aims to synthesize the findings.

2.1. Making sense of the distances in distributed software development

In their review of literature da Silva et al. [2010, 87] find that management of software development in a distributed setting is recognized as more demanding than if the collaborating parties were co-located with each other: According to literature, distributed setting adds new variables and related challenges to software project management, which in itself is already complex. In practice, physical and geographic distance, social and cultural differences, as well as time zone differences cause hindrances in communication, collaboration, problem solving and trust. [Binder, 2007, Carmel, 1999, Krishna *et al*., 2004, Macgrecor *et al.*, 2005, McBride, 2005, Nidiffer and Dolan, 2005 cited in da Silva *et al.*, 2010, 87]

Previous research structures the challenges in DSD in a number of ways: For instance, communication, cultural differences, coordination, time zone differences and trust have been identified as the most important areas relating to challenges in DSD [da Silva *et al.*, 2010, 94]. It is also said that boundaries causing difficulties in globally distributed software activities are temporal, geographic, social, cultural, historical, technical and political in nature [Orlikowski, 2002 cited in Yalaho and Nahar, 2010, 1]. Further, cultural, technical, infrastructure, time zone, methodological and language differences are named as the significant barriers between domestic and offshore suppliers [Rottman and Lacity, 2006]. The challenges in distributing work have also been grouped in two categories: 1)

product management, which mainly concerns the version management and integration of artefact components, and 2) work management, which relate to the team work issues, such as the quality of communication and documentation [Jaakkola *et al.*, 2010, 789].

Even though many of the challenges in DSD are present in collocated work too, in a distributed setting they are amplified by the geographic dispersion, which causes physical distance, organizational and cultural differences, and time-zone issues [Sengupta *et al.*, 2006, 734]. It could be deduced that most of the challenges in DSD work, especially in a global context, come back to the *temporal*, *physical* and *socio-cultural* distances [Šmite and Wohlin, 2011, 17; Carmel, 1997, 446; Lanubile, 2009, 177]. This notion lays the basis for the proposed concept map: It is suggested that factors impacting the success of collaboration in DSD work are all at least to some degree influenced by physical, temporal and socio-cultural distances. Those distances are discussed in more detail in the following paragraphs.

2.1.1. Physical and temporal distance

Sengupta, *et al.*, [2006, 731] draw that many of the challenges in DSD work can be traced back to inadequate informal communication between team members who are separated by physical and temporal distances: According to studies, the frequency of communication drops off sharply due to physical separation, and particularly so in a multi-site environment. When added with the reduced time window of synchronized communication caused by differences in time zones [ibid], information flows may become irregular, which is said to lead to misalignment and rework [Herbsleb and Moitra, 2001 cited in ibid] While the time zone differences allow the "follow-the-sun" approach, the drawbacks can be more serious than the benefits: the lack of overlap in working hours means that there is less time for synchronous communication across sites [Meadows, 1996 cited in Carmel, 1997, 449].

It is known that communication and coordination issues particularly in large software projects are significant, and research suggests that they get disrupted when operating across sites. Not only takes cross-site work longer, but it also requires more human resources for a job that is of equal size and complexity in comparison to operating collocated. It has been found that there is a strong relationship between delay in cross-site work and how much remote colleagues are perceived to help each other when the workload is heavy. [Herbsleb *et al.*, 2001, 81, 89]

A gap between a query and an answer can increase stress and causes inefficiency in time critical tasks, especially if parties collaborate across several time-zones [Lee-Kelley and Sankey, 2008, 53].

Additionally, a time-zone difference can create unreasonable working hours for the offshore party [ibid, 59], which among other factors again may increase the associated overhead [Šmite and Wohlin, 2011, 18].

Further, Bell and Koslowski [2002 cited in Lee-Kelley and Sankey, 2008, 51] note that physical distance causes reliance on technology in communication, which is seen to impede performance management and team development. The level of physical dispersion has also been found to have a relationship to difficulty in monitoring group behaviour and interaction [Ebert, 2007, Paasivaara and Lassenius, 2003 cited in Prikladnicki and Audy, 2012, 218]. It is aptly remarked that distance "amplifies dysfunction" and can "dilute leadership" [Davis, 2004 cited in Lee-Kelley and Sankey, 2008, 53].

2.1.2. Socio-cultural distance

Software development is expert work executed in closely collaborating teams. The business and the work itself is becoming more and more internationally oriented. Distributing expert work increases its difficulty, and even more so, if the participants represent different cultural backgrounds. [Jaakkola *et al.*, 2010, 789] Cultural distance is not limited to differences in national cultures but it also encompasses the distance in organizational cultures [Prikladnicki and Audy, 2012, 226]. In addition, multiple cultural levels have been identified to guide people in their ways in a business context: organizational culture, organizational subculture, subunit culture, work culture, professional culture, project culture and team culture [Jaakkola *et al.*, 2010, 791]. The list is not exhaustive, and many more could be added. Thus, rather than speaking of cultural distance, the term socio-cultural distance is appropriate in encompassing differences in norms, practices, values and spoken languages [Lanubile, 2009, 177].

In offshore outsourcing projects, culture has been named even as the most influential perceived risk factor. Culture is difficult to quantify and systematize due to its intangible characteristics. [Ramingwong and Ramingwong, 2011, 1] Among the reported challenges caused by cultural differences are the divergence in attitudes, perception, collaboration, communication and other project related aspects, which may cause conflicts and misunderstandings. [Schmidt *et al.*, 2001, Minevich and Richter, 2005 cited in Ramingwong and Ramingwong, 2011, 1] Literature also shows that if the team members do not have enough understanding of how cultural differences impact work, challenges affecting communication process, coordination and trust acquisition may arise [Carmel, 1999, Höfner and Mani, 2007 cited in Prikladnicki and Audy, 2012, 220].

Cultural distances reach deep into organizations' practices, and as Herbsleb *et al.* [2005, 530] discovered, even subtle cultural differences complicate communication and may lead to frustration and misunderstandings. Further, corporate, technical and national cultures each play a role, appear it in email response times and etiquette, willingness to admit problems or the general level of openness. Language, cultural preferences, coding standards and documentation styles may vary [Lee-Kelley and Sankey, 2008, 53; Bhattacharjee *et al.*, 2013, 164]. There are also differences in conception of time and urgency, confrontation avoidance and general straightforwardness [Lee-Kelley and Sankey, 2008, 55, 60].

Additionally, members of a global team may fall into different places in competing values models [Lee-Kelley and Sankey, 2008, 54]. If cross-national teams have no extensive experience in international work [Milliman *et al.*, 2002 cited in Lee-Kelley and Sankey, 2008], this may happen without the employees even being aware of it. With the support of Jarvenpaa and Leidner [1998] Sengupta *et al*. [2006, 732] write that cultural division may distract team cohesion, which then may lead to less trust, poor cooperation and conflicts. These issues show especially in communication intensive activities, such as requirements analysis and management [Sengupta *et al.*, 2006, 732].

All this can manifest itself in product defects, if not addressed properly, which creates costs and reduces stakeholder confidence [Bhattacharjee *et al.*, 2013, 1], and can thus severely hamper productivity. What more, it may be difficult to distinguish whether an organization is dealing with people issues or differing concepts of quality, which creates an extra challenge for management. Culture is hard to change, and therefore different management and relational strategies are required in a GSD setting. [Lee-Kelley and Sankey, 2008, 60]

2.2. Factors identified to impact the success of collaboration – a multi-layered view

The following paragraphs propose that atop the physical, temporal and socio-cultural distances present in DSD work, there are elements which directly impact the collaboration of geographically distributed teams. If successfully managed, they can support collaboration, but if lacking or misdirected, they effectively act as hindrances. The extent of their effect is situation and context dependent, and they are influenced by the underlying distances. The factors can undoubtedly be grouped and investigated in various ways, depending on the emphasis and perspective. In this study they are perceived as three dimensions, or levels, surrounding the core concept of *distributed team collaboration:* First, there are factors originating from *the team level*, which are human related. Next, there are factors

originating from *the organizational level,* which the team is a part of, such as management practices, technical factors and project factors. Finally, there are factors originating from *the operating environment level* of the organization, as are the offshoring country or competition specific characteristics. The following sections discuss these factors based on literature.

2.2.1. The team level factors

Team level factors have been identified as important in determining the success or failure of an offshore project, as they impact the knowledge integration in offshore teams, and greatly influence team member communication and interaction [Balaji and Ahuja, 2005 in Yalaho and Nahar, 2010, 1]. Likewise, Sengupta *et al.* [2006, 733] note that people aspects are very important in distributed projects. Interestingly, a number of studies have perceived social aspects as *"constraints on globally distributed collaboration"* [Kotlarsky and Oshri, 2005, 37], and also as a challenge to coordination of distributed collaborative work [Kotlarsky and Oshri, 2005]. The team of distributed workers has been characterized as *"a community of strangers"* [Gupta and Fernandez, 2011, 185], which in the light of the argument that *"software development is an inherently collaborative activity"* and the well-grounded view that collaboration between different stakeholders is essential for successful software development [Sengupta *et al.*, 2006, 734], constitutes a difficult equation.

The findings from studies that investigate people related aspects in DSD seem to be intertwined. For instance, shared knowledge and knowledge sharing could be seen as next of kin in that knowledge sharing is something that acts as an antecedent for achieving shared understanding. Indeed, a lack of context sharing and difficulty in gaining shared understanding have been reported as issues in distributed settings [Prikladnicki and Audy, 2012, 223; Sengupta *et al.*, 2006, 733] among other people related aspects. Bhattacharjee *et al.* [2013, 164] in turn identified that domain knowledge, which needed to be shared between teams, was scattered around global locations. They also noted that requirements understanding was out of sync between global stakeholders.

The overall importance of knowledge sharing in collaborative work has been established in previous studies, as Kotlarsky and Oshri [2005, 39] write. For instance, Storck [2000 cited in Kotlarsky and Oshri, 2005, 39] recognized knowledge sharing as important to trust building and group work effectiveness. Knowledge management challenges hamper timely sharing of knowledge and reduce opportunities for knowledge reuse in distributed setting [Sengupta *et al.*, 2006, 732].

With regards to application knowledge, two sources have been identified: the formal one, such as the official software artefacts, test cases and specifications, and the informal one, such as informal documentation or field notes. The latter form includes a human agent, for example the developers or users of a system. [Sengupta *et al.*, 2006, 735] This too gives weight to the importance of human related aspects in DSD work. It is therefore important that team members' efficiency and willingness to communicate are supported [Lee-Kelley and Sankey, 2008, 61]. Investing in face-to-face meetings, temporal collocation and exchange visits, as well as enabling effective, frequent communication through synchronous interaction has been recommended [Šmite and Wohlin, 2011, 17-18]. Naturally, also the individual team member attributes, such as skills and expertise, and determination and outcome orientation [Lee-Kelley and Sankey, 2008, 51], have an impact on the success of team collaboration and overall productivity.

Based on previous studies Kotlarsky and Oshri [2005] ground that a team's effectiveness depends on the effectiveness of communication, which is dependent on the quality of trust among the team members. Further, trust is identified as the foundation, but also as most difficult to establish at a distance. [Smith and Blank, 2002 cited in Kotlarsky and Oshri, 2005, 39] Further on, *"trust is more likely to be built, if personal contact, frequent interactions and socializing between teams and individuals are facilitated"* [Arino *et al.*, 2001, Child, 2001 cited in Kotlarsky and Oshri, 2005, 39]. Developing rapport is also perceived a significant element of collaborative work. Together trust and rapport help build social ties, which along with knowledge sharing were on average associated to successful collaboration to the same extent as collaborative tools among informants in their study [Kotlarsky and Oshri, 2005, 41, 43]. The researchers thus suggest that human-related issues, namely social ties and knowledge sharing, are some of the key factors in successful collaboration – together with technical solutions [Kotlarsky and Oshri, 2005, 43-44].

Informal communication is seen as yet another important enabler of collaboration. It is noted that distribution significantly reduces the informal communication and visibility between team members, and in turn increases the time and effort required in interaction. [Seaman and Basili, 1997, Herbsleb and Mockus, 2003 cited in Gupta and Fernandez, 2011, 185]. Positive people related outcomes and successful remote collaboration can be supported by open and rich informal communication channels, encouragement of interactions between parties and team cohesion [Hoegl and Gemuenden, 2001, Nelson and Cooprinder, 1996, Gallivan, 2001 cited in Kotlarsky and Oshri, 2005, 40]. Means such as face-to-face meetings, social spaces, clear communication procedures, regular meetings and

a variety of communication tools are proposed [Kotlarsky and Oshri, 2005, 45]. Specifically, informal communication is noted to help to disseminate project knowledge, familiarize people with working styles of and build general understanding between team members [Sengupta *et al.*, 2006, 731].

Finally, by examining various literature in the field, Espinosa *et al*. [2007] discuss the concept of team awareness, which I briefly aim to summarize here: Team awareness can be seen as a real time perception of what is happening in a team or task environment. It is an important factor among the human related, team level aspects: Knowledge of an upcoming deliverable deadline and knowledge of the progress of a development phase helps in synchronizing one's actions in a team. The writers also quote Endsley [1995 cited in Espinosa *et al.*, 2007, 141], who defines team awareness as *"understanding of the activities of others, which provides a context for your own activity"*. This is stated as especially important in interdependent activities, and has been described as a shift from individual to shared activities, as it helps to understand the required sequence, timing and temporal limitations of the team. Being aware of the relevant task activities of others can help team members to coordinate their work more effectively in a distributed setting. Furthermore, it is important to be able to locate and contact the right people, when engaged in interdependent tasks. [Espinosa *et al.*, 2007, 140-142]

2.2.2. The organizational level factors

The factors perceived to belong to the organizational level, such as the management practices, technical factors and project factors, are presented in the following paragraphs.

Management practices. Management practices, such as organizational and software processes, work mechanisms and team organization can have a central role in supporting or hindering distributed team collaboration. Challenges in management agenda, asymmetry of processes as well as unclear roles and responsibilities are identified in distributed projects [Lee-Kelley and Sankey, 2008, 58-59; Prikladnicki and Audy, 2012, 222]. Similarly, uneven workload of teams and coordination and managerial overhead may reduce the benefits of DSD [Šmite and Wohlin, 2011].

Process differences between parties can lead to problems in task synchronization and system integration. Deployment of consistent processes has been found important. [Sengupta *et al.*, 2006, 732-733] Yet, in a literature review conducted in 2010 it was discovered that most organizations still manage distributed projects using the same methods, processes and tools, as in co-located projects [da Silva, *et al.*, 2010, 87]. Especially in the beginning of a relationship, offshore suppliers have been expected

to require more micromanagement than local suppliers in order to mitigate higher risk, build trust and coordinate remote and often culturally diverse teams [Rottman and Lacity, 2006].

One of the risks increased by team distribution is that functionally divided teams create silos causing inefficient information flow. Multiple handoffs between silos and locations cause bottlenecks and miscommunication, which easily results in work moving in lumps and information not reaching all the parties. [Chandrasekaran *et al.*, 2014, 2-3] To tackle these issues Chandrasekaran *et al.* [2014, 3-4] suggest breaking down the silos by organizing teams in cross-functional "work cells" instead, where each team would have a full responsibility of their modules, and which would potentially result in increased individual and collective accountability, better communication and coordination, as well as shorter iteration times.

Examples of work mechanisms for the support of productive distributed teams include implementing short and incremental development cycles to facilitate effective feedback loops and ensure team focus [Sengupta *et al.*, 2006, 733; Šmite and Wohlin, 2011, 18], tailored personal development programmes and team-building exercises to support cultural awareness and empathy [Lee-Kelley and Sankey, 2008, 61], commonly defined and followed coding standards to ensure quality [Bhattacharjee *et al.*, 2013, 166], and creating and maintaining a glossary of common terms [Sengupta *et al.*, 2006, 733]. Additionally, the management should show strong commitment to addressing human related issues and dedicate resources for renewal of social relationships [Kotlarsky and Oshri, 2005, 45]. This supports the idea that in conjunction to directly impacting the collaborative activities of the team, the management practices also impact the collaboration through strengthening the human related aspects.

Technical factors. Together with the work processes and mechanisms, an organization offers its teams the technology, tools and infrastructure for operation. Information and communication technology (ICT) is identified as an enabler that eases and reduces the cost of offshore software development [Yalaho and Nahar, 2010, 11]. It is said to be the engine of a distributed collaborative organization. The ability to recognize the optimal technology is key to its success [ibid] which in general terms today is rather self-evident. Investing in reliable infrastructure, a centralized (data) repository, common configuration management tools, and rich communication media, is recommended [Šmite and Wohlin, 2011, 17-18]. Even though there are advanced collaboration tools available in the market, it is suggested that the usage of those tools has been *"suboptimal"* with *"insufficient value leveraged"* from them in organizations [Gupta and Fernandez, 2011, 1].

Having different tools [Prikladnicki and Audy, 2012, 222] and different versions of tools at different sites [Lee-Kelley and Sankey, 2008, 59], lack of standardization and infrastructure to support distributed work [Prikladnicki and Audy, 2012, 223], lack of common brainstorming forums [Bhattacharjee *et al.*, 2013, 164] and challenges in network speed and connectivity [Sengupta *et al.*, 2006, 732] are some of the technical perils faced in DSD. When successfully chosen, implemented and applied, tools can be used for learning the expertise of different teams [Sengupta *et al.*, 2006, 736], increase the ability to find experts and ease asynchronous, informal and clear communication [Herbsleb *et al.*, 2005, 532; Herbsleb *et al.*, 2001, 89].

Project factors. Project related factors that impact the distributed team collaboration include project type and characteristics, such as the complexity and interdependency of project components, as well as its sourcing strategy, for example, how many and which locations are involved in different project activities.

Prikladnicki and Audy [2012, 218, 220] review literature in their discussion on project and distribution strategy specific aspects: The activities that should be performed differ between a maintenance project and a new, from scratch, development. Certain sites may be more appropriate to certain type of work, and it is possible that not all projects should be distributed at all. The latter notion relates to the strategic challenge of how to distribute work across sites [Sengupta *et al.*, 2006, 732]. Based on their review Prikladnicki and Audy [2012, 220] maintain that there is a lack of decision and distribution models to support decision making in project allocation, which together with an inability to assess project specific characteristics create challenges in DSD.

Similarly, it is argued that distributed collaboration results depend on the nature of the work, such as independency or integration of tasks. It is therefore important to distinguish the different project types, when evaluating project success. [Šmite and Wohlin, 2011, 17] For example, how well does the follow-the-sun approach serve large, complex activities that require high interdependency and close coordination among work streams [Conchúir *et al.*, 2009 cited in Šmite and Wohlin, 2011, 17] [see also Chandrasekaran *et al.*, 2014, 4-5]? Keeping the task dependencies low across sites, for example by the means of architectural decisions, is suggested [Šmite and Wohlin, 2011, 18].

2.2.3. The operating environment level factors

The final level in the constructed concept map, the operating environment level, is a broad area, and in this thesis its handling is limited to considering the country specific characteristics in GSD, and the potential competition between collaborating parties – together labelled the sourcing partner related factors. Thorough handling of this area would require a broader scope for the literature review. The area is, however, brought up in this study as an entity of factors that affect the GSD collaboration, and that thus needs to be considered, when examining the topic.

Possible competition between collaborating parties can affect how distributed projects succeed at many levels: There may be competition in the marketplace; there may be competition between delivering parties; there may even be competition for jobs [Herbsleb *et al.*, 2005, 525-526]. Things like organizational structures, organizational cultures, development methodologies, policies and standards, measurement techniques and metrics [see Prikladnicki and Audy, 2012, 220] used all affect the competitive stance of the parties. Benefits gained from common coordination may not be clear to all. This is seen to even affect the product structure, which can be based on personal and political reasons rather than technical. [Herbsleb *et al.*, 2005, 526]

In a wider perspective, country characteristics play their role in affecting the collaborative activities of globally distributed teams: the level of technological development, cultural diversity, communication styles, ways of pursuing one's career, the number of experts available in the market, quality of education, cost factors and even the political environment to name but a few [e.g. Ruohonen *et al.*, 2014; Deshpande and Richardson, 2009]. On the one hand, it could be said that the socio-cultural distance present in DSD setting would already be inclusive of these characteristics. On the other hand, different countries possess profoundly different, unique, characteristics that may have a significant effect on collaboration and the overall sourcing decisions. Therefore, the country characteristics are brought up as their own entity.

2.3. Synthesizing the findings

Based on the findings of the literature review, a concept map was drawn, as presented in Figure 2. The map presents the factors that were found in the literature to impact distributed team collaboration and thus its productivity, as a response to the research question of the literature review.

The concept map denotes the different levels of operation that those factors originate from in relation to the team. The temporal, physical and sociocultural distances often inherent in distributed team work are positioned in the outer square of the map to indicate that they influence the distributed team collaboration at the background. The factors originating from the team, organization and operating environment levels are presented surrounding the core concepts of distributed team collaboration and productivity. In sum, it can be seen that the factors impacting successful collaboration and productivity of DSD teams are numerous, intertwined and originate from various levels of the DSD setting.

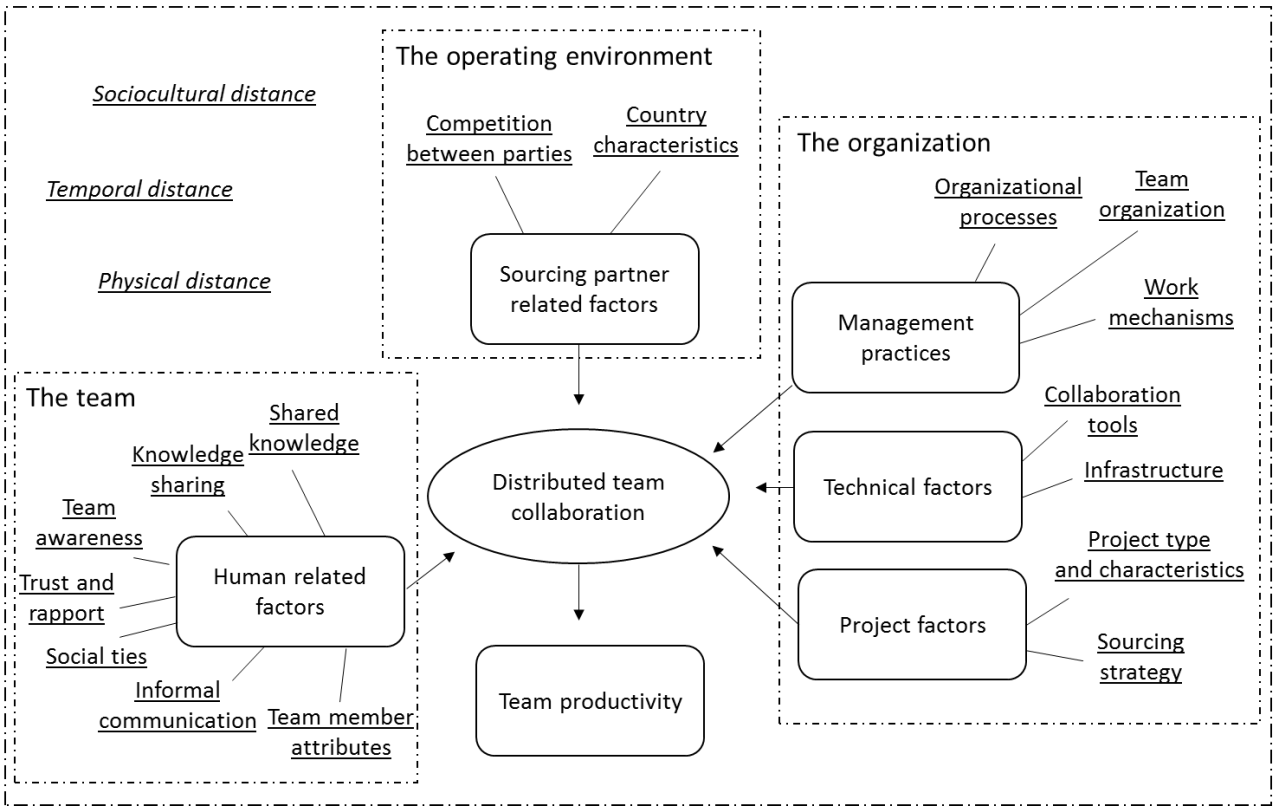

Fig. 2. A concept map of factors that impact collaboration and thus productivity of distributed software development teams, based on literature [originally in Löytty and Ingalsuo, 2015]

This result from the literature review facilitates understanding of the problem domain, and provides a multidimensional frame for further research on the topic. The literature on DSD team collaboration approaches the topic with various perspectives, and therefore offers multifaceted findings that may

be difficult to synthesize. In the preceding sections I have aimed at integrating the different elements identified in literature into a single-view concept map.

The literature review could be further developed by aiming to systematically harmonize the concepts and minimize the possible overlaps and duplicates between them. Harmonization could be done both in relation to the literature and within the concept map itself. Also, the levels and dimensions could be further evaluated in terms of linkages, divisions and inclusions. Questions, such as do the management practices impact the team collaboration through the human related factors, or do they impact the collaboration directly, could be asked. It could also be examined, which of the factors have the most importance according to literature, and which of the areas have the widest consensus among the research community. Finally, it could be examined, what kind of emphasis should be laid on the relations and causality between the concepts. Taking these measures would direct the results from the understanding and sense making sphere towards explaining the problem domain [Rowe, 2014].

However, as the main goal of this examination of literature was to provide a frame and support for devising an appropriately comprehensive and focused interview structure, the current level of detail and depth was considered suitable. The dissertation moves forward by introducing the methods of the empirical part, including the case, data collection plan and its realization in the next section.

3. Data collection methods

The issues discussed from section onward (apart from the sections 5.1 through 5.7) were initially examined in a working seminar paper entitled *Mapping the Collaboration and Productivity Factors in Distributed Software Development Teams – An Interview Study in India* [Löytty and Ingalsuo, 2016]. At the time of writing this thesis, the paper was accepted to be published in the 39th Information Systems Research Seminar in Scandinavia (IRIS39) in Ljungskile, Sweden in August 2016.

A single-case study with multiple informants was chosen as the approach to answer our second research question, b):

> *What are the factors, which affect collaboration and productivity in teams that work in distributed software development…*
>
> *b)…according to the empirical findings of interviews at a global software development centre operating in a dynamically and globally networked business environment?*

Case study is especially useful for understanding complex, social phenomena – such as collaboration in a distributed organization – within a real-world context. [Yin, 2014, 4] Case study is a suitable method for research asking *"how"*, *"why"*, as well as for exploratory *"what"* questions [Yin, 2014, 9-11]. The research question of this dissertation is considered to be an exploratory *"what"*, as we are examining context dependent matters that are expected to be at least partly intangible and even hidden to certain degree. Moreover, the research objects are anticipated to be embedded in the daily operation and collaborations between people within a complex operating environment.

The empirical data collection was conducted by qualitative theme based semi-structured interviews. A semi-structured interview provides deep knowledge of the phenomenon under investigation and it is suitable when the number of participants is relatively small [Hirsjärvi and Hurme, 1982, 38; Tiainen, 2014, 2]. The advantage of this kind of an interview is that as it progresses based on themes, instead of strictly defined questions, it allows for the interviewees voice to arise while diminishing the voice of the researcher. The method also considers that people's interpretations of things, and the meanings that they give to those things, are central. [Hirsjärvi and Hurme, 2011, 48]

The goal was to achieve in-depth data of the research problem with a limited number of informants. The aim was to conduct the interviews without narrowly predefining the scope of the discussions and thus allowing for new and potentially important themes to emerge. Based on these rationale, approaching the topic from a case study perspective and conducting semi-structured interviews were regarded as appropriate for answering the research questions.

3.1. The case: Collaborative work on complex software products in a multi-location environment

The case organization is a large company that operates globally in multiple locations across the continents. The company's sourcing strategy can be characterized as being networked and multi-site with internal on-, near- and offshoring sites as well as external partners located around the world. The company has been engaged in global operation for years, and thus as an organization has extensive experience in operating with remote stakeholders from a variety of cultures. The company develops and maintains large and complex software and hardware products and systems which are marketed to business clients. The company has clearly defined and relatively matured business and software development processes that are applied across its internal locations.

The company is considered a fit case for this study, as it has insight and relevance on the topic of dynamically distributed, collaborative knowledge work. Also, it is a representative case in the domain of GSD due to the various globally distributed activities it has engaged in in the course of years.

3.2. The data collection plan in India and Finland

The objective was to achieve a set of data that would be representative and reflective of the essential characteristics of the research topic [Tiainen, 2014, 18]. Data that would uncover the topic from several angles, and show a wide spectrum of views [ibid], within the problem domain was aimed for. To meet this requirement, the interviewees were selected from different functional, product and process areas within the case organization. This decision could be described as one aiming for horizontal diversity.

The study also aimed to achieve data that would be commensurable in terms of the organizational level of the informants. Therefore, all the interviewees were selected from managerial levels. This could be characterized as an aim for vertical uniformity. This decision was made, as the managerial view was considered appropriate for providing a broad understanding of the topic.

Further, the plan was to interview people with substantial experience in working in the industry of software development in a globally distributed setting. It was essential that the interviewees have a developed understanding of the potential challenges in and factors that support successful collaboration and productivity in multi-site software work. Initially, the plan was to interview approximately five people working at a software R&D location in India and after that their counterparts working at a site in Finland to incorporate a comparative view to the research.

The concept map that was presented in the previous section provided the theoretical frame for the interview planning. Simultaneously, the aim was to formulate the questions so that the interviewees would be able to relate to the concepts and describe the phenomenon based on their experiences and views. Therefore, concepts commonly used in the industry and the case organization were adopted during the process. This would lean towards Deetz's [1996, 195-196] "local/emergent" approach, where the concepts used emerge from the organization rather than purely from the theory. This essentially leads to *"practical"*, *"knowing how"* type of knowledge [ibid]. The interview plan was reviewed by the case company representative and among the researchers prior to the interviews.

The interview questions were built around seven themes that were formulated based on the theoretical frame. The planned interview themes were:

1. *Background information*: the organizational role of the interviewee, the composition and distribution of the interviewee's team and organization
2. *Collaboration, coordination, communication:* practices and processes in activities requiring collaboration, coordination and communication within and across teams; identified challenges and their effects
3. *Collaboration tools:* tools used for collaboration; challenges, perceived usefulness, development ideas
4. *Knowledge sharing, shared understanding:* practices for knowledge sharing and creating shared understanding; the key success factors and challenges
5. *Social ties:* quality of social ties; practices and mechanisms applied to build them
6. *Competencies, project characteristics:* the most important competencies; challenges in achieving them; the effect of project type on productivity
7. *Productivity:* perceptions on productivity, measuring; the most important factors supporting/hindering productivity

The interview plan was drafted in collaboration with the case company representatives in Finland and the research group CIRCMI at the University of Tampere. In practice, the work was divided so that the thesis worker acted as the primary researcher constructing the interview plan, while the other participants provided advice and ideas to ensure that the plan met the requirements content and quality-wise. See Appendix 1 for the initial interview structure.

Prior to the actual research interviews, a number of background meetings, discussions and workshops was participated in as preparation for the data collection. Also the company's processes were acquainted with. The data from the background activities is excluded from the analysis of this thesis work. Instead, it provided a context and understanding of the problem domain, the case company's concepts and operating environment within which the interviews were to be conducted. As a preparatory measure I also examined cultural differences between Finland and India, Indian business etiquette and culture in general to prepare for and aim to cross anticipated cultural gaps.

While this kind of extended understanding is valuable, it also offers a challenge: the researchers should remain objective and open in the face of the actual collected research data without letting the background understanding set too strong presuppositions for the interview situation or the analysis of the collected data.

3.3. Realization of the plan

Finally, the data that is being handled in this dissertation was collected during six interviews that were carried out at the case company's internal large software R&D location in Bengaluru, India. The Indian and international interviewees were from managerial levels, and worked in different functional, product and process areas – offering a broad spectrum of viewpoints, as planned. In contrast with the initial plan, the hereby reported study was limited to the interviews at the Indian location, thus directing the results from a comparative study to a descriptive one. The anticipated interviews in Finland were left for further research, outside the scope of this thesis, due to time restrictions.

The interviews were conducted individually, face-to-face with the informants. There were two interviewers in five and one in one interview. The thesis worker acted as the leading interviewer in four interviews, and the second interviewer, a more senior researcher from the CIRCMI research group, in two. The interview sessions lasted from 1 hour to 1 hour and 40 minutes yielding approximately a total of 8 hours and 35 minutes of interview material. All the interviews were recorded.

In practice, the first interviewer led the discussion, while the second interviewer posed supplementary questions during the session and ensured that all the themes were covered. The interviewer roles were switched two times, as we wanted to see whether new kind of information would emerge by changing positions. I as the thesis worker also found this an effective way to observe the work of a senior colleague and take learnings from the process. The collaboration between the interviewers was smooth and constructive. An informal feedback and improvement discussion was held after each interview in order to identify and address any gaps that could be filled in the subsequent interviews.

The aim was to create a conversational and relaxed interview session with the informants, which in some instances was achieved better than in others. This is thought to be mainly due to socio-cultural distances between the interviewers and the interviewee, which are discussed in more detail in the section *6.4. Revisiting the India-Finland axis.* Nevertheless, all the interviews were conducted in a friendly and professional spirit.

During the sessions all the themes were handled, and scope was left for the interviewees to move outside the pre-drawn set of questions, as planned. As each interviewee perceived the topic from their own perspective, the emphasis of the themes varied somewhat, which gave the data the richness that was sought for. Also the handling order of the themes was adjusted accordingly, as the interviewees' discussion approach of the topics unfolded.

In general, the interviews firstly focused on descriptions of the work and team setting. Secondly, the interviews covered actions, elements and phenomena that were perceived to influence collaboration and productivity in teams operating within the globally distributed multi-location environment. Towards the end of the interview round saturation of the collected data was already noticeable, so it was possible to elaborate on and go somewhat deeper in the themes than what was initially anticipated.

In all, the following themes were handled:

- team structure, size and geographical distribution
- collaborative activities between teams and sites
- tools and infrastructure
- knowledge and information sharing, forming of shared understanding
- social and human related aspects
- competence management and transfer

- product and project characteristics
- perceptions and experiences on productivity and measuring

4. Analysis

The collected interview material was transcribed, and analysed by qualitative content analysis during March-August 2015. In content analysis textual data is investigated by breaking it down, looking for similarities and differences as well as condensing it [Tuomi and Sarajärvi, 2002 cited in Saaranen-Kauppinen and Puusniekka, 2006]. The aim of content analysis is to achieve a condensed description of a phenomenon under investigation and to tie the findings to their broader context and results from previous research [ibid].

The analysis was primarily performed by the first interviewer – the thesis worker – but in frequent consultation with the second interviewer throughout the analysis process. During the analysis, the findings were also reviewed with the case company representatives and other researchers participating in the DD-SCALE project.

Atlas.ti-software was utilized to facilitate the analysis, coding and categorizing of the material. As a result, a categorized set of factors that were identified to affect collaboration and productivity of teams working in globally distributed software development was produced. The next paragraphs first give a brief introduction to the Atlas.ti-software. After that the analysis process is described in detail. The findings are then discussed in the sections five through seven.

4.1. Atlas.ti-software

Atlas.ti software is a program for analysing qualitative research material. It was originally developed in the University of Berlin and it has since evolved into a commercial product. It is important to note that Atlas.ti itself does not analyse the data nor write research reports on behalf of the researcher. Instead, it works as a database and archive for a study or research project by storing both the research data and its analysis. Further, it helps to visualize the data, concepts and their relations as well as to report and trace back on findings. [Ruohomäki, 2013, 3]

In other words, Atlas.ti helps the researcher to analyse and code even large amounts research data, such as textual material, in a concise way. The software keeps track of the coded entities, existing codes and their quantities. It also allows for categorization of findings in different ways, as well as writing notes and comments on pieces of analysed data. With the help of the software it is also pos-

sible to create visualized networks and illustrate multiple relations between codes and their categories. Finally, the researcher can export his or her work from the software in .xml format, which supports multiple uses of the data.

4.2. The analysis process

The analysis process can be examined as five overlapping and intertwined phases. The analysis was carried out iteratively until an acceptable level of quality and depth had been reached. The first and second phase focused on the transcribed material, and the third and the fourth phase on refining the findings. In the fifth phase the findings were summarized and reviewed. Throughout the analysis the data was viewed as a whole while carrying a reflective discussion between the individual interviews, preliminary findings, theoretical frame and other researchers' feedback. This conduct is in line with the principles of the hermeneutic circle, the fundamental recommendation in interpretive field research by Klein and Myers [1999, 71], where *"the process of interpretation moves from a precursory understanding of the parts to the whole and from a global understanding of the whole context back to an improved understanding of each part"*.

In the initial phase raw coding of the material was done and the precise mode of analysis and codification was specified. The purpose was to gain an overall picture and in-depth understanding of the collected data. Questions such as what kind of entities should be sought for, what level of precision the codes should achieve, and in what kind of a logic excerpts of the interviews should be assigned to individual codes, were asked. During this round the analysis was mainly guided by the theoretical frame.

Figure 3 below shows a snapshot of the coding in the raw coding phase. The *Name* column shows the name of the code, *Families* column tells the concept map or other logical area(s) that the code relates to and the *Grounded* column specifies the number of times the code has been used in the text.

Name	Families	Groun...
B: management practices	Concept map areas	280
A: human related aspects	Concept map areas	151
C: technical aspects	Concept map areas	130
E: "operational environment" aspects	Concept map areas	44
D: project aspects	Concept map areas	49
cultural distance identified~	Distances	46
temporal distance identified	Distances	11
physical distance identified~	Distances	44
5: potential bottleneck areas	Identified focus areas	45
1: competence development and management	Identified focus areas	173
6: knowledge sharing	Identified focus areas	62
4: process evolution and innovation	Identified focus areas	72
3: motivation and engagement	Identified focus areas	103
2: team interfaces and dependencies	Identified focus areas	110
something else potentially meaningful	Other meaningful observations	13
relates to perceptions on productivity, efficiency and measuring	Other meaningful observations	107
direct effect on communication and collaboration identified	Other meaningful observations	87
direct effect on productivity and efficiency identified	Other meaningful observations	141

Fig. 3. A snap shot of the raw coding phase in Atlas.ti -software. The *Concept map areas* and *Distances* relate to the concept map built in the literature review. The *Identified focus areas* and *Other meaningful observations* relate to the thus far achieved early understanding of the analysed material.

Finally, as the result of this phase, it was discovered that:

1. The entities to be sought for are essentially *descriptions of activities, attributes and phenomena* identified by the interviewees and/or researchers to influence collaboration and/or productivity of the teams.
2. The precision of individual codes should be further refined in the next analysis phases.
3. A piece of an interview was to be tagged as a quotation in Atlas.ti-software, when it described one activity, attribute or phenomenon understandably, but so that it would be limited to a manageable length. Thus, lengthy and meandering descriptions were split in two or more quotations.
4. One quotation potentially includes descriptions of several attributes, activities and phenomena, and therefore multiple codes could be attached to a single quotation. The aim of this was to ensure comprehensive handling of the various aspects that emerged from one quotation.

In the second phase the codes' level of precision was brought closer to the actual *factors* that influence collaboration and productivity. Prior to this stage, some of the coded entities were at an undesirably high level, resembling more a category than an individual factor. Also the descriptions and definitions

of the codes were refined. At this point, the analysis started to lean towards a research data based exploration rather than a theory based one. This phase started to give the findings their final form.

The third, lighter round consisted of further revisions of the codes, their definitions and descriptions. Each code was formulated into a factor card with a name, long description and quotations that represented the factor as well as its organizational scope. This enables future re-use of the encoded material independent of the actual interview transcriptions. The aim was to name the factors in a neutral or a positive way to avoid giving them unintentional value judgements. At the end of this phase, it was concluded that the factors were of acceptable quality and precision in order to answer the research question.

During the fourth phase the factors were grouped into a two-level categorization to convey their logical, real-life contexts and meaningful entities. As Corbin and Strauss [1990, 7] define, "*categories are higher level and more abstract than the concepts they represent".* However, simply grouping concepts under a name tag does not make it a category. Instead the properties, dimensions and characteristics of the phenomenon the category aims to represent must be reflected by it. [Corbin and Strauss, 1990, 7-8] During the analysis a decision was made to use an emergent categorization based in the identified factors, instead of utilizing an existing, theory based set of categories. The goal here was to prevent the analysis from accidentally getting directed by a pre-defined categorization that findings should presumably fit to.

The creation of the categorization was evaluated by reflecting it to taxonomy creation criteria of Nickerson *et al.* [2013, 341-342] in the IS (information systems) field: A useful taxonomy is *concise, robust, comprehensive, extendable* and *explanatory*. As summarized by Tiainen [2014], this means that a good classification has a limited number of dimensions and characteristics, but enough to distinguish the essential aspects. The classes should not be overlapping, and the objects within each class should be alike. All the objects must fit some class, and all the relevant characteristics of the objects must appear in the classification. If new objects emerge, it must be possible to add classes or characteristics in the classification. Finally, the classification must explain the substantial qualities of its objects. [Tiainen, 2014, 22-23] Even though creating a taxonomy or a classification as such was not the objective in this study, these guidelines gave a feasible evaluation point when categorizing the findings.

Figure 4 below provides an overview of the coding process of an interview excerpt first by the means of raw coding in the step 1. The excerpt was then refined into two factors (*competence development* and *fast development cycle*) in the step 2. The factors were then formulated into factor cards (step 3.) and finally categorized (step 4.).

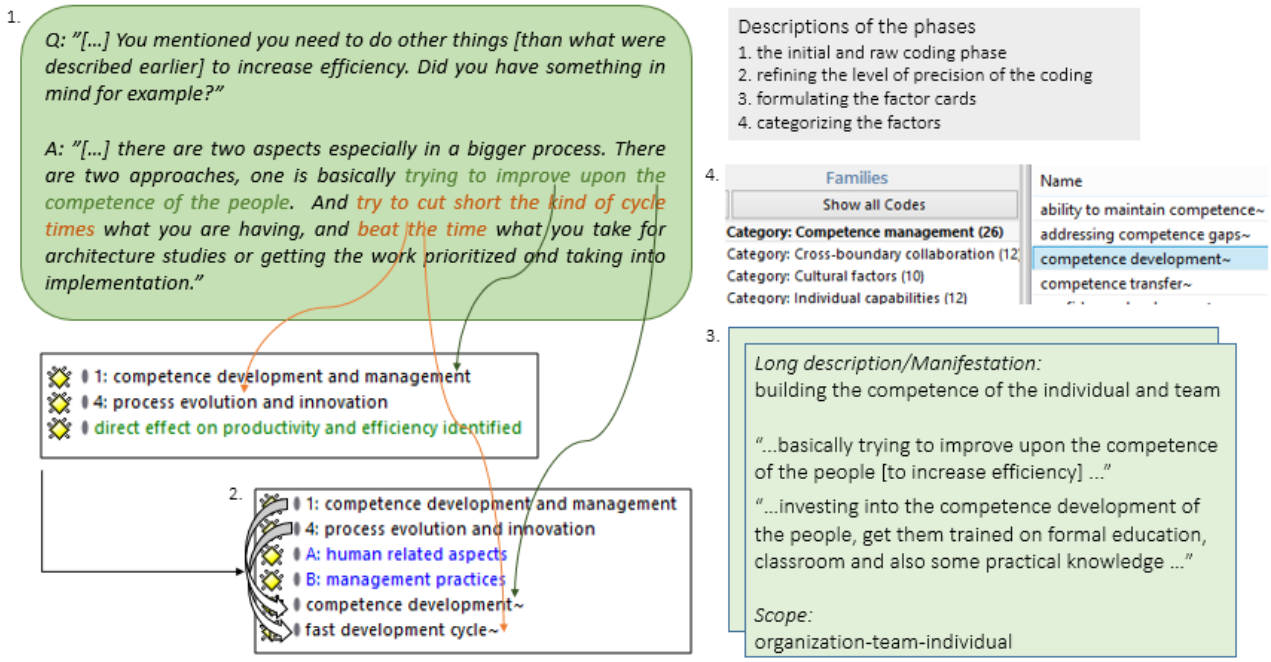

Fig. 4. An overview of the progression of the coding process of an interview excerpt (phases 1-4).

The fifth and final phase included writing an interim report that summarized the findings for the purposes of the research project. In this last phase the factor names and categorization were finalized.

5. Empirical findings

As the result of the analysis, a set of 217 factors – attributes, activities and phenomena – perceived to affect the collaborative activities and productivity of teams in software R&D in a globally distributed setting was identified. These factors were grouped into 16 categories and further consolidated into seven higher level viewpoints.

Table 2 shows a summary of the viewpoints and categories with a description, the number of factors and the number of citations within them. It is to be noted that the quantities of factors and citations are meant to convey no meaning of relative importance between the factors, categories or viewpoints in this study. The quantities are there to illustrate the depth and level of detail that was applied and achieved through the qualitative analysis.

The purpose of the viewpoints and categories is to group together the factors that are interpreted to be related to similar issues in globally distributed software work. The naming of the viewpoints aims at reflecting the essence of the categories and the naming of categories aims at describing the nature of the factors that have been placed in that category.

Table 2. A summary of the findings: The viewpoints and categories of factors with descriptions [originally in Löytty and Ingalsuo, 2016 in a condensed form]

Viewpoint	Category (if applicable)	No. of factors	No. of citations
Cross-boundary collaboration - collaboration across team, site and functional boundaries; takes place across software component and product areas and different software development (SD) phases; may be daily or occasional		12	55
Competence and knowledge - developing, maintaining and disseminating knowledge, competency and expertise; the required knowledge assets in software R&D work; sharing information and knowledge in and between teams	**Competence management** - managing and developing the competences of newly hired as well as experienced employees; a systematic and set process of maintaining and increasing the competency level of individuals and teams; overall learning in an organization	24	112
	Knowledge assets - the required knowledge in software R&D work; especially acquired through training or gained from experience over the time	8	31
	Knowledge and information sharing - communicational issues related to information and knowledge sharing between teams and individuals in everyday development activities and in one-time knowledge and work transfer situations	9	54
Improving practices and processes - evolution of teams' work; improvement of practices, processes and methods, eliminating waste and building team maturity; has a software engineering process and a wider organizational work practices perspective	**Software engineering process and methods refinement** - continuous improvement of SD processes and methods	24	105
	Work practices evolution - evolution of the work practices and approaches in an organizational context	19	60
	Waste elimination - elimination of time and effort wastage in processes and activities	10	28
	Maturity perspective - maturity related aspects of the organization, teams, processes and products	5	43
Socio-cultural view - bridging the potential social and cultural barriers	**Social angle** - human factors in relationship building, team working; woven into many of the collaborative activities	12	70
	Bridging cultural barriers - addressing differences in organizational and regional cultures	10	29
Human capabilities and characteristics - capabilities at the people level, employees' motivation, engagement and outlook on work	**Individual capabilities** - valued capabilities at an individual level, especially in the context of SD work	11	22
	Motivation and engagement - motivation and engagement factors of people	15	43
	Outlook on work - individuals' outlook and attitudes towards working in DSD	9	23
Management and leadership - work distribution and organization across sites; assignment of responsibilities and allocation of resources; the management facilitating smooth functioning of teams	**Work distribution and organization** - distribution and organization of work, responsibilities and resources across teams and sites	7	46
	Management as a facilitator - measures supporting work at team and individual levels; practices that originate from the managerial level in a broad organizational context	11	62
Tools and infrastructure - valued ICT tool and infrastructure characteristics; the ways in which these tools and infrastructure offer support for efficient working		31	58
Total		217	841

The results presented in the following sections 5.1 through 5.7 were first reported to the case company as a stand-alone report entitled *Factors affecting collaboration and productivity of teams working in globally distributed software R&D – Summary of interviews in India.* This report is presented in the following sections in a somewhat revised form. The revision was conducted with the aim to bring the results outside the specific context of the company and to a slightly higher level of discussion.

Therefore, the factors are discussed in a generic and neutral manner, without an assessment of the quality of any one factor in the case organization. Instead, the factors are viewed so that if lacking, or in some cases excessively present, they are expected contribute as hindrances to collaboration and productivity. In other words, the factors are presented rather as potential capabilities than as challenges. There are two reasons for the decision: Based on six interviews and in a study looking for a broad spectrum of factors it is not feasible to make specific recommendations on individual factors. Additionally, this formulation allows the findings to be utilized also outside the context of this case. The core content and essence of the report however remain unrevised.

The handling of the results proceeds from a broader entity, a viewpoint, to a narrower unit, a category, and finally to the smallest element, a factor, one viewpoint at a time. A narrative style is applied in presenting the findings. The factors are explained by opening their meaning and manifestation based on the interview material and the analysis. In the beginning of each category a listing of its factors is presented in a table form. After that, the factors are described. The factors are marked in **bold** in the text and illustrated by selected extracts from the interviews. The excerpts are taken directly from the transcriptions only with mannerisms and elements that could be used in identifying the speaker omitted. The practical and theoretical implications of the findings will be reflected on in the section *6. Discussion*.

5.1. Cross-boundary collaboration

The viewpoint of *Cross-boundary collaboration* consists of factors that relate to or facilitate collaboration across team, site and functional boundaries. This collaboration takes place across software component and product areas as well as different software development phases, such as designing, implementation and testing. It may be daily business-as-usual practice, or more occasional in nature. The factors under the viewpoint of *Cross-boundary collaboration* are listed in Table 3. This viewpoint has no further sub-categories.

Table 3. A summary of factors in the viewpoint of *Cross-boundary collaboration* (in alphabetical order)

Cross-boundary collaboration: a summary of factors
aligning teams' work together
being experienced enough to interface globally
being used to collaborative cross-team work
being used to remote collaboration
common organizational practices
established interfaces
having a common goal
having a similar work approach
inter-team/inter-site collaboration
manageable time-zone difference
predictability/dependability
understanding the context of a remote person

When examining the findings at a factor level, it is apparent that **inter-team and inter-site collaboration**, working together with people from different teams and locations, is essential in various stages of the software development process. Having a *"global R&D workforce"* involves crossing time-zones, team boundaries, geographical boundaries and functional boundaries. This collaboration ranges from day-to-day software development activities to seeking for specific expertise in testing issues and maturing new features by gradually involving different parts of the organization in the process. The factor of inter-team and inter-site collaboration can be considered a certain lead-in to the discussion of the findings, or a kind of a baseline phenomenon that is constantly present in global operation. The below interview excerpt illustrates a networked organization whose segments and individual actors are dependent on one another.

> *"It [interfacing with other sites and teams] would be day-to-day. It could be some software issues, it could be some testing issue. It could be related to some specification discussion. So all kind of engineering, software development activities we need to interface. Because we all have dependency..."*

Aligning teams' work together in terms of the content and timeline allows synchronizing the work between and within teams. This facilitates **predictability and dependability**, which again enable smooth collaboration, work alignment and integration: Knowing when the other team is going to

deliver and knowing what effects that delivery has on other parts of the system eases coordination and helps minimize waste of effort and calendar time. These attributes are especially necessary in complex co-dependent collaborative work. Successful integration systems reduce the need to communicate about expected delivery schedules, which in turn reduces the coordination overhead:

> *"…after establishing this kind of integration system, it is pretty smooth, they know how it works and they don't even ask the other team, when they are going to deliver."*

Established and trusted contacts, **established interfaces**, across sites enhance collaboration and problem solving. Having these interfaces is particularly vital in a distributed setting, as one often lacks a frequent face-to-face contact with co-workers, and the possibility to simply walk across the room to seek for advice. Building these interfaces happens over the time by working together, getting to know who knows what and where, as well as learning to trust the partner in cooperation. These interfaces can break when work is transferred from one location to another, which means re-establishing the contacts, as the below extract describes. That space of time may carry reduced efficiency especially in situations where quick problem solving across teams is required.

> *"...there are well established interfaces, contacts. It means re-establishing new interfaces [if transferring work] to be able to trust the interfaces."*

Having **similar work approaches**, **common organizational practices** and **a common goal** to work towards across sites create rapport and harmonize work when operating in different locations with differing organizational and regional cultures. Even if some perceptions and approaches would differ, having a common ground in ways of thinking, work practices and objectives helps to bring the parties closer to each other:

> *"In some ways, I think that we also share between Finland and India some common traits about the way we approach work. So those trends, some of these common ideals, help. Some perceptions and approaches are very different, on some layers you tend to think alike."*

The possibilities of **understanding the context of the remote person** (e.g. *Is it raining? Is the day very busy? Is the other person just about to run to a meeting? Is there a critical issue on the table?)* are more limited in distributed than collocated collaboration, but can be facilitated by the means of

various collaboration tools. **Being used to collaborative cross-team work** and **remote communication** while **being experienced enough to interface globally** make cross-boundary collaboration more effective. These attributes, if not cancel out, at least take away from the burden of geographical and socio-cultural distances.

> *"I think it was very much the practice that we had teams, quite global teams in Germany, and in India and China. So people have been used to work in a kind of collaborative mode with the teams across quite much, so I think it's kind of quite common to work in that mode."*

Finally – and quite naturally, **a manageable time-zone difference** was identified as one enabler of synchronous collaboration from country to country.

5.2. Competence and knowledge

The viewpoint of *Competence and knowledge* presents the identified factors that relate to developing, maintaining and disseminating knowledge, competency and expertise. The factors relate to the required knowledge assets in software R&D work, as well as sharing information and knowledge in and between teams. The viewpoint is divided in the following categories, which are discussed in the respective paragraphs:

- Competence management
- Knowledge assets
- Knowledge and information sharing

5.2.1. Competence management

The category of *Competence management* examines factors that are related to managing and developing the competences of both newly hired and more experienced employees. On the one hand, competence management is seen as a systematic and set process of maintaining and increasing the competency level of individuals and teams. On the other hand, the discussion relates to facilitating overall learning in an organization. The factors under the category of *Competence management* are listed in Table 4. The following paragraphs open up each of the factors.

Table 4. A summary of factors in the category of *Competence management* (in alphabetical order)

Competence management: a summary of factors
ability to maintain competence
addressing competence gaps
competence development
competence transfer
continuous feedback when learning
detailed enough instructions when learning
enabling new people to become productive
encouraging the new person to take new responsibilities
expertise development
flexibility in resource movement within the organization
formal competence development plan
hiring practices
implementation of training
individual learning
inducting new people into the team
knowledge broad-basing
learning as an organization
level of attrition
preparing for attrition
pull model of training
quality assurance of training
supportive atmosphere of learning
supportive environment of competence development
systematic competence transfer

Inducting new people into the team, ramping them up, training them competence-wise, and **enabling them to become productive** members of the team as fast as possible, are keys in retaining productivity of the team, when taking on new human resources. **Competence development** with a **formal competence development plan** or induction program, with different forms of training, such as classroom sessions, on-the-job-trainings, and assigned senior buddies, is utilized. Bringing the new people up to speed in an efficient way was seen as a central factor supporting productivity, as is demonstrated in the below quotations.

> *"...how are we getting these new people into our system? And what is the kind of enabling that we do that they will become more productive and effective, and how can they work in this environment?"*
>
> *"I think definitely the supporting factor number one [of productivity] in our case would be that the new guys are able to ramp up very fast. That is definitely something."*
>
> *"How to make them [the new people] as productive as the old people, who are inside the system?"*

Also the **hiring practices** as regards to the hiring channel (internally or from the market) and existing expertise level (junior or senior expert) of the newly hired staff impact this entity.

What is more, **competence transfer** between locations and teams is often a challenge that requires constant attention, both in terms of acquiring new competency to a team and managing the limited and dynamically allocated competence resources. A **systematic** way of managing **competence transfer** is essential in an environment where changes in project resourcing are common. Acquiring competence is *"not such a fast process"*, but yet a crucial one. Retaining a high level of productivity in existing projects when transferring competence one way or another is demanding. While **flexibility in resource movement** within an organization certainly caters for expertise and resource requirements across products, it also poses the above mentioned challenges to competence management.

Attrition has a noted and significant impact on the **ability to maintain competence** within teams. Maintaining competence is naturally easier, when the **level of attrition** is low. **Preparing for attrition** in terms of competence is a good idea in an environment, where changes are frequent and movement is constant. Attrition may mean employees leaving the organization, but attrition can also occur internally: moving resources around within the organization consequently shows as turnover in the team that is handing the resources over. (Factors relating to addressing external attrition are discussed in the section *5.5.2. Motivation and engagement*.)

Expertise development, advancing competency of an individual and a team, and deepening the required specific expertise, happens in the process of time. The support of centralized repositories of expertise can be utilized to complement a team's knowledge. **Addressing competence gaps** relates to assessing and reducing competence bottlenecks in software component and technology areas –

both at team and individual levels. A competence gap could be a case of only few people knowing how to perform a certain task, or an individual lacking a certain required competency. **Knowledge broad-basing**, acquiring and sharing new knowledge or technology with a team, can prove challenging, especially in the presence of conflicting priorities.

Offering **training in a pull model** is seen to encourage employees to initiate the required trainings for themselves, which may be more effective than pushing them top-down to people. Together with the model of training offerings, the **implementation** practices **of training** – how they are actually conducted – affect how much the trainings are greeted as an opportunity to improve oneself. Finally, **quality assurance of training** helps to ensure that the trainings given in fact meet the requirements of the need. The below quotation reflects on the risk of training turning into measurement point rather than a genuine opportunity for skills development:

> *"...find the fine balance, so that it [training] is understood by everybody that it is an opportunity to improve themselves, and not that it is another control point..."*

Individual learning and **learning as an organization** go together: Nurturing **a supportive atmosphere** of learning and building a **supportive environment for developing one's competence**, where failure is not feared but rather seen as an opportunity to learn, not only helps the individual but the whole team to grow. This **encourages the new people to take on new responsibilities** and thus widen their competence base.

> *"How much ever ... training sessions you have, so you have to take that risk, even [if] the person is not experienced, you start the work, make some mistakes, learn from it and then you become a better... You have better knowledge to do it, better the next time..."*

Moreover, **continuous feedback while learning**, and **detailed enough instructions** from more experienced people, help to know where you are in your learning effort and grasping the new area.

5.2.2. Knowledge assets

The category of *Knowledge assets* contains factors that reflect the knowledge that is considered to be required in software R&D work. The category considers the kind of knowledge and competency that is acquired for instance through training or gained by work experience over the time. The "soft skills"

side is covered under the viewpoints of *Human capabilities and characteristics* and *The Socio-cultural view*. The factors under *Knowledge assets* are listed in Table 5. The discussion continues in the subsequent paragraphs.

Table 5. A summary of factors in the category of *Knowledge assets* (in alphabetical order)

Knowledge assets: a summary of factors
domain knowledge
ecosystem knowledge
hardware knowledge
legacy understanding
process knowledge
system knowledge
technical competence
understanding of specifications and design

Technical competence in areas such as programming technologies, software components, testing and troubleshooting, tools and coding guidelines is essential. **Hardware knowledge,** especially in software areas that reside close to hardware, is also required. **Process and ecosystem knowledge** are necessary in understanding the process, its guidelines and different roles involved, and the overall surrounding work environment.

Having **system** and **domain knowledge** beyond one's immediate area of responsibility is needed in order to comprehend the *"problem and solution space"* of the system. This knowledge provides the context in which to make adequate design, implementation and configuration decisions. **Understanding of specification and design** then gives comprehension of why *"this [product] backlog item exists, what it is going to be used for"*. This provides the team a wider context for a development task. Finally, **legacy understanding**, understanding of the historical information, background and reasons for design decisions of the product, lies with and is shared by the long term experts.

5.2.3. Knowledge and information sharing

The category of *Knowledge and information sharing* contains factors related to communicating information and knowledge from one person or a team to another, both in everyday development activities and in one-time knowledge and work transfer situations. The factors under this category are listed in Table 6. The factors are described in more detail thereafter.

Table 6. A summary of factors in the category of *Knowledge and information sharing* (in alphabetical order)

Knowledge and information sharing: a summary of factors
access to needed information
active participation
adequate documentation
effective forums
encouraging people talking
expert access
knowing who knows what
one-on-one/direct conversation
unimpeded communication

Maintaining **unimpeded communication** in a global multi-site setting requires addressing challenges that may arise from technical hitches or cultural and language differences. Modern communication tools help crossing barriers, language and otherwise, as long as they are reliably available. *"Communication itself ceases to become a barrier",* largely thanks to the technology. Even with the availability of advanced technology, matters such as selecting the most appropriate mode and practices of communicating must be considered, for instance in tackling issues of achieving mutual understanding or differences in organizational cultures.

Adequate documentation of artefacts, processes and error situations supports information sharing, competence transfer and learning. Documentation is especially important in competence transition that was discussed earlier. A team that is experienced and well established may feel less of the *"pinch of missing documentation",* than a team that is in the process of ramping up, i.e. forming and building their basic competence.

A reliable and available **access to experts** is necessary for instance when support and reviews on complex changes, or understanding of past design decisions, is required, as is illustrated by the below excerpt:

> *"...if I don't have experts to support, help me in reviews, or giving me feedback inputs, that will hamper my productivity."*

Knowing who knows what [cf. Espinosa *et al.*, 2007] enables locating the required expertise, and is facilitated by the established interfaces and clearly defined responsibilities. Further, **access to needed information** through databases and **effective forums** that are sufficient in quantity and quality; **participating actively** in grooming and other information sharing sessions; **encouraging people talking** and carrying **direct conversations**, rather than discussing via a problem ticket for example, further ensure effective knowledge sharing and gaining mutual understanding.

5.3. Improving practices and processes

The viewpoint of *Improving practices and processes* encompasses factors that relate to the evolution of teams' work by continual improvement of practices, processes and methods, waste elimination and team maturity. The viewpoint looks at the factors from both a software engineering process perspective and a wider organizational work practices angle. The viewpoint is divided in the following categories:

- Software engineering processes and methods refinement
- Work practices evolution
- Waste elimination
- Maturity perspective

The discussion continues in the below sections.

5.3.1. Software engineering processes and methods refinement

The category of *Software engineering processes and methods refinement* includes factors that relate to supporting the continuous improvement of software development processes and methods. Thus this section is especially tied to the context of software development work. This category is closely related to the subsequent category of *Work practices evolution*, which looks at factors in a wider organizational context. The factors in the current category are summarized in Table 7. The following paragraphs elaborate on the findings.

Table 7. A summary of factors in the category of *Software engineering processes and methods refinement* (in alphabetical order)

Software engineering processes and methods refinement: a summary of factors
automation
being aware of dependencies
coding guidelines
comprehensive design guidelines
continuous improvement
creating an integrated development environment
delivery capability
end-to-end competency
exception handling
good design
good planning
how tools are used
knowing where you stand
managing dependencies
meeting the road map and targets
minimizing dependencies
mutual understanding of requirements
optimizing the entity
process compliance
smooth context switching
software practices
streamlined architecture
streamlined process
synchronous way of working

A **streamlined process** refers to the functioning of the process as a whole: How well defined are the road map and commitments? How well is the whole pipeline working together? How ”*well-oiled*” and optimized is the *“entire machine”*? A **streamlined architecture**, managing, minimizing and being aware of dependences, and applying good planning between teams, sites and software components then impacts the complexity of the development effort and productivity of the overall system. The lesser the dependencies, the more productivity the system affords.

Meeting the road map and targets in terms of quality, content and timeline, and having a **capability to deliver** per commitments, was perceived as a joint effort between different functional areas. Teams' delivery capability improves as collaboration practices between teams mature, and the level of competence of the delivering team grows. Increasing **end-to-end competency of teams**, looking at the process from one end to another end, and thus **optimizing the entity** in the chain of design, implementation and testing, requires reviewing competency at individual, team and inter-team levels.

Continuous integration system helps to **know where you stand** in relation to your development targets, *"whether you are track, or whether you are falling behind"*. This enables taking corrective action or providing for changes on time. **Exception handling**, dealing with situations that fall outside the standard process and practices, happens for instance by escalating the matter to a line manager, and in a broader context by continuously evolving the system. **Process compliance** in turn promotes adherence to the quality guidelines and keeping the controlled documents up to date.

Achieving an overall **good design** for a fault free product entails considering **comprehensive design perspectives**. That is taking into account different domains in the design process, such as stability, operability and usability of the product. Gaining **mutual understanding of requirements** demands the engineers to actively *"talk to each other, and make sure that others [are] understanding the same with the requirements"* to avoid errors later in the process, when components are integrated.

Context switching and asynchronous mode of working cause hindrances in R&D work, where people often handle many items simultaneously, as is described in the below fragment.

> *"... as we work in R&D, context switching is a major challenge. People have [to] switch their context. We are not working with one item, you are having several items that you need to work [on]. You get stuck and you partly then move to [an]other one, and move to [an]other one."*

An **integrated development environment** that supports **smooth context switching** and **synchronous way of working** by means such as instant feedback and a limited need for constantly switching windows ease these kinds of challenges. In the software work front improving **the software practices**, further developing the **automation** of testing, looking at how and what **coding guidelines** and

tools are used shape the level of productivity. **Continuous improvement** by the learnings and feedback from past activities help gradually to develop the processes for better team performance and smooth operation:

> *"So we take the learnings from that, and go back and change the process, adapt it. So that, it's a continuous activity, we keep evolving the processes to suit according to the needs of the team. And make it better and better, because we definitely do want to keep improving to be a better team."*

The process evolution is also discussed in the next section.

5.3.2. Work practices evolution

The category of *Work practices evolution* includes factors that relate to the evolution of working practices and approaches. This category is closely related to and intertwined with the previous section of *Software engineering processes and methods refinement*. In comparison, this current section observes the topic from a wider organizational perspective. Table 8 summarizes the factors in this category.

Table 8. A summary of factors in the category of *Work practices evolution* (in alphabetical order)

Work practices evolution: a summary of factors
adapting to state of the art
agile mind set
balanced load
bottom-up efficiency improvement
challenge acknowledgement
emphasizing local initiatives
empowering people to find ways of improving
end-to-end responsibility
evolving the processes according to the needs
expanding the technologies used
expertise leveraging for exploration
getting to know different practices by interfacing globally
looking into new ways of doing things
self-direction of teams
sharing feedback, ideas and thoughts
sharing tasks within the team
using feedback to improve the processes
using tried good practices as a basis
utilizing natural creativity of people

Teams **evolving their processes according to their needs**, taking controlled and agreed upon deviations from the common mode of operation, when it is relevant to them, allows the teams to work better. **Tried good practices** serve as a solid base for process evolution, especially when new teams built. Retrospective meetings, reviews, discussions and **feedback** from employees are **used in improving the processes** and collaboration:

> *"If sprint on sprint, we see that certain things are not going well, and it's because of certain… Probably the process needs some adaptation, or something is not meaningful, and … team is ending up spending, wasting effort. That comes from the discussions. Then we take that as an input and we go back and change the processes. So there's the retros and the reviews, I would say the check points, which give us the insight into what is working, and what is not working. And that then is the input to modify our way of working, or the processes..."*

Interfacing globally helps to **get to know different** kinds of work **practices**. Learning to know and trust your teammates encourages **sharing of feedback, ideas and thoughts** among and within teams, which enables the evolution of the team.

Challenge acknowledgement entails admitting that there is a challenge or a problem requiring a solution, and look for ways to solve it. This is elementary in triggering improvements and development at individual, team and inter-team levels. Having **end-to-end responsibility** manifests in different ways: For instance, in some roles, it can mean a broad responsibility, where *"the bug stops there"* regardless of *"whose fault"* it actually was. In other roles the end-to-end responsibility can relate to commitment, to taking the responsibility and working together with the team, also crossing team lines to solve issues when necessary.

Agile mind set together with a high level of competency in teams is prone to allow for more flexibility in **sharing tasks within the team**. This is related to the **self-direction** or self-organization **of teams**, which in itself requires careful evaluation of the overall competence level in the team in order to avoid potential quality risks, for instance.

Continuous **adaptation to the state of the art** in terms of technologies and ways of working can be advanced by **looking into new ways of doing things** and **leveraging the experts**, the best people of the teams for exploration and **expanding the technologies used**.

> *"We need to take our best people out, to take a look into how we can leverage their expertise. … And they have to take time out, and look at what's available… What is the gap that we could fill? How will we get us to the next productivity level?"*

This requires the individual's **load to be balanced** so that it is possible to allocate time alongside the day-to-day responsibilities for these kind activities.

A **bottom-up** approach can further support **efficiency improvement**: **Emphasizing local initiatives**, **utilising the natural creativity of people** and **empowering people to find ways of improving** are anticipated to create new solutions that impact the every-day work of the employees and therefore provide efficiency gains.

5.3.3. Waste elimination

The category of *Waste elimination* discusses factors that relate to eliminating waste of time and work effort in the R&D process and other activities. Table 9 shows the factors categorized within the *Waste elimination.*

Table 9. A summary of factors in the category of *Waste elimination* (in alphabetical order)

Waste elimination: a summary of factors
design to requirements
doing things at the right time
fast development cycle
minimizing collateral damage
minimizing dismantling teams
minimizing disturbances
minimizing waste of time and effort
short feedback time
speeding up repetitive tasks
success at the first time

Eliminating and **minimizing waste of time and effort** in activities and processes frees resources for value adding activities, such as developing features, services and products. Waste elimination can mean **fast development cycles**, **short feedback times** and **speeding up repetitive tasks** with the help of automation, for instance, thus increasing the throughput of the system. Eventually the waste shows in the incurred cost. The below quote views shorter feedback times in testing as a way to improve productivity:

> *"The best way to improve productivity, is to shorten the feedback time [of test results]."*

Changing a team's organizational structure often results in forming an entirely new team, which can require *"much time to settle and feel comfortable"* hindering the team members' ability to focus. **Minimizing dismantling teams** and instead moving work, for instance, can help the existing team to maintain efficiency and enables building of team maturity. Similarly, **minimizing external disturbances** allows teams to gain control over their work environment. This facilitates a team's focus on their core tasks and long-term competence development.

Finally, **doing things at the right time**, not too early and not too late in the development cycle, helps eliminating waste. Achieving **success at the first time**, delivering with high quality and without errors, **minimizes** lost calendar time and **collateral damage** to other parts of the system. **Designing to requirements**, limiting making *"provisions"* for requirements that may not exist yet, prevents spending effort on features that in the end may not materialize.

5.3.4. The Maturity perspective

The category of *The Maturity perspective* groups together factors that discuss the maturity of organizations, teams, processes and products. Maturity develops in the course of time, and it can greatly affect the fluency of practices and processes in teams and organizations. Table 10 gathers the factors of this category together:

Table 10. A summary of factors in the category of *The Maturity perspective* (in alphabetical order)

The Maturity perspective: a summary of factors
organizational maturity
organizational stability
process maturity
product maturity
team maturity

Team maturity refers to the maturity of a team's composition and practices, such as collaboration or set-up within the team: How long has the team worked together? How well refined their practices are in supporting efficient operation? How well are the people used to working with each other? How well do they deliver? **Organizational maturity** is seen as a similar factor, but it refers to the practices and set-up between different teams and sites. The below quotations are representative of the effects of maturity – the first from the output and the second from the communication perspective:

> *"...where we started..., it was a similar new team trying to learn, but today that team is very matured. So the kind of delivery or output they have today, is tremendous compared to how it was in [the beginning]. So this [number of] years, they have really learned and become experts."*

> *"In terms of communication, we are a well settled organization, things are fairly settled … we have set up and established these forums quite well. Handling of issues and synchronization is happening fairly "business as usual"."*

The related factors of **process maturity** and **product maturity** involve questions such as, how advanced the process and product refinement are, how streamlined the process is, how good mechanisms of planning commitments and roadmap are in place, how stable the product is.

Organizational changes have an influence on the maturity aspects, as teams, organizations and processes go through transformations. The effects involved may relate to matters such as team formation and dynamics, retaining the acquired competence, maintaining the established and evolved practices as well as employee engagement. **Organizational stability** is therefore regarded as a supportive factor of maturity.

5.4. The Socio-cultural view

The viewpoint of *Socio-cultural view* covers the factors that relate to bridging potential social and cultural barriers, by for example learning to know each other and increasing cultural understanding. The viewpoint is divided in the following categories, which are discussed in the subsequent paragraphs:

- The Social angle
- Bridging cultural barriers

5.4.1. The Social angle

The category of *Social angle* comprises of factors that relate to human beings, relationship building and team work. These social factors are woven into the collaborative activities, and therefore have an impact on many other areas, such as the *Cross-boundary collaboration*. The factors in this category are summarized in Table 11.

Table 11. A summary of factors in the category of *The Social angle* (in alphabetical order)

The Social angle: a summary of factors
being trusted
building relationships
confidence in others
face-to-face contact
knowing each other
respect/appreciation of each other
social cohesion
supporting each other
teamness
trusting each other
understanding the importance of different roles in a team
working together

Working together helps getting to know each other in the course of time and build relationships, which in turn facilitates easier collaboration. This could be seen as a kind of a positive cycle that helps strengthen the collaboration. The below excerpt demonstrates this effect:

> *"The most important thing is that we now know each other a lot more, and trust each other a lot more. We know names, we have travelled, we have met each other. And we have delivered together over the [number of] years."*

Face-to-face contact promotes communication and building of good relationships. Especially, if face-to-face contact takes place in the beginning of the collaboration, it will facilitate future smooth working together. Encouraging face-to-face contact is relevant both in a distributed and co-located setting. It not only helps create collaborative connections with people, but also allows one to fully concentrate on the discussion at hand, without communication technology or other tools in between.

Sense of working as one team, **teamness** [cf. Prikladnicki *et al.*, 2012], enables a team to work well together both in a co-located and distributed setting. The below fragment illustrates a situation with a lack of feeling as one team:

> *"We are now fairly well settled. If I go back [a number of] years we were not one team, we almost felt like two teams. That mainly came from the cultural differences, and lack of knowing each other."*

Teamness can be achieved by learning to know each other and establishing trust. **Trusting each other**, **having confidence in others** and also **feeling of being trusted** support building of social relations. Establishing trust and confidence help further confidence building. Trust is considered one engine of feedback sharing, and therefore it is an important component in team evolution.

Also **respect and appreciation of each other**, **social cohesion**, **supporting each other** and **understanding of different roles in a team** facilitate collaboration across boundaries, working as one team and gaining good results.

5.4.2. Bridging cultural barriers

The category of *Bridging cultural barriers* includes matters that deal with crossing potential differences in organizational and regional cultures. Similarly as in the category of *The Social angle*, the influence of these cultural factors spans across several areas. The factors of this category are summarized in the Table 12.

Table 12. A summary of factors in the category of *Bridging cultural barriers* (in alphabetical order)

Bridging cultural barriers: a summary of factors
addressing cultural differences
awareness of the company culture
being aware of cultural stereotypes
common organizational culture
cultural learning
cultural training
openness of the organizational culture
sharing common values
understanding of cultural differences
understanding of each other

Understanding of each other, as well as **addressing** and **understanding cultural differences**, while **being aware of cultural stereotypes**, helps understand cultural nuances, avoid conflicts, and

thus lower and cross potential cultural boundaries. This kind of a two-way learning is present in the below interview citation:

> *"I think we have better understanding of each other. Also cultural aspects, way we talk, what we mean when we say something both by mail and on phone. So these are little things … As an Indian, you say yes to everything, and I think we also learnt to say no."*

Cultural trainings and workshops support cultural learning, and create a better of understanding of each other across different cultures. This kind of cultural learning can also be built over the time, as a result of working together and getting to know each other. Visiting the other end *"to get to know the people, and also to see a little how it works over there"* carries a long way in remote collaboration.

Sharing common human **values** that are generally appreciated, and having **a common organizational culture** across locations, act as overarching attributes that support international collaboration. The below sample exemplifies these thoughts.

> *"…I think the culture as such doesn't come too much in the way, as long as you are able to express ... And each of us is professionally able to work respecting the time difference, scheduling a meeting, expecting the other to respond, and the person is responding. These are kind of basic etiquettes and practices. If everybody is following that I think... ...some professional guidelines that all of us follow, and work together..."*

Further, the overall **openness of the organizational culture**, and **awareness** of it among employees, encourages rich and communicative teamwork.

5.5. Human capabilities and characteristics

The viewpoint of *Human capabilities and characteristics* discusses factors that relate to embracing the different types of capabilities of people, and encouraging the employees' motivation, engagement and outlook on work. This viewpoint is divided in the following categories, which are discussed in the subsequent paragraphs:

- Individual capabilities
- Motivation and engagement
- Outlook on work

5.5.1. Individual capabilities

The category of *Individual capabilities* groups together factors (as in Table 13) that concern the valued capabilities at an individual level, especially in the context of complex software development work. This category interlinks with other categories such as *Knowledge assets, Knowledge and information sharing* and *Social angle* since these factors influence on how knowledge assets are used, how knowledge and information is shared and social aspects are handled.

Table 13. A summary of factors in the category of *Individual capabilities* (in alphabetical order)

Individual capabilities: a summary of factors
ability to express oneself
ability to make decisions
analytical thinking skills
aptitude for programming
clear thinking
communication skills
confidence in one's own capabilities
confidence to make decisions
finalization of things
language skills
mind set to fill gaps

The **ability to express oneself** to others across socio-cultural and geographical distances, **communication skills** and **language skills** go hand in hand in the necessary skillset for smooth collaboration in a global set-up. The ability to express oneself in English seems to be a more important concern than potential cultural distances per se. Having good intentions and motivation to collaborate are important, but alone insufficient, if you are unable to communicate fluently. This capability is particularly emphasized in distributed collaboration where direct contact with colleagues is reduced:

> *"…even if you have good intentions, but if you are not able to communicate verbally and in written form, then you can get into trouble. And that's a very important skill. And I cannot say it more. I cannot reinforce it too much. Especially, because you don't see people. Then you have to be able to talk properly, you have to be able to communicate, and you have to write, and you have to understand."*

Along with the technical competency of an individual, **analytical thinking skills**, for instance when trouble-shooting and debugging the code, are valued. The **ability to think clearly** and **make decisions** in order to come to conclusions and **finalize things** are among the desired capabilities, *"especially for orchestration roles"*, and when operating under tight timelines. A **mind set to fill gaps** in the adopted work practices, a *"flare"* to seek for new and more efficient ways of working, using tools, and solving problems advances renewal and continuous improvement of the individual and the team.

Aptitude for programming, keenness and ability to absorb, naturally affects the steepness of one's productivity improvement curve especially in the beginning of learning. **Confidence in one's own capabilities** and **confidence to make** independent **decisions** have an impact on how efficiently the *"basic things"* are run, and how much validation is sought for from colleagues.

5.5.2. Motivation and engagement

The factors of *Motivation and engagement* are various, and they originate from different levels of an organization. These factors are listed in Table 14. As people are motivated by different types of things, the *Motivation and engagement* category is placed under the viewpoint of *Human capabilities and characteristics*. This category is tied together with the category of *Outlook on work*, and it is recommended that they are read in conjunction with each other.

Table 14. A summary of factors in the category of *Motivation and engagement* (in alphabetical order)

Motivation and engagement: a summary of factors
appropriate rewarding system
attractive company image
attractive technology
attractive travel opportunities
attractive work environment
attractive work location
being happy in the work environment
compensation
employee morale
enthusiasm
good work-life balance
mitigating relocation needs
motivating people
positive mood
professional growth

The factor of **motivating people** relates to aspects such as engaging with the company, performing well, being committed or even using a specific tool. Motivating is done in different ways, for instance through compensation, providing good working conditions, inspiring the employees. For example, suitable key performance indicators (KPIs) with achievable targets positively motivate *"the team to be delivering things well"*.

Positive mood, **enthusiasm at work**, high **employee morale**, **being happy in the work environment** and **having a good work-life balance** help employees to remain focused and reinforce engagement both with the company and with other the team mates and other colleagues. Maintaining the **compensation** at an encouraging level and utilizing other **appropriate rewarding systems** help to acknowledge and support both individual and team performance.

Moreover, **professional growth**, progressing and growing in one's own work role and career through achievement of wider responsibilities provides occupational satisfaction, which in the below excerpt is demonstrated by collaboration with remote sites. This excerpt also reflects the positive outlook that the team members are reported to have on multi-site collaboration:

> *"I would say people are quite happy … Quite excited to do that kind of collaboration, because people feel, at least the sense I get from the people is that people feel good, if they are actually collaborating with colleagues outside. They see that as growth in their responsibility. Typically what happens, is that very junior ones would not be interfacing too much because they are still learning, and probably they are not having all information to start discussing with another team. A little senior ones are the ones who are doing the external interfacing. So they feel that it's kind of progression, when I am collaborating with other teams and working together. So it's a positive thing how people look at it."*

In addition, things such as being able to work with **attractive technology**, or the company having an **attractive image**, promote motivation and engagement. **Mitigating** and addressing potential **relocation needs**, having a logistically **attractive work location**, or interesting **travel opportunities** also contribute to the reasons of engaging with a company.

5.5.3. Outlook on work

The category of *Outlook on work* observes factors that reflect individuals' outlook and attitudes towards working in a GSD environment. The factors in this category (see Table 15) are considered as supportive of responsibility taking and fruitful collaboration.

Table 15. A summary of factors in the category of *Outlook on work* (in alphabetical order)

Outlook on work: a summary of factors
attitude to wanting to make the change for better
attitude to working in a global environment
being open
commitment to work together
professional pride
sense of ownership
sense of responsibility
taking initiative
willingness to work together

Willingness to work together in a distributed setting and collaborate with others, **being open** to working with people at different levels of expertise, and having overall right **attitude to working in**

a global environment increase the chances of success. Willingness is even seen to help compensate for a lack of competence:

> *"I still believe that [it is possible to] compensate for lack of competence and experience, if there is a willingness. So I think at the very end, how open are we to work together for something like a common good? And that's the fundamental equation determinant."*

Sense of responsibility and understanding of it in one's work role as well as an attitude of **wanting to make a change for the better** are attributes that support chances of accomplishing good results. Making a process phase more effective or a team stronger requires **taking initiative** also at an individual level. The first is described in the below extract:

> *"So it's about communication, participation, asking more questions and trying to gather the right information. And if they are not clear, then going back and checking frequently, because [a requirements refinement session] is as effective as you want to make it. I can just be a passive listener and I can come back, or I can really participate, ask more questions that I have proper clarity and … go into implementation."*

Sense of ownership, actually feeling the ownership of the tasks, and **commitment to work together** as a team facilitate responsibility taking and motivation to perform well. For instance, a sense of ownership can be fortified by entrusting responsibilities to the team and by utilizing positively motivating performance indicators. Related to the above, the right amount of **professional pride**, for example seeing it *"a matter of honour"* to deal with an issue thoroughly, aiming at finding the root cause of a fault and not let bugs through to the next development phase, helps produce quality deliverables.

5.6. Management and leadership

The viewpoint of *Management and leadership* observes factors that relate to distributing and organizing work across sites, assigning responsibilities and allocating resources. Further, the viewpoint discusses factors that concern the management facilitating smooth functioning of teams. The viewpoint is divided in the following categories:

- Work distribution and organization
- Management as a facilitator

The categories are elaborated in the following paragraphs.

5.6.1. Work distribution and organization

The category of *Work distribution and organization* describes the factors that relate to distributing and organizing work, responsibilities and resources across teams and sites. A summary of these factors can be found in Table 16.

Table 16. A summary of factors in the category of *Work distribution and organization* (in alphabetical order)

Work distribution and organization: a summary of factors
clear ownership
clear responsibilities
distribution of competence resources
distribution of hardware and lab resources
good interlock between product management and capacity planning
good mechanisms of planning of commitments
optimal work organization

Optimal work organization emerges at many levels: What kind of work should be distributed, and what kind of work is better conducted at the same site? How are the teams organized? What kind of work to allocate to which team? These are focal questions in an environment that is essentially distributed around the globe. What more, dispersion accentuates the need for having **clear responsibilities** and **ownership** of tasks between teams and sites. This lightens the coordination effort across locations and facilitates availing of standard set up practices and modes of collaboration. Thus for instance locating experts and solving issues becomes speedier.

Further, **good mechanisms for planning of commitments** as well as a **good interlock between product management and capacity planning** help manage the work load of the teams effectively, which supports keeping the commitments. A carefully planned **distribution of competence resources** prevents bottlenecks from accumulating into the system - especially when work or competence transfers are underway. In a similar manner, a sufficient **distribution of hardware and lab resources** is important.

5.6.2. Management as a facilitator

The category of *Management as a facilitator* comprises of factors that support work both at a team and at an individual level, and that are interpreted fundamentally to originate from the managerial level in a broad organizational context. These factors are listed in Table 17.

Table 17. A summary of factors in the category of *Management as a facilitator* (in alphabetical order)

Management as a facilitator: a summary of factors
ability to see the future road map
confidence in the company and leadership
creating confidence in not needing to compete but complement
employees' understanding of management decisions
goal orientation
management removing impediments
managing organizational change
metric relevance
supporting the ability to focus
target clarity
top management communication

Supporting the ability to focus denotes ensuring that the focus of activities is on the right point. The ability to focus can manifest itself at task, team, and organizational levels. For instance, at a task level this could mean enabling a software engineer to mostly concentrate on *"the actual work"* instead of having to *"wonder how Webex [a remote conferencing tool] works"*. At an organizational level the ability to focus could mean stable and comfortable conditions for teams to settle in in order to allow them to focus on productive work.

Moreover, knowing what is expected of you, having **target clarity**, and being **able to see the future road map** with its priorities support an individual's productivity, engagement and – the ability to focus. Of the same type is the factor of **goal orientation**, being able to systematically work towards a set (long term) goal. This can be facilitated by the **management removing impediments** of different types in the team's operation. These impediments can range from everyday common disturbances to team competency issues, and ultimately they may avert the team from achieving their goal.

Metric relevance, meaningful measurements that are understood and that relate to one's work, contribute to the above discussed factors, providing employees with confidence in relation to their tasks and objectives. The more relevant the metrics are to the team's operation, the more precise actions can be taken based on those measurements at a team level. At the same time, if *"skewed"*, the metrics easily lead to focusing on the *"control point"* of measurement instead of the activities themselves. Furthermore, since skewed metrics rarely reflect the real situation, decisions could be taken based on flawed data.

Top management's communication and **employees' confidence in the company and its leadership** help build and maintain constructive and positive spirit. **Employees' understanding of the reasons behind management decisions**, and management **creating confidence at different sides in not needing to compete but complement** each other are seen to lead to successful collaboration, especially in times of organizational flux. The below excerpt brings together many of the related factors that have been discussed in the past paragraphs:

> *"Trying to give that kind of confidence to both the sides that this kind of distributed set up is a business need, not a call taken by someone. … And then investing in confidence development. I think, define the responsibility and improving the competence of people, so the quality deliverables are coming, and then addressing cultural differences, and creating the kind of confidence that both the sides have a kind of feature and they don't need to compete. Rather they complement each other. That will lead to quite successful collaboration."*

Further, as change is natural in a dynamic global operating environment, **good and robust ways of managing organisational change** and the related competence needs contribute to mitigating the momentary hindering effects of change.

5.7. Tools and infrastructure

Finally, the viewpoint of *Tools and infrastructure* groups together factors related to the valued ICT tool and infrastructure characteristics, and the ways in which these tools and infrastructure offer support for efficient working. This viewpoint has no further sub-categories. This viewpoint differs from the others in the aspect that it mostly comprises of factors related to the characteristics of *artefacts*, man-built objects [e.g. Lehtonen, 2014, 140-141], such as software, that are used in making the remote collaboration and development work possible. In contrast, the other viewpoints discussed factors that are more intangible and often consist of actions, characteristics or attributes of people and organizations. Nevertheless, this category is of importance, as we are talking about distributed knowledge work, which is conducted in a technology mediated way. The summary of the *Tools and infrastructure* factors can be found in Table 18.

Table 18. A summary of factors in the viewpoint of *Tools and infrastructure* (in alphabetical order)

Tools and infrastructure: a summary of factors
adequate support for tools and infrastructure
availability of tools and infrastructure
awareness and visibility of available tools
capability of tools
collaboration tools allowing multitasking
collaboration tools conveying status and availability
context awareness supporting tools
control over software development tools
ease and intuitiveness of tools
effectiveness of tools
efficiency of tools
evolving tooling infrastructure
fast and easy collaboration possibilities
friendliness of tools
good communication mechanisms
having the right infrastructure
improved collaboration technologies
improving tools used for development
investing in communication technologies
modernizing the tool set used
network reliability
partners understanding the importance and business context of infrastructure
reliable communication infrastructure
reliable development infrastructure
standardized tools
sufficient facilities
teleworking options
tools supporting mobile office
tools supporting remote working
tools supporting synchronous working
visible management of infrastructure

The **availability of tools and infrastructure**, overall having a **right infrastructure** and **sufficient facilities** to suit the needs of the kind of work that is done are vital. This includes the even very *"basic things, like having a good place to work on"* and adequate meeting *"amenities"*, both IT- and facilities-wise.

Reliable communication infrastructure, which allows you to reach your collaboration partners reliably, is one key enabler in a distributed work setting. **Network reliability**, having a stable network that suffices for the requirements of the organization, and **a reliable development infrastructure**, having for instance stable machines that do not *"come off"* unplanned, are important for both timely operation and maintaining data. The importance of these aspects is illustrated in the below sample:

> *"That [the overall quality of infrastructure] definitely affects productivity. Because very key things …, the lifeline of our development team, the whole infrastructure is managed by IT … The IT hardware that we're using. And if that machine comes off, I cannot build my software. So it's a big productivity loss. And if that is not immediately rectified, it delays, or if there is a shutdown, and all your machines goes off, and if the data is not recovered, then you have a problem."*

Today many organizations have outsourced their tools and infrastructure function to external service provides. Retaining **adequate support for tools and infrastructure** requires that **the service provider understands the importance and business context** of them to the users. Making the **management of infrastructure visible** in the location where the services are used is seen a one means to facilitate this.

Keeping **improving and modernizing the tool set** helps further increase and is a requirement for maintaining efficiency in a world that is going through rapid digitalization at almost all fronts. However, the **overall evolution of the tooling infrastructure** according to the needs of the users may be a long-term effort especially in an environment, where the vendor changes frequently. Having the right amount of **control over the software development tools** is seen to safeguard their availability and efficiency. *"The efficiency and capability domains"* involve aspects such as **efficiency, capability, effectiveness, friendliness** and **ease and intuitiveness of tools**. The more intuitive and friendly the tool is to use, the more efficient it is considered.

Tools supporting remote working, both for development and collaboration activities, **mobile office** and **teleworking options** are a necessity in work roles that involve a lot of travelling or working

remotely. **Fast and easy collaboration possibilities**, such as instant messaging, **context awareness supporting tools, collaboration tools allowing multitasking** and **conveying status and availability** ease remote collaboration.

Overall, **good communication mechanisms** are valuable, especially when communicating complex information across distances. **Improved collaboration technologies** with information sharing possibilities make collaboration easier than it was before. **Investing in communication technologies**, can mean improving the network connections side or equipment, such as the headsets.

Standardizing the tools used, for instance in different testing phases, can help narrow down gaps in operation and practices between teams. At the same time, the level of **awareness and visibility of available tools** among employees impacts how and if the tools are used. Finally, **tools enabling synchronous way of working** and reducing asynchronicity, the need for context switching between tasks, by providing feedback as you move forward are especially helpful in development work.

5.8. Summarizing words on the findings

The preceding paragraphs presented the 217 factors in 16 categories and seven viewpoints that were identified in the interview material to have an effect on collaboration and productivity in teams that work in the domain of GSD. Many of the factors are relevant to distributed knowledge work in a broader sense, and some of the factors are GSD context specific, especially in the category of *Software engineering processes and methods refinement*. Further on, as the literature review revealed, many of the factors are indeed applicable in a collocated setting but the distances are prone to amplify their meaning. At the same time, many of the factors are unique to a work community that is distributed around the globe. The factors could be seen as enabling productive and fruitful collaboration if managed optimally, and if present in the right quantity. The findings are further discussed in the next section.

6. Discussion

In the following sections I will first summarize and make some general remarks about the findings. Then I will take a look at how they relate to the theoretical frame and what their practical usability is in more detail. After that the methodology, validity and limitations of the study will be evaluated, followed by reflections on India and Finland specific aspects within the study. Finally, before moving on to the concluding remarks, ethical considerations are presented.

The twofold research question was:

> *What are the factors, which affect collaboration and productivity in teams that work in distributed software development…*
>
> *a) …according to the previous research in the field of global software development?*
>
> *b) …according to the empirical findings of interviews at a global software development centre operating in a dynamically and globally networked business environment?*

The literature review presented in the section 2 provided an answer to the first research question, a), which aimed to examine and synthesize the previous research in the GSD field. The concept map (Fig. 2) on the findings provided a view of the topic, firstly from the perspective of the socio-cultural, temporal and physical distances, and secondly from that of the various identified human, management practices, technical, project and sourcing partner related factors. Those factors were seen to originate from the team, organization and operating environment levels in relation to the distributed team collaboration, which was viewed as the central concept.

The findings on the research question a) provided the frame and guidance for devising the tool for answering our second research question, b). One of the main contributions of the concept map was that it integrated the elements discussed in literature in various ways into a unified view. The concept map offered guidance in developing the interview plan and structure, and pointed out which areas should be covered and examined by the interviews.

The set of factors presented in the section 5 provides a basis for answering the second research question, b): The factors that were discovered concern the individuals', teams' and organizations' cross-boundary collaboration, competencies and knowledge, current and evolving work practices and processes, social, cultural and other human related aspects, managerial and leadership capabilities as well as the available tools and infrastructure. More specifically, the factors featured ways of managing and developing competences and knowledge; required knowledge assets; enablers for knowledge and information sharing; desirable aspects of organizational processes, methods and practices; ways of eliminating waste; views on maturity; ways of nurturing social cohesion and cultural understanding; vital individual capabilities for distributed, complex environment; motivational and attitudinal aspects as well as management of distributed work and management's capability to act as a facilitator of that work.

Looking at this set of factors, we can ask how those differ from issues familiar to collocated organizations. Here the discussion goes back to the beginning and the literature review, where it was noted that many of the challenges in a distributed setting are similar to the ones in collocated work, but that they are accentuated by the several distances that come along with the geographical dispersion. Therefore, we could say that many of the factors that facilitate collaboration and productivity are similar to the ones in collocated work, but they are emphasized by the reduced possibility for face-to-face meetings and the dynamic allocation of resources, not to forget the complexity of across-distance work and the globally networked nature of the work force.

The case context is reflected in the results in various ways: The internal global sourcing, insourcing, model shows in matters such as valuing a common organizational culture and goals across locations. The globally networked organization is mirrored in the management frequently being in contact with different locations across the globe. The complexity of the developed products is seen in the requirement for an efficient and systematic competence management, development and *"ramp-up*" practices. Finally, the dynamic business environment is reflected on many of the categories, especially on the viewpoint of *Improving practices and processes* and the category of *Competence management*.

Interestingly, what did get less attention than what I initially anticipated, were issues reported to be caused by cultural differences between collaborating parties. Classic conflicts caused by cultural differences, such as those discussed in the literature review, appear to be manageable by openness of the organizational culture and practices that increase cultural awareness and familiarity. This is not to say that no matters of cultural gaps appeared, but that they were described as secondary, somehow

milder issues in comparison to potential competency or communication challenges. Several reasons can be seen to account for this: 1) the teams are so used to working across different cultures globally that it is *"business as usual"*, 2) common and open organizational culture carries across regional cultural differences, 3) cultural gaps got less attention in the interviews for reasons of sensitivity or 4) other issues are more pressing.

Since the analysis does not constitute quantitative data, and due to the small number of informants and the very much diverse problem domain, I refrain from bringing out any individual factors as the most important or most prominent ones. However, three seemingly connected areas arose in the findings: competency, familiarity and continuity. Based on the analysed material, it seems that successful competence management and building of team and organizational relations and maturity are very much relevant to the productivity of organizations and teams. Discussion on these aspects is continued at the end of the next section with a reflection base taken from the theoretical frame that was presented in the concept map (Fig. 2).

6.1. From intertwined factors to the view of continuity

This section carries on the discussion with the aim to show how these empirical findings relate to and build on the previous research and the theoretical frame, and how they contribute to the current research body of knowledge in DSD.

Firstly, Table 19 illustrates how the identified viewpoints and categories link up to the concept map areas, based on the factors contained by each category.

Table 19. The categories and their key related areas in the concept map (Fig. 2) [originally in Löytty and Ingalsuo, 2016]

		The key related concept map areas				
Viewpoint	Category	**Human** related factors	**Sourcing partner** related factors	**Management** practices	**Technical** factors	**Project** factors
Cross-boundary collaboration	Cross-boundary collaboration	x	x	x		x
Competence and knowledge	Competence management			x	x	x
	Knowledge assets	x		x	x	
	Knowledge and information sharing	x		x	x	
Improving practices and processes	SWE processes and methods refinement	x		x	x	
	Work practices evolution	x		x	x	
	Waste elimination	x		x	x	x
	The Maturity perspective	x		x		x
The Socio-cultural view	The Social angle	x		x		
	Bridging cultural barriers	x	x	x		
Human capabilities and characteristics	Individual capabilities	x				
	Motivation and engagement	x		x		
	Outlook on work	x		x		
Management and leadership	Work distribution and organization			x		x
	Management as a facilitator			x		
Tools and infrastructure	Tools and infrastructure			x	x	

It can be seen that most of the categories that emerged from the interview material relate to multiple areas in the concept map. This illustrates how intertwined and embedded in an organization's layers these factors are. The concept map areas of *Management practices*, *Human related factors* and *Technical factors* seem to be the three with most linkages to the findings. Further, the area of *Management practices* appears to be linked to all but one of the categories. These areas could be seen as the real world areas, or intersections, in which the factors of a particular category can be influenced within an organization.

These notions give affirmation to the observation, which was made during the literature review, that the factors impacting collaboration and productivity in distributed work can be interdependent to great degree. Therefore, managing them effectively seems to require understanding of this interdependency. The noticeable salience of the concept map area of *Management practices* as well as the concurrent presence of multiple other areas in relation the empirical findings also yield support to this thinking. For instance, looking at the category of *Software engineering process and methods*

refinement would involve considering the competency of people, team and task coordination, development tool usage as well as design and architectural issues. As for *Knowledge and information sharing*, managerial aspects such as organizing effective forums, supporting unimpeded communication and providing efficient tools for accessing the required information would be tied together with the human related aspects of awareness of who is knowledgeable in what and active participation in knowledge sharing sessions.

Secondly, what did not explicitly appear in the concept map were questions of accumulation of expertise, evolution of practices and maturing of teams and their relations in the long run. Therefore, reviewing the findings also through the lenses of accumulating capabilities, such as competency and team relations, and how continuity enables these aspects, seems feasible. To lay the ground for this discussion, the below image (Fig. 5) presents the concept map supplemented with the view of *Continuity* containing the spheres of *Accumulation of competency* and *Growing team relations, familiarity* which are seen to promote *Team and organizational evolution, increased maturity*. These spheres are applicable at individual and team as well as inter-team and organizational levels.

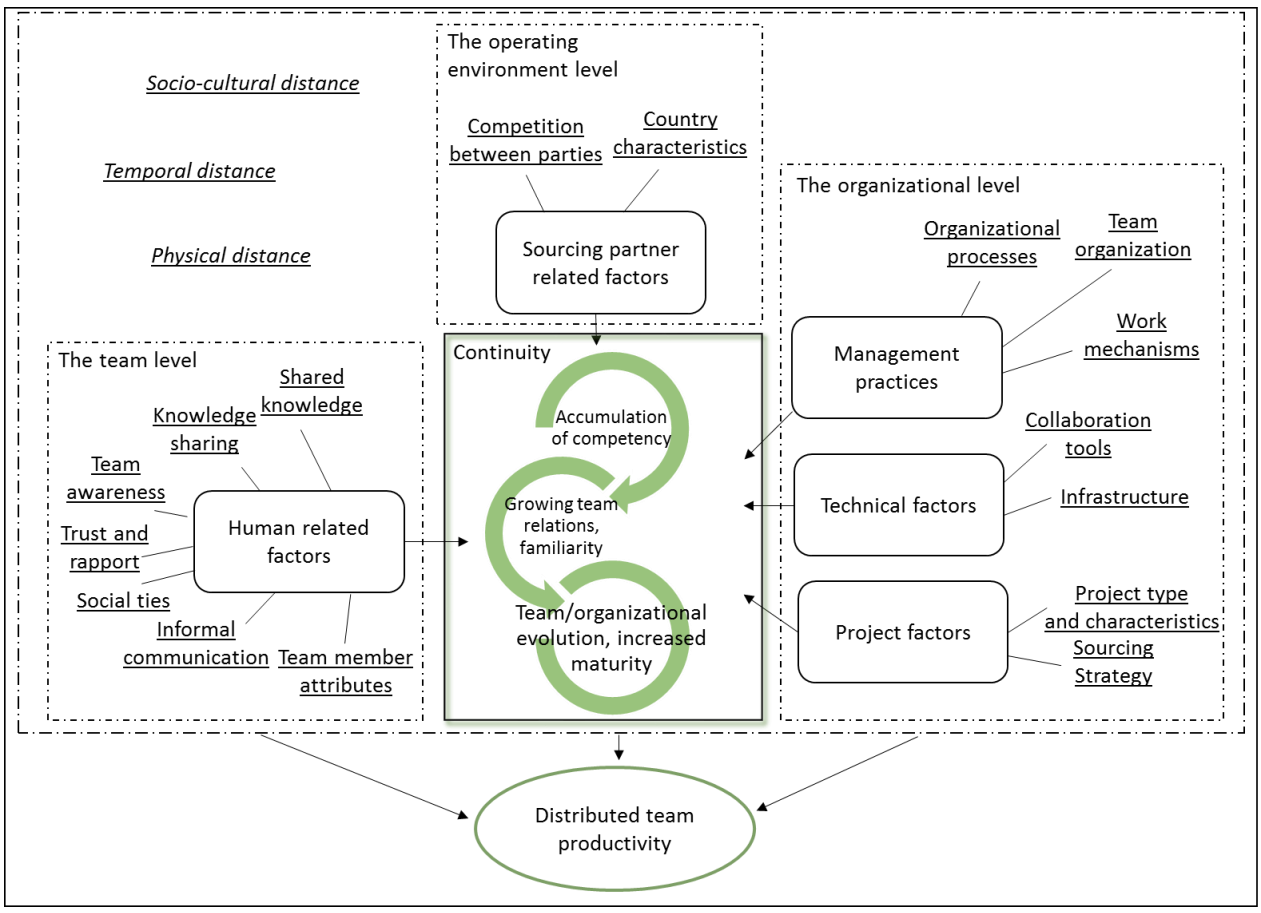

Fig. 5. The concept map supplemented with the view of *Continuity*.

The above figure describes how factors from different organizational areas and levels get fed into the figurative loop of continuity, where they build up into accumulated capabilities in the competencies of team members – be it technological competence, process knowledge, or legacy understanding. Similarly, team relations develop and familiarity of the people one works and collaborates with grows – be it remotely across distributed sites, or co-located within the same team. Together these aspects allow for teams and organizations to evolve and increase their productivity, as they mature with minimal disruptive interruptions.

To further ground this reasoning, factors that appear to be related to the spheres within the view of continuity are analysed in Tables 20-23. These kind of factors can be identified throughout the material, at least in ten of the categories: Especially the categories of *Knowledge assets* (section 5.2.2) and *Competence management* (5.2.1.) seem to be enabled by the accumulation of competency. *The Social angle* (5.4.1.), *Cross-boundary collaboration* (5.1.) and *Knowledge and information sharing* (5.2.3.) get reflected in the growing team relations and familiarity. The categories of *Work practices evolution* (5.3.2.), *Software engineering processes and methods refinement* (5.3.1.) and the *Maturity perspective* (5.3.4.) include factors that manifest particularly as the teams and organizations evolve. In turn, the listed factors from the categories of *Competence management* (5.2.1.), *Management as a facilitator* (5.6.2.) and *Waste elimination* (5.3.3.) enable continuity – or at the least, a sense of it. The relevance of each category to continuity is specified in the rightmost column of the tables.

Table 20. Factors enabled by continuity in the sphere of *Accumulation of competency*

Category	Factor	Relevance to continuity
Knowledge assets	domain knowledge	The level and quality of accumulated knowledge, competency and skills in the related technological and organizational domain at individual, team and organizational levels is expected to increase over the time.
	ecosystem knowledge	
	hardware knowledge	
	legacy understanding	
	process knowledge	
	system knowledge	
	technical competence	
	understanding of specifications and design	
Competence management	ability to maintain competence	As competency, knowledge and skills get accumulated in individuals, teams and organizations, competence management and development practices are based on the existing, continuously advancing level of competency, instead of having to go back and refill recurring gaps.
	addressing competence gaps	
	competence development	
	expertise development	
	knowledge broad-basing	
	learning as an organization	

Table 21. Factors enabled by continuity in the sphere of *Growing team relations, familiarity*

Category	Factor	Relevance to continuity
The social angle	being trusted	The relationships between people in teams and organizations develop over the time, which enables feelings of trust, confidence and teamness, which in turn support smooth collaboration.
	confidence in others	
	knowing each other	
	trusting each other	
	building relationships	
	teamness	
	working together	
Cross-boundary collaboration	established interfaces	Effective collaboration and operation of teams is benefited by established connections across teams, organizational levels and locations, for instance in acquiring specific expertise for problem solving. It takes time to build these relationships.
Knowledge and information sharing	expert access	
	knowing who knows what	

Table 22. Factors manifested and enabled by *Team and organizational evolution, increased maturity*

Category	Factor	Relevance to continuity
Work practices evolution	challenge acknowledgement	Through the development of competency and team relations work practices evolution and improvement takes place in an advancing "spiral" together with continuous and end-to-end improvement of teams, organizations, processes and methods.
	end-to-end responsibility	
	evolving the processes according to the needs	
	self-direction of teams	
	sharing feedback, ideas and thoughts	
	using feedback to improve the processes	
	using tried good practices as a basis	
Software engineering processes and methods refinement	continuous improvement	
	delivery capability	
	end-to-end competency	
	optimizing the entity	
The Maturity perspective	process maturity	As teams' work practices, processes and methods evolve and get refined together with the social relations and competency, the teams and organizations get more mature and are able to increase their productivity.
	organizational maturity	
	team maturity	
	organizational stability	

Table 23. Factors enabling *Continuity* (or perception thereof)

Category	Factor	Relevance to continuity
Competence management	level of attrition	Sustainability of employees is one enabler in effective competence management and development of team relations.
	preparing for attrition	
Management as a facilitator	ability to see the future road map	Management is a facilitator of actual and perceived continuity in teams, for instance by the means of supporting employees' ability to see their future road map within a company, clearly communicated targets and well managed organizational change.
	confidence in the company and leadership	
	creating confidence in not needing to compete but complement	
	employees' understanding of management decisions	
	goal orientation	
	managing organizational change	
	supporting the ability to focus	
	target clarity	
	top management communication	
Waste elimination	minimizing dismantling teams	Minimal disruptive disturbances to teams' work and composition enable continuity of the teams' development.
	minimizing disturbances	

As a conclusion of this discussion and the preceding tables, these considerations could be formulated into further questions of how to support factors that enable continuity in teams, skills and competences wise and, perhaps more importantly, the developing relations between people in an environment where dynamism and responsiveness to changing requirements are crucial. In other words, we should ask how to retain and nurture, and not lose, the accumulated (intellectual) capital within an organization, when changes take place.

6.2. Practical implications

The study can be expected to provide value in four distinct ways. First, from a company point of view, the categorized set of factors introduced here provides value as an entity: Rather than looking at the factors individually, which alone may seem even self-evident, it is useful to examine them as a whole. This entity of the viewpoints, categories and factors provides a descriptive and structured overview of elements that are identified in the domain of distributed software work to affect and shape its collaboration and productivity. It is beneficial to be aware of these elements, when evaluating and managing the activities of teams that operate in a distributed setting. Secondly, the material can help to uncover areas that would benefit from further examination within an organization. For

instance, the factors can serve as a check list on whether certain aspects have been considered in a particular area. As the identified factors are presented in a structured way, and thus made more visible, they are expected to also become more manageable and measurable

Application of these notions seems relevant also outside the domain of GSD, especially in other KW intensive efforts that require coordination and collaboration across boundaries. Naturally the weight and importance of each viewpoint, category and their respective factors depend on the context that they are examined in: The industry and sourcing model of the company, the age and composition of the teams and organizations, the recent and foreseeable changes in the operating environment and the tasks the teams engage in all influence the significance.

Thirdly, one of the objectives of this study was to provide information for the utilization of the DD-SCALE-research project, especially from a team collaboration and distribution perspective. This target has been met in that the findings have been evaluated and utilized as a component in the overall research material of the project. The particular contribution of these findings is that they provide a distributed work and an offshoring location perspective to a broader discussion on the topic of software work productivity within the project.

Finally, in addition to the set of factors itself, the points that were presented in the preceding sections can be likewise capitalized on. The reflections on the aspects of continuity invoke new questions for further research relating to the management of continuity in team competencies, relations and evolution.

6.3. Evaluating the methodology, validity and limitations of the study

Overall, the strength of the factor set is that it covers a broad spectrum of angles in the domain of distributed collaborative knowledge work in the context of GSD. Its limitations, such as the limited scope of the managerial, offshoring location view, are evaluated in this section. The following paragraphs examine the study from three perspectives: the overall appropriateness and feasibility of the chosen methods, the reliability and validity of the conducted research, and the limitations in the scope of the study.

Appropriateness of the chosen methods. The overall approach of this work was a case study with the methods of semi-structured interviews and qualitative content analysis. The empirical research

problem was to seek for factors that affect collaboration and productivity of teams that work in dynamically and globally networked, distributed software development. As the aim was to gain in-depth knowledge with a relatively broad spectrum of themes within a real life complex context, conducting interviews in a case study is considered an adequate decision.

The described method of content analysis is likewise regarded as appropriate for answering our research question. The analysis was conducted meticulously and in consultation with other researchers aiming for objective and systematic approach as well as a proper level of precision in the findings. Nevertheless, the challenges in the chosen data collection and analysis methods do include that the results reflect 1) what the interviewees felt comfortable enough to disclose to the interviewers and 2) the interpretations of the researchers. These issues are something we have to acknowledge, but something that cannot be fully avoided when searching for elements that may by underlying or hidden, and thus may not appear in quantified, hard data. The following paragraphs evaluate the measures that have been taken to ensure the validity and reliability of the study in the face of these challenges.

Validity and reliability of the study. In this assessment I follow Yin's analysis [2014] of criteria for judging the quality of research designs. Three areas, *construct validity*, *external validity* and *reliability* of the results, [Yin, 2014, 45] are examined here. Yin [2014, 238, 240] defines these areas as follows:

- construct validity entails *"the accuracy with which a case study's measures reflect the concepts being studied"*,
- external validity means *"the extent to which the findings from a case study can be analytically generalized to other situations that were not part of the original study"* whereas
- reliability implies *"the consistency and repeatability of the research procedures used in a case study"*.

Firstly, construct validity was addressed in the study by selection of the case organization and the interviewees, as was described in the *Methods* section 3, with the essential considerations that the case represents the context of the research problem, and that the informants are able to reflect representatively on the factors examined in the research.

Among other tactics to increase construct validity is to *"use multiple sources of evidence* [Yin, 2014, 45]*"*. This was addressed by selecting informants from multiple areas within the case organization.

However, no other methods than interviews were used in data collection. Alternative sources, such as examining "hard", quantified data collected, for example, from programming and testing logs should also be considered. This kind of data would likely provide valuable information on *how* productivity manifests itself, but would yield little knowledge on *what* is that shaping productivity, *why* productivity is as it is. Nevertheless, alternative data sources could be applied for both validation of the current findings by triangulation and extension of the scope.

The next recommendation, *establishing "a chain of evidence"* [Yin, 2014, 45], was approached by ensuring that the research process, all the way from the initial planning to the data collection and analysis and finally to the findings and conclusions, has been recorded in such a way that it is possible to *"follow the derivation of any evidence from initial research questions to conclusion"* [Yin, 1989, 97]. In practice this means that tracing from the concept map to an interview question to an interviewee's response to a coded excerpt and finally to the categorized factors is made possible by documentation.

The final recommendation of ensuring construct validity is to *"have key informants review draft case study report"* [Yin, 2014, 45]. This was applied to a certain extent in that the interim results as well as the draft and final reports were reviewed by the case company representatives both during construction and after finalization of the findings. Circulating the findings to the informants was left for the case company to consider due to the limited time resources in the study. The key findings from the review sessions dealt with cultural distances of the study being potentially reflected on the collected and analysed data. These aspects are addressed in the next section, *6.4. Revisiting the Finland-India axis.*

The threat to external validity, that is how generalizable the results from case studies are, got addressed in the sections *6.1. From intertwined factors to the view of continuity*, which analysed how the findings relate and link up to the constructed theoretical frame within the field of GSD, and in the *6.2. Practical implications,* which considered extending the application of the findings to other distributed knowledge intensive efforts besides software development. What comes to the latter, the fact that software development possesses many of the traits that are identified in KW, supports this aspect of generalization, as was already noted in the section *1.3 Defining the key concepts*. The extent in which the results can be applied to domains outside DSD/GSD depends on the factor category that

we are looking at. For example, the categories such as *Software engineering processes and methods refinement* and *Tools and infrastructure* are relatively software development specific.

Also the discussion on accumulation of capabilities and (intellectual) capital relates to and builds on existing theory, which too can be seen as a sign on generalizability. These points could be further assessed by examining for example theories of competence development and team building from the domains of business and human resource management.

Finally, the reliability of a study can be tested by its repeatability. In other words, if someone else repeated the study with the same case, would it show the same results? [Yin, 2014, 48] The repeatability of this study is supported by the documentation in the *Methods* and *Analysis* sections. Therefore, it seems that it would be feasible to repeat the case and thus test its reliability. However, it is important to note that results evolve during time as the global business environment changes and technological development advances. Therefore something that today is deemed an issue of importance could show less relevance in the future.

Limitations. Further to the considerations in the preceding paragraphs, it must be acknowledged that the findings show a managerial view on the topic. If the same questions were asked the team members who programme the software, the findings would likely show different factors. Again, this practice could be used for testing and broadening the scope of the current results. For example, similarities and differences between results achieved from different types of informants could be examined.

The relatively small number of informants constitutes another limitation. The generality and validity of the results could be evaluated by incorporating a larger sample and other sources of data in addition to these interviews. Also to tackle the mentioned challenges of the case study and qualitative interviews as methods, triangulation by using alternative sources of information and quantified data could be conducted, as was noted earlier in the section. Methods used in grounded theory for assessing the representativeness of the identified concepts within the problem domain [Corbin and Strauss, 1990, 9] could also be applied.

6.4. Revisiting the India-Finland axis

In this section I approach the discussion from a cultural perspective. People's behaviour in any given situation and participation in the society at large are impacted by social contexts and cultures [Foulkes Savinetti, 2015, 48]. By applying Foulkes Savinetti's analysis [2015, 48-51] on migrants and the

influence of culture, it can be deduced that in multicultural environments, not only how one naturally behaves but also how one is expected to behave by the cultures of the society, him- or herself and the *"other"* contribute to social citizenship, and therefore to the way one participates in that society or in a given social situation. Therefore, the various socio-cultural distances between the researchers and the interviewees is something that deserves to be reviewed.

At least three dimensions of socio-cultural distances can be identified, which potentially influence the data collection and analysis processes: 1) There are differences in organizational and societal cultures between the researchers and informants, 2) the Finnish researchers and Indian interviewees speak different first languages and 3) the interviews which were conducted in English utilized a language that was the second tongue to both the informants and the researchers. These aspects not only affect how different concepts are used and understood but also the general approach to things in life. Thus these aspects are also likely to get reflected on the study.

Indeed, as the findings were discussed with case company representatives during a review session, some of the feedback concerned how the cultural distances present may have affected the findings. This concern can be seen applicable to the collection style of data, the data itself and the interpretation of the data. In the review session, the presented factors as such were acknowledged and accepted. However, the concern was whether the study had been able to capture all the relevant factors or had some been "lost in translation" due to the potential static posed by the cultural distances. This concern is relevant, and also something that the researchers evaluated, as is presented in the next paragraphs.

An additional set of interviews was conducted in Finland as part of the DD-SCALE project after this study. The scope was outside this study, but the topic and themes were in the same problem domain of collaboration and productivity in GSD. These interviews were conducted in the same case company but at a different organizational level and at different sites. The preliminary analysis of those interviews provides support for the validity of the findings presented in this work: Issues portrayed in the latter interview set seem to be similar to those that were discovered in the interviews that were conducted in India. The main difference appears to be that the interviews in Finland went deeper into the topics, providing perhaps more detailed examples of the issues. Additionally, the view points and emphasis differed between the interview sets.

Potential reasons for these differences are various: Firstly, the first set of interviews, the one analysed within this thesis, was conducted in an international environment, that is in India, with Finnish researchers and India-based informants. The second set of interviews was conducted in Finland, by Finnish researchers and Finnish interviewees. Therefore, the cultural distances between the participants in the latter were considerably smaller, which could have an impact on the depth of the discussions. At the same time, during the latter set the interviewers were more experienced on the topic, so the level of discussion could have been deeper already to start with. The differences could also be due to matters such as differing organizational roles of the informants, and therefore differing perspectives to the topic. Nevertheless, when evaluating the impact of cultural distances on the findings, the key is that overall the issues that emerged in the two interview sets were similar to, and not in contravention with each other.

The final point to be addressed in this section is that even though the empirical part of the study took place in India, one has to be mindful not to unintentionally over-emphasize the Indian perspective, nor make the study solely *India-specific*. The environment where the interviews were conducted represents one kind of a GSD setting as a case. The scope of six interviews is not meant to provide a representative result in a country specific sense – especially as a diverse and large country as India. Instead, the study aims to provide a comprehensive image of factors that are present in distributed knowledge work, and more specifically GSD, which in this case takes place in India. Further, the goal is to provide a result that can be utilized and extended in conjunction with cases from other sites and locations. Finally, it is up to the reader and the situation to determine how much of the study is seen as India-focused and how much of it is applicable in a broader context.

6.5. Ethical considerations

Throughout the analysis, the researcher(s) aimed at maintaining a neutral and objective stance in terms of identifying, naming and defining the factors. While additional context related information obtained in the course of the study, such as in project workshops and discussions, offered insight into the world surrounding the collected material and a reflection base for the results-in-progress, this also presented a challenge for remaining objective, without letting information from outside the research material influence the analysis.

The second ethical consideration relates to the confidentiality of the interviews: Finding the balance between maintaining confidentiality of the discussions and providing enough information of the results to their users requires consideration in how to present the findings. For example, the aim was to

omit any elements of the interview quotations that could be used in identifying the speaker. This conduct was considered appropriate even though the level of discussion during the interviews maintained a professional and decorous tone throughout.

The last ethical consideration here relates to the limited size and scope of the study. When reporting the findings and making conclusions, the researcher needs to view the study from a distance in order to reliably evaluate the generalizability of the findings. Similarly, taking actions based on these findings should be carefully considered in the light of these considerations.

7. Summarizing and concluding remarks

This thesis examined factors that affect collaboration and productivity in dynamically distributed knowledge work in the context of global software development, firstly, according to previous GSD research and secondly, according to empirical findings from interviews. The empirical study was carried out in an R&D centre of a globally distributed and networked software development intensive company that has engaged in global sourcing activities for several years. The study progressed from a literature review and data collection planning to a set of six semi-structured interviews that were conducted with managerial level ICT R&D professionals in Bengaluru, India. The collected data was analysed by the method of qualitative content analysis.

As outputs, the thesis provides two distinct but connected artefacts: First, a concept map synthesising previous GSD research on team collaboration and productivity. According to previous research essentially three distances – those of socio-cultural, temporal and physical – amplify the various factors that influence distributed team collaboration and productivity. These factors can be seen to originate from team, organization and operating environment levels of a company, and be associated with the areas of human, management practices, technical, project and sourcing partner related issues.

Second, the empirical part of the study brings forth a managerial, offshoring location view of factors that are perceived to affect collaboration and productivity in teams within dynamically and globally networked DSD work: a set of 217 factors – attributes, activities and phenomena – grouped into 16 categories and seven higher level viewpoints was gathered. These factors relate to cross-boundary collaboration of teams; management of competences, knowledge assets and knowledge sharing; evolving organizational practices, processes and teams; socio-cultural aspects; human capabilities and characteristics; motivational and engagement aspects; capabilities of management and leadership as well as those of tools and infrastructure in the context of a globally operating and distributed knowledge intensive organization.

These artefacts can be utilized as such when evaluating and managing the activities of knowledge intensive teams that operate in a distributed setting. The material can also help to uncover areas that would benefit from further examination in globally operating, distributed organizations. The limitations of the empirical study include the limited scope and the small number of informants. The study

could be tested and broadened by including informants from alternative functional areas, organizational levels and locations. Also including additional sources of information, apart from interviews, would strengthen the results.

Similarly to the artefactual outputs, the conclusions of the study are twofold: Firstly, the empirical findings are in line with those of the literature review. The factors impacting productivity and collaboration in distributed work are interdependent, and embedded in multiple organizational layers. Moreover, based on this comparative analysis between the theoretical frame and the empirical study, the areas of management practices, human related issues and technical factors seem to be the most focal to the collaboration and productivity elements discovered in the interviews.

Secondly – and perhaps more importantly – what did not explicitly appear in the constructed theoretical frame were questions relating to *accumulation of competency, growing team relations and familiarity, team and organizational evolution* and *increased maturity* in the long run. Based on the analysis, these areas can be seen to be enabled by *continuity*, which allows teams and organizations to evolve and increase their productivity, as they mature with minimal disruptive interruptions. Factors that appear to be affected by or enabling these "spheres of continuity", could be identified throughout the set of factors at least in ten of 16 categories, namely those relating to knowledge assets, competence management, social aspects, cross-boundary collaboration, knowledge and information sharing, work practices evolution, refinement of processes and methods, maturity, waste elimination and management as a facilitator of teams' work.

In closing and with further research in mind, the findings point to the significance of enabling maturity, evolution and continuum in teams to support the accumulation of capabilities and (intellectual) capital in a dynamic and fast changing business environment of global software development as well as other distributed knowledge intensive work. It is therefore suggested that the dimension of continuity should be further addressed in GSD research. Questions, such as how to retain and nurture factors that enable continuity in teams and organizations from the competency and team relations perspective in a dynamic, fast-changing global business environment, should be asked.

References

[Bhattacharjee *et al.*, 2013] Samrat Bhattacharjee, Abhinandan Bhadauria and Girish Kumar IK, Managing product delivery quality in distributed software development. In: *Global Software Engineering (ICGSE), 2013 IEEE 8th International Conference on Global Software Engineering* (2013), IEEE, 164-167.

[Bonn, 2012] Heinz-Paul Bonn, Foreword by BITKOM. In: Ulrich Bäumer, Peter Kreutter and Wolfgang Messner (eds.), *Globalization of Professional Services: Innovative Strategies, Successful Processes, Inspired Talent Management, and First-Hand Experience*. Springer, 2012, v.

[Bosch-Sijtsema *et al.*, 2009] Petra M. Bosch-Sijtsema, Virpi Ruohomäki and Matti Vartiainen, Knowledge work productivity in distributed teams. *Journal of Knowledge Management* **13**, 6 (2009), 533-546.

[Carmel, 1997] Erran Carmel, Thirteen assertions for globally dispersed software development research. In: *System Sciences, Proceedings of the Thirtieth Hawaii International Conference* **3** (1997), IEEE, 445-452.

[Central Intelligence Agency, 2016] Central Intelligence Agency. The World Factbook, South Asia: India. (2016) [Online] Available at: *https://www.cia.gov/library/publications/the-world-factbook/geos/in.html*. [Accessed 18 April 2016].

[Chandrasekaran *et al.*, 2014] Sriram Chandrasekaran, Sauri Gudlavalleti and Sanjay Kaniyar, Achieving success in large, complex software projects. McKinsey and Company, 2014. Available at: http://www.mckinsey.com/business-functions/business-technology/our-insights/achieving-success-in-large-complex-software-projects [Accessed 18 June 2016].

[Corbin and Strauss, 1990] Juliet Corbin and Anselm Strauss, Grounded theory research: procedures, canons and evaluative criteria. *Qualitative Sociology* **13**, 1 (1990), 3-21.

[Da Silva *et al.*, 2010] Fabio Q. B. da Silva, Catarina Costa, A. César C. Franca, and Rafael Prikladinicki, Challenges and solutions in distributed software development project management:

a systematic literature review. In: *Global Software Engineering (ICGSE), 2010 5th IEEE International Conference on Global Software Engineering* (2010), IEEE, 87-96.

[Deetz, 1996] Stanley Deetz, Describing differences in approaches to organization science: rethinking Burrell and Morgan and their legacy. *Organization Science* **7**, 2 (1996) 191-207.

[Deshpande and Richardson, 2009] Sadhana Deshpande and Ita Richardson, Management at the outsourcing destination - global software development in India. In: *ICGSE 2009. 2009 Fourth IEEE International Conference on Global Software Engineering*, (2009), IEEE, 217-225.

[Engardio, 2006] Pete Engardio, *Chindia - How China and India Are Revolutionizing Global Business*. McGraw-Hill, 2006.

[Espinosa *et al.*, 2007] J. Alberto Espinosa, Sandra A. Slaughter, Robert E. Kraut, and James D. Herbsleb, Team knowledge and coordination in geographically distributed software development. *Journal of Management Information Systems* **24**, 1 (2007), 135-169.

[Foulkes Savinetti, 2015] Nicol Foulkes Savinetti, *Encountering Difference: The experience of Nordic highly skilled citizens in India.* Academic Dissertation, Acta Universitatis Tamperensis 2060, Tampere University Press, 2015.

[Gupta and Fernandez, 2011] Mayank Gupta, and Jude Fernandez, How globally distributed software teams can improve their collaboration effectiveness? In: *Global Software Engineering (ICGSE), 2011 6th IEEE International Conference on Global Software Engineering* (2011), IEEE, 185-189.

[Herbsleb *et al.*, 2001] James D. Herbsleb, Audris Mockus, Thimas A. Finholt and Rebecca E. Grinter, An empirical study of global software development: distance and speed. *In: Software Engineering, ICSE 2001. Proceedings of the 23rd International Conference* (2001), IEEE, 81-90.

[Herbsleb *et al.*, 2005] James D. Herbsleb, Daniel J. Paulish, D. J. and Matthew Bass, Global software development at Siemens: experience from nine projects. In: *ICSE '05: Proceedings of the 27th international conference on Software engineering* (2005), ACM, 524-533.

[Hirsjärvi and Hurme, 1982] Sirkka Hirsjärvi and Helena Hurme, *Teemahaastattelu.* Kyriiri Oy, 1982.

[Hirsjärvi and Hurme, 2011] Sirkka Hirsjärvi and Helena Hurme, *Tutkimushaastattelu – Teemahaastattelun teoria ja käytäntö*. Gaudeamus Helsinki University Press, 2011.

[Ingalsuo, 2015] Timo Ingalsuo, *Digitalisaatio ja arvon yhteisluonti valmistavassa teollisuudessa – teollinen internet ja sosiaalinen tietojenkäsittely mahdollisuuksina.* Master's thesis, University of Tampere, School of Information Sciences, 2015.

[Jaakkola *et al.*, 2010] Hannu Jaakkola, Jaak Henno and Petri Linna, Software Development in a Multicultural Context: Adaptive and Learning Organizations. In: *MIPRO, 2010 Proceedings of the 33rd International Convention* (2010), IEEE, 789-797.

[Järvinen, 2008] Pertti Järvinen, *On developing and evaluating of the literature review.* University of Tampere, Department of Computer science, Series of publications D – Net publications, **D-2008-10**, September 2008.

[Kamaja *et al.*, 2015] Pekka Kamaja, Mikko Ruohonen and Timo Ingalsuo, Challenges in the intellectual capital evaluation for dynamic distributed software development teams – DD-SCALE program in progress. In: Cegarra Navarro, J. G. (ed.), *Proceedings of the 7th European Conference on Intellectual Capital, Cartagena, Spain* (2015), Academic Conferences and Publishing International Limited, 173-180.

[Klein and Myers, 1999] Heinz K. Klein and Michael D. Myers, A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly* **23**, 1 (1999), 67-93.

[Kotlarsky and Oshri, 2005] Julia Kotlarsky and Ilan Oshri, Social ties, knowledge sharing and successful collaboration in globally distributed system development projects. *European Journal of Information Systems* **14** (2005), 37-48.

[Kumar, 2014] Nagesh Kumar, National Innovation Systems and the Indian Software Industry Development. In: Shyama V. Ramani (ed.), *Innovation in India - Combining Economic Growth with Inclusive Development*. Cambridge University Press, 2014, 143-185.

[Lambgrets *et al.*, 2016] Bart Lambgrets, Niels Beerepoot, and Robert C. Kloosterman, The local impact of services offshoring in South and Southeast Asia: introduction and overview. In: Bart Lambgrets, Niels Beerepoot and Robert C. Kloosterman (eds.), *The Local Impact of Globalization in South and Southeast Asia: Offshore Business Processes in Services Industries.* Routledge, 2016, 1-13.

[Lanubile, 2009] Filippo Lanubile, Collaboration in distributed software development. In: Andrea de Lucia and Filomena Ferrucci (eds.), *Software Engineering, International Summer Schools, ISSSE 2006-2008, Salerno, Italy, Revised Tutorial Lectures*, **5413**, Springer, 2009, 174-193.

[Lee-Kelley and Sankey, 2008] Liz Lee-Kelley and Tim Sankey, Global virtual teams for value creation and project success: A case study. *International Journal of Project Management*, **26**, (2008), 51-62.

[Lehtonen, 2014] Mikko Lehtonen, Maa-ilma – Materialistisen kulttuuriteorian lähtökohtia. Vastapaino, 2014.

[Löytty and Ingalsuo, 2015] Katriina Löytty and Timo Ingalsuo, Factors impacting successful collaboration and productivity of distributed software development teams: a proposed multidimensional concept map. In: Anssi Öörni, Netta Iivari, Kari Kuutti, Harri Oinas-Kukkonen and Mikko Rajanen (eds.), *Proceedings of the 38th Information Systems Research Seminar in Scandinavia (IRIS38)* (August 2015).

[Löytty and Ingalsuo, 2016] Katriina Löytty and Timo Ingalsuo, Mapping the Collaboration and Productivity Factors in Distributed Software Development Teams – An Interview Study in India. In: *Proceedings of the 39th Information Systems Research Seminar in Scandinavia (IRIS39)* (to be published, August 2016).

[Marques *et al.*, 2012] Anna Beatriz Marques, Rosiane Rodrigues and Tayana Conte, Systematic literature review in distributed software development: a tertiary study. In: *Global Software Engineering (ICGSE), 2012 IEEE Seventh International Conference on Global Software Engineering* (2012), IEEE, 134-143.

[Mittal, 2012] Som Mittal, Foreword by NASSCOM. In: Ulrich Bäumer, Peter Kreutter and Wolfgang Messner (eds.), *Globalization of Professional Services: Innovative Strategies, Successful Processes, Inspired Talent Management, and First-Hand Experience.* Springer, 2012, vii-viii.

[Niazi *et al.*, 2012] Mahmood Niazi, Narciso Cerpa and Valentine Casey, Editorial: Management of global software development: opportunities, challenges and lessons learned. *IET Software* **6**, 3 (2012), 165-166.

[Nickerson *et al.*, 2013] Robert C. Nickerson, Upkar Varshney and Jan Muntermann, A method of taxonomy development and its application in information systems. *European Journal of Information Systems* **22** (2013), 336-359.

[Nonaka *et al.*, 2000] Ikujiro Nonaka, Ryoko Toyama and Noboru Konno, SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation. *Long Range Planning* **33**, 1 (2000), 5-34.

[Oshri *et al.*, 2009] Ilan Oshri, Julia Kotlarsky, Joseph W. Rottman and Leslie L. Willcocks, Global sourcing: recent trends and issues. *Information Technology and People* **22**, 3 (2009), 192-200.

[Prikladnicki and Audy, 2012] Rafael Prikladnicki and Jorge Luis Nicolas Audy, Managing global software engineering: A comparative analysis of offshore outsourcing and the internal offshoring of software development. *Information Systems Management* **29**, 3 (2012), 216-232.

[Ramingwong and Ramingwong, 2011] Sakgasit Ramingwong and Lachana Ramingwong, Culturally influenced risk exposure: a new approach to tackle risks in offshore outsourcing. In: *Information Science and Applications (ICISA), 2011 International Conference on* (2011), IEEE, 1-5.

[Rottman and Lacity, 2006] Joseph W. Rottman and Mary C. Lacity, Proven practices for effectively offshoring IT work. *Sloan Management Review* **47**, 3 (April 2006), 56-63.

[Rowe, 2014] Frantz Rowe, Editorial – What literature review is not: diversity, boundaries and recommendations. *European Journal of Information Systems* **23**, 3 (2014), 241-255.

[Ruohomäki, 2013] Olli Ruohomäki, Atlas.ti 7 -pikaopas. Opintomoniste, 2013.

[Ruohonen *et al.,* 2014] Mikko Ruohonen, Marko Mäkipää and Pekka Kamaja, Competencies and work practices for dynamic distributed software development in global value networks. In: Passey, D., Tatnall, A. (eds.), *Key Competencies in ICT and Informatics. Implications and Issues for Educational Professionals and Management*, **444**, Springer, 2014, 42-51.

[Ruohonen *et al.,* 2016] Mikko Ruohonen, Marko Mäkipää and Timo Ingalsuo, *"Ketterä Digitalisaatio" – Strateginen Ketteryys Verkostoissa ja ICT:n Älykäs Hyväksikäyttö.* Tampere University Press, 2016 (to be published).

[Saaranen-Kauppinen and Puusniekka, 2006] Anita Saaranen-Kauppinen and Anna Puusniekka, KvaliMOTV – Menetelmäopetuksen tietovaranto – Sisällönanalyysi. [Online] Available at: *http://www.fsd.uta.fi/menetelmaopetus/kvali/L7_3_2.html*. Tampere: Yhteiskuntatieteellinen tietoarkisto, 2006. [Accessed 18 June, 2016].

[Sengupta *et al.,* 2006] Bikram Sengupta, Satish Chandra and Vibha Sinha, A Research Agenda for Distributed Software Development. In: *ICSE '06: Proceedings of the 28th international conference on Software engineering* (2006), ACM, 731-740.

[Šmite and Wohlin, 2011] Darja Šmite and Claes Wohlin, A whisper of evidence in global software engineering. *IEEE Software* **28**, 4 (2011), 15-18.

[Tangen, 2005] Stefan Tangen, Demystifying productivity and performance. *International Journal of Productivity and Performance Management* **54**, 1 (2005), 34-46.

[The Hofstede Centre] The Hofstede Centre, Country comparison – India/Finland. [Online] Available at: *https://geert-hofstede.com/india.html.* [Accessed 18 April 2016].

[The World Bank, 2014] The World Bank, Population, total. (2014) [Online] Available at: *http://data.worldbank.org/indicator/SP.POP.TOTL?order=wbapi_data_value_2014%20wbapi_data_value%20wbapi_data_value-last&sort=asc* [Accessed 18 April 2016].

[Tiainen, 2014] Tarja Tiainen, *Haastattelu tietojenkäsittelytieteen tutkimuksessa*, University of Tampere, School of Information Sciences, Informaatiotieteiden yksikön raportteja **25/2014**, January 2014.

[Webster and Watson, 2002] Jane Webster and Richard T. Watson, Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly* **26,** 2 (2002), xiii-xxiii.

[Yalaho and Nahar, 2010] Anicet Yalaho and Nazmun Nahar, Key success factors for managing offshore outsourcing of software production using the ICT-supported unified process model: a case experience from Finland, India, Nepal and Russia. In: *Technology Management for Global Economic Growth (PICMET), 2010 Proceedings of PICMET '10* (2010), IEEE, 1-14.

[Yin, 1989] Robert K. Yin, *Case Study Research: Design and Methods*. Sage Publications, 1989.

[Yin, 2014] Robert K. Yin, *Case Study Research: Design and Methods.* 5th edition, Sage publications, 2014.

Appendix 1: The interview structure

Background information

1. Can you please describe your role in the organization?

2. How large is the organization you are managing?

3. Can you please describe your organization's role in the process?

4. How is your organization distributed geographically?

Theme 1: Collaboration, coordination and communication

(Overall: "What are the collaboration, coordination and communication practices, perceived challenges and their effects on productivity at a team and feature level?")

5. Can you please describe your team's collaboration with teams at other sites, for example, when building a new software product feature?

6. Can you please describe the communication with teams at other sites, for example, when discussing about requirements of a feature?

7. Can you please describe how tasks are coordinated with teams at other sites, for example, when building a feature?

8. If you think about collaboration, communication and task coordination, what kind of challenges have there been?

9. How do these challenges affect productivity, in your opinion?

Theme 2: Collaboration tools

(Overall: "How are collaboration tools and related challenges perceived to affect productivity?")

10. Can you please describe the tools that are used for supporting the collaborative activities between teams?

11. What kind of challenges have there been in using those tools?

12. In what ways would you like to further develop the available tool set?

13. How do you find the efficiency of the current tools?

14. How do these challenges affect productivity, in your opinion?

Theme 3: Knowledge sharing and shared understanding

(Overall: "What is the nature of knowledge sharing and shared understanding, and factors supporting them, among teams located at multiple sites?")

15. When a feature is being developed, how is a shared understanding formed, for example, about feature requirements among teams located at multiple sites?

16. Can you please describe how knowledge is shared across teams located at different sites, for example, when testing a feature?

17. In your opinion, what are the most important factors in successful knowledge sharing and forming shared understanding?

18. What kind of challenges are there in successful knowledge sharing and forming shared understanding?

19. How do cultural differences, organizational and national, affect these aspects?

Theme 4: Social ties

(Overall: "What is the nature of social ties among teams located at multiple sites?")

20. Can you please describe the social ties between the teams at different sites?

21. What kind of practices and mechanisms are there that support building of social ties between teams at different sites?

Theme 5: Competencies and project characteristics

(Overall: "How are team competencies and their effects on feature development perceived?")

22. In your opinion, what are the most important team competencies in software R&D in a multisite environment, such as this?

23. In your perception, what kind of challenges have there been in achieving the right competence mix among feature developing teams across sites?

24. How does the type of the feature being developed affect the productivity of the process, in your opinion?

Theme 6: Productivity

(Overall: "How are productivity and factors affecting it perceived?")

25. Overall, what do you consider as productivity in your organization?

26. How is productivity measured in your organization?

27. In your opinion, what are the most important factors supporting productivity in this kind of a multicultural and multisite environment?

28. What do you see to be the most important hinderers of productivity of software R&D in your company?

29. Which areas would you like to further develop in order to support productivity of software R&D in a multicultural and multisite environment like this?