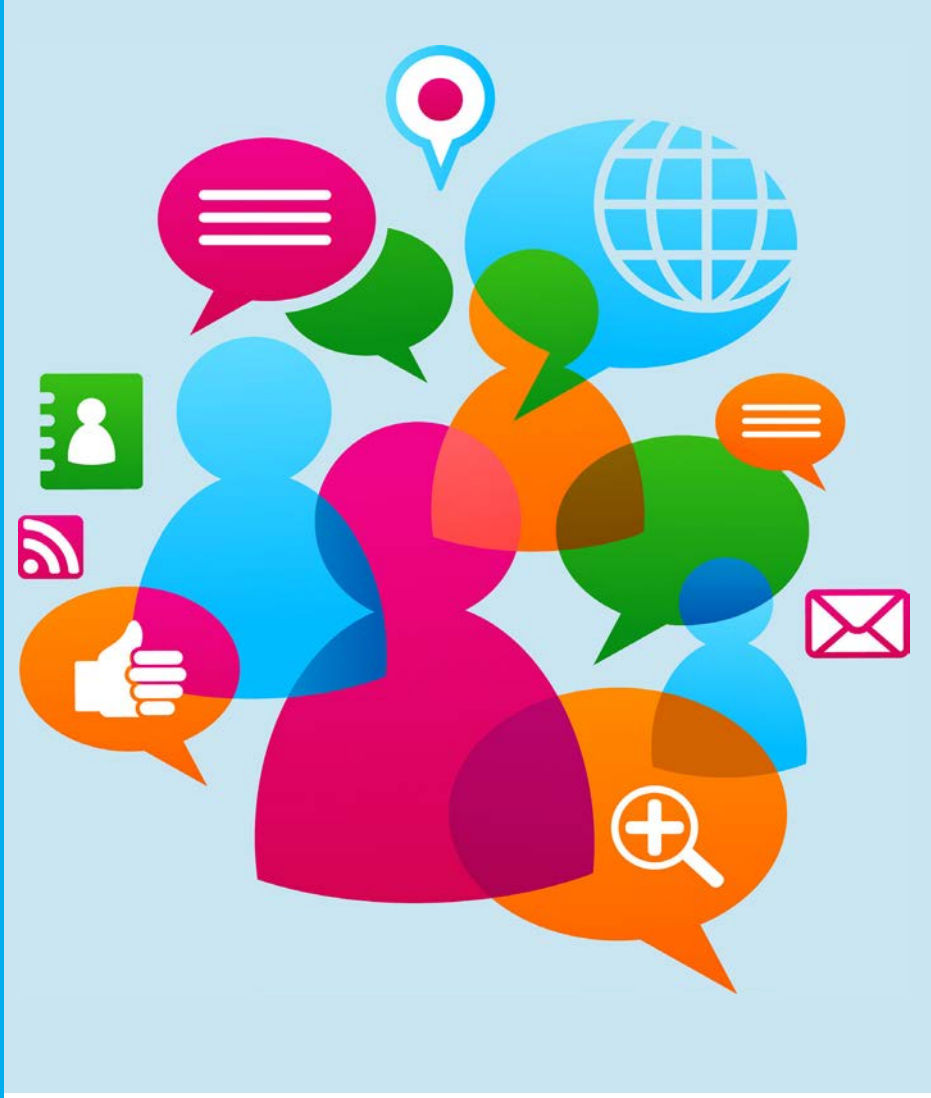

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Supporting distributed knowledge work in a knowledge intensive organisation

Hannamaija Määttä

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Supporting distributed knowledge work in a knowledge intensive organisation

[Hajautetun tietotyön tukeminen tietointensiivisessä organisaatiossa]
Hannamaija Määttä. Espoo 2012. VTT Technology 14. 95 p. + app. 11 p.

Abstract

The purpose of this case study was to explore the aspects of distributed work and its challenges from the knowledge worker perspective, and discover how an organisation can better support employees working in a distributed work environment. The focus is on the phenomenon of distributed knowledge work, which is examined in the case organisation VTT, Technical Research Centre of Finland.

The theoretical part of the study examined distributed work in the context of knowledge workers. The theoretical review showed that the distribution of knowledge work is increasing due to the changes experienced in the working environment. This is mostly based on technological advances enabling work to be conducted anytime and anyplace. The technological developments have added distributed and mobile features in organisations in terms of employees working in and between multiple locations and collaborating across time and space in various collaboration forms. Previous studies have indicated that the distribution of work will increase more in the future. This results to new and different challenges for the employees in knowledge intensive organisations, especially relating to the redefinition of work hours. The challenges require organisations to rethink their current work practises, based on a time when work was done at a fixed place during regular work hours. Some organisations have started renewing the organising of work according to the distributed work setting by analysing the work of the knowledge workers, creating protocols for distributed work and developing the workspaces to better correspond the working style of distributed knowledge workers.

The empirical part of the study was conducted using a mixed method approach, consisting of a survey study and two group interviews. The survey respondents consisted mainly of VTT researchers and the group interview participants were two research teams working in distributed manners. The data were analysed with statistical methods and content analysis. The results of the empirical part of the study showed the distribution of knowledge work at the case organisation, and it was discovered that organisational policies and alignments have great effect in enabling the conducting of knowledge worker tasks. The study indicates that in order for knowledge intensive organisations to better support their employees in an increasingly distributed work setting, more emphasis should be put on developing the organisational policies. An organisation can support distributed knowledge work by developing realistic work hour monitoring, creating guidelines for distributed working, understanding and supporting the social aspects of work, supporting and encouraging the usage of virtual collaboration tools and acknowledging the differences in workspace requirements.

Keywords knowledge workers, distributed work, challenges of distributed and mobile work, organisational support

Hajautetun tietotyön tukeminen tietointensiivisessä organisaatiossa

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Tiivistelmä

Tapaustutkimuksen tarkoituksena oli tarkastella hajautettua työtä ja sen asettamia haasteita tietotyöntekijöiden näkökulmasta. Lisäksi tavoitteena oli selvittää, kuinka tietointensiivinen organisaatio voi tukea hajautettua työtä tekeviä työntekijöitään paremmin. Tutkimuksen fokuksessa on hajautetun tietotyön ilmiö ja case-organisaationa on Teknologian tutkimuskeskus VTT.

Tutkimuksen teoreettisessa osuudessa tarkasteltiin hajautettua työtä tietotyön kontekstissa. Teoreettinen katsaus osoitti, että työn hajautuneisuus lisääntyy työympäristön muutoksien vuoksi. Tämä perustuu pääosin teknologisiin edistysaskeliin, jotka mahdollistavat työn tekemisen missä ja milloin vain. Teknologinen edistys on lisännyt hajautetun ja mobiilin työn piirteitä organisaatioissa, joissa työntekijät työskentelevät liikkuen eri paikoissa ja tekevät yhteistyötä ajasta ja paikasta riippumatta monenlaisissa tiimikokoonpanoissa. Aikaisemmat tutkimukset ovat osoittaneet, että työn hajautuneisuus tulee lisääntymään myös tulevaisuudessa. Tämä aiheuttaa uusia ja erilaisia haasteita työntekijöille tietointensiivisissä organisaatioissa, erityisesti uudelleen rakentuvan työajan suhteen. Monet nykyiset työjärjestelyt perustuvat aikaan, jolloin työtä tehtiin yhdessä paikassa ennalta määrättyjen työaikojen puitteissa, minkä vuoksi organisaatioiden tulisi suunnitella järjestelyt uudelleen. Jotkut organisaatiot ovatkin jo aloittaneet työjärjestelyidensä uudistamisen analysoimalla tietotyöntekijöidensä työtä ja luomalla hajautetun työn käytäntöjä sekä kehittämällä tilajärjestelyitään hajautetun työn tukemiseksi.

Tutkimuksen empiirinen osuus toteutettiin monimenetelmällisellä lähestymistavalla soveltaen kyselytutkimusta ja kahta ryhmähaastattelua. Kyselyn vastaajat koostuivat pääosin VTT:n tutkijoista, ja ryhmähaastatteluissa haastateltiin kahta hajautetusti työskentelevää tutkijatiimiä. Aineisto analysoitiin tilastollisin menetelmin sekä sisällönanalyysia hyödyntäen. Empiiriset tulokset osoittivat työn hajautuneisuuden case-organisaatiossa ja korostivat sitä, että organisatorisilla käytännöillä ja linjauksilla on suuri vaikutus tietotyöhön kuuluvien tehtävien suorittamisessa. Tutkimus osoittaa, että tukeakseen työntekijöidensä hajautettua työtä tietointensiivisen organisaation tulisi keskittyä organisatorisiin käytäntöihinsä. Organisaatio voi tukea hajautettua tietotyötä kehittämällä realististen työtuntien seurantaa, luomalla ohjeistuksia hajautetun työn tekemiseen, ymmärtämällä työn sosiaalisen puolen merkityksen, tukemalla ja rohkaisemalla virtuaalityökalujen käyttöä sekä huomioimalla erot työtilojen vaatimuksissa.

Avainsanat knowledge workers, distributed work, challenges of distributed and mobile work, organisational support

Preface

This publication is based on a Master's thesis completed for the University of Tampere, School of Management. The thesis was conducted as a part of VTT Technical Research Centre's internal development program VTT WorkWays, which focuses on creating a workplace where research is enabled through advanced technology and modern workspace innovation, and supported by novel team and management practices, technology and space solutions. The purpose of the thesis was to provide information about the work ways of VTT's employees in the challenging knowledge work environment, and to examine the distribution of workforce in the organisation. The study examined 114 VTT employees located in a particular office building in Otaniemi, Espoo. The research was conducted during January 2011 and September 2011.

The opportunity to come and work for the organisation as a research scientist trainee was granted by my VTT thesis supervisor, Dr. Heli Talja, to whom I wish to express my sincere gratitude for her support and insightful ideas throughout the research process. I would also like to thank the members of the project team in the internal development program VTT WorkWays – Dr. Jussi Manninen and Asko Kauppinen in particular – for providing the interesting research topic, and the many discussions and idea generations. Writing the thesis for VTT and examining the phenomenon in a research environment was altogether a great learning experience, and my gratitude goes to all of the VTT employees who contributed to the research process. A special thank you to the VTT employees located at the KCL building in Otaniemi for their time and contributions to the empirical part of the study.

I also wish to thank my VTT team leader Dr. Maaria Nuutinen for her guidance in conducting the quantitative phase of the study. Thank you also to Professor Matti Vartiainen at Aalto University School of Science and Technology for providing insight to the distributed research work of Aalto's Virtual and Mobile Research Unit. The guidance of the thesis supervisors Dr. Johanna Kujala and Dr. Hanna Lehtimäki at the University of Tampere was very valuable, and I wish to thank them for their support and patience. I would also like to thank my family and friends for the extensive encouragement and understanding during the research process.

Espoo, March 2012

Hannamaija Määttä

Contents

1. Introduction

In today's working environment, the most common employee is the knowledge worker, working in a rapidly changing digital world. The concept of knowledge work was first presented over 50 years ago, and has since been evolving – as Drucker (2009) has stated, it is the nature of knowledge itself that it changes fast, and today's certainties always become tomorrow's absurdities. Due to technological advances, the ways of working, communicating and conducting business transactions have progressed at an accelerating pace. Harrison et al. (2004) discuss about *the new economy*, which is characterized by the increasing virtual developments of products, processes, organisations and relationships. These changes experienced have increased the time and space interdependence of knowledge work – it can be done at any times, in multiple locations; at home, at the office, at the customer's premises, during travelling and always online (see e.g. Vartiainen, 2006; Virtaharju, 2010). These features are the characteristics of a distributed organisation, consisting of knowledge workers working virtually in an increasingly mobile and multi-locational manner.

Recent studies indicate that distributed and mobile work will increase still more from now on, and the challenges of multi-locality are a reality which has to be recognised in organisations (see Vartiainen et al., 2007). Flexibility is becoming the norm of the 21st century, and organisations face great challenges in providing suitable working practises and environments for knowledge workers. Many organisations are re-evaluating their objectives, the nature of work, their workers, and their preparedness of information and communication technologies (ICT) around distributed work settings (Roper & Kim, 2007). Still, many organisations have failed to take into consideration the true requirements of the modern knowledge worker. According to the research done by Vartiainen et al. (2007), one of the reasons for this is neglecting of the functional needs of employees inside an organisation. The "new office" is needed, as management policies and workspaces have to adapt to the distributed work style, provide the needed flexibility and still promote teamwork and collaboration (Harrison et al., 2004).

Organisations around the world have awakened to the new challenges in the work environment. Many have joined the network of New Ways of Working bringing together various disciplines to dialog about the work practises in a distributed world (New Ways of Working Network, 2011). Among them, VTT Technical Research Centre of Finland, the case organisation of this study, has also launched

an internal development program, VTT WorkWays, in order to meet the requirements of distributed work. According to Andriessen and Vartiainen (2006, 5), developing the distributed working methods can be highly beneficial for organisations, which can become more flexible, effective and innovative, and for employees who prefer dynamic work environments or a more flexible integration of work and private life. There is no ready-made recipe for successful organising of work – individuals, groups and organisations must find their own way to survive in this new kind of environment (Ruohomäki & Koivisto, 2007, 42). According to a recent study by Bosch-Sijtsema et al. (2011), an important question in studying distributed knowledge work in new working context is *if* and *how* company policies support distributed, mobile and multi-locational knowledge work, and this study focuses on discovering how a knowledge intensive organisation can support its distributed workforce in the increasingly challenging work environment.

1.1 The purpose of the study and research questions

Even though the distribution of work has increased, little research has been done on the subject in practise, and the studies have mainly focused on technological aspects of the phenomenon (Ruohomäki & Koivisto, 2007, 41). The purpose of this study is to understand the phenomenon of distributed work and examine how a knowledge intensive organisation can support its distributed workforce from the view point of employees, referred to in this study as distributed knowledge workers.

The study aims at answering the following research question:

> *How can a knowledge intensive organisation support the work of its distributed knowledge workers?*

In order to answer the main research question, it was seen appropriate to support it with four sub-questions:

1. *How has knowledge work developed due to changes experienced in the work environment?*
2. *What kind of challenges does distributed knowledge work bring forth for employees?*
3. *What kind of knowledge work and distribution of workforce can be found in the case organisation?*
4. *How can distributed knowledge work be supported?*

A knowledge intensive organisation is regarded in this study as an organisation consisting of highly qualified expert workers conducting knowledge work tasks, such as analysing, interpreting, developing, and creating products and services by applying their knowledge (Drucker, 1999; Alvesson, 2004; Davenport, 2005; Pyöriä, 2005). Distributed work is regarded as consisting of multi-tasking, collaboration with multiple parties, conducting work regardless of time and from various places, such as office, home, train, partner's premises and hotels, and using virtual col-

laboration tools to attain mutual goals (Vartiainen et al., 2007; Virtaharju, 2010). Organisational support in this study refers to the activities and policies with which an organisation enables its knowledge workers to conduct work tasks successfully in an increasingly distributed work environment.

1.2 The research process

The research process begun in the autumn 2010 when the first ideas for the master's thesis were inspired by the internal development project at VTT concerning new ways of working. At that time, the research interest focused on the future developments of the working life in general and the change drivers affecting them. During the autumn term, a lot of literature and earlier research was examined as a part of the master's thesis seminar. The context for the study started developing rapidly in January 2011, as the researcher was hired in the case organisation to examine the working ways at VTT as a part of the internal development project VTT WorkWays.

The topic for the thesis was limited to the distribution of work examined from the perspective of knowledge workers, as the case organisation consists of high degree expert workers in a complex multi-project research environment. The ideas for carrying out the research came from various discussions with the project group and the researchers in the organisation. The plan for the research process was finalised to include an extensive literature review and combining quantitative and qualitative research methods, since there was no earlier research data gathered from the case organisation in terms of distributed work. First, the literature relating to the topic was thoroughly explored, and the appropriate studies were chosen as a base for the research. The recent studies by the Virtual and Mobile Research Unit (vmWork) at Aalto University, led by Professor Matti Vartiainen, proved to be an excellent starting point, as they focused on the multiple aspects of knowledge work in a distributed and mobile work context. The theory part for the thesis was structured and written during the spring time 2011, and later modified and refined during the summer.

As mentioned before, a mixed method approach, combining both quantitative and qualitative data, was chosen for the empirical part of the study. A questionnaire survey and two group interviews were conducted to gain extensive data about the phenomenon (see chapter four for a more precise description of the process). The quantitative phase was planned and conducted before the qualitative group interviews with the help from the VTT WorkWays project group and Professor Matti Vartiainen from Aalto University, who in all his kindness, gave his valuable advice to the researcher in the planning process of the questionnaire survey. The data from the survey were analysed with statistical methods, which almost proved to be too much to handle for the researcher having only little experience in dealing with statistical analysis. However, the long and agonising process proved to be a great learning experience, and provided the basis for developing the theme questions for the qualitative part of the thesis. The group interviews

were conducted and analysed during the summer of 2011, after which the actual writing process truly begun. The thesis process as a whole was not straightforward, as the researcher went back and forward many times between the theory and empirical part. The research organisation VTT proved to be an excellent environment for discussion and generating new thoughts regarding the phenomenon. The finalising process included multiple discussions with the VTT supervisor, Heli Talja, who gave her insight and suggestions before sending the thesis to the supervisors at the University of Tampere for final comments. The valuable suggestions from the supervisors Johanna Kujala and Hanna Lehtimäki were taken into consideration, and the thesis was refined before sending the final version to the University press.

1.3 Structure of the report and limitations

As for the structure of the report, first, the literature review is presented in chapter two, focusing on the aspects of knowledge work, distributed work and its challenges, and actions supporting distributed knowledge work in organisations. These three main themes were seen to provide the sufficient background for understanding the phenomenon examined. The theoretical themes are summarised then in a synthesis. Secondly, the case organisation and the internal development project are presented, to provide the reader more background information about the motivation and need for this study from the case organisation's perspective. Thirdly, the methodology is presented, with a more comprehensive grasp on the choices made for carrying out this study, including more precise descriptions of the data gathering and analysis phases. To avoid confusion, the two empirical phases are presented in the order in which they were conducted; first the quantitative, followed by the qualitative. Then, in chapter five, the research results are presented, again following the logic of presenting first the quantitative phase and then the qualitative phase. The results are examined by reflecting them with the previously presented theoretical review. The conclusions and discussion construct the final chapter of this thesis, with propositions for further research.

As presented earlier, this study focuses on distributed knowledge work and how organisations can support their distributed workforce, which is why the thesis is limited to examine knowledge work in the context of distributed work from the employee's perspective, all the while acknowledging the various other interesting aspects arising from the concept of knowledge work. In terms of the research area itself, a lot of research has been done lately from the productivity perspective of knowledge work in the distributed work environment; however, in this research the topic has been left with less attention, as the interest lies in how organisations can support their knowledge workers in the challenging distributed work environment. This view point can also be seen as interesting and current, since not much research has been done on how organisations should consider renewing their policies to match the distributed working style of modern knowledge workers.

In terms of the case organisation VTT, it is noted that it would provide research areas in various different forms of knowledge work because of the diverse expertise in the organisation, however, the interest in this thesis lies on understanding the meaning of its *distributed workforce*, as it has not been researched earlier in the organisation. Considering other limitations from VTT's perspective, the empirical part of the study focuses only on a part of the organisations employees, mainly consisting of employees conducting research: the R&D function's employees and some of the Group Services function's employees located at the KCL building in Otaniemi. Hence, when speaking about the case organisation, it has to be remembered that the results represent the views of these employees at the KCL building, and do not necessarily represent the viewpoints of the entire VTT Group (see chapter three). Nevertheless, the views and comments of the pilot group are of great value and importance, as they bring forward valuable information about the working methods and requirements in the organisation.

2. Knowledge workers in a distributed work environment

2.1 Knowledge work

The most important competitive advantage organisations today have is knowledge (Sydänmaanlakka, 2000, 167). According to Pyöriä (2005), the demand for informational labour that is capable of handling, synthesizing and creating new knowledge has grown in the recent years, while space for traditional manual work, which can be replaced by automation and mechanization, has been reduced. Knowledge work as a concept is not new and a lot of research has been done on it, since the time Drucker first presented it in the 1950s'. Nevertheless, there is still a lack of a clear and concise definition for it. (Pyöriä, 2005; Acsente, 2010) Harrison et al. (2004, 6) define knowledge work as creating, developing, manipulating, disseminating or using knowledge to provide competitive advantage or some benefit contributing towards the goals of an organisation. According to Davis (2002), knowledge work is inherently cognitive rather than physical; it is human mental work performed to generate useful information and knowledge. Knowledge work depends less on following a repeating process, and more on applying theoretical knowledge and learning in a culture of collaboration, exploration, autonomy and initiative (Greene & Myerson, 2011). According to Heerwagen et al. (2004), knowledge work tasks include planning, analysing, interpreting, developing, and creating products and services using information, data or ideas. Davis (2002) determined three types of knowledge work tasks; job-specific, knowledge creation and maintenance, and work management. Job specific refers to producing outputs of value to the organisation; knowledge creation and maintenance tasks refer, for example, to scanning and reading professional literature, attending professional meetings, learning new systems and technologies and building networks; and work management tasks refer to the self-management aspect of knowledge work, such as planning and scheduling. (Davis, 2002, 68)

Knowledge intensive organisations or knowledge intensive firms (KIFs) are the environment where these knowledge work tasks are performed. According to Alvesson (2004, 21), there are many specific characteristics in knowledge intensive organisations, which include highly qualified individuals performing knowledge-

based work; a high degree of autonomy in the organisation; the use of adaptable organisational forms; the need for extensive communication for coordination and problem-solving; idiosyncratic customer services; information and power asymmetry; and subjective and uncertain quality assessment. Sydänmaanlakka (2000) discusses about the *intelligent organisation*, which is based on continuous learning, renewal and the ability to look ahead in an environment where the amount of knowledge increases constantly. In the changing work environment, the most important asset for knowledge intensive organisations are the employees who possess the knowledge – the knowledge workers, who know how to allocate knowledge into productive use (Drucker, 1993; Nonaka & Takeuchi, 1995).

2.2 Knowledge workers

According to Cortada (1998) all work requires specific skills and knowledge; hence everyone could be categorized as knowledge workers. Davenport (2005) agrees, but states that knowledge workers are those whose jobs are particularly knowledge oriented. He defines knowledge workers in the following way: *"Knowledge workers have high degrees of expertise, education, or experience, and the primary purpose of their jobs involves the creation, distribution, or application of knowledge."* (Davenport, 2005, 10.) Drucker (1993) distinguishes knowledge workers by the fact that they *own* both the tools and means of production – value is created by productivity and innovation. Knowledge workers tend to identify themselves more with their professional discipline and specialism and less with their employer or place of work (Myerson et al., 2010, 9). Roper and Kim (2007) discuss the distributed nature of knowledge work and point out that some workers need a high degree of face-to-face interaction and direct communication to effectively undertake their work, whereas knowledge workers usually need a high degree of choices available as to when, where, and how their work is undertaken. Knowledge work is relatively free of conventional boundaries and controls (Acsente, 2010). According to Davenport (2005), knowledge workers differ from other kinds of workers in their autonomy, motivations and attitudes. Styhre et al. (2010) state that knowledge workers have strong preferences regarding autonomy and individual decision making, and operate on the basis of individual or collective know-how, skills and experience.

Alvesson (2004, 23) explains that the high autonomy needs occur because individual knowledge workers often have the best insights to problems areas and are most familiar with the subject, while superiors may have a general overview and less understanding of what should be done in specific situations. This creates flexibility needs in the hierarchical structures of organisations. According to Pyöriä (2005), the key in knowledge work is in fact flexibility, interdisciplinary cooperation and rapid learning; the knowledge workers of today are dependent on theoretical knowledge and formal education rather than on empirical and anecdotal experience only.

For organisations to truly understand the nature of their knowledge workers, it is important to determine different modes and types of them. Davenport discusses the importance of understanding different knowledge worker types, in order to improve the work and intervene when necessary (Davenport, 2005). According to Haapamäki et al. (2010) a distinguishing feature of knowledge work is its diversity; knowledge work is done in very diverse compositions. The work may include more or less periods, which require working alone, for example writing reports and producing new knowledge, and periods where working with colleagues, partners and clients is essential, for example in planning and demanding problem solving. The work of knowledge workers is a continuous process and a mixture of solo work, asynchronous and synchronous communication and face-to-face meetings (Vartiainen et al., 2007, 10). According to Virtaharju (2010), knowledge work is done in a periodic manner, partly moving between the four knowledge worker modes described in figure 1.

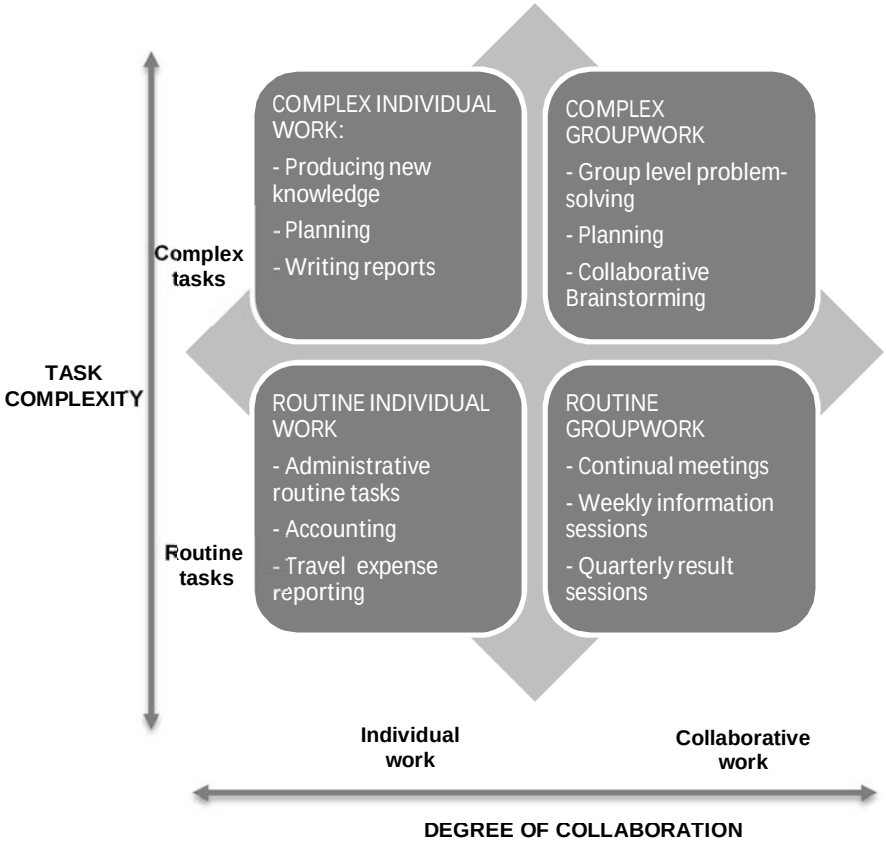

Figure 1. Knowledge worker modes (Virtaharju, 2010; Harrison et al., 2004; Davenport, 2005, Roper & Kim, 2007).

Davenport (2005) has developed a similar classification matrix, still emphasizing that it would be a great mistake to treat all knowledge workers as if they were the same, as in some respects knowledge work is all over the map. He defines the generalised knowledge worker modes based on the level of interdependence and complexity of work. From the most routine work to the most demanding, and from individual work to collaboration, the four categories of knowledge workers are transaction workers, integration workers, collaborative workers and expert workers. (Davenport, 2005, 26–27). This classification scheme is intended as a tool for designing the most effective work environment for each group (Acsente, 2010). Transaction workers perform routine tasks and are reliant on formal rules, procedures and training; integration workers conduct routine and repeatable work, and are reliant on formal processes, methodologies or standards; collaborative workers conduct improvisational work and are highly reliant on deep expertise across functions; and expert workers perform judgement-oriented work and are highly reliant on individual expertise and experience (Davenport, 2005, 27). While Davenport recognizes that the perfect matrix for distinguishing knowledge workers does not exist, the classification scheme stands out as the first viable attempt to classify knowledge workers for the purpose of increasing productivity and performance (Acsente, 2010). According to Bosch-Sijtsema et al. (2009) the product of a knowledge worker is typically intangible; knowledge is the addition of meaning, context and relationships to data or information, hence knowledge work is difficult to measure with traditional productivity measures. The classification scheme developed by Davenport is a good start, but in order to be able to measure the productivity of knowledge workers, it becomes important to understand the impact of different elements affecting knowledge work and its productivity (Bosch-Sijtsema et al., 2009, 537). Drucker (1993, 8) has stated that the biggest challenge and the most valuable asset of the 21st century institution will be its knowledge workers and their productivity.

2.2.1 Collaboration in knowledge work

The role of collaboration is essential in knowledge work. According to Pyöriä (2006), the core of knowledge work is in a collaborative individual rather than a homogenetic work collective, as well as in the individual's ability to act as a critical interface between new technology and human interaction. Because of the increasingly abstract nature of knowledge, it is often necessary to work closely with other specialists (Pyöriä, 2005, 121). Modern organisations consist of knowledge specialists, hence it must be organised as a team; of equals, of colleagues and associates (Drucker, 2009, 65). Erhardt (2010) discusses the team-based knowledge work, which is conceptualised as a multidimensional construct consisting of knowledge sharing, knowledge creation and team learning. Knowledge sharing includes exchanging tacit and/or explicit understanding through various means of communication; knowledge creation involves expanding the individual's under-

standing into new knowledge and applying it; and team learning is developed after an error in knowledge creation has occurred (Erhardt, 2010, 3).

According to Sari et al. (2008), knowledge work also involves collaboration across organisational boundaries and requires working together towards a specific goal by combining the knowledge and competencies of different people. According to Arthur et al. (2008), knowledge work collaboration can occur between four different activity participants; individuals, communities, organisations and industries. *Individuals* participate through the pursuit of career interests by applying what they know, learning something new and satisfying personal aspirations; *communities* participate through members' identification with a shared agenda by developing greater occupational expertise, becoming better users of a particular product or service or promoting a valued cause; *organisations* participate on behalf of their separate missions by delivering successful products or services, meeting stakeholders' expectations or succeeding in the knowledge economy; and *industries* participate as promoters of regional or national interests by providing more employment, maintaining industry leadership or contributing to further innovation. (Defillippi et al., 2006; Arthur et al., 2008) The interdependences among the four participants can be described as a “knowledge diamond” (see figure 2.)

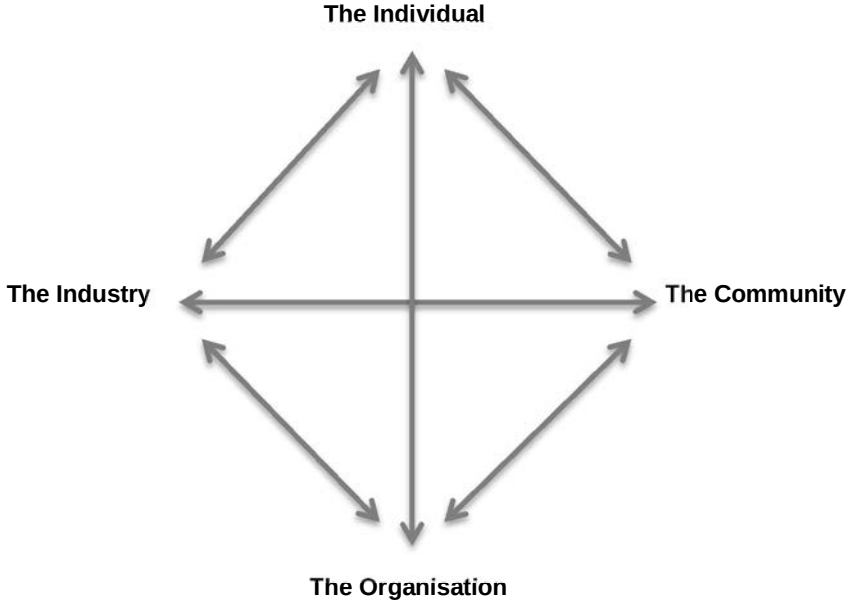

Figure 2. The Knowledge Diamond (Defillippi et al., 2006, 19).

The model describes the relationships among the participants, for example organisational learning and strategic alliances, which are essential in knowledge worker collaborations. (Arthur et al., 2008) Multidimensional collaboration therefore, is an important aspect of knowledge work.

Heerwagen et al. (2004) state that knowledge work is both highly cognitive and highly social. They distinguish three social dimensions of collaboration; awareness, brief interaction and collaboration. Awareness involves knowing what is happening in the surrounding space as well as the meaning of events and actions. Brief interaction includes functional communications as well as social interactions, which may only last less than one minute. Collaboration involves two or more people working together over time to produce a joint product or other outcome through long-duration interactions, for example problem-solving, or through short collaborations which occur spontaneously, for example sharing ideas or information. (Heerwagen et al., 2004) Though consisting of individual experts, knowledge work can be said to have highly social features as well.

2.2.2 Change drivers moulding the future of knowledge work

This chapter presents the forces affecting the development of knowledge work. The most significant change driver is without a doubt the advances in technology. According to Ware & Grantham (2003) computing and communications technologies have transformed the traditional workplace into a virtual workspace. Technology allows employees to work flexibly and improve their work-life choices by working whenever and wherever they need (Venezia & Allee, 2007). This has significant impact on how people interact, conduct research, solve problems and produce new knowledge. Mobile technology opens a new perspective to products, services, work and organisation by increasing possibilities to select more freely the place of working, and by allowing higher mobility than "wired" technologies (Andriessen & Vartiainen, 2006, 4). The modern communications technology has helped change the way the world is viewed – it has changed most basic beliefs about how people interact with one another in commercial, social and learning environments (Ware & Grantham, 2003).

Cook (2008) speaks about social software and “the 4 Cs”, which are communication, cooperation, collaboration and connection. *Communication* platforms include discussion forums, blogs, instant messaging, social presence and virtual worlds; *cooperation* includes sharing software via image and video, social bookmarking and social cataloguing; *collaboration* tools refer to people collaborating with each other directly and indirectly in both central and distributed ways, for example via Wikis and human-based computation; and *connection* refers to networking technologies, which make it possible for people to make connections with content and other people. According to Andriessen and Vartiainen (2006, 4), the consequence of this all is to be found in the growth of distributed work processes, network organisations, physical mobility of workers and intensive interaction through various ICT tools.

According to Heinonen (2004), another force affecting all society's sectors is globalisation, especially the globalisation of the economy. Heinonen (2004) discusses the direct consequence of globalisation – the digitalisation of the economy, which enables virtual activities between organisations. According to Andriessen and Vartiainen (2006, 4), globalised business is not possible with local organisations, as the on-going globalisation of markets and businesses leads to higher mobility requirements and widely distributed international cooperation. Even small organisations operate in a globally networked business environment, where cooperative partners are spread all over the world. According to Meister and Willyerd (2010), organisations are likely to tap into a global talent pool and managing a virtual workforce regardless of whether it is an established multinational or a high-tech start-up firm. Defining work hours is becoming more difficult, since technology connects people together, and the global network is open 24/7 (Otala & Jarenko, 2005).

The ageing of population is also a megatrend, which has been widely discussed considering the preparation for the future. This creates various challenges in how work is organised and managed. According to Myerson et al. (2010), the average age of the twenty-first century workforce will be older than at any time in human history. It has been estimated that in the year 2015, 50 per cent of the European adult population is over 60 years old. (Heinonen, 2004, 19) According to Alasoini (2010), more people are retiring than entering work life in the Finnish employment market, which results to a decrease in the workforce. The overall drop during the years 2005 and 2020 will be 40 per cent of the country's employed population in 2005. This is an immense change in the structure of the workforce, and it has not been seen since the post-war born generation entered the work life during the years 1965 and 1975. (Alasoini, 2010, 13) According to Zemke et al. (2000) the different generational groups can be defined as the veterans (born between 1922 and 1943), the baby boomers (born between 1943 and 1960), generation X (born between 1960 and 1980) and generation nexter, or more commonly known as generation Y (born between 1980 and 2000). Today's workforce is composed of the three latter mentioned. According to Alasoini (2010) the gap between generations has grown.

One significant threat organisations are facing is lost knowledge – practical knowledge acquired by baby boomers, which will be difficult to replace because it has been developed in an era of unprecedented technological and scientific advances. Only a fraction of this knowledge is documented and shared, which results to employees leaving without passing on enough of this valuable expertise. (DeLong, 2004) These generations experience the working life in different ways, and the recognition and integration of the core traits of each generation is essential in order for an organisation to thrive. (Meister & Willyerd, 2010) According to Heinonen (2004, 19), on a global scale the future belongs to the young – half of the world's population are under 25 years old. At one end of the knowledge workforce, entrants to employment today are the first group to have been educated in classrooms where interactive white boards, laptops and the Internet are take for granted (Myerson & Ross, 2006, 13). According to a study by Steelcase (2006), the generation Y is entering the workplace and already creating new workplace

trends – they are adept at dealing with fast-paced data and information, and expect technology to enhance their lives. These 'new workers' have different expectations about work/life balance, management practises, compensation and organisational careers (Ware & Grantham, 2003). They have grown accustomed to using new interactive social media based on web 2.0 technologies, which is why they expect to be actively involved in various work processes. If these requirements are not fulfilled, employers lose the highly educated “Peter Pan” generation to competitors. It is estimated that by the year 2020, the generation Y composes 45 per cent of the employed Finnish workforce. (Alasoini, 2010)

According to Heinonen (2004) the knowledge society is mobile, and a central polluting factor in the society is traffic. Moving workers to work made sense in the early industrial era when the means of production were large machines and highly structured assembly lines located near sources of power, but today this is no longer a necessity (Ware & Grantham, 2003). As the environmental awareness grows, companies and organisations will give more attention to the impacts of their own work processes and activities on the environment. (Heinonen, 2004) According to Saurin et al. (2008), ubiquitous wireless technology will lead to a growth in sustainable remote and flexible working. According to Myerson et al. (2010, 21), knowledge workers are already mobile and moving around a lot both within the building and outside the employer’s workplace. Vartiainen et al. (2007, 13) have predicted that distribution and mobility of work and employees will increase, as will working in multiple locations, rather than staying in the “main office”. According to the IDC Worldwide Mobile Worker Population 2009–2013 Forecast by Drake et al. (2010), the mobile worker population is set to increase to 1,19 billion in 2013, accounting for 34,9% of the workforce. In Western Europe the annual growth rate for mobile workers is 6%, which will reach 129.5 million mobile workers in 2013. The changes now being experienced are real and accelerating – they promise fundamental changes to the relationship between the individual, work and the workplace (Saurin et al., 2008, 246).

2.3 Distributed work

There are many concepts referring to the distributed nature of knowledge work, such as multi-locational work, remote work or telework, which has the longest tradition. The variety of concepts and their concurrence are an understandable outcome of the recent developments in working life, which inevitably result in confusion (Vartiainen, 2006, 13). The term telework is often associated to home-based telework and is strongly related to an individual’s preference to do the work on another place than the traditional office (Andriessen & Vartiainen, 2006, 6). Pyöriä (2009) discusses how the traditional telework has not been able to keep its promise as a generalised work form, whereas distributed and mobile work forms are becoming increasingly accepted. Nowadays telework is seen as one aspect of distributed work, as the term distribution of work gathers together various forms of flexible work.

The distribution of work is one overarching characteristic of all aspects of knowledge work (Vartiainen et al., 2007, 9). A distributed organisation is a temporary or a fixed organisation, in which employees work from different locations using communications technology in attaining a mutual goal (Vartiainen et al., 2004; Pyöriä, 2009). Small groups and projects carry out the basic mission of the organisation. According to Vartiainen et al. (2007), distributed work can have many different aspects to it; one form of distribution is that people involved are multi-tasking, doing multiple tasks with many others, while, in another form, activities may be distributed in the sense that they are conducted by people located in different divisions within the organisation or different firms, often in distant environments and different time zones. The employee either carries the needed tools for working (phone, laptop) along, or they are provided at different workplaces.

According to Pyöriä (2009, 37), a distributed organisation consists of communities working in different locations toward a mutual goals, and networking by using information technology. Harrison et al. (2004) state that a distributed workplace can be defined as workplaces in more than one location within a city, country or region depending on the work process and work life preferences of individuals and organisations. Ware (2003) considers a workforce distributed if it meets any of the following conditions; 1) individual workers are in different physical locations; 2) most normal communications and interactions, even with colleagues in the next office, are asynchronous and do not occur simultaneously; and 3) the individual workers are not all employed by the same organisation, or work within distinctively different parts of the same parent organisation. Work may also be distributed in the sense that the "value created" by the work may be achieved in virtual space, through information and communication technologies, where the physical location of the involved parties is irrelevant (Vartiainen et al., 2007). From an individual's perspective, work is distributed when a person works at multiple places, such as own workstation, home, customers' and partners' premises, conference centres, hotels and airports (Virtaharju, 2010; Bosch-Sijtsema et al., 2010). Instead of home becoming a the second workplace, work has become more locationally flexible, and workers settle down temporarily whenever it suits their job, tasks and personal preferences best, all the time staying connected to the networks they need for their work (Gareis et al., 2006, 46). The next chapter discusses the distributed aspects of knowledge work and mobile employees more in depth.

2.3.1 Mobile workers

According to Vartiainen et al. (2007, 15), mobility is an additional dynamic feature of a distributed organisation. Mobile work as a concept has two meanings – in stricter sense the documents and tasks that move, either physically or digitally, and in a wider sense it also refers to the work of a mobile worker (Andriessen & Vartiainen, 2006). Davenport (2005) discusses how the advances in mobile information technology have allowed and structures increased mobility into knowledge workers' jobs. The ownership of the means of production makes knowledge work-

ers uniquely mobile, as they can take it wherever they go (Drucker, 1993; Drucker, 1999). The term mobile can be defined as a quality of an individual who moves to and from different places and works in them and, while travelling, uses information and communication technologies as tools (Vartiainen, 2006, 14). According to Vartiainen et al. (2007,18) mobile workers are those who spend some paid working time away from their home and away from their main place of work, for example on business trips, in the field, travelling or on customer's premises. High-intensity mobile workers are regarded to be those who work in this manner over 10 hours per week. Mobile workers use a variety of different environments for working purposes, such as trains, airport lounges, hotels or even museums (Harrison et al., 2004, 22; Hyrkkänen et al., 2011, 7). Mobile employees establish their "instant office" by adapting to the environment at hand, and do so again quickly (Vartiainen et al., 2007, 16).

The term mobile is often associated with individuals, although a team can be mobile as well to a certain degree in the sense that all or some of its members are sometimes physically mobile during the week (Andriessen & Vartiainen, 2006, 7). If collaboration with distant workmates is needed, this is possible with mobile, wireless ICT technologies. (Vartiainen et al., 2007, 16) The physical mobility of employees is realized at least at two levels: individuals move alone as members of a distributed team or organisation, and teams and projects move as a part of a distributed organisation or network using different sites. Mobile work involves alternative arrangements, changing the definition of the traditional office and blurring the boundary between home and workplace, and, furthermore, sometimes totally ignoring the spatial solutions of the regular office, for example, team spaces, shared offices or hoteling and those applied to space outside the regular office, such as home offices, telework centres and mobile offices. As location is becoming more irrelevant, the quality of the place where work is done becomes more important. One of the crucial features of the future workplace is also the quality and functionality of technological infrastructure and tools, because these provide the platform that can be used for collaboration in a distributed workplace. (Vartiainen et al., 2007, 16)

In distributed work settings, it is important to determine the different *mobility stages* of knowledge workers. According to Davenport (2005, 34), many companies have found that whether an employee is mobile is a critical factor in work design, as mobility can influence what kind of office a knowledge worker needs, the types of technology he or she will employ, the relative ability to observe the worker's performance and the ease of communicating with the worker. Vartiainen et al. (2007, 18) refer to the study by Lilischkis (2003) in which the identification of physically mobile employees is done on a topology based on two dimensions of space and time – the space criteria being the number of locations, recurrence of locations, whether there are headquarters to return to, whether work takes place while moving without changing it, whether there is a limitation of the work area, and the distance between locations. The time criteria being frequency of changing locations, the time spent moving between work locations, and the time spent at a certain work location if not moving. In Lilischkis (2003) research, each type of

mobile work has its constitutive criterion: “on-site movers” work in a limited work area, “yo-yos” return back to the main office, “pendelums” have two recurrent work locations, “nomads” work in more than two places, and “carriers” cannot do their work at a fixed location while moving (Vartiainen et al., 2007, 18). Schaffers et al. (2005) distinguish three features of mobile workplaces in terms of mobility support and work location changes: micromobility, which supports on-site mobility; multi-mobility, which supports ad-hoc and occasional mobility; and total mobility, which supports on the move working (see figure 3).

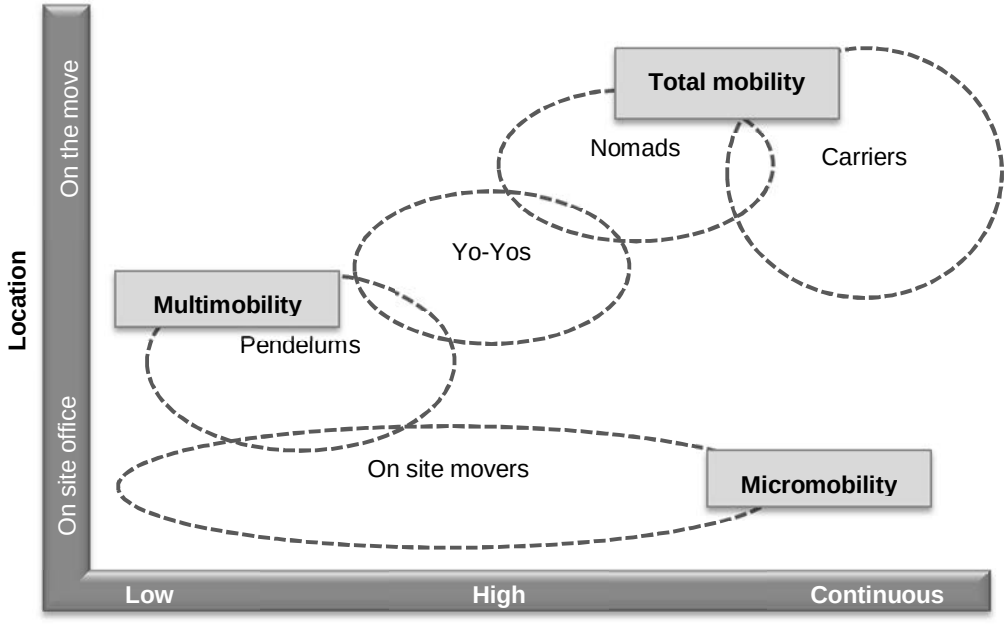

Figure 3. Types of physically mobile employees (Lilischkis, 2003; Schaffers et al., 2005; Vartiainen et al., 2007, 19).

Referring to the mobility factor, Greene and Myerson (2011) have determined four key types of mobile knowledge workers; *the anchor,* an iconic office worker who is reliably in the office every day and likely to be found at their desk; *the connector*, who spends half of the time in different places around the building in meeting rooms, at the café or at colleagues’ desks; *the gatherer*, who spends around half the week away from the office at different appointments; and *the navigator*, a knowledge worker who is a “visitor” to the own office, and can rarely be seen at the office at all. Davenport (2005, 35) states that it is a good idea for organisations to have this kind of a segmentation category for knowledge workers, in order to

understand the types of various employees and how they differ. Each segment or category would have different IT, process development approaches and other aids for productivity determined for them. In the context of knowledge work, this segmentation can also be criticised by referring back to the previous chapters discussing how knowledge workers tend to work between different modes; hence, depending on the day, they could be any one of the mobile knowledge worker types determined by Greene and Myerson (2011). Therefore, more flexibility is needed in terms of categorising knowledge workers in a distributed work environment.

2.3.2 Distributed collaboration

As mentioned before, knowledge work is highly collaborative. According to Davenport (2005, 12) as knowledge workers are dispersed across the organisational structure and the globe, their work requires them to collaborate effectively with others in various functions, physical locations, time zones and organisations. Vartiainen et al. (2007, 21–22) state that the collaborative nature of knowledge work creates distributed, virtual organisations, which consist of employees or teams working apart but towards a mutual goal, mainly collaborating via information and communication technologies. Vartiainen et al. (2007) further distinguish four types of organisational teams; conventional and distributed, virtual and mobile virtual teams, also described as non-conventional teams (see figure 4).

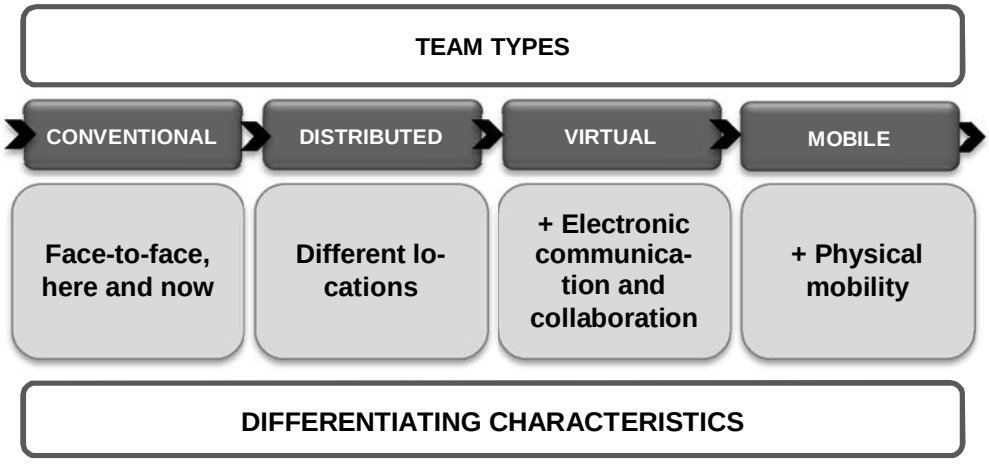

Figure 4. Team types by contextual complexity (Vartiainen et al., 2007, 25).

In conventional teams employees work together in the same location and communicate face-to-face. Task complexity does not differentiate conventional teams from distributed teams, as the variation of task demands from simple to complex and their interdependence can be same in both. However, geographical distance,

mode of interaction and physical mobility provide a distinguishing factor in contextual complexity. (Vartiainen et al., 2007, 23)

Distributed teams operate from different locations. According to Bosch-Sijtsema et al. (2011), distributed teams are often closely imbedded in a temporarily structured social system which has fluid borders with other actors, such as customers and contingent workers. Hinds and McGrath (2006) discuss about geographically distributed teams, in which team members reside in different cities, countries or continents and work together interdependently to accomplish a common task. A team becomes virtual when group members communicate and collaborate with each other from different locations using electrical media (Vartiainen et al., 2007). According to Arnison and Miller (2002), virtual team members rarely meet face-to-face, since modern computer driven technologies allow employees to work across boundaries of space. This enables the physical mobility, moving between locations, of team members adding a new feature to distributed work (Vartiainen et al., 2007). According to Bosch-Sijtsema et al. (2011), these teams often work in a multi-project organisation setting, where team members can simultaneously work in multiple projects with different members.

The nature of these teams remains extremely complex, since they have various overlapping features. A conventional team can work virtually, even if the team members are located in the same building, same floor and in the same room (Arnison & Miller, 2002), and mobile virtual teams are always distributed, but not all distributed, virtual teams are mobile (Vartiainen et al., 2007). Arnison & Miller (2002) state that many modern organisations remain structured around conventional face-to-face teams, even though they have established virtual teams. They also argue that conventional teams will remain the dominant organisational form, though virtual team characteristics are beneficial in strengthening the communication. Pyöriä (2009) agrees and states that being in the same physical space with the team members helps the changing of thoughts and encourages asking help when needed. According to Vartiainen et al. (2004, 157), only few distributed groups are completely virtual and do not meet face-to-face. The benefits of meeting face-to-face especially in the beginning of work process include the familiarising with the group members, building trust and creating a “we-spirit”, which helps the group members in committing to mutual goals (Vartiainen et al., 2004, 158).

According to Bosch-Sijtsema et al. (2011, 5), understanding knowledge work requires understanding of the nature of the team task and identifying factors in collaborative work processes and working environments, including the organisational context as well as multiple work locations. The degree of complexity of a distributed team can be characterised with six features; location, mobility, time, temporariness, diversity and mode of interaction (Vartiainen et al., 2004; Vartiainen, 2006). The location examines if the work is conducted face-to-face in the same location or geographically dispersed in various locations; mobility is examined by defining how often employees move between workplaces; time can be examined by exploring if the work is done synchronously or asynchronously in different or same time zones; temporariness is defined by examining the permanent and temporary degrees of collaboration in a team; diversity is examined by

discovering the differences in a group in terms of the background of employees, such as age, education, sex, nationality, religion and language; and mode of interaction is examined by exploring whether communication and collaboration in a group takes place directly face-to-face or via different technological tools (see figure 5). (Vartiainen, 2006, 29–30)

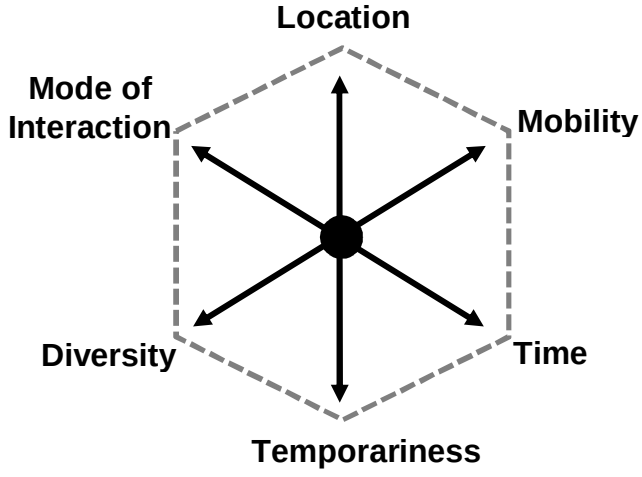

Figure 5. The complexity features of distributed collaboration (Vartiainen, 2006, 30).

These six characteristics can be evaluated in examining the nature of a distributed team. The dimensions are closely related to each other as a change in one creates changes in the others as well (Vartiainen, 2006). This model helps organisations to understand the contextual complexities of its work groups, as there are many forms of distributed collaboration. These dimensions are also linked to the workspaces in distributed knowledge work. As location is becoming more irrelevant, the quality of the place where work is done becomes critical.

2.3.3 Distributed workspaces

Because of mobile technologies, which have liberated work from being bound to a particular place and time, many knowledge workers spend their working time at a number of different locations (Bosch-Sijtsema et al., 2010). According to Harrison et al. (2004), knowledge workers are often absent from the office, spending a large part of their working time on the road or at customer or client locations. Hence, physically mobile work invariably takes place in some location. Vartiainen (see e.g. Vartiainen, 2006; Vartiainen et al., 2007; Vartiainen, 2009) has studied different workspaces in knowledge work on the basis of the Japanese concept *ba*, which is useful for differentiating the various spaces used for distributed knowledge work. *Ba*, which roughly translates into the English word “place”, was originally proposed

by a Japanese philosopher Kitaro Nishida and further developed by Shimizu (Nonaka & Konno, 1998; Nonaka et al., 2000). According to Vartiainen (2007), *ba* refers to a shared context in which knowledge is created, shared and utilized by those who interact and communicate there, as often happens in knowledge work. A workplace is no longer only the physical office spaces but rather a combination of physical, virtual, social and mental spaces, which form a collaborative working environment (Vartiainen, 2009) (see figure 6). All of these spaces are interlinked with each other.

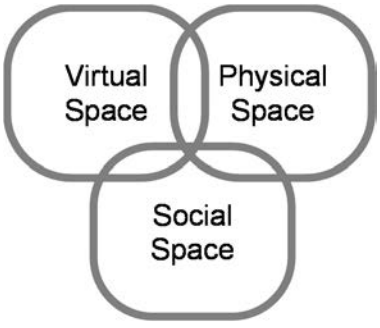

Figure 6. The physical, virtual and social aspects of work (Haapamäki et al., 2010, 13).

The physical space refers to the physical environment where work is conducted, which can be further categorized to home, the main workplace, moving places, customer's and partner's premises, hotels and cafés. *The virtual space* refers to the electronic working environment, for example, the Internet which provides a platform for simple communication tools, such as e-mail, and more complex collaboration tools such as video conferencing. (Vartiainen, 2007) One of the important features of the future workplace is the quality and functionality of technological infrastructure and tools, because these provide the platform that can be used for collaboration in a distributed workplace (Vartiainen et al., 2007, 16). The combination of physical and virtual workspaces can be described as a 'workscape' (Harrison et al., 2004, 56; Vartiainen, 2006, 16). It refers to the "layers of where we work"; the constellation of real and virtual work settings (such as furniture and IT), within particular spaces (such as meeting rooms, project areas and cafés), which are located on a specific environment (such as office building, city district, home, airport) (Vartiainen, 2007). These together form a hybrid work environment.

According to Vartiainen (2009), *the social space* refers to the social context and the whole social network where working takes place; other team members, managers and customers. Harrison et al. (2004, 8) state that the social importance of a workplace is likely to be increasingly emphasized. The office can be seen as a means of expressing the culture and reinforcing the values and beliefs of an organisation, and as a place of interaction, collaboration, knowledge transfer and communication (Harrison et al., 2004, 44). *The mental space* refers to individual

cognitive constructs, thoughts, beliefs, ideas and mental states that employees share through communication and collaboration. (Vartiainen, 2009) The challenge of the knowledge intensive organisations is how to make these spaces support the knowledge workers' tasks in a distributed work setting. There is no one rule to this, and organisations should start the process by analysing the work of knowledge workers (Haapamäki et al., 2010). The work environment should be understood as an entity comprising all the previously described spaces.

2.3.4 Challenges of distributed and mobile work

As distributed and mobile work becomes an increasingly frequent phenomenon, it also presents many challenges for knowledge workers. At work, people deal with the demands of information overload, quick customer response time, the need to be constantly available and an increased pace of change (Richter et al., 2006, 247). This creates strain on the employee in performing the daily work tasks. Vartiainen et al. (2005, 89–93) discuss the seven strains of distributed work; loneliness and isolation at work; the quantity of workload; travelling; requirements for self-management; the unclarity of targets and roles in a distributed group; uncertainty in career development; and inequality inside a work group. According to Vartiainen et al. (2005, 89), geographically distributed group members easily feel alone and isolated due to the lack of social contact normally experienced in the work community. Constant moving around in a distributed environment is reported to diminish the amount of communication, which can result to isolation of an employee, especially if there is no “home-base” to return to (Vartiainen, 2004, 39).

Because of constant information flow, the work load increases in distributed groups (Vartiainen et al., 2005). As a result, frequent e-mails and phone calls from group members and customers create pressure in dealing with them immediately, which inevitably leads to an uncontrolled amount of tasks. According to Helle (2006), if work is conducted outside the employer’s premises, the workload increases, due to the lack of traditional official control of working time and social control. As technology creates new possibilities for new forms of working, work time and places, the time spend doing the tasks may increase (Uhmavaara et al., 2005, 9). The continuous movement between places and mobile technology have without a doubt an impact on the content of home life and free time as well. According to Richter et al. (2006, 247), in the 1990s, the development of information and communication technologies promised a life where people choose their own workplaces and have increased leisure time. However, in spite of multifunctional support by ICT, work life imbalance has increased during recent years. The limits between work, free time and family are blurred, and seem to merge with one another which results to problems in time division and finding a balance (Vartiainen et al., 2005, 79–80). When mobile employees travel between places because of the distribution of work, the travel days tend to become longer, which causes challenges for the employee to arrange the working time and free time (Vartiainen et al., 2005). In this kind of situation, the suitable recovery time has a crucial role in terms of well-being.

In mobile work, the supervision of the employer diminishes, which results to the responsibility for managing, organising and prioritising being transferred to the employee (Vartiainen et al., 2005, 91). This creates great challenges especially for novice employees without experience from distributed working. According to Vartiainen et al. (2005), in these situations it is important to know the interest groups and networks, so advisory will be more easily found. Even though the technological advances make it possible to collaborate all over the world at any times the difficulties in planning and coordination across time zones and cultural differences are barriers to successful performance (Richter et al., 2006, 240). Working in a multi-cultural work environment requires communication and collaboration with foreign languages as well as understanding different cultures and modes of action (Hyrkkänen et al., 2011, 21). An employee must work increasingly harder in order to avoid misunderstandings and conflicts. Misunderstandings may arise faster because of language and culture barriers, and especially due to the loss of social cues in computer mediated communication (Richter et al., 2006, 240). When working in distributed work groups, employees working away from the organisation may also fear not being considered equally or being left out from interesting career possibilities There is also a risk of being a distant onlooker, if a core group in a distributed team is located in the same premises, while some are mobile or located outside the premises. (Vartiainen et al., 2005, 92)

All these strains have an effect on employee well-being at work. According to Kokko and Vartiainen (2006, 22), the complexity factors in distributed work create different strains for the employees than regular onsite work. Managing the strains in a distributed work environment is often left to the employees, which creates challenges in monitoring the physical, social and mental workload (Kokko & Vartiainen, 2006, 17). According to Pyöriä (2009, 39), nowadays stress and work exhaustion are extensive issues for organisations. Individual factors, the social support of the work community and functional coping methods help control the stress and increase the well-being at work (Kokko & Vartiainen, 2006, 20). In order to control the problems arising from distributed work, organisations need to carefully plan the work arrangements to support the work requirements (Pyöriä, 2009, 39).

According to the research on distributed and mobile work conducted by Ruohomäki and Koivisto (2007), many organisations have not yet grasped the practical challenges mobile and distributed work bring along. Vartiainen et al. (2007) discuss how the variety of distributed work creates many challenges for the management in organisations. As the distribution of the workforce is increasing, organisations struggle in providing the suitable work environment and work practises for their employees. In a recent study about the current state of telework in the US by Lister and Harnish (2011), it was stated that some organisations are not ready to make the organisational culture to shift to manage the remote workforce. Dealing with distributed work and mobility is new and challenging for organisations which attempt to hold on to their traditional modes of action (Vartiainen, 2008). The work culture is still strongly leaning on traditional work practises, office spaces and attitudes in a modern virtual world, which requires a different kind of approach. Pyöriä (2009) emphasises that in discussing about the distributed work forms, it

has to be remembered how the current work culture is still strongly bound into the long traditions of industrialism – the management culture based on the ability to hold on to control. Especially full-time telework or mobile work requires the management to focus on results, not on the actual daily work progress or the monitoring of work time. For many organisations this would mean destruction of the last illusion forms of familiar and safe hierarchical management of work (Pyöriä, 2009, 40).

2.4 Actions supporting distributed work in organisations

2.4.1 Work analysis

Acknowledging the challenges in mobile and distributed work, some organisations have begun to renew their work environment to match the requirements of the distributed workforce. Identifying the work styles and understanding how the employees work in the organisation are the starting points, as the key to supporting distributed and mobile work successfully seems to lie in the profound understanding of the work people do (Vartiainen et al., 2007, 146). According to Haapamäki et al. (2010), the decisions of organising work should be based on the understanding of the core tasks and work processes of an organisation and its units. It is also important to examine how individual employees perceive the distribution and mobility at their work and how it affects them (Ruohomäki & Koivisto, 2007). This could be done with multiple methods; by interviewing the employees, observing the daily work and creating a questionnaire survey for the personnel.

There are multiple methods for work analysis, which have been developed to understand the requirements of complex socio-technical work systems; for the example, Cognitive Work Analysis (CWA), the Core Task Analysis (CTA) and the Contextual Assessment of Working Practises (CAWP). The CWA is a framework supporting a formative design focusing on new ways of doing work, and the purpose of it is to uncover the requirements for work that will help workers be flexible and adaptive problem solvers (see Vicente, 1999, 121). The CTA is an analysis method promoting the understanding of the core content of a particular work by focusing on clarifying how employees do their work and why they do what they do in dynamic, complex and uncertain environments (see Norros, 2004). The CAWP aims at identifying work demands, strengths and weaknesses of the current practises and to explain them and formulate objectives for development (see Nuutinen, 2005). All these methods aim at understanding the work done in complex work environment, so that practises supporting it could be developed.

The analysis of the work and the work environment is extremely important when deciding on actions supporting distributed and mobile workers. The design and management of workplaces seem largely to neglect the real tasks of employees, which is why the work of the knowledge workers should be carefully analysed in order to succeed in supporting the demands of work. If not, even well-intended supporting actions can result to reverse effects and only increase the strains of distributed employees. The role of collaboration in the process is extremely im-

portant, as the lack of it may cause ineffective and long planning and implementation processes of new innovative organisational solutions. The collaboration between human resources, ICT and facilities management is important, however, it is crucial to include the personnel in the process, as they have the best practical knowledge and experience of the real requirements of their work. (Vartiainen et al., 2007, 140–142)

2.4.2 Protocols for distributed work

In their research of mobile work and wellbeing, Hyrkkänen and Vartiainen (2005, 244–246) discuss the importance of discussion and creating guidelines and practises that support an individual's distributed work, and how important it is to train and familiarize the employees into their mobile work and agreed work tasks, as the meaning of work time diminishes. They emphasize the necessity of this with novice employees who have little experience on mobility and moving around globally. Mutual work protocols and guidelines make it possible for a distributed organisation to succeed (Vartiainen et al., 2004). Referring to the well-being factor, Hyrkkänen and Vartiainen (2005) suggest that an organisation should ponder methods for recognising the health risks in distributed work, prevent them, and increase the well-being of employees. According to the research by Ruohomäki and Koivisto (2007), many employees need practical guidelines and support from the organisation in dealing with the challenges of distributed work. It is important for the organisation to develop contractual policies to support the work of the employees and their superiors in a distributed environment (Hyrkkänen & Vartiainen, 2005). Ruohomäki and Koivisto (2007) suggest that mutual guidelines and practices suited for the changing work environment and new working methods will be needed more in the future, and organisations should also create alignments for balancing work and family life.

The distribution of work processes sets new requirements and challenges for work cultures based on a fixed workplace and time (Heinonen, 2005, 64). It is necessary to acknowledge that when committing to the results and definitions of work tasks, the meaning of work time diminishes for the employee, and the superior is not able to control the amount of time spent on working as the responsibility is transferred to the employee (Hyrkkänen & Vartiainen, 2005, 245). The increasing self-management of work time challenges the labour laws, collective agreements and customary routines in organisations (Hyrkkänen et al., 2011). In many tasks, the work time is not based on the traditional working hours, as employees themselves organise the work time and are responsible for the results, since the management and controlling of time diminishes (Uhmavaara et al., 2005, 8). According to Heinonen (2005, 21), modern corporations are no longer employee-pyramids, located on fixed places and following the 9–17 working hours. Hyrkkänen and Vartiainen (2005, 245) discuss how the contracts and agreements should be developed concerning employees who work in various spaces. According to Helle (2006, 73), unlike telework, which has been defined in the European

framework agreement in 2002, mobile and virtual work are not legal definitions at the EU level; they are organisational concepts, which describe the method of organising work and the environment of working rather than the legal status of the worker. However, she states that there is usually a need to prepare some kind of common workplace policy in distributed work arrangements, including, for example, issues concerning availability, working time and the methods and safety protocol of transferring data, as well as safeguarding the privacy of employees if technical surveillance is in use. According to Helle (2006), employees have the right under the telework agreement to receive appropriate training in the characteristics of this kind of work, also in terms of its management. Training the employees is important so that they are provided with the proper manners of conducting their work, but also to help employees control their workload and the entity of the distributed work environment.

2.4.3 Workspace management

According to Vartiainen et al. (2007, 13), new types of work are challenges for workplace designers, premises and facilities management in companies, as well as for those who provide services for them, such as workplace consultants, and for the employees themselves. The provision of workspace should be a direct response to the considered needs of people, individually or collectively, in supporting them in their current and future work situations (McGregor, 2000). According to Häkkinen and Nuutinen (2007), the employees own understanding about the nature of work should be considered as a starting point in workspace management. The main challenge of workplace designers and management is to support those employees in their organisations who work in multiple locations during their working days and weeks and collaborate therefrom (Vartiainen et al., 2007, 77).

As the requirement of work itself changes, so will the requirements for the management of workspace (McGregor, 2000). Work environments should now be understood in terms of the extent to which they support the performance of knowledge workers, by balancing a range of different elements in an integrated approach that includes spatial, technological and organisational issues (Harrison et al., 2004, 121). Many of the workplaces have been designed to respond to old approaches to work, and therefore fail to take account the present needs of people and businesses (McGregor, 2000).

According to Acsente (2010), many organisations are paradoxically still structured to suppress innovation, creativity and initiative. In today's economy, knowledge work is increasingly important and there is a need for workspaces supporting the gathering and structuring of information, creative thinking and combining of ideas, methodical solution finding and evaluation (Harrison et al., 2004, 37). In an increasingly paradoxical world, organisations want to be both centralised and dispersed, private and collaborative, outward looking but inwardly secure, economical with resources whilst generous to employees. Standard solutions that fit all situations are rare. (Worthington, 2006, 7) Patterns of work and structures of

organisations are evolving faster than the built environment can be transformed to meet their needs (Harrison et al., 2004, 7). Helping corporations to gain competence to design the infrastructure to support and enable this distributed mobile work is at the core of helping them to be productive and agile (Vartiainen et al., 2007, 13). Even though mobile technology enables much of knowledge work to be performed anywhere and anytime, the role of the office as a workspace is still very relevant.

Virtaharju (2010) states that in order for knowledge work to be efficient, it requires several different workspaces. When knowledge workers are doing complex work, including phases with different activities and job roles, providing adequate work settings for these different needs and minimizing conflicts between them becomes a more difficult task for workplace designers (Harrison et al., 2004, 17) According to Hyrkkänen and Vartiainen (2005, 246), the future workplace is more of a meeting point, since the work tasks can be conducted wherever. Becker (2004) presents the idea of an *activity-based work system*, which includes space, technology, and management practises working in harmony. This system provides places for concentration without interruptions, informal discussions, confidential conversations and conferences with clients (see figure 7). Individuals may choose where to work over the course of the day or week according to their preferred work style, the nature of their work, and the needs of team members (Becker, 2004, 32).

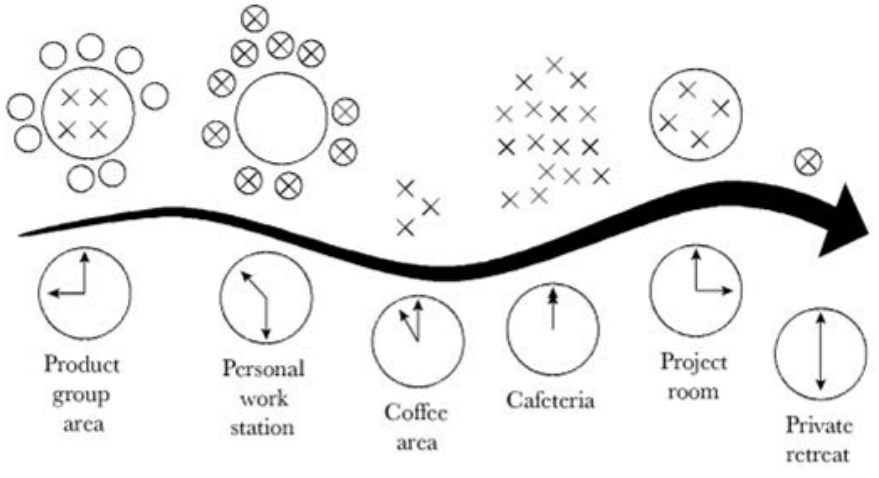

Figure 7. An Activity-Based Workspace (Becker, 2004, 32).

The activity based workspace is an especially intriguing concept when thinking how the employees rarely are in the same activity mode; when some are collaborating or taking phone calls others might be trying to read or concentrate. Rather than assuming an individual will do all his work while in the office building in one place, and then trying to design that place to support every conceivable work

activity, the concept is to create a series of work settings – each designed to support a particular kind of activity especially well (Becker, 2004). Harrison et al. (2004,) discuss a similar concept – *the activity setting* – which is based on the premise that a single "all-purpose" workstation is no longer sufficient in knowledge work. In the activity setting, employees are offered a variety of spaces to accommodate the range of specialist activities of which they have the liberty to choose the one that fits their task best, and move between the alternative spaces provided for specific needs in the course of the workday. (Harrison et al., 2004, 20) Workplaces should be designed to fit flexible solutions to support the various phases in knowledge work, as the comprehension of a workplace needs to be broadened to be seen as a physical, virtual and social space (Hyrkkänen & Vartiainen, 2005, 246). According to Bell (2010, 7), a workplace can become a liberated environment where employees can choose how and where they work and where different work styles can co-exist in harmony – from different teams, perhaps often even different organisations.

According to Myerson et al. (2010, 22), companies around the world have begun experimenting heavily with workplace redesign in recent years. When designing workplaces, it is customary to investigate the nature of the work to be undertaken in the new workplace and to provide a range of work settings to accommodate these activities. (Harrison et al., 2004, 53) According to Vartiainen et al. (2007), this can be achieved by interviewing the people who the changes affect and by organising a questionnaire to which all are able to respond. Roper & Kim (2007) suggest that in the knowledge age, distributed workspace decision making should be human-centred, in order to satisfy people's social and psychological needs. When deciding upon the actions to support the work of distributed and mobile employees, the analysis of the work and work environment is extremely important. The problem according to Davenport et al. (2002, 27) has been the mistake organisations have made in "lumping" all knowledge workers into one category. Many knowledge work tasks – writing, editing, analysing, programming and designing – require settings that facilitate solo working without distraction. Studies have shown that workers devote nearly two-thirds of their time to quiet work. Getting the balance right between the needs of collaboration and concentration is just one of the challenges in designing for knowledge work. (Myerson et al., 2010, 23)

If the real needs of work are not considered, well-intended supporting actions can have a reverse effect and appear to increase the strains of distributed employees. (Vartiainen et al., 2007, 140) One challenging factor in designing workspaces for knowledge workers it that people lack the confidence to break out from traditional work settings; companies have not prepared the ground in terms of culture change; the new rituals required to make the cutting-edge knowledge workplace succeed have not yet been eased into use. (Myerson et al., 2010) According to Davenport (2005, 165), the physical environment affects the productivity of knowledge workers, but unfortunately most decisions concerning the workspaces are made without seriously considering their implications for performance. Above all, a workplace has to support the work being undertaken by an organisation and its workforce, in whatever form, shape or distribution that organisation might

take. (Bell, 2010, 28) According to Roper and Kim (2007), a fully distributed workplace is said to exist at a point when organisations can offer multiple options for workers, allowing them to work as needed in the best arrangement for each particular task.

2.5 Synthesis

The theoretical part of this study presented the concept of knowledge work and knowledge workers, examined the changes experienced in the working environment, described the emergence of distributed work and its dimensions, and discussed how organisations are pursuing to respond to the requirements of those distributed workers. Though without a concise definition, knowledge work is seen in this study as cognitive, mental work including creation, development and application of knowledge to provide competitive advantage or some other benefit for an organisation. Knowledge workers are those who perform knowledge work tasks with high degree of expertise and experience. Knowledge workers differ from other workers in the sense that they have a need for high autonomy and individual decision making, which requires flexibility from the hierarchical structures of organisations. The complexity of knowledge work increases also as the work is performed in a periodic manner, moving between complex group and individual work to routine group and individual work. The nature of knowledge is that it changes fast, as does knowledge work in the constantly developing modern world. The factors affecting the changes in the working environment include the technological developments, the ageing of population and the new employee generations, environmental issues and increasing mobility of the workforce. Technological advances in communication have enabled new ways of collecting, maintaining and distributing knowledge. These changes make it possible to work anywhere and anytime, and have enabled the birth of distributed organisations.

The distribution of work is seen in this study as being an increasingly critical part of knowledge work in the modern working environment. In many previous studies the concepts telework or remote work were used to refer to the similar themes dealt with in this study, however, they were seen to be too narrow to cover the diversity of the phenomenon. Distributed work has many different aspects to it; it can mean a composition of employees working from different locations using communications technology to achieve a mutual goal; multi-tasking and working with people from different divisions, organisations or firms in distant environments; or working at multiple places such as the office, home, customer's premises, hotels and airports. Distributed work has also expanded the concept of a work environment; it is now seen as an entity of comprising of social, virtual and physical space, meaning the social context and network of an organisation, ICT solutions and the built environment. The main aspects of distributed work are its locationally flexible features, which enable knowledge workers to work in a mobile manner in various places. Mobility is seen as an integral part of any distributed organisation. Mobile workers spend their working time away from the main office during busi-

ness trips or visits to the customer's or partner's site and adapt to the space available; they can work during their travelling as well. Technology has made it possible to be constantly online, which enables the employees to conduct their work tasks wherever.

As presented in the literature review, the distributed knowledge work will increase in the following years, which is why it is necessary to learn more about the challenges distributed and mobile work bring along. The previous literature has examined the challenges mainly from the employees' perspective, as the distributed work environment provides new and different challenges in terms of managing the workload, travelling, communication and collaboration. In distributed work the travelling times expand the working hours, the role of self-management is emphasised as the supervision from the employer is reduced, multi-cultural work creates pressure in communication, and the danger of being a distant onlooker grows. These situations have great effect on the well-being at work, which is why it is important for organisations dealing with the distributed workforce to address the issues. However, previous studies have indicated that not all organisations are ready to make the change in their processes to manage the distributed workforce, due to the fear of losing the ability to hold on to control. Nevertheless, some organisational activities have been developed in pursuing towards a work environment supporting the distributed knowledge workers. Analysing the work of the distributed knowledge workers is seen very essential in the literature, so that the solutions made are from the basis of profound understanding about what kind of work is actually being done in the organisation. Creating protocols for the distributed workforce was also seen important, as they help the employees to better operate in the distributed work environment. Workspace management was also an important and very much researched topic in the recent literature, as the role of the multi-functional workspaces were seen critical in enabling the distributed and mobile workers to conduct their individual and group work tasks efficiently. The theoretical review is visualised in figure 8.

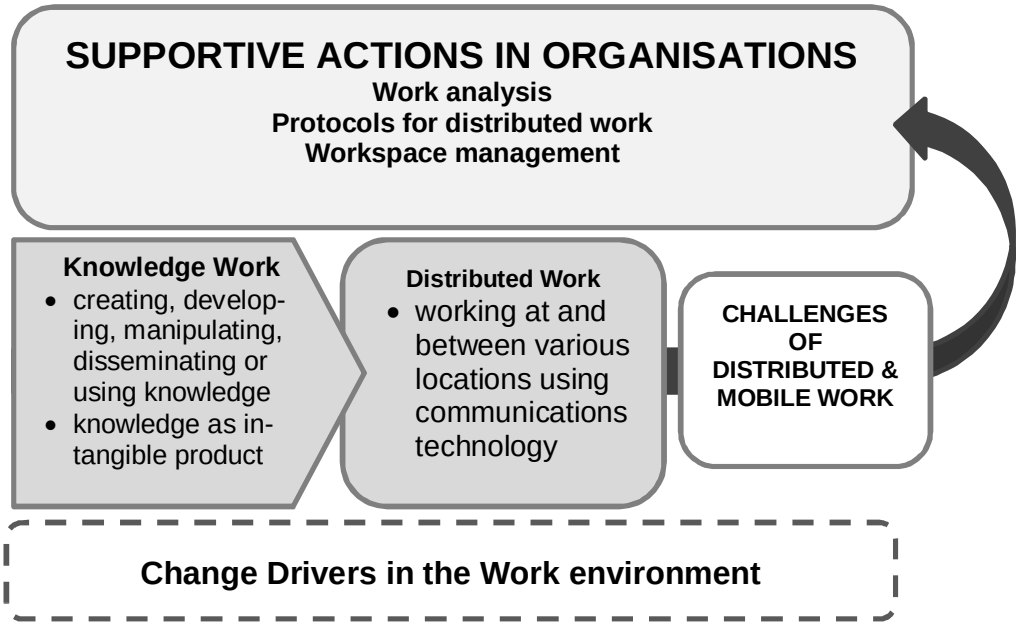

Figure 8. The theoretical framework for the study.

The purpose of the theoretical part was to provide a deeper understanding of the distributed knowledge work phenomenon which is at the centre of this study. The interest lies particularly in how organisations can support the distributed knowledge workers in the challenging new work environment, since not much research has been done on the subject. Work analysis, distributed work protocols and workspaces are of course a good start, however, as mentioned in describing the challenges of distributed and mobile work, in many organisations the work and management culture have remained rather traditional, and it is insinuated that renewal of the organisational policies is also needed in order to correspond to the requirements of the distributed workforce. This forces organisations to rethink their way of organising work, to which this study aims at providing more insight in the context of a knowledge intensive research organisation.

3. Case organisation and the research context

3.1 VTT Technical Research Centre of Finland

This study focuses on distributed knowledge work, and for this purpose the case organisation, VTT, provides an exceptionally comprehensive view point, being a knowledge intensive research organisation. VTT, the Technical Research Centre of Finland, is the largest multi-technological research organisation in Northern Europe. VTT was founded in 1942 to serve the government offices and institutes, cities, municipalities and private persons, as well as industries (Michelsen, 1993). Nowadays VTT is an integral part of Finland's innovation system, spearheading research and innovation to enhance the international competitiveness of its customers and society as a whole by providing high-end technology solutions and innovation services. VTT works with customers and partners to identify emerging technologies and create new products, processes, services, and business opportunities based on new technological solutions and business concepts.

VTT's main tasks are research and development and the transfer and testing of technologies. The organisation steers and develops its activities in cooperation with industry, research institutes, universities and the authorities in charge of technology policies and research funding. As a whole, VTT is a not-for-profit organisation. (VTT Review, 2010) At the moment, there are 2800 people working in the organisation, and the operations are geographically distributed into the capital area, Tampere, Oulu and Jyväskylä, as well as Turku and Lappeenranta. VTT operates in a VTT Group structure, which consists of functions Research and Development (R&D), Business Solutions, Strategic Research, IP Business, and Group Services (GS), as well as VTT Group companies; VTT Expert Services Ltd, VTT International Ltd and VTT Ventures Ltd (see figure 9).

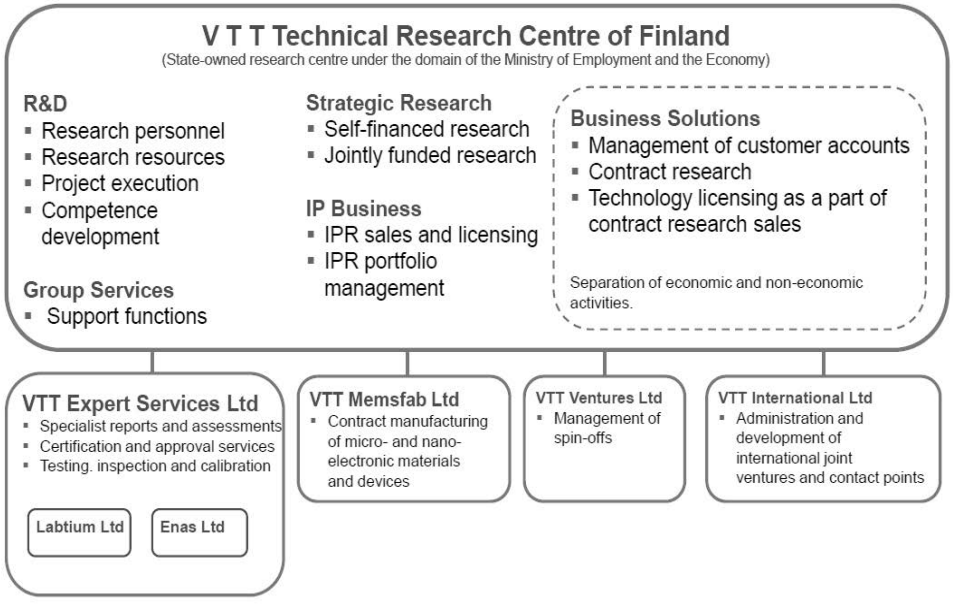

Figure 9. VTT Group structure (2011).

VTT has characteristics of a matrix and network organisation, as the operations are organised and managed in various ways, the above mentioned functions collaborate with each other, and organisational clusters within the functions work as a network with each other. The clusters are further divided into knowledge centres (KCs) and teams, which also work together. In addition to this, the organisation forms a network with clients, financiers and external partners. VTT can also be described as a project organisation, as the research is carried out in projects. (Buhanist et al., 2010, 16–17) The project types are further divided to *commercial projects*, which are tailor-made to the client's needs; *joint projects*, which are carried out and funded in cooperation with businesses, research funders and other partners; and *self-financed projects*, which are technology based, strategic research projects aimed to improve the competitiveness and expertise in the organisation to better serve the needs of customers in the future. VTT is also a significant global actor and focuses on internationalisation – it has active research connections to Europe, USA and Japan, and operates in large international networks. The organisation develops advanced technology, international effectiveness, networks and innovation partnerships with EU projects (VTT Overview, 2011).

3.2 Towards new ways of working

This thesis is conducted as a part of an internal development project, VTT WorkWays, which was launched during the year 2010 at the case organisation. Inspired

by the changes experienced in the knowledge work environment, the aim of the project is to create a workplace where research is enabled through advanced technology and modern workspace innovation, and supported by novel team and management practices, technology and space solutions. The project will run for several years, as it is recognised that the changes needed in the organisation will not happen overnight. During the year 2011, the project has focused on gathering comprehensive data on the working habits and requirements of VTT's employees, in order to better correspond to the needs of the workforce and steer the organisation towards innovative ways of working. At the moment, the project focuses on the personnel located at VTT's Otaniemi site, and this study examines a smaller pilot group, the 114 VTT employees located at the KCL building. The KCL building is a traditional office where the employees have their assigned work rooms; own or shared between 2–3 people. The building also has labs, conference rooms, a cafeteria, a small coffee area and few kitchens. VTT has rented these facilities from KCL (a central laboratory owned by Finnish forest companies) with a three-year contract as a result of the integration of KCL's operations to VTT. Soon the three-year contract will expire, which requires the relocation of VTT's employees to other premises. This has provided a chance to examine the working practices and work requirements of the employees more closely in planning the future work arrangements for the employees. The contribution of this study in the project is to shine light and understanding to the nature of work of the employees located at the KCL building, and specifically understand the requirements of distributed knowledge workers. Studying the changing requirements of knowledge work at VTT can be seen as very important, as the organisation is composed of knowledge workers operating in various different technological research fields, affected by the constant developments in the working environment. Due to its diverse expertise, VTT provides an interesting and challenging field for research. Since the distribution of the workforce has not been researched previously in the organisation, more information was seen to be needed about the working habits of the employees at the KCL building, which is why a survey study was chosen as a method of research. To get a more in-depth view on the work requirements, the research was also seen to be in need of qualitative data. The methodological choices for this study are presented in the next chapter.

4. Methodology

4.1 Research methods

As this study focuses on understanding the phenomenon of distributed knowledge work in a particular organisation, it can be stated that it has the characteristics of a case study. A case study research examines one or few purposefully chosen cases, such as an organisation, parts of it or a particular unit (Koskinen et al., 2005, 154). According to Yin (2009, 4), a case study allows investigators to retain the holistic and meaningful characteristics of real-life events. The case is examined in connection with its environment and the data are gathered by using multiple methods (Hirsjärvi et al., 2010). Yin (2009, 19) emphasises that though case study research is usually associated with qualitative research methods, a researcher may go beyond the type of qualitative research by using a mix of quantitative and qualitative evidence. A mixed method approach combines quantitative and qualitative approaches in the research methodology of a single study or a multi-phased study (Tashakkori & Teddlie, 1998). Consequently, in order to answer the research questions of this study, a mixed method approach was chosen. The approach was seen to be suitable as using multiple methods enables acquiring an extensive amount of information about the phenomenon, since no previous research had been done on the subject in the case organisation. Mixed methods research is said to provide more evidence for studying a research problem than either quantitative qualitative research alone. The reviewing of the same phenomenon from multiple angles is called triangulation (see e.g. Tashakkori & Teddlie, 1998, 41; Tuomi & Sarajärvi, 2002; 141; Metsämuuronen, 2003, 208; Hirsjärvi et al., 2010, 233), which can be seen to elaborate the validity of a study as well.

Creswell and Plano Clark (2011, 5) incorporate the definition of the mixed method approach with multiple diverse view points, for example that in mixed methods the researcher collects and analyses persuasively and rigorously both qualitative and quantitative data; mixes the two forms of data by combining them, sequentially by having one build on the other, or embedding one within the other; and gives priority to one or to both forms of data. In this research, the data is gathered sequentially and the priority is in both forms of data. Creswell and Plano Clark (2011) further distinguish six different mixed method designs: the convergent parallel design, the explanatory sequential design, the exploratory sequential

design, the embedded design, the transformative design and the multiphase design. This research follows the explanatory sequential design, which can be used when a researcher wants to use quantitative results about participant characteristics to guide purposeful sampling for a qualitative phase. The two-phased design starts with the collection and analysis of quantitative data and is followed by the phase of collecting and analysing qualitative data. In choosing the explanatory sequential design for the mixed method research, the researcher connects the two strands from quantitative data analysis to qualitative data collection, so that the quantitative results point the direction to the decisions about the qualitative research questions, sampling and data collection in phase two. (Creswell & Plano Clark 2011, 71–82) The two-phased process is described in figure 10 below, and the next chapters present the steps in more detail.

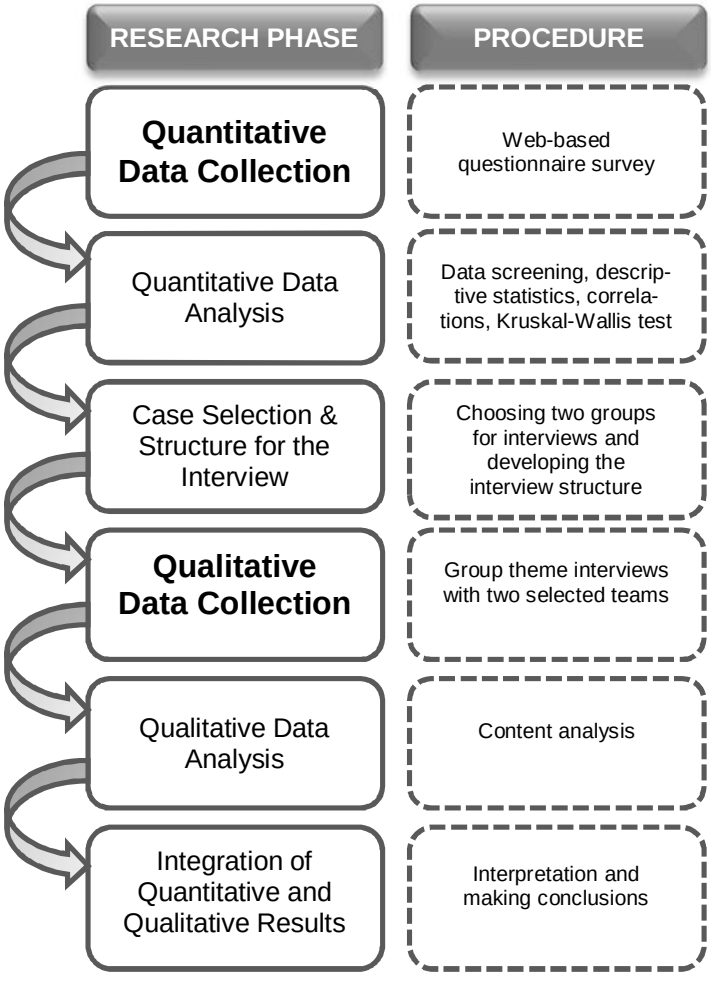

Figure 10. Description of the two-phased empirical part of the thesis.

4.2 Realization of the quantitative phase

As the study focuses on examining the 114 knowledge workers located in the KCL building, a structured questionnaire survey was chosen because it is recommended to be used when gathering information of actions, attitudes and opinions of large number of people (Alkula et al., 1999, 118). The purpose of the questionnaire was to produce information about the nature of work of employees at KCL building, the distribution of the workforce, and whether or not there are statistically significant differences between organisational groups. The results of the survey play an important role in choosing two teams from different organisational groups for the interviews in the qualitative phase, which aims at examining two distributed teams which differ from each other in terms of perceptions of workspaces, collaboration practises and ICT.

4.2.1 Questionnaire development

The development of the questionnaire begun in January 2011. There was no previous model for the questionnaire; hence, it had to be developed for the purposes of this study, keeping in mind the requirements of the case organisation. The complex nature of knowledge work in the case organisation was not familiar for the researcher, which is why a more in-depth examination of the work was useful at the beginning of the research process. As the thesis was done as a part of an internal development project, it was possible to utilize the expertise of the project group in the questionnaire development process. A part of the project group was gathered to discuss the nature of work at VTT from a Core-task perspective. As briefly described in the literature review, the Core Task Analysis (CTA) methodology is an approach for analysis of the development of work practices and a tool for defining the shared meaning and out-come critical content of a particular work, and which demands put it to action (see Norros, 2004, 17–18). The outcome critical features of modern working environment are dynamism, complexity and uncertainty, based on which the discussions of nature of work at VTT were held. The CTA workshop with the project group was held on March 7th, 2011, and the outcome was the views of work at VTT in terms of dynamism, complexity and uncertainty, which were later included in the questionnaire in the form of statements about the nature of work.

The development of the questionnaire was structured on information gathered from the CTA workshop, the literature review and the ProWork survey II[1]. All together there were 23 questions in the questionnaire, consisting of questions about

[1] ProWork (2006–2009) is a research project between Helsinki University of Technology, Stanford University (USA) and NTNU(Norway), which aimed to understand the requirements of productive knowledge work in physical, virtual, and social work settings and how to manage the workplace change processes.

the respondents' background, nature of work, work practises and workspaces. The questionnaire instrument consisted of five sections: 1) Background information; 2) Nature of work; 3) Work practices and physical space; 4) Teamwork and social space; and 5) ICT and virtual space. There were three open-end questions concerning the important things at one's work post and disturbing factors at the work post, and one for general comments or thoughts at the end of the questionnaire. Sections 2, 3, 4 and 5 consisted of statements measuring attitudes, for which a five-scale Likert was seen fit to be used (see e.g. Valli, 2001; Metsämuuronen, 2003). These sections were constructed to gather information about the respondents' personal experience. Statements in section 2 were developed from the CTA workshop in order to get a more in-depth view of the nature of work at VTT. The statements dealt with the dynamics, complexity and uncertainty factors that were discussed in the workshop. Sections 3–5 were developed from theoretical concepts presented in chapter 2. Because there was no ready-made instrument for this research, it is important for a researcher to operationalize the concepts used for a quantitative study (Alkula et al., 1999). The structure of the questionnaire instrument is presented in figure 11 to illustrate the connection between relevant concepts and the developed variables.

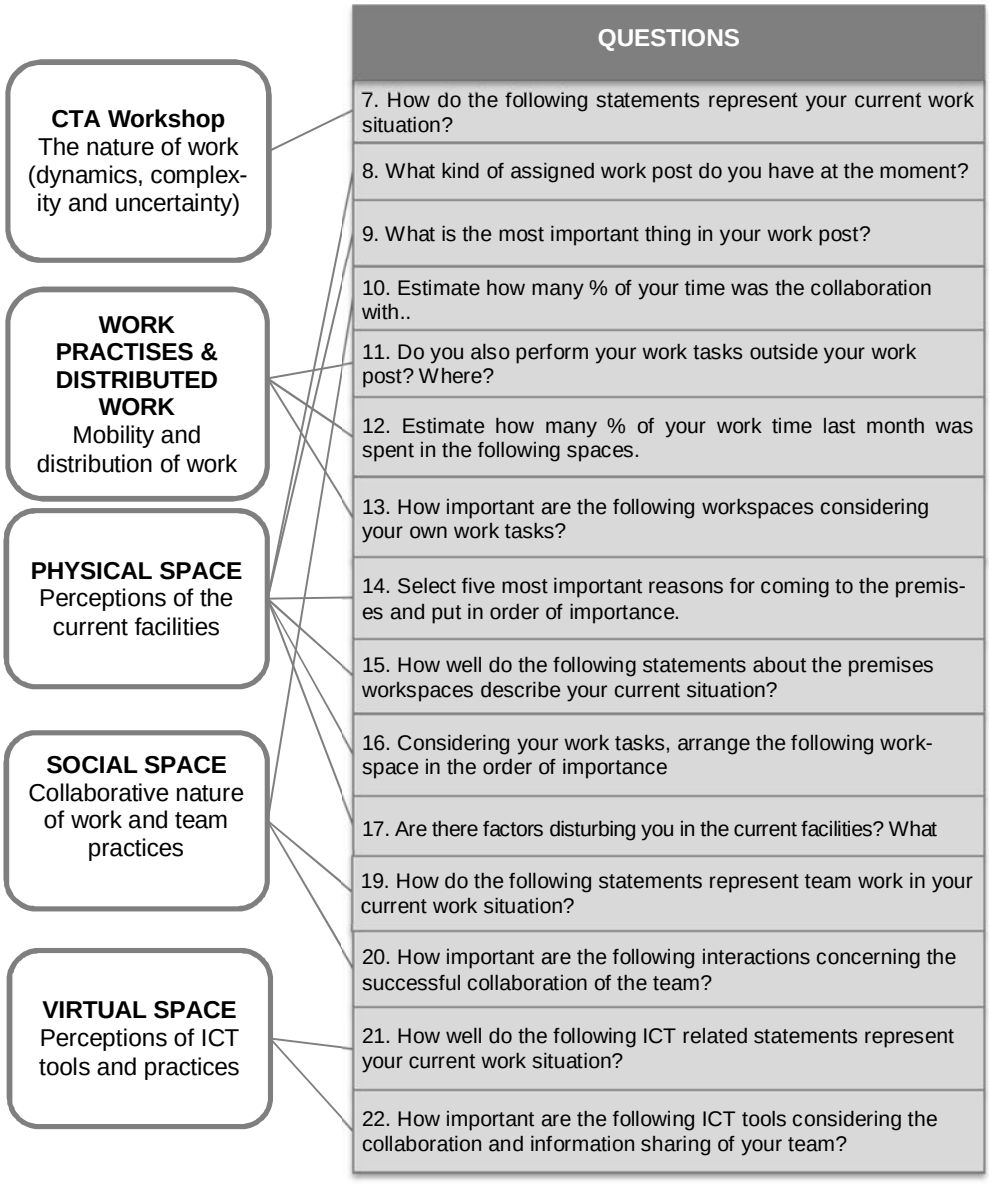

Figure 11. Concepts and the questionnaire instrument.

The instrument was tested on six researchers representing different teams located at the KCL building. After the test run, the instrument was further developed and modified. The questionnaire instrument was also sent to the members of the VTT

WorkWays steering group for a final reviewing and acceptance. For the final form of the questionnaire, an information gathering tool, Digium software, was used. The printable version of the questionnaire form and cover letter can be found in appendix 1.

4.2.2 Data collection

The questionnaire was sent to VTT employees located at the KCL building, consisting of 108 employees belonging to the R&D function, and six employees from the GS function. These employees represent the six organisational groups examined in the data analysis, referred to as KC1, KC2, KC3, KC4, KC5, KC6 and Other. All of the groups differ by expertise area at VTT, which provides an interesting insight to the diversity of knowledge work in the organisation. The web link to the questionnaire was sent to total 114 employees via e-mail, which included the cover letter (see appendix 1) on 4th of April 2011. The e-mail was sent by the project manager, and included general information about the project and its goals. At first, the web link was planned to be open for two weeks, but the time was extended to two and a half weeks in order to increase the response rate. A week before the closing the respondents were reminded to answer the questionnaire. The internal development project also sparked a lot of discussion among the employees at the KCL building during coffee breaks and lunchtime, which provided excellent opportunities for the researcher to remind the personnel about the importance of answering the survey. In the end, the amount of acceptable responses was 80, giving a response rate of 70%.

4.2.3 Data analysis

The data analysis begun immediately after the questionnaire was closed. The data were inserted in PASW Statistics 18, a comprehensive system for analysing quantitative data. The data were thoroughly checked and examined. Some missing data values were replaced with the sample mean solution, which assumes the missing data and available data were random subpopulation of the total sample, and the mean for available data can be treated as an unbiased estimate of the mean for the total sample, not altering sample mean. (Alkula et al., 1999; Hertel, 1976) The data from the questionnaire were analysed with statistical methods. In describing the results, the data are examined by reflecting them to the previously presented literature, as theory in mixed method research can have a guiding role in the study (Creswell, 2003, 136). Because there was only one respondent representing the organisational group KC4, it was left out from the analysis part, because it was seen that one person's views cannot be generalised to represent the group as a whole. The description of the data was done using percentage distributions, mean values and standard deviation. The average values median and mode were also used, since they are more suited for the sections measured with an ordinal scale (Valli, 2001; Metsämuuronen, 2003). The normal distribution of the

data was analysed by using the Kolmogorov-Smirnov test, and it was discovered that the survey data is not normally distributed. This discovery presented certain conditions for choosing methods for further data analysis. Cross-tabulation was also executed, however, the results of the Chi-square test did not meet the assumption of expected frequencies; no more than 20% of the expected frequencies can be under five (Clark-Carter, 1997, 210). The expected frequencies are partly governed by the sample size, so the small sample size of this survey (n = 80) had an effect on the results of the analysis.

The correlations were checked with Spearman's rank order correlation coefficient to see if there were connections between the variables measured with ordinal scale (see Metsämuuronen, 2003, 301). Principal component analysis (PCA) was planned to be used for the section presenting statements about the nature of work to reduce variables. The purpose of using the principal component analysis is to group variables into fewer components or factors reducing the incoherence of the data (Clark-Carter, 1997; Metsämuuronen, 2003). The PCA was executed in order to create variable groups for the dynamic, complex and uncertain features of the nature of work at VTT, however, the three components created did not result to rational entities content-wise. The issue seen here was that the statements created from the CTA workshop need to be further developed, in order to produce entities that can be differentiated from one another more clearly. To test if there are differences between previously mentioned organisational groups in terms of perceptions about the work environment, the non-parametric multiple comparison test, Kruskal-Wallis, was used. The Kruskal-Wallis test can be used if the conditions for interval measurement or a normal distribution are not met (Dickinson Gibbons, 1993; Keppel & Wickens, 2004). The Kruskal-Wallis test enables the discovery of possible group differences, and can be used when the examined feature in the data is distributed into more than two groups (Valli, 2001, 79). Other variable groups, for example age, gender and years of employment at VTT were also tested, however, they did not produce statistically significant differences which should be considered in this study. The results from the examination of the differences between organisational groups, however, provided important information in choosing the cases for the qualitative part of this study, which is described next.

4.3 Realization of the qualitative phase

For the qualitative part of this study, group interviews were seen as an appropriate data collection method. Group interviews are a qualitative data gathering technique where the interviewer has a directing role in the discussion (Fontana & Frey, 1998, 54). The core of a group interview consists of the interview frame created by the researcher, which cuts the discussion into a series of questions. The interview situation is close to a conversation where people can freely exchange their views about the phenomenon under discussion (Koskinen et al., 2005, 123–124). Group interviews are inexpensive, rich with data, flexible and stimulating to respondents. Some disadvantages include the emerging group culture, which may interfere with

individual expression; the group may be dominated by one person; the group format makes it difficult to discuss about sensitive topics; “group-think” directs the conversation; and the requirements for the interviewer’s skills are greater because of group dynamics. (Koskinen et al., 2005, 124, Fontana & Frey, 1998, 55) Nevertheless, the method was chosen, because it was seen to encourage lively discussion about the topic from the perspective of the team as a whole – keeping in mind the research questions and purpose of this study.

4.3.1 Selection of groups for the interviews

The quantitative data gathered enabled the discovery of organisational groups which differ from each other in terms of perceiving the workspaces, collaboration practises and ICT. Because the purpose of this study is to examine the distribution of work, it was seen appropriate to choose two organisational groups, which work in distributed manners, but still differ from each other in their perceptions. To make the choice easier, the results from the Kruskal-Wallis tests were visualised in a form which shows the differences between the organisational groups in terms of mean ranks. The visualised form enabled the researcher to see the differences more clearly and choose the suitable groups for the interviews. The differing organisational groups were KC1 and KC3 (see appendix 3), from which two teams were selected for the group interviews. Interviewing teams instead of the entire KCs was seen sensible because the tight schedules of the researchers would have made it difficult to gather the whole group together, and because the closest formal organisational unit for researchers is the team they belong to, even though for some employees the role of the organisational team is purely administrative. The team from KC1 seen appropriate for this study was found with the help of the project leader of the internal development project, and the team from KC3 was chosen on the basis that the group is generally known to be working in a highly distributed manner. In this research, the teams will be referred to as KC1a and KC3a.

KC1a consists of ten researchers and operates at the KCL building in Otaniemi. All team members are located in the same building where they have their own work rooms in the same corridor. The team formation is quite new, and they have worked together for two years. The team members work in multiple projects, and the group collaborates closely with each other; normally there are 1–6 members of the team in the same project. The workspace they occupy functions as a portal for communication, as the team members often consult each other personally during their workdays. The project settings include external clients, other teams and KCs at VTT, as well as international partners, since 1/3 of their projects are EU projects.

KC3a consists of eight researchers and one Key account manager. The team is geographically distributed as it operates at the KCL building in Otaniemi and at VTT’s premises in Tampere, and soon one member will work abroad. Five of the team members have their own work room, and the rest four team members have been working in shared team rooms with two or more people. The team works in multiple projects; one team member described the team as the “satellite” team,

because the team operates with many customers and partners in various projects. The team members also collaborate with each other, however the collaboration is mostly done using virtual tools or during work trips to the customer's or partner's site. As the two teams selected for the interviews differ in their expertise areas and terms of distribution, they were seen to provide interesting information about how the diverse distributed knowledge work can be supported in the organisation.

4.3.2 Data collection

The data for the qualitative phase was collected from two group interviews, for which the teams from the differing organisational groups mentioned earlier were chosen for. The nature of the group interview can be described as semi-structured or a theme interview (Tuomi & Sarajärvi, 2002). Theme interviews are efficient because they are based on the researcher having more of a guiding role, rather than controlling the situation entirely (Koskinen et al., 2005, 105). The themes for the interviews dealt with 1) the current work and collaboration practises of the team; 2) future visions of the team in terms of change drivers presented in the literature review and 3) work and collaboration practises supporting the work of the team in the future (see appendix 4).

The first team, KC1a, was interviewed on May 30th as a part of their weekly team meeting at the KCL building. Only one team member was not able to attend the meeting. The interview was held at a previously reserved conference room, which was a silent and undisturbed space where the team could discuss without interruptions. The team members agreed for the interview to be audiotaped and no cautiousness because of it was observed. First, the team was presented with general information about the purposes of this study and a brief introduction to the topic. Then they were presented with the themes concerning the current work practises of the team. The team discussed about how they operate at the moment, after which they were asked to consider the same issues in the light of the change drivers presented in the introduction of this report, and discuss how the drivers will affect their work and how the work practises should change in order to support the work. The team discussed first in pairs, and then presented their views for the whole group. There was a lot of lively discussion during the interview, and all team members were allowed to speak about their own views. The role of the interviewer was guiding, and additional elaborative questions were asked when needed. The team was active in the discussion, and showed interest in the topic at hand. The general atmosphere in the interview was free and friendly, and it was evident that the team had a high community spirit, and that the role of the team played an important part in their daily work processes. The time for the interview was limited to 1 hour and 15 minutes, which was agreed before with the team leader, since the interview was included in the team's weekly meeting, and there were other issues to be dealt with as well. Still, the duration of the interview did not feel too short, as the timing for each theme under discussion was carefully planned beforehand.

The second team, KC3a, was interviewed on June 13th also at the KCL building. There were challenges in finding a suitable date for all of the team members, due to the fact that the team works in a highly distributed manner, and days when all team members are at the same location are rare. Still, a suitable date was found to which only two team members were not able to attend, and a room was reserved for the interview. All team members agreed to the audiotaping of the interview, and again, there was no cautiousness observed. The process and topic of the thesis were introduced briefly, after which the team talked about their current work practises. The change drivers created a lot of discussion about how the team operates and how the work practises should support the work. The discussion flowed very effortlessly and all team members were eager to present their views, which could partly be due to the fact that the team members themselves conduct many interviews as a part of their work, and the interview setting is very familiar to them. Many times the interviewees even gave the possibility for others to present their views by asking them "how do you find this issue?" or "what is your point of view in this?", so again, the role of the interviewer was a guiding one. The group was very active and showed a lot of interest in the topic, and the general atmosphere was enthusiastic and open. The duration of the interview was 1 hours and 30 minutes, which was considered to be enough, since the team members stayed on topic and gave the possibility for everyone to present their views.

4.3.3 Data analysis

When an interview is used as a data gathering method, the result is typically wide and diverse, and can be approached in many ways (Ruusuvuori et al., 2010, 11). The group interviews were audio-taped and transcribed into memos afterwards, which resulted into 21 pages of text. Because the interview language was Finnish, parts of the transcriptions were translated into English. The level of transcribing was fitted for the purposes of this study, and all the pauses and fill words were left out, as the focus was on the content of the interviews (see e.g. Metsämuuronen, 2003, 196; Ruusuvuori et al., 2010, 14). The analysis of the interviews begun immediately after each interview was transcribed.

Content analysis was seen fit as an analysis method, because it can be applied in all qualitative research traditions and allows the data to be examined systematically and objectively. Content analysis enables the researcher to gain a concise and generally clear description of the data, which is constructed for making conclusions without losing the information that it entails. In the analysis it is important to choose a carefully limited phenomenon, but describe everything that can be retrieved from it. (Tuomi & Sarajärvi, 2002, 93–110) In this research, the centre of focus is distributed knowledge work, which is why the analysis focused on aspects concerning practises supporting distributed knowledge work, even though there were many other interesting issues rising from the data. The nature of the analysis can be described as inductive, where the analysis process is divided into three main phases; the reduction of data, the grouping of data and the abstraction of

data. Clustering the data can be seen as a part of the abstraction process, from which the researcher proceeds to theoretical conceptualisation and making conclusions (Tuomi & Sarajärvi, 2002, 110–114).

According to Koskinen et al. (2005, 232), the analysis process always begins with reading and browsing through the data many times. First, the audiotapes were transcribed after each interview, then the transcriptions were examined and read through thoroughly many times in order to gain a clear view of the data. Printing the interviews on paper and highlighting the main points helped to visualise the entity of the text. After getting familiar with the content, the main points of both interviews were listed in a same document. Then, similarities and differences of the two interviews were examined, after which categories of discussion were created by clustering the content under main themes. The whole process was executed according to the research questions, so the purpose of this study was not lost in the analysis. According to Ruusuvuori et al. (2010, 19) it is important for the researcher to remember that categorising the data in a systematic way is not the same as analysing it. The content was examined many times to make sure that all the relevant data was logically clustered under the appropriate themes. In the abstraction process, the clustered data was examined thoroughly again to enable making conclusions. In making conclusions from the data, the researcher aims at understanding what the themes mean for the research object from their point of view (Tuomi & Sarajärvi, 2002, 115). Each theme is presented in the qualitative phase of chapter five, where the main points of the interviews are presented and discussed, reflecting them to the previously presented literature.

4.4 The reliability and validity of the study

Examining the reliability and validity of a study is an essential part of any research process. All studies attempt to avoid errors, which is why it is important to evaluate the reliability of the research conducted (see Hirsjärvi et al., 2010, 231; Tuomi & Sarajärvi, 2002, 131). Issues in considering the reliability of a study are often related to the generalisation of the research results (see e.g. Alasuutari, 1993), however, it is important to acknowledge the extent to which a researcher wishes to generalise the information discovered. As this study is a case study, it has to be remembered that the results can be generalised only to that part of the organisation represented in the quantitative and qualitative phases. Similarly, Hirsjärvi et al. (2010, 233) state that in case study research the researcher can be of the opinion that all studies concerning people or culture are unique, and therefore traditional reliability and validity measures do not apply. Still, it is recommended that the validity and reliability are somehow appraised.

The *validity* of a study refers to the instrument's or method's ability to measure what it is supposed to measure (Uusitalo, 2001, 84; Metsämuuronen, 2003, 43). The validity is often divided into internal validity and external validity. The internal validity means the study's logicality and consistency, and the external validity concerns the generalisation of the study; if it can be generalised and to which

groups (Koskinen et al., 2005, 254; Metsämuuronen, 2003, 35). According to Metsämuuronen (2003, 35), a good composition, definitions of concepts, combination of theoretical point of views and sampling can increase the validity. In this research, a thorough examination of the recent studies and literature was done, which guided the course of this study. The researcher also spent a lot of time in constructing the research so, that the theoretical part and empirical part support each other logically. In quantitative research, problems in validity may occur if the researcher and the respondents have different comprehension of what the questions in a questionnaire are trying to measure. To improve the validity from this point of view, the questionnaire form was reviewed and evaluated by various researchers, after which the instrument was discussed and further developed. In qualitative research, the validity of a study can also mean the compatibility of the description and interpretation of data (Hirsjärvi et al., 2010, 232), which in this study was supported by presenting the interviewee's quotations in the results of the qualitative part, in order to give the reader a possibility to examine the statements, and challenge the interpretation of the researcher. From the perspective of the entire study, the validity is increased with *triangulation*, where multiple methods, researchers, information sources and theories are used to gain an extensive view of the phenomenon examined (Hirsjärvi et al., 2010; Tuomi & Sarajärvi, 2002). More precisely, this study utilises the methodological triangulation, where both quantitative and qualitative methods are used.

The *reliability* refers to the repeatability of a study and its ability to produce unaccidental results (Hirsjärvi et al., 2010, 231). To increase the reliability of an instrument in a quantitative study, Metsämuuronen (2003, 37) recommends testing an instrument many times, and refining it after getting comments and feedback on it. Creating the questionnaire instrument for this thesis was a long process, during which many people inside and outside the case organisation were consulted on the content, structure and functionality issues. The project's steering group also gave valuable comments which were then used to modify the questionnaire. Before sending out the questionnaire, a pilot group was chosen to answer the survey, after which some changes were made. According to Hirsjärvi et al. (2010, 232), the reliability of a study can also be improved by describing the different research phases in detail, which was also considered to be very necessary by the researcher in order to control the content of the empirical part. This was attained by describing both quantitative and qualitative data gathering and analysis very carefully in the previous chapter. In presenting the results, the two teams interviewed are also described more in detail in order to give the reader an understanding of their modes of action in the organisation. Tuomi and Sarajärvi (2002, 139) also discuss about increasing the reliability of a study by having colleagues to evaluate the research process in a so called "expert panel", where they examine the results and conclusions. As the thesis was conducted as a part of a development project, the results and conclusions were also discussed in various occasions with researchers and members of the project group.

5. Empirical results

5.1 Quantitative phase

5.1.1 Profile of the respondents

In examining the background information of the survey it was discovered that 54% of the respondents were male, and 46% were female. The age groups varied from under 25 to over 55. 3% of the respondents reported their age under 25 years; 28% were between the ages of 25–35; 32% were between the ages of 36–45; 11% of the respondents were between the ages of 46–55, and 26% of the respondents reported their age as over 55 years. The starting year of employment varied from 1970 to 2011, and one respondent reported having started first in 1984 and then again in 2006. 5% of the respondents had started between the years 1970–1979; 13% had started between the years 1980–1989; 20% had started between the years 1990–1999; 32% had started between the years 2000–2009; and 30% had started from the year 2010 onwards.

As for the work task, 36% of the respondents reported that they work as a research scientist, 29% work as senior research scientists, 14% work as a team leaders, 5% work as a research scientist trainee, 4% work as technology managers, 2% work as laboratorians, 2% work as secretaries, and 8% reported their work task being “something else”, such as research professor, development manager, business development specialist, finance analyst, and chief research scientist. 66% of all the respondents reported that their work includes leadership tasks, such as project management. Represented in the survey were six different KCs and the group “Other”, which consisted of six people from the GS function. The response rates of the KC’s (in relation to the employees represented at the KCL building) varied between 33% and 100%. The summarized profile of the respondents (n = 80) is presented in appendix 1.

5.1.2 Nature of knowledge work

The questionnaire presented statements regarding the nature of work at the case organisation determined in the CTA workshop. There were altogether 28 state-

ments regarding the dynamism, complexity and uncertainty features of the work environment, which were evaluated with a five-scale Likert (1 = strongly disagree, 5 = strongly agree). The data from this section were analysed with average values of mean, median and mode. The statements that received the highest average values are presented in table 1 below.

Table 1. Nature of knowledge work (highest average values).

Statement	Mean	Median	Mode	Std. D
My work is mainly project work	4.3	5	5	1.052
My work includes a lot of tasks requiring silence and concentration	4.3	4	5	0.935
My work requires balancing between many different assignments during the day	4.1	5	5	1.166
My work tasks include a lot of problem solving	4.1	4	4	0.924
My work requires balancing between projects that are in different phases of the project life cycle	4.1	4	5	1.147
I work in multiple project teams at the same time	4.1	5	5	1.249
Sharing information regularly is essential in my work	4.0	4	4	0.974
My work requires working in different modes (e.g. from group work to individual work tasks)	3.9	4	5	1.193
My work requires a lot of flexibility	3.9	4	5	1.107
I often collaborate with external clients	3.8	4	4	1.073
My work requires making precise plans and following their steps	3.8	4	4	0.873
Every day is different in my work	3.7	4	4	1.030
My work requires fast adaptation to new situations	3.6	4	4	1.051
I often have to work relying on uncertain information	3.6	4	4	1.064
My work requires collaboration and integrating schedules regardless of time and space	3.5	4	4	1.136
I often collaborate with other teams or knowledge centres at VTT	3.5	4	4	1.079
My work requires constantly looking ahead	3.5	4	4	1.030

From the table it can be seen that the case organisation functions in a multi-project work environment, balancing between projects in different life cycle phases. It is also evident that many employees balance between different assignments during the work day, and the work requires them to work in different knowledge worker modes. The work also requires a lot of problem solving, and includes tasks requiring silence and concentration. The collaborative nature of knowledge work can also be seen, as sharing information, collaborating and integrating schedules regardless of time and space, and collaboration with external clients and with other organisa-

tional groups at VTT received high average values. There were many correlations that could be found within this section, and it could have been possible to conduct principal component analysis to reduce the variables into fewer components, however, as mentioned earlier, the components produced did not differ from one another in a manner that would have created coherent entities content-wise.

5.1.3 Knowledge worker collaboration

The respondents were asked about the collaborative nature of their work, and they had to estimate how many per cent of their work in March 2011 had been collaboration with the organisational team; with VTT's internal project teams; with other VTT colleagues; with external partners; with external customers; and working alone. A more specific time frame of one month was set to this question because it was reported being one of the busiest months of the year. The purpose of this question was to discover the collaborative nature of the respondent's work. The mean percentage values for collaboration with the organisational team was 13%, with VTT's internal project teams 16%, with other VTT colleagues 9%, with external partners 10%, with external customers 10% and for working alone 42% (see figure 12).

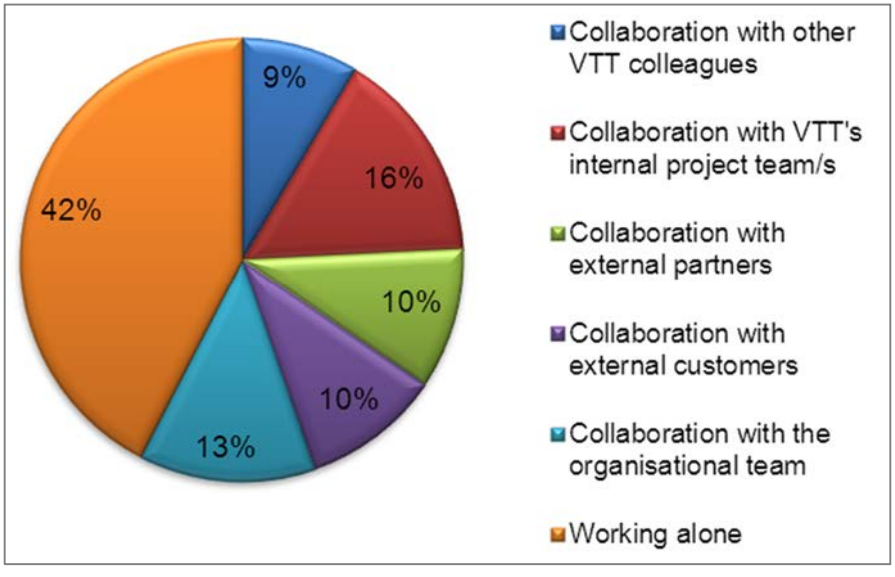

Figure 12. The respondent's collaborative nature of work.

Figure 11 demonstrates that the respondents evaluated over half of their working time being of collaborative nature with various different parties (see e.g. Pyöriä, 2005; Arthur et al., 2008). This fact received a further verification, when the respondents were asked to select five most important reasons for coming to the KCL building's

premises (1 = most important, 2 = second important, etc.). It was discovered that the option receiving the closest value to 1 (most important) was collaboration with work colleagues (mean = 2.51).

5.1.4 The distribution of work

The distribution of work in this survey was examined through the nature of work, the variety of spaces the respondents work at, the importance of the spaces regarding the respondent's work tasks, and how much time is seen spent at the spaces. The form of work distribution could be seen from the results of the nature of knowledge work presented before, as it can be concluded that the work in the case organisation is distributed in the sense that employees are multi-tasking, collaborating with many others inside the organisation and with external clients (see Vartiainen et al., 2007). The respondents were also asked if they perform work task also outside their own assigned work post to discover the distribution from an individual's perspective (see Virtaharju, 2010). The results are presented in figure 13. The variety of workplaces is evident in the figure and the highly distributed nature of work can be seen as 83% of the respondents reported that they also work at home; 71% reported working in the conference rooms at KCL building; 55% work also at partner's or customer's premises in Finland; and 50% also work at other VTT's locations in Otaniemi. The number of different work locations also demonstrates that the work done at the case organisation has mobile features as well (see e.g. Harrison et al., 2004; Andriessen & Vartiainen, 2006).

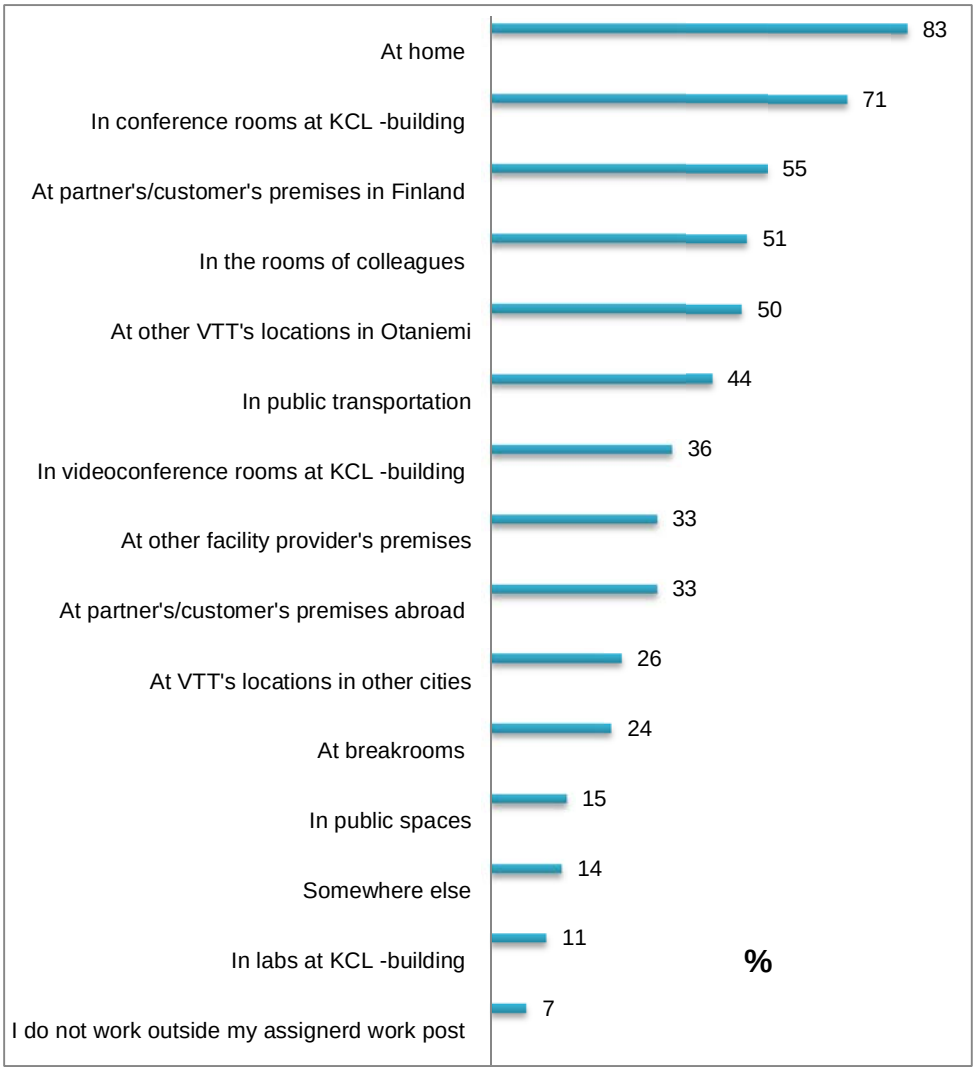

Figure 13. Variety of places where the respondents conduct their work assignments.

The employees were also asked to estimate in percentages how much time they spent working on their own assigned work posts and the before mentioned other workplaces in March 2011. The mean values of the percentages showed that over half of the time (54%) is seen to be spent at the assigned work post, and the rest of the working time is divided between the other workplaces. Considering the validity of the responses, it has to be kept in mind that these are the personal estimations of the respondents, and not accurately measured information. The respondents were also asked about the importance of the before mentioned spaces

considering their work tasks on a scale from 1 to 5 (1 = not important at all, 5 = extremely important). Own work post and conference rooms at KCL building received the highest average values, while labs at KCL building and public spaces, such as cafés and libraries received the lowest. The average values are presented in table 2. The importance of the own assigned work post was also emphasized in many of the comments in the open-end questions of the questionnaire, as the tasks of the respondents require individual concentration as well. Many of the respondents had had bad experiences from open-space office solutions, where employees were put in a same space without places for individual concentration, which was seen vital in the work of a researcher.

Table 2. The importance of workspaces in terms of work tasks (average values).

Statement	Mean	Median	Mode	Std. D
Importance of own assigned work post	4.8	5	5	0.624
Importance of conference rooms at KCL building	4.0	4	4	0.928
Importance of home	3.3	3	3	1.267
Importance of videoconference rooms at KCL building	3.1	3	3	1.173
Importance of partners'/customers' premises	3.1	3	3	1.083
Importance of breakrooms	3.0	3	3	1.185
Importance of other VTT's locations in Otaniemi	2.9	3	3	1.188
Importance of something else	2.8	3	4	1.403
Importance of public transportation	2.2	2	2	0.943
Importance of VTT's locations in other cities	2.1	2	1	1.145
Importance of labs at KCL building	1.8	1	1	1.069
Importance of public spaces	1.7	2	1	0.896

The "Something else, please specify" possibility in this section was described as conferences abroad, online project collaboration spaces, car, second apartment, hotels and other places for inspiration, such as art museums and nature. When checking to see if there were any correlations between organisational groups in perceiving the importance of the before mentioned spaces, it was discovered that there were small positive correlations between the group KC6 and labs ($r = .383$, $p < .01$); videoconference rooms ($r = .380$, $p < .01$); and VTT's other locations in Otaniemi ($r = .350$, $p < .01$). It was also discovered that there was negative correlation between the group KC5 and conference rooms ($r = -.378$, $p < .01$); videoconference rooms ($r = -.434$, $p < .01$); VTT's other locations in Otaniemi ($r = -.298$, $p < .01$); and VTT's locations in other cities ($r = -.327$, $p < .01$). From this it could be concluded that the organisational groups differ by their expertise area; some groups need labs or videoconference rooms because of the nature of their work,

while other groups do not. To examine the differences between organisational groups a bit further, the Kruskal-Wallis test was conducted. Statistically significant differences between organisational groups were found in the importance of labs (p = .005), conference rooms (p = .024), videoconference rooms (p = .000), VTT's other locations in Otaniemi (p = .009) and VTT's locations in other cities (p = .011). From the mean ranks of the organisational groups (see table 3) it can be seen which groups received the strongest and weakest average values in terms of perceiving the importance of the previously described spaces (darker grey represents strongest values and lighter grey the weakest values). For example, it can be concluded that considering the organisational groups, labs are most important to KC6 and least important for KC2. This is mostly likely due to the fact that in KC6, 78% of the respondents reported working in labs, while all of the members of KC2 reported not working there at all. It was also interesting to see that for the other statements, KC5 received the weakest mean ranks. This could be explained by the fact that only 39% of the group reported working in conference rooms, 5% reported using video conference rooms, 44% reported working in other VTT's locations in Otaniemi and only 5% reported working at VTT's locations in other cities.

Table 3. The importance of workspaces in terms of work tasks by organisational group (mean ranks of the Kruskal-Wallis test).

	Mean Rank by Organisational Group						
Statement: Importance of…	**KC1**	**KC2**	**KC3**	**KC5**	**KC6**	**Other**	**Sig.**
Labs	34.9	33.4	34.5	39.7	61.1	56.3	0.005
Conference rooms	51.5	44.4	43.1	25.2	46.3	37.2	0.024
Video conference rooms	34.4	50.8	42.2	22.4	63.3	34.0	0.000
Other VTT's locations in Otaniemi	38.1	46.2	40.2	27.9	61.5	33.2	0.009
VTT's locations in other cities	34.1	51.0	41.6	27.0	54.8	35.7	0.011

5.1.5 Physical, social and virtual workspaces

Physical space

The physical space in this research is regarded as the physical environment where the respondents work (see Vartiainen et al., 2007). The respondents were presented statements and questions concerning the work environment at the KCL building to discover how they perceive their current physical workspaces. When asked about all the types of assigned work posts the employees at KCL building had, 66% reported that they had an own private work room, 24% of the respondents shared a work room with max. two people, 10% shared a room with more than two people, 23% had also a work post at home, 4% of the respondents had a

work post at other VTT locations, and 4% had a work post outside VTT (e.g. customer's premises.) The statements about the KCL building's workspaces were evaluated by using the scale of 1 to 5 (1 = strongly disagree, 5 = strongly agree). The strongest average values were given to the statements "Workspace arrangements play an important role in my work satisfaction" and "The current workspaces are suitable for the requirements of my work tasks". The weakest mean values were given to the statements "The workspaces encourage creativity and innovation" and "The workspace solutions allow me to identify with the organisation" (see table 4 below).

Table 4. Perceptions of physical workspace (average values).

Statement	Mean	Median	Mode	Std. D
Workspace arrangements play an important role in my work satisfaction	4.2	5	5	1.003
The current workspaces are suitable for the requirements of my work tasks	4.2	4	5	1.006
The workspaces provide suitable spaces for undisturbed, silent working	3.9	4	5	1.182
I can talk on the phone at my assigned work post without disturbing others	3.8	5	5	1.477
The workspaces support working in different modes (from collaboration to individual work)	3.6	4	4	1.181
I can easily find places where I can interact also informally with my colleagues	3.4	3	5	1.326
The workspaces support group work	3.3	3	3	1.174
The workspaces are flexible	3.2	3	3	1.275
Noise and interruptions are not an inconvenience at work	3.2	3	4	1.285
The workspaces support interaction among the work community	3.2	3	3	1.302
The workspace solutions provide a healthy work environment (e.g. ergonomics, air quality)	3.0	3	3	1.097
It is easy to find places for spontaneous conferences	3.0	3	2	1.377
There are suitable places for taking a break and resting	2.9	3	2	1.467
The workspace solutions allow me to identify with the organisation	2.8	3	3	1.220
The workspaces encourage creativity and innovation	2.7	3	3	1.094

When checking the correlation between the type of work room the respondents had and perceptions about physical workspaces at the KCL building, it can be seen that there are small positive and negative correlations between some of the statements and own private room and shared room with a maximum of two people (** $p < .01$). From this, could be concluded that some types of work rooms have a connection to the way workspaces are perceived (see table 5).

Table 5. Spearman's correlations between type of work room and perceptions of physical workspace.

	Spearman's correlations	
Statements	**Own private room**	**A shared work room with max. 2 people**
I can talk on the phone at my assigned workpost without disturbing others	0.668**	-0.550**
The current workspaces are suitable for the requirements of my tasks	0.440**	-0.343**
The workspaces support working in different modes	0.383**	
The workspaces provide suitable spaces for undisturbed, silent working	0.354**	
It is easy to find places for spontaneous conferences	0.306**	-0.290**
Noise and interruptions are not an inconvenience at work	0.291**	

To see if there are significant differences between organisational groups and perceptions of workspaces with the Kruskal-Wallis test, it was discovered that there are differences in how the groups perceive the spaces. The statements with statistically significant differences are presented in table 6 along with the mean ranks by organisational group. From the table it can be seen which organisational groups receive the strongest average values, and which ones the weakest average values. For example, KC1 has the strongest average values in "The current workspaces are suitable for the requirements of my work tasks", and KC3 has the weakest, from which we could conclude that KC1 is most pleased with the current workspaces, and KC3 is least pleased.

Table 6. Perceptions of physical workspace by organisational group (mean ranks of the Kruskal-Wallis test).

	Mean Rank by Organisational Group						
Statement	**KC1**	**KC2**	**KC3**	**KC5**	**KC6**	**Other**	**Sig.**
The current workspaces are suitable for the requirements of my work tasks	56.6	36.2	29.5	46.0	43.8	47.3	0.015
The workspaces are flexible	67.4	28.6	29.6	46.6	38.1	54.2	0.000
The workspaces support group work	59.8	33.4	32.7	44.7	40.7	43.4	0.048
It is easy to find places for spontaneous conferences	53.9	34.2	31.3	40.6	50.4	52.9	0.039
I can easily find places where I can interact also informally with my colleagues	49.8	29.5	27.6	48.7	51.3	58.5	0.001
The workspaces support interaction among the work community	54.2	30.5	28.8	53.3	34.5	56.8	0.001
The workspace solutions allow me to identify with the organisation	55.4	30.0	35.7	46.7	31.7	50.3	0.042
The workspaces provide spaces for undisturbed, silent working	57.2	34.5	30.6	50.1	38.0	41.2	0.012
There are suitable places for taking a break and resting	44.7	25.6	26.9	57.6	44.9	58.8	0.000

The respondents were also asked an open-end question about what is the most important thing in their work post. 93% of the respondents reported their views. The most common comment concerned the possibility to work in silence and being able to concentrate when needed. Also being able to store important material, such as books, articles and necessary equipment was seen as important. Those who had their own room reported the importance of being able to have brief and spontaneous meetings with colleagues and being able to make phone calls or having Live Meetings with customers without disturbing others. Respondents who had an own room and also performed leadership tasks reported the importance of being able to have confidential meetings with subordinates. Ergonomics, proper lighting and sufficient ventilation were also highlighted in many responses, and the air quality concerned many respondents. An open-ended question about factors that disturb the respondents work at the current facilities got a response rate of 70%. The most commonly presented comment concerned noise; the machinery located in the premises or the noise of other people moving in the corridors. Many

reported that there are not enough conference- or video conference rooms available, which creates challenges for distributed work. One respondent discussed about the old-fashioned and uninspiring workspaces preventing the community feel in the organisation, and the requirements for an extensive change into a more innovative and group supporting work environment. The respondent continued stating that the workspace should be understood as an entity consisting of various different work tasks during the day, which requires different spaces for each task (see also Becker, 2004; Harrison et al., 2004).

Social space

The social space in this research is regarded as the social context and networks, where the work of the respondents is done (see Vartiainen, 2009). The respondents were presented with statements and questions concerning team work and collaboration, before which they had to choose the team they considered communication and collaboration being most important at that moment. This question was seen relevant in the questionnaire development phase because of the nature of the organisation; some employees work closely with their organisational team, whereas some work mostly with other internal and external project teams. 30% of the respondents chose organisational team; 55% chose a project team; and 15% chose some other group with which they collaborate closely. When specified, these kinds of groups were described as entire knowledge centres, various specific teams, management teams and VTT Group Services.

The respondents were asked to evaluate statements about teamwork in their current work situation on a scale of 1 to 5 (1 = strongly disagree, 5 = strongly agree). The highest average values were given to the statements “I know the people I work with” and “If I wish, I can easily communicate with my team”. The weakest mean values were given the statements “All team members work at the same assigned location with me” and “I often communicate to my superior about the progress of my work”. From this it could be concluded that generally the respondents know their team members and are easily able to communicate with them. Team members in many groups do not work in the same location, which again proves that the work is distributed. The weak value given to often communicating to the superior about the progress of one’s work could indicate the high level of autonomy in a knowledge intensive organisation (see Alvesson, 2004). The average values for this section can be seen in table 7.

Table 7. Perceptions of team practises and collaboration (average values).

Statement	Mean	Median	Mode	Std. D
I know the people I work with	4.3	5	5	0.978
If I wish, I can easily communicate with my team	3.9	4	4	1.042
I can easily contact people whose expertise I need	3.9	4	4	0.985
I am aware what their work tasks are	3.8	4	4	0.995
Completing my work tasks requires close collaboration with the team	3.7	4	4	0.978
I communicate with my team regularly on a daily base	3.6	4	5	1.185
Team members collaborate regardless of time and space	3.6	4	4	0.992
I often collaborate spontaneously with the team	3.4	4	4	1.133
I can make the team aware when I should not be disturbed	3.4	4	4	1.336
Sharing information within the team is mostly done using technological tools (e-mail, etc.)	3.3	4	4	1.171
My workload is visible to my team members	3.0	3	3	1.153
I often communicate to my superior about the progress of my work	2.9	3	4	1.209
All team members work at the same assigned location with me	2.7	2	1	1.567

When checking the correlations between the kinds of teams the respondents chose (organisational team, project team and some other group) and the statements, there was small positive correlation between organisational team and the statement “All team members work at the same location with me” ($r = .364$, $p < .01$), and between organisational team and the statement “My workload is visible to my members” ($r = .357$, $p < .01$). This could be due to the fact that many organisational teams operate in the same assigned location which makes the workload more visible to them.

The places and situations where interactions among the teams occur were at the centre of examining social space. The respondents were asked to evaluate the importance of various interaction situations on a scale of 1 to 5 (1 = not important at all, 5 = extremely important), in terms of the successful collaboration of the team. As can be seen from table 8, the highest average values were given to “Regular sharing of information” and “Spontaneous face-to-face chats”. The lowest average values were given to “Unofficial meetings outside work” and “Videoconferences”. From these results it could be interpreted that while the regular sharing of information is the most important interaction method in terms of successful collaboration, the respondents also see that meeting face-to-face spontaneously is important as well.

Table 8. The importance of various team work interactions (average values).

Statement: Importance of…	Mean	Median	Mode	Std. D
Regular sharing of information	4.3	4	5	0.780
Spontaneous face-to-face chats	4.2	4	5	0.878
Work related pre-arranged meetings with the group	4.1	4	5	0.95
Coordination of work	4.0	4	4	0.732
Ensuring the flow of information	4.0	4	4	0.839
E-mail and phone conversations	3.9	4	4	0.808
Physical presence	3.8	4	4	0.956
Daily communication	3.5	4	3	1.036
Mutual pre-arranged development days	3.1	3	3	1.141
Videoconferences	2.5	3	3	1.060
Unofficial meetings outside work	2.5	2	3	1.197

To see are the differences between organisational groups in terms of perceiving the interactions, the Kruskal-Wallis test was conducted again. There were only two statements with statistically significant differences between the groups: videoconferences ($p = .006$) and unofficial meetings outside work ($p = .019$). The groups which received the strongest and weakest values are presented in table 9.

Table 9. The importance of various team work interactions by organisational group (mean ranks of the Kruskal-Wallis test)

	Mean Rank by Organisational Group						
Statement: Importance of…	**KC1**	**KC2**	**KC3**	**KC5**	**KC6**	**Other**	**Sig.**
Video conferences	29.6	43.4	52.0	29.0	41.3	26.2	0.006
Unofficial meetings outside work	53.0	25.6	48.1	39.2	31.0	31.8	0.019

In the open-end question about factors disturbing the work of the respondents there were many comments about the lack of break rooms, spaces for innovative group work and idea generation and places for spontaneous encounters. This was seen to be preventing community spirit and social interactions.

Virtual Space

The virtual space in this research is regarded as the electronic or virtual work environment, which is mainly used for collaborative purposes (see Vartiainen et

al., 2007) In evaluating the virtual space, the respondents were asked to describe how well statements concerning ICT represent their current work situation on a scale of 1 to 5 (1 = strongly disagree, 5 = strongly agree). The highest average values were given to “The available technology is suitable for my current work needs and requirements” and “I can easily access project data and relevant information I need”. The lowest average values were given to “Spaces for distributed team work (e.g. teleconferencing) are easily accessible” and “There are enough of tools for successful distributed work” (see table 10).

Table 10. Perceptions of virtual space/ICT (average values).

Statement	**Mean**	**Median**	**Mode**	**St. D**
The available technology is suitable for my current work needs and requirements	3.9	4	4	0.974
I can easily access project data and relevant information I need	3.7	4	4	1.006
The available technology is suitable for the work needs and requirements of my team	3.7	4	4	0.963
The available technology is suitable for work outside my assigned work post	3.6	4	4	0.991
I can easily access project data and relevant information I need outside my assigned work post	3.1	3	4	1.122
The organisation encourages and supports the use of all ICT tools	3.1	3	3	1.139
I am aware of all ICT tools available in the organisation	2.8	3	2	1.098
There are enough of tools for successful distributed work	2.7	3	3	0.996
Spaces for distributed team work (e.g. teleconferencing) are easily accessible	2.6	3	3	1.031

From these results it could be concluded that overall, the respondents are satisfied with the available technology in terms of the needs and requirements of their own work, and the project data and other relevant information are easily accessible. However, in terms of distributed collaboration, the respondents found that teleconferencing tools are less easily accessible and there are not enough of tools for successful distributed work. Using the Kruskal-Wallis test to examine if there are statistically significant differences between organisational groups, it was discovered that there were differences in perceiving the suitability of the available technology in terms of work needs and requirements of teams. It was also discovered that there were differences in perceiving the suitability of the technology for distributed work (see table 11.)

Table 11. Perceptions of virtual space/ICT by organisational group (mean ranks of the Kruskal-Wallis test).

	Mean Rank by Organisational Groups						
Statement: Importance of…	**KC1**	**KC2**	**KC3**	**KC5**	**KC6**	**Other**	**Sig.**
I can easily access project data and relevant information I need outside my assigned work post	59.3	32.7	41.3	32.3	50.1	31.2	0.030
The available technology is suitable for work outside my assigned work post	57.1	31.0	39.9	32.6	51.0	40.2	0.040
The available technology is suitable for the work needs and requirements of my team	58.9	29.6	35.6	45.3	45.8	30.2	0.023
There are enough of tools for successful distributed work	57.1	38.2	42.3	28.8	47.2	33.5	0.036

When evaluating the importance of various ICT tools considering the collaboration and information sharing of a team on a scale of 1 to 5 (1 = not important at all, 5 = extremely important), it was interesting to discover that the already existing tools for distributed work (Office Live Meeting and Communicator) were given a value below the average. The highest mean values were given to the traditional virtual tools; e-mail, calendar and phone. The lowest mean values were given to Yammer and social media (e.g. Facebook and Twitter). All the mean values can be seen in table 12. When asked to specify “Something else” in this section, the responses were for example Gmail, Doodle, Mendeley, the X-folder and a document server outside VTT.

Table 12. The importance of ICT tools (average values).

Statement: Importance of…	Mean	Median	Mode	St. D
e-mail & calendar	4.8	5	5	0.540
Phone	4.3	5	5	0.918
Something else	4.1	4	4	0.994
Office Live Meeting	2.6	3	1	1.284
Office Communicator	2.3	2	2	1.108
Skype	2.2	2	1	1.347
SharePoint	2.1	2	1	1.100
DOHA	1.8	2	1	0.949
Google Docs	1.8	1	1	1.062
Social media (Facebook, Twitter, etc.)	1.3	1	1	0.711
Yammer	1.2	1	1	0.604

Considering the communications technology in the organisation, one respondent representing the younger generation at VTT discussed his amazement about the organisation's conservative approach towards incorporating new technologies into daily work in the last open comment part:

> *"…We have no mutual guidelines for using the internal communications, external networking, virtual working or using the social media. If the organisation wishes to attract future talents, there should be a change in its procedures. I feel that I can only use one arm, since I cannot utilise skills learned elsewhere in knowledge sharing, collaboration and keeping track on information. The organisation is full of great and talented employees…but the modern working methods are completely lost."*

In checking the statistically significant differences between organisational groups again, the Kruskall-Wallis test showed that there were differences in how the groups perceive the importance of Skype and Google Docs (see table 13). The strongest mean rank for both communication tools was received by KC3 and weakest was received by KC6. From this it could be concluded that KC3 works in much more distributed manner than KC6.

Table 13. The importance of ICT tools by organisational group (mean ranks of the Kruskal-Wallis test).

	Mean Rank by Organisational Group						
Statement: Importance of…	**KC1**	**KC2**	**KC3**	**KC5**	**KC6**	**Other**	**Sig.**
Skype	42.7	29.9	59.5	30.5	18.0	33.7	0.000
Google Docs	48.0	29.9	53.3	34.8	23.0	33.2	0.000

5.1.6 Summary of quantitative results

The purpose of the quantitative phase of this study was to gather information about the nature of knowledge work in the case organisation and discover what kind of variety between organisational groups can be found. From the results it was evident that the respondents operate in a diverse and complex multi-project environment with various internal and external partners. The nature of work is highly collaborative, as employees evaluated over half of their working time being collaboration with different parties. The most important reason for coming to the premises of the KCL building was also seen to be collaboration with work colleagues. The work of the respondents can be said to be distributed, as the work includes multi-tasking, shifting between different work modes, and the work is also conducted in various other places as well besides the assigned work post. The mobile features of the respondents were discovered as well, as over half of the respondents reported working also from home, in the conference rooms at KCL building, in the rooms of colleagues and at partner's or customer's premises in Finland. Still, the importance of the own assigned work post was emphasized, and it received the highest average values when evaluating the importance of various work spaces. The main reason for this seemed to be the possibility to work in silence when conducting work tasks requiring individual concentration, as it was presented in many of the comments in the open-end questions of the questionnaire. Low average values were given to statements concerning spaces and tools for distributed working, which indicates that the respondents find them being difficultly accessible. There were also many comments about this in the open-end questions; how there are not enough of tools for successful distributed working, how there are too few spaces for distributed working and how the technology is difficult to use. Still, the respondents evaluated the tools for distributed working in the organisation as less important considering the collaboration and information sharing of their team; traditional tools such as e-mail and phone were considered to be most important.

It was also discovered that the organisational group to which the respondents belong to, correlated with the physical, social and virtual space variables. These results indicate that there are differences in the way organisational groups perceive their work environment. The Kruskal-Wallis test supported the results when

examining the statistically significant differences a bit further. The Kruskal-Wallis test was used in all sections presenting statements about physical, social and virtual spaces. It could be seen that there were statistically significant differences in all of the sections, which indicates the diversity of knowledge work within the organisation. For example, the results of the perceptions of the importance of various work spaces, such as labs and video conference rooms, provided an interesting viewpoint considering the differences between the organisational groups.

Keeping in mind the qualitative phase of this research, it was particularly interesting to see that the perceptions of work spaces of groups KC1 and KC3 varied quite a lot (see table 6 & appendix 3). When examining the two KCs a bit further, it was also discovered that both of the groups work in a distributed manner, and had similar average values in the sections dealing with the nature of work and collaborative practises. The differences in the form of distribution could be that KC1 operates mostly in the manner of multi-tasking with many people who are in different divisions or firms, in different environments or time zones, while KC3 operates more at multiple different places, for example at home, at customer's or partner's premises or at airports. This assumption is supported by the evaluation of time spent at different locations by the two groups; KC1 reported working 61% of their time at their own work post, while KC3 reported 46% of their work time being spent at their own work post. Since the topic of this thesis focuses on distributed knowledge work, these two organisational groups differing from each other in the manner of distribution were thought to be suited for the next phase of this research; the group interviews. The diversity of the two groups was seen to provide a more comprehensive view of practises supporting distributed work, since, as previously mentioned, the distribution of knowledge work has many aspects to it. The next chapter presents the results of interviews with the teams chosen from the two organisational groups.

5.2 Qualitative phase

5.2.1 Team profiles

Team KC1a has a team meeting every Monday, and most of the team members are present at that time at the KCL building. The team meetings have two main themes; general issues and expertise development. Every other week the meeting consists of general matters concerning the targets of the team and larger strategic VTT-level issues, and on other weeks the team has an expertise development meeting, where all team members get to present their work and progress one at a time, and discuss themes from which others may learn something new or incorporate it into their own expertise area. The role of the team in KC1a was seen as seen extremely crucial and the feeling that people sharing the same interest are near was seen as very important. The team often has coffee breaks and lunch together, and the team seemed to have a high community spirit. The members of the KC1a team come from different educational and work backgrounds, but have

one larger theme under which they all operate. The team collaborates closely with each other, as all projects the team has consist of at least two KC1a team members. The physical location of the team and the fact that all team members are on the same corridor was regarded as advancing the collaboration of the team. The doors are open all the time and team members consult each other in project issues. If the team members are not present, phone and e-mail are used as communication tools. Referring to the team types described in chapter 2.2.2, KC1a could be characterized as a distributed team collaborating with each other in conventional and virtual ways (see figure 4).

Team KC3a has regular team meetings, approximately once every two months. As some of the team members have their assigned work post in VTT's premises in Tampere, the meetings are often conducted using virtual tools, such as video conferencing. Team meetings are held on a shared responsibility principal, where each team member is responsible for arranging the meeting on their turn. The principal was taken into use in order to share the workload and to give an opportunity for all team members to participate in their own way in the teams' activities. The themes for the meetings follow VTT's annual management practices and are decided before each meeting. Resource planning is also done in collaboration to see the workload of all team members and divide the resources accordingly. All team members have their own project base which is monitored in resource planning. The projects vary quite a lot, and the course of the projects set the working procedures. The team members thought that there is a social community role for the team, which is quite solid. The team was seen easily approachable by one new team member, despite the fact that the team rarely sits on the same table in the same location. Even though the team members have different educational backgrounds, the members thought that they have a mutual view point and basic understanding of research areas, which makes it easier to collaborate. Collaborating with the team is important, because it helps the team members, especially new team members, to comprehend the vast expert knowledge in the team. The team members also have wide professional networks, which can be utilized only through collaborating with each other and having discussions. The members of KC3a are geographically distributed and operate in various different places. The communication of the team is constructed mainly on the project work, and team members communicate regularly on shared project issues. Team meetings are also a good portal for communication, especially for more general issues. Team members often travel together to the customer's sites and found that public transportation is a good place for communication and interaction. Collaboration is also a way to keep informed about the progress of the team members' work. The team could be described as a distributed team communicating via virtual tools with mobile characteristics (see figure 4.)

The purpose of the qualitative part of this study is to understand the differences of these two distributed teams, but still find mutual discussion topics about the practises supporting the forms of distributed knowledge work. Even though the teams differ in their own work practises and in terms of distribution, there were various mutual themes found from the discussions. Next, the main themes of

practises supporting distributed work which arose from the semi-structured interviews are presented.

5.2.2 Re-defining work hours

A topic evoking a lot of discussion among the teams was the tracking of working hours and definitions of work time at the organisation. At the moment, the work time is monitored with a data terminal box, which is inserted in the walls of the office buildings. The employees sign in with their time cards when they arrive to the building and sign out when they leave, and have a possibility to sign in the reasons for their "leave of absence", if they plan not to come to the workplace the next day. The work time in the organisation is referred to as being flexible, as the employees are allowed to arrive to work between the hours of 04.00 and 9.00, and are able to leave after 15.00 o'clock. The work hours done in other places on the side of the office building are not monitored. The main common view was that the tracking of work time does not support the distributed work done in the teams. As can be seen from the results of the questionnaire survey in this thesis, the work in the organisation is done in many other places than the main office as well. One interviewee reported giving up on caring about the time card, as it does not tell the reality of the hours done anyway, the result from the work is what matters (see Pyöriä, 2009, 40) The members of both teams felt that the traditional 8.00–16.00 definition of the work time is not valid in their work anymore, as many of the employees reported working during various different times in a day, as well as during nights and weekends when needed. The projects which the employees have mostly direct the pace of working instead of traditional working hours, and as technology allows the employees to work from home as well, they tend to work as long as the task requires (see Uhmavaara et al., 2005, 9).

The teams felt that the tracking of work hours does not match the actual hours being done. Still, despite the fact that the work is seen to be done in a flexible way and that the concept of working hours is blurred, the teams thought that some kind of monitoring is necessary in order to control the workload of employees. One team member in KC1a stated that monitoring the hours is needed, because without it employees will work at their own expense, which seemed to be the case at the moment (see Helle, 2006). A member of team KC3a wondered about the current monitoring practises and why the employees at the organisation are "tied to a wall" and not to their computers, which is the main tool used for working, and can be taken wherever the employee chooses or is required to work at. The team also pondered why the organisation recently invested in newer data terminal boxes instead of updating the concept of working time to fit the actual working hours the employees do.

> *"…Its insane how our work time is monitored at the moment… I work here [Otaniemi], travelling, at the customer's site, at home…and then the employer invests in newer data terminal boxes, and that is called progress?"*

> *"..how many people can do that? [stop working after 5 o'clock] It's always the projects that drive our working hours…"*

One member of KC1a wondered about the organisation's reluctance to adapt to the available technological possibilities which would enable the monitoring of work hours through, for example, mobile devices (see Pyöriä, 2009, 36). Team KC1a also discussed about the travelling policies in the organisation, and pondered why the travel time during evenings is not considered working time, but during the regular office hours it is, and how it creates major challenges in arranging work and personal life (see e.g. Vartiainen et al., 2005). Being in a conference all day and then travelling back home takes the whole day from the employee, even though 7 hours are acknowledged as official work time. Members of both teams reported utilizing the travelling hours by working also, for example, in airplanes or trains (see Harrison et al., 2004, 22; Hyrkkänen et al., 2011, 7; Vartiainen et al., 2007,16).

> *"The working hours in the organisation do not support working wherever and whenever, because at VTT the working time, abroad as well, is seven hours…the work time nowadays is not the seven hours as traditionally is thought.…at the moment, the travelling times are not considered working time, even though employees mostly work during the travelling as well…"*

The members of team KC1a also discussed about working time and international collaborations, and how the employees could work together, if a project group would be globally distributed. If the concept of work time is not going to change in the organisations, the systems should at least allow the employees to come to work a bit later, when they have had to work late because of time zone differences. As mentioned earlier, at the moment the "flexi-time" in the system still requires the employees to come to work before 9.00 am. There was also discussion about using the "common sense" in these kinds of situations; just coming to work later in the morning, if working late the night before. However, in team KC3a the team members discussed the barriers in these kinds of situations and the difficulty of knowing what is allowed and what is not, especially among younger employees.

5.2.3 The rules of the game

Referring to the previously presented theme, both of the teams also discussed about the general policies in the organisation regarding working habits. One team member in KC1a was not happy about the employer's attitudes towards the work times and travel policies, and stated that the way of thinking is old-fashioned (see Pyöriä, 2009, 36). KC3a discussed about the organisations general outlook on distributed working. Currently there are no mutual guidelines for distributed work, only a separate contract and instructions for teleworking, which is defined as regularly occurring work at home or at some other non-VTT location, conducted using a computer. The telework contract should be signed if an employee plans to regularly work from some other place than the office building. It was also discovered

that only few have singed the teleworking contract, even though they regularly work in many other places besides their assigned work post. The organisation's Intranet does not provide any guidance in how to operate if employees work at and between various other places, as the distribution and mobility of the workforce is not generally acknowledged. One recently recruited employee stated how difficult it was to understand how the organisation operates, and what is required from the employees in terms of distributed work, and what is allowed and what is not. Team KC3a also discussed the confusion of what is considered to be remote work, as the concept does not cover all aspects of the nature of their work (see Helle, 2006, 73). One team member who works at home a lot pondered to what extent the organisation is willing to support the work conducted from home.

> *"…telework is wrongly defined here…it is also telework when I occasionally work at the customer's premises, away from my assigned work post…"*
>
> *"At the moment the old culture lives on so strongly on the side of new ways of working that we do not really know how to operate and what is acceptable…"*
>
> *"…what are the rules of the game exactly, when you work for example from home? …of course I would wish that the fact that I have equipped my home with proper tools would be somehow compensated…at the moment I don't even dare to take printing paper home…"*

Rules and guidelines were seen to be needed so that the whole entity of working life stays manageable by the employee and by the organisation itself as well (see Ruohomäki & Koivisto, 2007). Having updated guidelines would help employees to find the ways of working that suit them the best in the organisation. KC3a discussed how there are many silent rules which cannot be found on the Intranet, and the difficulty it causes especially for new employees in finding the work methods supporting the work requirements. From their own point of view, KC1a emphasized the importance of their organisational team's role in giving the support for new employees.

According to the teams there are many different policies and ways of working in the organisation because of the variety of knowledge work; different KCs and teams have very different working cultures (see e.g. Davenport, 2005, 26). KC3a discussed about the "sub-cultures" of working methods which are created in the organisation. One team member also stated that in the long run, having these sub-cultures does not benefit the employee or the employer, which is why it is important to discuss about the different working methods in the organisation. Team KC3a suggested that considering the diversity in the organisation, teams or KCs could have their own more precise working guidelines in accordance with larger organisation wide policies to support the variety of work requirements (see also Helle, 2006).

> *"…from a management perspective VTT is very challenging because there are so many histories, working cultures and multidisciplinary functions…it would be difficult to create them [guidelines] on an organisation level only…on KC-level and team level it would be easier to formulate."*

It was evident, that both of the teams acknowledged the complexity of the organisation in terms of working styles and requirements. Understanding the diversity of various units inside the organisation was seen important in discussing about practises supporting the knowledge work.

5.2.4 Supporting well-being in a distributed work environment

The increasing value of free time was discussed in both teams, and the integration of private life and work life. KC1a talked about how employees try to create a balance between work, family, friends and hobbies, which should be taken into consideration in organisations (see also Ruohomäki & Koivisto, 2007). KC3a discussed how it is important to acknowledge that the work practises should support the employees according to the changing situations in their personal life; for example, if an employee has small children at home and has to balance the life accordingly.

Wellbeing at work was also widely discussed; as the requirements of the distributed working create new challenges in managing the work load (see Vartiainen et al., 2005, 91). Team members in KC1a were worried about employees working too much and not knowing where the limit is, as the working life is going more towards "work anytime, anywhere". One team member stated that burnouts are an increasingly important issue, especially in this kind of distributed knowledge work environment. The team acknowledged that distributed work especially in the future creates new kind of challenges for the employees in terms of well-being at work (see also Kokko & Vartiainen, 2006, 22). Team KC3a discussed that distributed and mobile work is already a current way of working for many employees in the organisation, which why the work methods should be addressed by creating guidelines and indicators for measuring the well-being at work. One member wondered the work culture in which the employees are expected to be reachable all the time. However, there was discussion also about the management skills of individuals in these kinds of situations as well and how employees themselves tend to be working at times they are not expected to be working (see Vartiainen et al., 2005). The mobile devices make it possible for employees to be reachable at all times, which is why the organisation should address the protocols of distributed working and support the employees in managing their work hours.

> *"If the concept of work time is blurred, people burn out and it's dangerous if it's not compensated, monitored or noticed in anyway…"*

> *"…it's an organisational culture here, being available 24 hours a day, people send e-mail at so late hours or even call…even during weekends…it is a silent agreement, that you can contact people whenever."*

In addition to the organisation's support, self-management was emphasizes as a skill, on which employees themselves should focus on. There was discussion about how the employees should have the courage to take the time to recover from long work hours, however, in the case of newer employees this was thought to be quite difficult, since the recovery times are not discussed in the organisation. Distributed work was seen very consuming, for example if an employee must travel a lot during the week (see also Vartiainen et al., 2005). One team member stated that in the beginning of her career she would have wished some support from the organisation's side in creating boundaries at work.

> *"…this work requires the recovery time, and there is only little discussion about how it [exhaustion] affects creativity and well-being."*

> *"as a young employee, this environment challenges you to know what is enough… how can you tell when you've done too much or too little?"*

> *"…at the beginning of my career I would have wished more support and guidance on how this organisation truly operates and what are the rules of the game, how are you expected to act, how are you allowed to work…more discussion in the beginning is needed on how things are done around here…"*

KC3a also discussed about supporting new employees with a work pair with same professional interests who would act as a mentor for the first month. This would help in comprehending the work practises of the team in the daily work life, and ease the integration into the organisation.

5.2.5 Understanding the social aspects of work

The teams also discussed about the virtualisation of work and how collaboration can be arranged using virtual tools. KC1a talked about the globalisation of the world and the increasing project cooperations with international partners. Even though the tools are developing fast, the team considered the social aspects being very important still, especially with partners from different cultures, which create many challenges in terms of language and working methods (see Hyrkkänen et al., 2011, 22; Richter et al., 2006, 240). Meeting face-to-face at least in the beginning of a project was seen very important in creating trust in the collaboration (see Vartiainen et al., 2004, 158). Team KC3a discussed similar issues concerning the demands of customers and project teams, and concluded that trust would be difficult to create if you never see the person you deal with. It was seen important to

find a balance between necessary face-to-face meetings and using remote collaborative tools.

> *"…as the project scenery becomes more international, the purpose of meeting people face-to-face is emphasized…"*
>
> *"…the start-ups and kick-offs should be done face-to-face, and that way create the trust and familiarize ourselves with each other, and after that is done then move on to use the remote tools."*
>
> *"…if we discuss about customer work, though we have these remote possibilities already, they still appreciate that you visit them and spend time with them… It is difficult to see that this would go completely online, even though we do utilize social media as well in projects…"*
>
> *"…creating a peer group with the right combination of face-to-face working and utilizing new virtual tools… maybe that is the future."*

Referring to the social aspects of work in general, the purpose of belonging to a group and the role of the organisational team were also discussed. Team KC1a discussed about their collaboration with each other and stated that the community spirit and support from the group are a great help in conducting their challenging work tasks (see also Pyöriä, 2009). Even though the work is quite independent at times, the team consults and discusses with each other about their work tasks and projects. KC3a also talked about the social aspects their team provides, though emphasized that there are many policies among the organisation, and the role of organisational team varies a lot. Still, they thought that employees do need some social group with which share their expertise and experiences.

> *"…an individual needs…a point of reference in the organisation, some social peer group…after all, we are social beings and we have the need to discuss about these issues and share experiences, and if our work would become entirely independent or that everything would be done online with avatars…I don't know if we [as humans] have developed so far that we could actually get the satisfaction from there…at least not our generation…"*

Both of the teams thought that even though the technological development enables collaboration to be done via virtual tools, complete virtualisation is very unlikely (see also Vartiainen et al., 2004, 157). From the interviews it was evident still, that these two teams have different requirements and expectations of the organisational teams. Nevertheless, both teams emphasised that the social aspects of work should be taken into consideration, whether working in different cities or on the same corridor. Belonging to a group with same professional interests with

people from different educational backgrounds was seen important, as it was seen to create variety and broadness in the groups' expertise.

5.2.6 Attitudes towards virtual tools

Another topic which both teams discussed was the usability of technological tools, attitudes of employees and willingness to use the tools for collaborative purposes when required. Team KC1a discussed about virtual tools and how they will be integrated in their operations. If the tools do not feel natural or user friendly, the team found that there is no point in trying to learn how to use them. The tools should be adjusted so that they serve the fast paced working environment, and made usable in a way that makes the employee want to use them. However, one team member stated that it will require the employee's effort as well.

> *"…in the future, in 5 or 10 years, it is not a question of whether you want to use the tools or not, you will have to use them, otherwise you can't keep up."*

Team KC3a had a similar discussion; a member of the team is moving to another country for a certain period of time, and the team pondered how the communication can be arranged in different time zones. They discussed that the team itself has to be active in keeping in touch, which requires a more flexible way of working from the team members, so that the remote worker will not feel isolated from the group (see Vartiainen et al., 2005, 92). They also discussed how the organisation could promote utilising the virtual tools more, so that they would become more familiar to the employees at VTT.

> *"…when you yourself are the remote worker, you realize the necessity and importance of the communication technology tools…then you understand that hey, these are very handy, but if you don't have to use them, you don't…"*

> *"…[communicating and keeping in touch with remote team members] will require a new kind of flexibility and a change in how people think…"*

The team planned to schedule specific dates for virtual meetings, taking into account the time differences, and practice the use of the technological tools which make the communication possible even when the distance is long. Team KC1a had had few members working abroad as well for short periods, and admitted that they were a bit isolated from the group, as there were no unofficial social meetings with them, and the Skype meetings concerned the on-going projects mainly.

5.2.7 Differences in workspace requirements

The teams also discussed about the current facilities and their functionality in a distributed working environment. Team KC1a talked about how the current arrangements fit their requirements, as it is important to have the team members close, and at the moment they are all located in the same corridor. Even though the team operates in a distributed manner in various national and international collaborations, having a mutual space for the team and a home base to return to was seen to promote collaboration among the team members and the community feel of the group.

> *"…without [the closeness] of the team I could not manage, even though the work is independent, there are situations that occur daily, when you collaborate on something together…"*

> *"…there are constantly issues that you could not solve yourself so efficiently, but you know that similar knowledge and competences are around you, and that you can always get help…"*

Team KC3a presented views on the facilities and their working habits, and discussed how they do not match at the moment. The team mostly communicates face-to-face with each other in mutual projects and team meetings, and utilises virtual tools a lot. They do not sit around the same table collaborating as a group that much, but find the time for conversations for example in trains, when travelling to the client's premises. As many of the team members are physically mobile, working in multiple places during the week, the current facilities were found to be unsupportive of distributed working and not up to date (see Harrison et al., 2004, 7).

> *"…I have been waiting for the facilities to improve…I mean, I can't see how this works, how we work, running all over the place, and already working whenever and wherever…Our work methods have developed, but I keep waiting for the facilities to follow…"*

> *"…I admit that I would not need an assigned work post at the office where I would sit from 8.00–16.00, I don't need it at all, but I would now and then need some space where I could set my laptop and work when I am actually here…"*

Both of teams pointed out, that there are different working patterns among different teams, and the role of the organisational team varies a lot within and between of KCs, which creates different expectations and requirements for the team in terms of workspaces. The variety of knowledge work and work styles presents many challenges, and the team members wished that they would be taken into consideration in space solutions (see also e.g. McGregor, 2000; Harrison et al., 2004; Vartiainen et al., 2007).

5.2.8 Summary of qualitative results

Even though the teams operate in a quite different manner, there were many mutual issues raised in discussing the work practices of a distributed team. The concept of work hours and the tracking of working time were seen to be out-dated and old-fashioned, as both of the teams considered their work methods requiring a more flexible way of monitoring the work hours. The hours which are recorded in the organisation's systems was seen to be inaccurate and unrepresentative of the true work hours being done, as well as the hours in the work time tracking device on the wall of the premises, on which the employees sign in and out during work days. Employees work at home, at the customer's site, at the partner's site or travelling, and many times the work hours are done in a decentralized manner; at various different times during a work day. The teams thought that concept of work time should change in the organisation to match the work methods of today's diverse knowledge workers. Relating to general policies in the organisation, there was discussion about the work time during travelling and the lack of general rules concerning distributed work. There was confusion about the organisation's policies relating to distributed and mobile work, and what are the rules of the game, how are employees expected to operate, what is acceptable and what is not acceptable. The guidelines were seen as particularly useful from the view point of new employees.

The teams also discussed about the dangers of working in a distributed manner "anywhere, anytime". The organisation's support was seen important in balancing the workload, as the burnouts and exhaustion at work were considered to be serious problems, as the constantly developing technology make it possible for the employees to be available at all times. A need for discussion in the organisation about the strains of distributed work and how to manage them was seen important. Support in balancing work and leisure time was also seen necessary, as was discussion in the beginning of the careers of new employees about the strains of distributed working. Having a mentor for new employees was seen to ease the integration in the organisations working habits. The skill of self-management was also emphasised, as the culture of being available also depends on the employees themselves, and how much they allow work tasks to interfere their free time.

The social aspects of work were discussed, as neither of the teams believed that collaborations occurring only virtually would be possible in the near future. The need for face-to-face meetings especially in international collaborations was seen very important, as trust and understanding of different work cultures were seen to be constructed more easily. Finding the right combination of face-to-face meetings and virtual meetings was seen to be supportive of distributed collaborations. The attitudes towards virtual tools were under discussion as well, as collaborating via new technological tools was seen to require a new type of commitment and way of thinking from the employees. This was emphasised in situations where team members work abroad for longer periods of time. More support and promotion from the organisation about the usage of virtual tools was also seen necessary. The physical workspaces were discussed in terms of supporting the collaboration

among the team members and the distributed working manners. The views of the team's differed in regarding the suitability of the current facilities, as KC1a saw them supporting the collaboration and community feel among the team, since the team is located in the same corridor at the same building. KC3a thought that the facilities do not support their distributed working, since the team members are physically mobile and are rarely in the same physical location; the facilities were seen not following the development of the working methods in organisation.

From the interviews it was evident that both teams work in a distributed manner and many similar issues were raised in terms of the organisation's procedures supporting the work. Still, it was emphasised that there were differences in the requirements and expectations between teams, and all team members highlighted the diverse knowledge work to be found in the organisation. Team KC1a considered it important to have a "home base" to return to; a mutual space for all team members, while KC3a operates in a more physically distributed manner and appreciated the functionality and willingness of the team members to use virtual tools in collaboration as well.

6. Summary and conclusions

This mixed method case study focused on the aspects of distributed knowledge work in the rapidly developing work environment. The purpose was to understand the phenomenon of distributed knowledge work and examine how it can be supported in the context of the knowledge intensive case organisation, VTT Technical Research Centre of Finland. The topic can be seen very relevant, as previous studies have highlighted that the distribution of workforce will increase more in the future, and understanding the requirements of distributed work is very essential for organisations. This study aimed at answering the main research question with the help of four research sub-questions concerning the development of knowledge work, challenges in distributed work, nature of knowledge work and distribution of workforce in the case organisation, and practises seen to support distributed working.

In terms of the first sub-question, *how has knowledge work developed due to changes experienced in the work environment*, it was discovered in the theoretical part of this study that knowledge work can be conducted in a more distributed and mobile manner, mainly due to technological advances in communication technology. As the main product of knowledge workers is their intangible knowledge, technological developments have enabled knowledge workers to work and collaborate anytime and anywhere; during travelling, for example in trains or airplanes, or in multiple places, such as home, office, customer's premises, hotels and cafes. Collaborations with multiple parties, both national and global, are an increasing phenomenon, since work can be done in virtual team compositions. Having a laptop and being constantly online has also changed the concept of work time, as work is no longer done only between the hours of 8.00 and 16.00. Work tasks can be conducted at various different times in a day; in the morning, afternoon, evening or even in the night time, which has led to the confusion of work and leisure time. This relates closely to the second sub-question, *what kind of challenges does distributed knowledge work bring forth for employees,* as being able to be available around the clock creates new kinds of challenges for knowledge workers compared to traditional office-bound work with fixed working hours. The work well-being of distributed and mobile workers has been increasingly under discussion during the recent years. Distributed knowledge workers have difficulties in terms of managing the workload, as quick response times to various different collaboration parties and information overload may result to working overtime, which, after adding

some travelling between various places nationally and globally is extremely consuming. The strains of mobile and distributed knowledge also include the increasing requirements for self-management of employees, unclarity of targets and roles in a distributed group, uncertainty in career development and inequality of team members. Constant moving around in a distributed environment is said to reduce communication, and the lack of social interaction might make the employees feel alone and isolated from the workplace. Working in multiple places also creates strains in balancing work and leisure time, as the working hours are not limited to the time spend only in the office. To be able to control the challenges and strains of distributed work, organisations are advised to plan their work arrangements carefully, in order to support the work requirements.

The empirical part provided insight to the third sub-question; *what kind of knowledge work and distribution of workforce can be found in the case organisation*, which was seen necessary to examine in order to provide sufficient basis for further research of the distributed work phenomenon in the organisation. It was discovered from the empirical data that the work done in the multi-project based organisation was very complex and diverse, consisting of many different knowledge workers balancing between various different projects. Many respondents also reported working in between different knowledge worker modes during the day; from group work tasks to individual work. The work was reported to include a lot of tasks requiring silence and concentration, however, the collaborative nature of the work was highlighted in many occasions. The employees evaluated their work being of collaborative nature over half of their working time, and it occurred between various parties; co-workers in the organisation; internal and external project teams; external clients and partners. In terms of distribution, it was discovered that the distribution of knowledge work was realised in the previously mentioned multi-party collaborations, in terms of multi-tasking and working in various different places during the work hours. The variety of places where the work was conducted also presented assumptions on the mobility features of employees; some reported working, for example, at conference and videoconference rooms, in the rooms of colleagues, at home, in the customer's premises, and at other VTT locations in Otaniemi or other cities. Many reported working in moving places, such as trains or airplanes as well. Still, there were some respondents who reported their work being of more traditional in nature; working mainly at the assigned work post.

Due to the diversity of knowledge work and distribution of workforce in the case organisation, it was also interesting to see what kind of differences could be found between organisational groups. The Kruskal-Wallis test showed that there were statistically significant differences in how the respondents in each organisational group perceived the physical environment, social interaction and virtual collaboration tools. Groups seemed to differ by the nature of their work, as there were interesting differences between, for example, groups needing labs in their work and groups needing conference or videoconference rooms. There were also significant differences between groups working in a distributed manner, which proves that the knowledge work found in the case organisation has many different aspects and requirements in terms of distribution as well.

In finding the answer to the fourth sub-question from the empirical part of this study *how can distributed knowledge work be supported,* two differently distributed teams chosen for the group interviews, KC1a and KC3a, gave more insight to the working methods of the employees. The distinguishing factor of the teams was that KC1a has all its team members working in global and national collaborations in the same physical location which is considered to be their team's home-base, while members of KC3a are located in different cities and have a high degree of physical mobility among them while working in various collaborations. Nevertheless, many mutual topics of discussion were presented in terms of supporting the work of the two distributed teams. The interviews supported the theoretical examination in this study about the challenges of distributed knowledge work, as the members of both teams discussed similar straining factors in their own work. The main issues emerging from the group interviews concerned the concept of work hours and their monitoring, missing protocols for distributed work, supporting well-being in a distributed work environment, understanding the social aspects of work, the attitudes of virtual tools and the differences in workspace requirements. The work hour monitoring was seen to be out-dated, as the team members worked in a distributed manner; regardless of time and space when the tasks required. The tasks and projects were reported to direct the working hours, which made the traditional 8.00–16.00 time seem unrepresentative of the actual hours done. Work is done in a decentralised manner; during various different times in a day. Having a work hour tracking device on the wall of the office was seen old fashioned, as there is no way to record the hours done outside the premises. The team members presented their views on developing the concept of work time in the entire organisation to support the current way of working so that work hours done in multiple places and during travelling would also be acknowledged. The suggestion was to provide some kind of mobile solution for the employees which could be accessed with the laptop, which was seen to be the main tool for working for all members in the teams. Both teams also emphasised that realistic work hour monitoring is needed in order for the employees to manage their workload better.

Another emerging issue was that distributed work in the case organisation was seen to be in need of organisation-wide guidelines, as the existing teleworking protocols were seen to be insufficient to cover mobile and distributed working methods. The guidelines should cover the accepted practises of distributed work in the organisation. The variety of knowledge worker groups found in the organisation should be taken into account, and one suggestion was to create own guidelines on the KC –level in accordance with the organisation's distributed work protocols. As the fast paced distributed work environment was seen to increase the exhaustion at work, support from the organisation in managing the work overload was also seen to be needed. The employees acknowledged that distributed work creates new and different challenges in the work life which should be taken into consideration accordingly. This could be done by having a more visible discussion about the challenges of distributed work and the importance of recovery times, as well as by developing proper measurement of well-being in a distributed work

environment. Especially for employees new to distributed work, this was seen to be very important.

The importance of understanding the social aspects of work, especially in collaboration occurring with international partners was seen very important by both teams in the distributed work environment. Even though the technological development enables collaboration to be done via virtual tools, the mutual view of the teams was that full virtualisation is very unlikely. Meeting face-to-face was seen to be very important, especially in the beginning of collaborations, as was finding the suitable balance between face-to-face meetings and using of virtual tools. The social interaction was seen to be in need of more support from the organisation's side in terms of providing social spaces where spontaneous interaction can occur. Regarding the usage of virtual collaboration tools, the employees' own attitudes were seen to be preventing or enabling the communication between distant team members. This was highlighted with the team members' own experience in working away from the team for longer periods, and the possible isolation of distant team members. The willingness to practise using the tools was seen to be inevitable in the future to ensure successful collaboration, as was the support and encouragement from the organisation.

Acknowledging the differences in the requirements for physical space between organisational groups was also seen important, and it was emphasised that the organisation has many different working cultures and requirements in terms of workspaces. The distinction between the two interviewed teams was also recognisable, as team KC1a saw the physical space as a home base to return to and was quite satisfied in the current arrangements, while team KC3a thought the arrangements were out-dated and unsupportive of their distributed collaborative work. Examining the organisational team requirements was seen important in designing spaces that support the work of the employees. The challenges the case organisation presents in terms of variety of experts and work styles were included in many discussions in the group interviews, and the team members wished that they would be taken into consideration when designing the organising of work in the future. This study also proves that understanding the diversity of the nature of work at VTT is very important and critical in developing the practises and spaces supporting knowledge work, as the differences are visible in examining only one small part of the organisation.

To answer the main research question, *how can a knowledge intensive organisation support the work of its distributed knowledge workers,* it can be concluded that realistic work hour monitoring, guidelines for distributed working, understanding and supporting the social aspects of work, support and encouragement in using the virtual collaboration tools and acknowledging the differences in workspace requirements were seen to be supportive actions in developing the work environment in the challenging distributed world. Previous literature has presented similar themes regarding the guidelines and workspaces, which should follow after the thorough analysis of work in the organisation. The supporting actions arising from the empirical part of this study implicate however, that wider organisational policies are needed to support the work of the distributed workforce. These poli-

cies can be seen to have a significant role in developing the suitable working environment for the modern knowledge workers.

6.1 Discussion

This study has contributed to the thought that distributed knowledge work is here and increasing and it requires a new way of organising work in knowledge intensive organisations. Though previous research on the organisational level has been focusing on work analysis, guidelines for distributed work and developing the workspaces to support the work of distributed and mobile employees, the results from this study indicate that more emphasis on developing the organisational policies is also needed. Having the suitable spaces and tools for distributed working is not enough, if the organisation's alignments do not follow the working methods of the distributed workforce. A good example of this is the issue raised in both the theoretical discussion and empirical part of this study: work hours and their monitoring, which refer to the management practises in an organisation. The developments in the working environment have reshaped the concept of work time, however, at the case organisation the spreading of work between the office, home, customer's premises and during travels, and the increasing amount of work hours have not yet been considered accordingly. Assumptions regarding the reasons why this is so can be found in recent literature, which has suggested that the management practises and culture in many organisations still lean on traditional ways of organising work, tracing back to the times when work was done in one solid location during fixed hours. This is further supported by the study conducted by Buhanist et al. (2010) about VTT's current management practises, in which it is discussed how the organisation still relies on traditional and out-dated practises focusing on the illusion of control. The evaluation and renewal of the practises can therefore be seen as very relevant. This study proposes that truly supporting distributed work requires more emphasis on developing the management practises of an organisation as well to match the requirements of distributed knowledge workers.

As the working methods evolve in an accelerating pace creating challenges for the organisations to follow, the management culture should change from the traditional controlling mode to enabling and supporting the knowledge workers in their work environment. In this context the case organisation VTT provides great challenges, as it is a complex matrix organisation with long history in the research industry, and it consists of various different types of knowledge workers in terms of distribution and nature of work. Understanding the diversity of the workforce and its requirements is therefore essential. In developing the work environments, a thorough examination of management practises is needed in terms of how agile and supportive of distributed work they truly are. As the distribution of work is rapidly increasing, it is time for organisations to bring their management practises to the 21st century as well. This is a great challenge for knowledge intensive organisations struggling with balancing between autonomy and control, and more research on the subject is needed.

6.2 Implications for future research

So far, little research has been done in the context of the distributed work about how organisations renew their practises to manage their employees in this environment. More research is needed in terms of the change process an organisation goes through, when developing the work environments to match the requirements of the distributed workforce. Especially the organisational renewal perspective is needed, as this study has indicated that larger organisation wide policies have great affect in enabling the completion of knowledge work tasks in a distributed world.

A framework is needed for organisations planning to renew their policies, as it becomes crucial to find out which parts inside the organisation affect the successful supporting of distributed knowledge workers. It would be beneficial to have more understanding about the extent to which the management, organisational culture and policies enable or disable distributed and mobile working, and how they should be developed in order to better correspond to the constant changes in the working environment. It would be particularly interesting to examine this from the management's point of view, and discover how they plan to better support the distributed features of knowledge work in terms of management practises. The case organisation VTT would provide an excellent research field in the future, as it has already actively begun to tackle the challenges of distributed work and strives towards innovative workspace and management solutions to better support the work of its employees.

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Appendix 1: Cover letter and web-based questionnaire form

Welcome!

This survey is a part of a Master's Thesis written on the side of VTT WorkWays -project. The goal of the project is to create new work environments in which leading edge research and research support work is enabled through advanced technology and modern workspace innovation. The purpose of the survey is to collect information about the nature of work of VTT employees at the KCL -building, and their views about the current work environments.
Answering the survey should take approximately 15–20 minutes.

Any questions concerning the survey will be answered by Research scientist trainee Hannamaija Määttä, hannamaija.maatta@vtt.fi.

All your input/data will be treated confidentially.

Background Information
Choose the suitable option or write into the space reserved for it.

1. Gender

( ) Male
( ) Female

2. Age

( ) under 25
( ) 25–35
( ) 36–45
( ) 46–55
( ) over 55

3. Knowledge Centre
( ) KC1
( ) KC2
( ) KC3
( ) KC4
( ) KC5
( ) KC6
( ) Other

4. Employed at VTT from year _____

5. Worktask

( ) Research scientist trainee
( ) Research scientist
( ) Senior research scientist
( ) Team leader
( ) Technology manager

( ) Secretary
( ) Laboratorian
( ) Something else, please specify _____

6. Does your work include leadership tasks? (e.g. Project manager)

( ) Yes
( ) No

---

7. How do the following statements represent your current work situation?
1 = strongly disagree, 5 = strongly agree

- My work is mainly project work
- I work in multiple project teams at the same time
- My work requires balancing between projects that are in different phases of the project life cycle
- My work requires making precise plans and following their steps
- My work requires balancing between many different assignments during the day
- I often have to move from a project to another
- My work contains many administrative routine tasks
- My work includes a lot of tasks requiring silence and concentration
- Every day is different in my work
- My work requires working in different modes (e.g. from group work to individual work tasks)
- My work is constantly interrupted
- My work tasks include a lot of problem solving
- Sharing information regularly is essential in my work
- I often collaborate with other teams or knowledge centres at VTT
- I often collaborate with other functions at VTT
- I often collaborate with external clients
- My work contains a lot of coordination tasks
- My work requires collaboration and integrating schedules regardless of time and space
- My work requires a lot of flexibility
- The object of my work changes constantly
- My work requires constantly looking ahead
- I often have to work relying on uncertain information
- My work requires fast adaptation to new situations
- I feel that my work is important
- I know what the work community expects from me
- I am able to control my workload
- I can easily continue tasks left unfinished
- Overall, I am satisfied with my work situation

This section presents statements and questions concerning the current workspaces and practices at the KCL -building. Choose the suitable option or write on the space reserved for it.

8. What kind of assigned work post do you have at the moment?
Choose all the ones you have.

[ ] Own private work room
[ ] A shared work room with max. 2 people
[ ] A shared work room with over 2 people
[ ] A work post at home
[ ] A work post at other VTT locations (e.g. VM5)
[ ] A work post outside VTT (e.g. at customer's premises)

9. What is the most important thing in your work post? (Open end question)

10. Estimate how many percent of your work time last month (March) was

	The total sum must be 100%
Collaboration with the organisational team	_____
Collaboration with VTT's internal project team/s	_____
Collaboration with other VTT colleagues	_____
Collaboration with external partners	_____
Collaboration with external customers	_____
Working alone	_____

11. Do you also perform your work tasks outside your assigned work post?
Choose all the spaces you work at.

[ ] At home
[ ] In labs at KCL -building
[ ] In conference rooms at KCL -building
[ ] In videoconference rooms at KCL -building
[ ] In the rooms of colleagues
[ ] At breakrooms (e.g. lunch facilities, coffee areas)
[ ] At other VTT's locations in Otaniemi (e.g. VM5)
[ ] At VTT's locations in other cities (e.g. Tampere)
[ ] In public transportation (e.g. train, aeroplane)
[ ] In public spaces (e.g. cafés, restaurants, libraries)
[ ] At partner's/customer's premises in Finland
[ ] At partner's/customer's premises abroad
[ ] At other facility provider's premises (e.g. conference rooms at hotels)
[ ] I do not work outside my assigned work post
[ ] Somewhere else, please specify _____

12. Estimate how many percent of your work time last month (March) you approximately spent in the following spaces
You can use utilize your calendar.

	Total sum must be 100%
At home	_____
In labs at KCL -building	_____
In conference rooms at KCL -building	_____
In videoconference rooms at KCL -building	_____
In the rooms of colleagues	_____
At your assigned work post	_____
At breakrooms (e.g. lunch facilities, coffee areas)	_____
At other VTT's locations in Otaniemi (e.g. VM5)	_____
At VTT's locations in other cities (e.g. Tampere)	_____
In public transportation (e.g. train, aeroplane)	_____
In public spaces (e.g. cafés, restaurants, libraries)	_____
At partner's/customer's premises in Finland	_____
At partner's/customer's premises abroad	_____
At other facility provider's premises (e.g. conference rooms at hotels)	_____
Somewhere else, please specify	_____

13. How important are the following workspaces considering your own work tasks?
1 = Not important at all, 5 = Extremely important

- Home
- Labs at KCL –building
- Conference rooms at KCL –building
- Videoconference rooms at KCL –building
- Breakrooms (e.g. lunch facilities, coffee areas)
- Own assigned work post
- Other VTT's locations in Otaniemi (e.g. VM5)
- VTT's locations in other cities (e.g. Tampere)
- Public transportation (e.g. train, aeroplane)
- Public spaces (e.g. cafés, restaurants, libraries)
- The premises of a partner/customer
- Something else, please specify

14. Select five most important reasons for coming to KCL building's premises, and put them in order of importance on a scale of 1 to 5.
Most important is marked as 1, the next important is marked as 2, etc.

People expect me to work at my assigned work post	_____
Ensuring that my superior and work community know that I am present	_____
A sense of community within the organisation	_____
Collaboration with work colleagues	_____
Unofficial (social) meetings with colleagues	_____
The possibility to use various workspaces (e.g. labs, conference rooms)	_____
The availability of materials	_____
The possibility for concentration and silence	_____
Keeping work and spare time separate from each other	_____
Performing administrative tasks	_____
The availability and functionality of technological tools	_____

15. How well do the following statements about KCL -building's workspaces describe the current situation?
1 = Strongly disagree, 5 = Strongly agree

- The current workspaces are suitable for the requirements of my work tasks
- Workspace arrangements play an important role in my work satisfaction
- The workspaces are flexible
- The workspaces support working in different modes (from collaboration to individual work)
- The workspaces support group work
- It is easy to find places for spontaneous conferences
- I can easily find places where I can interact also informally with my colleagues
- The workspaces support interaction among the work community
- The workspace solutions allow me to identify with the organisation
- The workspaces encourage creativity and innovation
- The workspaces provide suitable spaces for undisturbed, silent working
- I can talk on the phone at my assigned work post without disturbing others
- Noise and interruptions are not an inconvenience at work
- The workspace solutions provide a healthy work environment (e.g. ergonomics, air quality)
- There are suitable places for taking a break and resting

16. Considering your own work tasks, arrange the following workspaces in order of importance on a scale of 1 to 5.
Most important is marked as 1, the next important is marked as 2, etc.

Flexible workspaces supporting various working modes _____
Workspaces that promote inspiration and innovativeness _____
Workspaces for concentration and undisturbed working _____
Workspaces supporting group work _____
Workspaces supporting the work community's interaction _____

17. Are there factors that disturb your work at the current facilities? If yes, what kind? (Open end question)

The following section presents statements and questions concerning **teamwork, communication and ICT**. Choose the suitable option or write on the space reserved for it**.** In this section, by team is meant the group on behalf of which you feel that communication and collaboration is most important at the moment. (This can be organisational team, project team or some other group with which you collaborate closely).

18. Choose the team that you mean:
( ) Organisational team
( ) Project team
( ) Some other group with which you collaborate closely, please specify
_____

19. How do the following statements represent teamwork in your current work situation
1 = Strongly disagree, 5 = Strongly agree

- Completing my work tasks requires close collaboration with the team
- All team members work at the same assigned location with me
- I often collaborate spontaneously with the team
- I can make the team aware when I should not be disturbed
- I can easily contact people whose expertise I need
- I know the people I work with
- I am aware what their work tasks are
- I communicate with my team regularly on a daily base
- Sharing information within the team is mostly done using technological tools (e-mail, etc.)
- Team members collaborate regardless of time and space
- If I wish, I can easily communicate with my team
- My workload is visible to my team members
- I often communicate to my superior about the progress of my work

20. How important are the following interactions concerning the successful collaboration of the team?
1 = Not important at all, 5 = Extremely important

- Work related pre-arranged meetings with the group
- Spontaneous face-to-face chats
- E-mail and phone conversations
- Videoconferences
- Physical presence
- Coordination of work
- Daily communication
- Regular sharing of information
- Ensuring the flow of information
- Mutual pre-arranged development days
- Unofficial meetings outside work

21. How well do the following ICT related statements represent your current work situation?
1 = Strongly disagree, 5 = Strongly agree

- The available technology is suitable for my current work needs and requirements
- I can easily access project data and relevant information I need
- I am aware of all ICT tools available in the organisation
- The organisation encourages and supports the use of all ICT tools
- I can easily access project data and relevant information I need outside my assigned work post
- The available technology is suitable for work outside my assigned work post
- The available technology is suitable for the work needs and requirements of my team
- Spaces for distributed team work (e.g. teleconferencing) are easily accessible
- There are enough of tools for successful distributed work

22. How important are the following ICT tools considering the collaboration and information sharing of your team?
1 = Not important at all, 5 = Extremely important

- Office Communicator
- SharePoint
- E-mail & Calendar
- Phone
- Office Live Meeting
- DOHA
- Skype
- Google Docs
- Yammer
- Social media (e.g. Facebook, Twitter)
- Something else, please specify

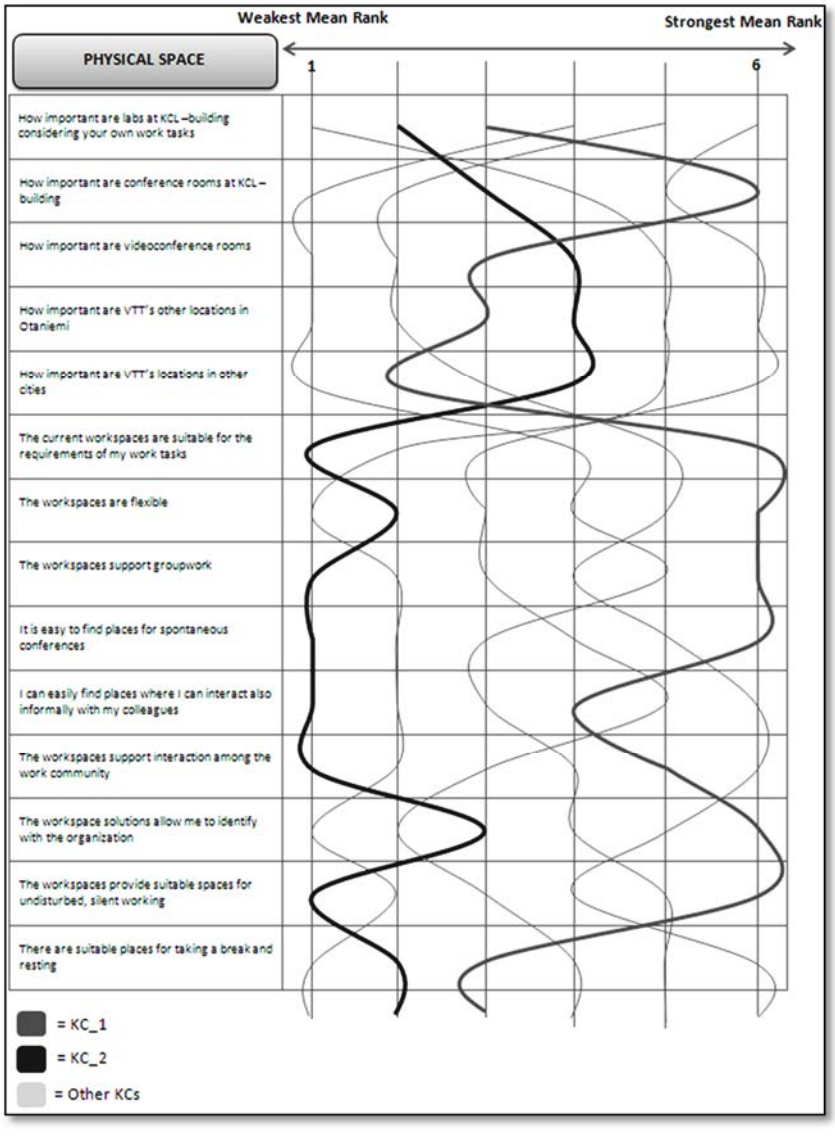
23. If you have something to add, you can write it here. (Open end question)

THANK YOU!

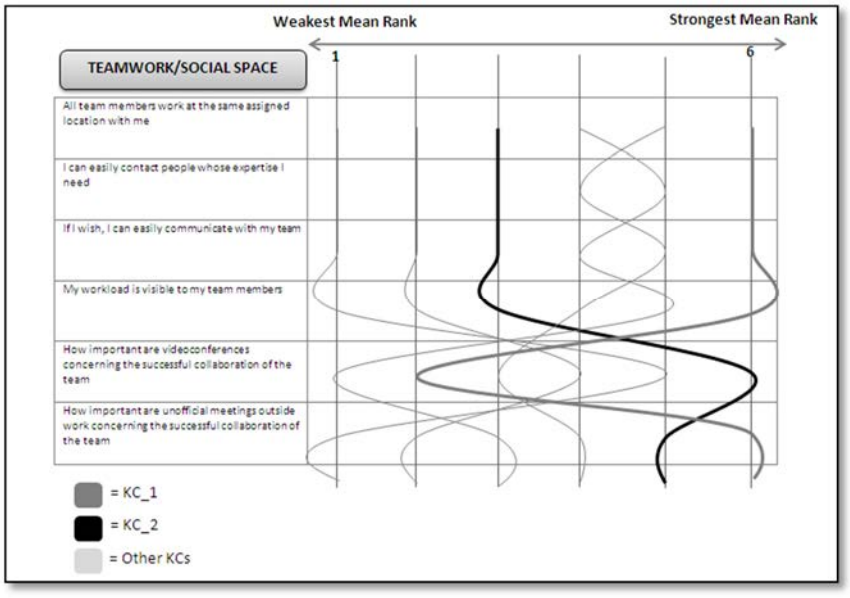
Appendix 2: Profile of the survey respondents

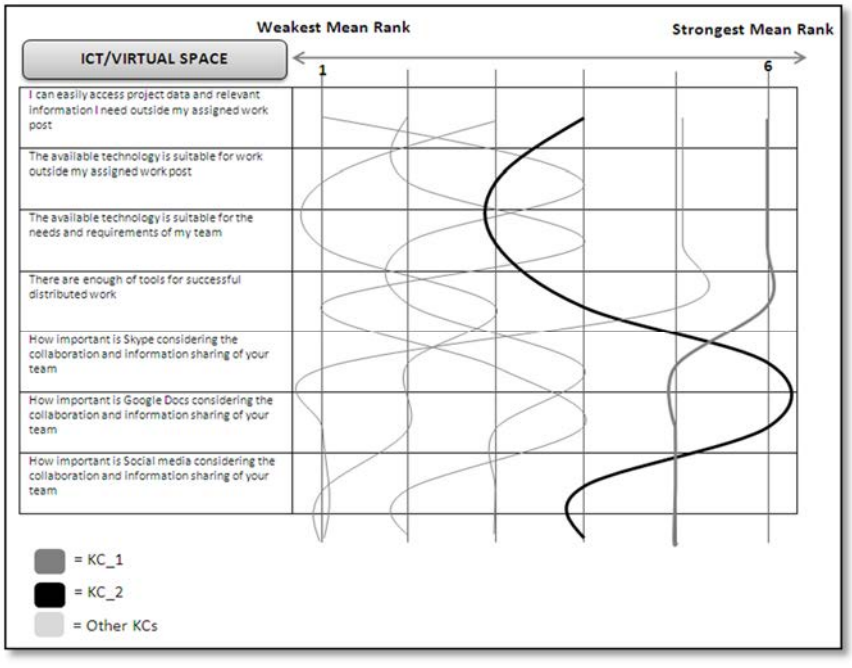
BACKGROUND INFORMATION	n	%
Gender		
Male	43	54
Female	37	46
Age		
Under 25	2	3
25-35	22	28
36-45	26	32
46-55	9	11
Over 55	21	26
Organisational group		
KC1	8	10
KC2	12	15
KC3	26	33
KC4	1	1
KC5	18	23
KC6	9	11
Other	6	7
Starting year of employment at VTT		
1970-1979	4	5
1980-1989	10	12
1990-1999	16	20
2000-2009	26	33
2010 ->	24	30
Worktask		
Research scientist trainee	4	5
Research scientist	29	36
Senior research scientist	23	29
Team leader	11	14
Technology manager	3	4
Secretary	2	3
Laboratorian	2	2
Something else	6	7
Leadership tasks, eg. Project management		
No	27	34
Yes	53	66

Appendix 3: Visualisation of the K-W test, differences of organisational groups KC1 and KC3



Appendix 3: Visualisation of the K-W test, differences of organisational groups KC1 and KC3





Appendix 4: Themes for the semi-structured group interviews

1. Describe the current working practises in terms of:
   - Project work
   - Collaboration
   - Management practises
   - Communication
   - The role and importance of the organisational team in the work

2. Discussion about the changing knowledge work environment in terms of change drivers (technology, globalisation, new generations, distributed and mobile work, environmental issues)

3. Visioning the future, how will the work change in 5–10 years from the team's perspective?
   - Collaboration and networking
   - Distribution of work and mobility
   - Team practises

4. What kind of work practises support/would support the work of the team in terms of
   - Project work
   - Collaboration
   - Management practises
   - Communication
   - Workspaces

Series title and number
VTT Technology 14

Title	**Supporting distributed knowledge work in a knowledge intensive organisation**
Author(s)	Hannamaija Määttä
Abstract	The purpose of this case study was to explore the aspects of distributed work and its challenges from the knowledge worker perspective, and discover how an organisation can better support employees working in a distributed work environment. The focus is on the phenomenon of distributed knowledge work, which is examined in the case organisation VTT, Technical Research Centre of Finland. The theoretical part of the study examined distributed work in the context of knowledge workers. The theoretical review showed that the distribution of knowledge work is increasing due to the changes experienced in the working environment. This is mostly based on technological advances enabling work to be conducted anytime and anyplace. The technological developments have added distributed and mobile features in organisations in terms of employees working in and between multiple locations and collaborating across time and space in various collaboration forms. Previous studies have indicated that the distribution of work will increase more in the future. This results to new and different challenges for the employees in knowledge intensive organisations, especially relating to the re-definition of work hours. The challenges require organisations to rethink their current work practises, based on a time when work was done at a fixed place during regular work hours. Some organisations have started renewing the organising of work according to the distributed work setting by analysing the work of the knowledge workers, creating protocols for distributed work and developing the workspaces to better correspond the working style of distributed knowledge workers. The empirical part of the study was conducted using a mixed method approach, consisting of a survey study and two group interviews. The survey respondents consisted mainly of VTT researchers and the group interview participants were two research teams working in distributed manners. The data were analysed with statistical methods and content analysis. The results of the empirical part of the study showed the distribution of knowledge work at the case organisation, and it was discovered that organisational policies and alignments have great effect in enabling the conducting of knowledge worker tasks. The study indicates that in order for knowledge intensive organisations to better support their employees in an increasingly distributed work setting, more emphasis should be put on developing the organisational policies. An organisation can support distributed knowledge work by developing realistic work hour monitoring, creating guidelines for distributed working, understanding and supporting the social aspects of work, supporting and encouraging the usage of virtual collaboration tools and acknowledging the differences in workspace requirements.
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Julkaisun sarja ja numero
VTT Technology 14

Nimeke	**Hajautetun tietotyön tukeminen tietointensiivisessä organisaatiossa**
Tekijä(t)	Hannamaija Määttä
Tiivistelmä	Tapaustutkimuksen tarkoituksena oli tarkastella hajautettua työtä ja sen asettamia haasteita tietotyöntekijöiden näkökulmasta. Lisäksi tavoitteena oli selvittää, kuinka tietointensiivinen organisaatio voi tukea hajautettua työtä tekeviä työntekijöitään paremmin. Tutkimuksen fokuksessa on hajautetun tietotyön ilmiö ja case-organisaationa on Teknologian tutkimuskeskus VTT. Tutkimuksen teoreettisessa osuudessa tarkasteltiin hajautettua työtä tietotyön kontekstissa. Katsaus osoitti, että työn hajautuneisuus lisääntyy työympäristön muutoksien vuoksi. Tämä perustuu pääosin teknologisiin edistysaskeliin, jotka mahdollistavat työn tekemisen missä ja milloin vain. Teknologinen edistys on lisännyt hajautetun ja mobiilin työn piirteitä organisaatioissa, joissa työntekijät työskentelevät liikkuen eri paikoissa ja tekevät yhteistyötä ajasta ja paikasta riippumatta monenlaisissa tiimikokoonpanoissa. Aiempien tutkimusten mukaan työn hajautuneisuus tulee lisääntymään myös tulevaisuudessa. Tämä aiheuttaa uusia haasteita työntekijöille tietointensiivisissä organisaatioissa, erityisesti työajan suhteen. Monet nykyiset työjärjestelyt perustuvat aikaan, jolloin työtä tehtiin yhdessä paikassa ennalta määrättyjen työaikojen puitteissa, minkä vuoksi organisaatioiden tulisi suunnitella järjestelyt uudelleen. Joissakin organisaatioissa on aloitettu työjärjestelyiden uudistaminen analysoimalla tietotyöntekijöiden työtä ja luomalla hajautetun työn käytäntöjä sekä kehittämällä tilajärjestelyitä hajautetun työn tukemiseksi. Tutkimuksen empiirinen osuus toteutettiin monimenetelmällisellä lähestymistavalla soveltaen kyselytutkimusta ja kahta ryhmähaastattelua. Kyselyn vastaajat koostuivat pääosin VTT:n tutkijoista, ja ryhmähaastatteluissa haastateltiin kahta hajautetusti työskentelevää tutkijatiimiä. Aineisto analysoitiin tilastollisin menetelmin sekä sisällönanalyysia hyödyntäen. Empiiriset tulokset osoittivat työn hajautuneisuuden case-organisaatiossa ja korostivat sitä, että organisatorisilla käytännöillä ja linjauksilla on suuri vaikutus tietotyöhön kuuluvien tehtävien suorittamisessa. Tutkimus osoittaa, että tukeakseen työntekijöidensä hajautettua työtä tietointensiivisen organisaation tulisi keskittyä organisatorisiin käytäntöihinsä. Organisaatio voi tukea hajautettua tietotyötä kehittämällä realististen työtuntien seurantaa, luomalla ohjeistuksia hajautetun työn tekemiseen, ymmärtämällä työn sosiaalisen puolen merkityksen, tukemalla ja rohkaisemalla virtuaalityökalujen käyttöä sekä huomioimalla erot työtilojen vaatimuksissa.
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Supporting distributed knowledge work in a knowledge intensive organisation

The knowledge work environment is under constant change, and the ways of working in organisations are evolving to increasingly distributed and mobile forms. Due to technological advances, knowledge work can be conducted anytime and anyplace in various collaboration compositions. As work is no longer bound to a particular time or space, knowledge workers face new and different challenges in conducting their work tasks. Organisations need to re-define their work arrangements to complement the new ways of working.

This study examines the changes experienced in the knowledge work environment and the nature of distributed and mobile work. The study explores the challenges distrtibuted work causes to knowledge workers, and presents suggestions on how a knowledge intensive organisation can better support employees working in a distributed work environment.

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