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17

State-of-the-Art Report on Knowledge Work

New Ways of Working

Iina Aaltonen | Paula Ala-Kotila | Helena Järnström | Jari Laarni | Hannamaija Määttä | Esa Nykänen | Ingrid Schembri | Antti Lönnqvist | Jenna Ruostela | Harri Laihonen | Aki Jääskeläinen | Joe Oyue | Gabor Nagy

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Abstract

This report is a State-of-the-Art survey on the main findings of "New Ways of Working". i.e., ways of working that are adapted to the needs of knowledge workers. The introduction of the report presents some background information as well as the grouping of all the concepts found in the references used in this report. The comprehensive list of concepts is presented in the appendix.

The report is divided to two main parts. The first part is "The Knowledge Work Environment" including chapters for distributed work, Contextual approach to the workspace design, Contextual approach to the workspace design, ICT for the knowledge worker and Benchmarking study. The benchmarking study is the biannual study made by NewWoW (USA) including this time six additional questions for this Finnish RYM SHOK NewWoW project. Among the chapters, especially the "Work places at present: a review of recent research" chapter, includes an insight into recent findings concentrating to 20 carefully selected articles both in a text and table format.

The second part is "Approach for Developing New Ways of Working" including chapters of workspace management, Measuring the impacts of New Ways of Working on knowledge work productivity, Profiles and ICT solutions for the future knowledge work. The second part also summarizes the key concepts and issues in developing New Ways of Working, including the challenges of measuring impacts.

Our results suggest that the core of knowledge work is non-routine problem solving. Knowledge workers are characterized by a need to handle abstract knowledge and constantly learn and adopt new knowledge. Knowledge workers do not necessarily need ICT, although ICT is already an integral part of many knowledge workers, everyday work. With the evolving society, physical matter becomes less important and knowledge that workers possess becomes an increasingly valuable asset. Organizations should focus on planning the arrangements for distributed work so that they support the employees. It is also important to involve the occupational health in evaluating the well-being of mobile and distributed workers. Though as evaluation concept has been created, more research is needed in this area.

Keywords New Ways of Working, State-of-the-Art survey, ICT

Preface

This report is a part of NewWoW project (2011–2013) as a work package in the Pre Engineering Research Program funded by RYM SHOK. Research program creates the means how the Real Estate and Construction cluster can serve as a new enabler of other industries' growth and development by bringing solutions to manage, support and speed up the change all industries are facing.

The goal of NewWoW research is the creation of concepts, implementation management models, and key metrics for high-performance and sustainable New Ways of Working.

Industry partners are Rapal Oy (project leader), Insinööritoimisto Olof Granlund Oy, ISS Palvelut Oy and Senate Properties.

The Research partners are VTT and Tampere University of Technology (TUT).

In this report there is also benchmarking chapter written by project subcontractors from USA (NewWoW LCC and Howart).

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1. Introduction

Knowledge work is increasingly done as an interaction work. It is characterized by information seeking and utilization, creation and sharing of ideas, and collaborative team and project work. There is a growing need to achieve a comprehensive understanding of the changing nature and requirements of knowledge and collaborative work, their productivity drivers and metrics, and the new work and workplace management needs.

In general, knowledge work is defined as *the creation, distribution or application of knowledge by highly skilled, autonomous workers using tools and theoretical concepts to produce complex, intangible and tangible results.* The ProWork project finished in 2009 concluded that *"The productive knowledge work needs physical places for meeting, virtual places for knowledge sharing, not only for information sharing, and that social places are in transformation due to the learning of New Ways of Working and learning to use both physical and digital places".* Moreover, it was stated that *"Work is something what you do, it is not something where you go"* (Nenonen et al. 2009). Springer (2011) has pointed out that "*The Work today is changing, often rapidly. It is more cognitive and complex, relying on communication, cooperation and collaboration among groups of people. This Change has an impact on work and work performance, either positive or negative. Unless you are able to measure the impact* of change, how do you know?" (NewWoW, Springer, 2011).

For companies, New Ways of Working (NewWoW) means a growing global business opportunity in providing services to organizations that are transforming their workplaces into flexible, adaptable, and collaborative learning environments. In addition, the environmental potential of New Ways of Working brings advantages that benefit the different stakeholders. However, earlier research has shown that the NewWoW change processes should be executed with care, taken into consideration the specific needs of the organisation under change. Also, the management of the change is a crucial factor for a successful outcome. If the change is not managed well the engagement of the workers fail at some point and lead to an unwanted result.

The goal of RYM SHOK NewWoW research is the creation of concepts, implementation of management models, and key metrics for high-performance and sustainable New Ways of Working. The research aims to investigate the following key research questions:

What are the work requirements that are based on business success factors and key performance indicators?

1. How do the ways of working and workplace arrangements affect productivity positively/negatively?
2. How can work requirements be turned into strategic guidelines?
3. How can the required change be managed and maintained?
4. What is the relationship between building performance and work performance?
5. How New Ways of Working support sustainable development and decrease environmental impacts?
6. How BIMs support management of sustainable facilities that support New Ways of Working?

The specific objectives of the state of art section presented in this report are as follows:

- To summarise the current state of knowledge work in workspaces, the indicators used for measuring space utilization and working efficiency, and the measurement practices. Special emphasis is placed on the connections between business results and knowledge worker and team performance.
- To analyse the existing alternative workplace practices and evaluate their validity for New Ways of Working (progress beyond). They also make a model of the relationship between business strategies, key performance indicators and new workplace practices. The end result is a definition of future needs and opportunities that can be used in developing service concepts for New Ways of Working.
- To investigate what factors (incl. management models) are crucial for the successful implementation of the NewWoW.

This report describes the methods, key concepts and work places at present from the viewpoint of knowledge work development. The “work places at present“-chapter is the core of this state of the art having the profound analysis of comprehensive list of references. Furthermore the chapter refers selected 20 articles in. The following “Approach for Developing New Ways of Working” chapter is raising the discussion for the key research questions in the project.

The RYM SHOK NewWoW research project also includes scenario & concept development, assessment of environmental impacts and BIM integration, and the piloting of the NewWoW concepts, which results are published in other reports.

The term “New Ways of Working” is used widely but has context specific meanings. It is widely accepted that there is always a combination of physical, virtual and social environments involved using the term. Furthermore there are a lot of factors within on between these three environments. The key terms are formatted in this report to six main groups (list below) and the comprehensive definitions list of the key concepts is presented in Appendix A .

- Nature of knowledge work and its changes
- Work environment
- Employee well-being
- Information technology and the usage of ICT in workplaces
- Organization and management
- Workplace management

The following presents the six groups above within the commonly used “triangle” and some concept names in one picture showing the complexity of the New Ways of Working.

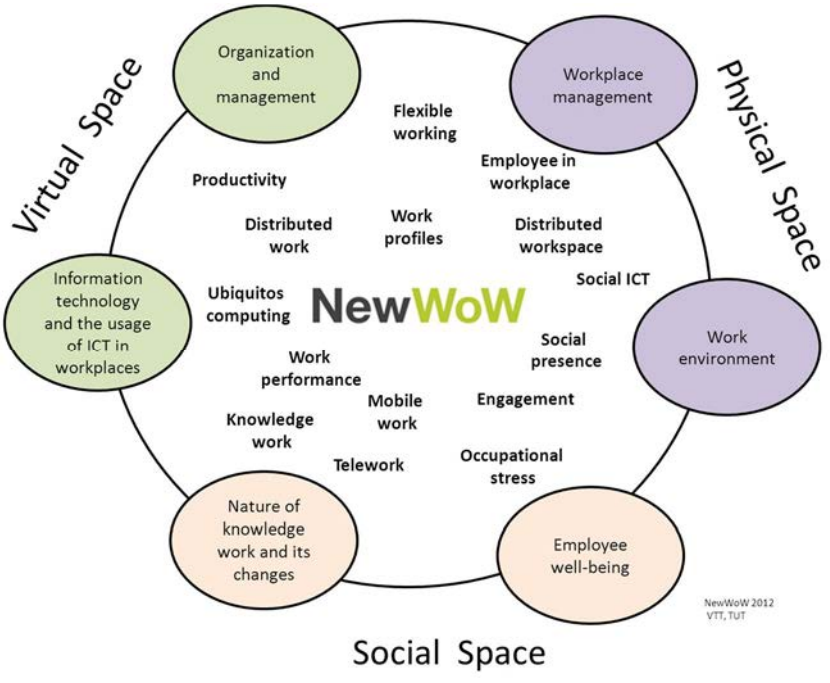


Figure 1. The complex environment of New Ways of Working.

2. The knowledge work environment

2.1 General introduction to knowledge work

Previous workplace and knowledge work projects have used various definitions for spaces, places as well as work itself. Furthermore, there are definitions for both physical and virtual ones. It is also stated that present knowledge work relies on communication, cooperation and collaboration. The variety of definitions brings out the fact that knowledge work is not only complex but also keeps changing constantly.

Pyöriä (2005) has reviewed extensively the definition of knowledge work. Most definitions include high level of education and skills and the use of information technology. Definitions or statements include “symbolic-analytical services or processing symbols” and “expert labour who solve, identify and broker new problems and often work in teams”. Some say that the use of IT is should be included in definition whereas others mean that knowledge work is a process that includes stages where IT is not needed at all; the cognitively most demanding part of work can be independent of time place and tools. Knowledge workers also do routine tasks now and then but non-routine problem-solving is the core of knowledge work with which the education criterion helps distinguish traditional workers and "routine IT users" from knowledge workers. To sum up, the concept of knowledge work is best understood as follows

- extensive formal education and continuous on-the-job learning
- transferable skills
- working with abstract knowledge and symbols and/or people (vs. physical matter)
- knowledge as a primary production factor, wide range of organizations.

There's an increase in knowledge-intensive work, possibly due to two primary reasons: 1) High educational level brings forth demand for symbolic and interactive skills and 2) Scientific and technical knowledge is a vital part of development of new products and services. *The future economic growth relies more on the human innovativeness (and education and rapid learning) than on improving efficiency* (Pyöriä 2005).

To go further into the understanding the nature of the work and its changes and challenges in the future we really need a set of different perspectives in definitions,

research and measurements as well as in daily change/choice management. As the proWork project concluded (ProWork, Joroff et al. 2007):

"*Today, firms in the mainstream have the expertise and processes to deliver traditional supports for work. But given the continuous change and challenge of today's business environment, enterprises now need to go beyond this to develop a low-key but on-going diagnostic capability to anticipate situation that may call for transformation.*"

"*A focus on work practice, a diagnostic capability to detect and respond to disruptive or potentially transformational events, and provisioning of work enabling systems are important challenges for most organizations today. This suggests that there be less reliance upon past patterns and solutions and less comparison with best practices of other organizations; instead there should be much greater reliance on real-time feedback from current work practices coupled with an active program of change in which the users are very much involved. We believe this is nothing less than a paradigm shift in how work is enabled.*"

According to Garrick and Clegg (2000) knowledge that workers possess is intellectual capital to a company that cannot directly be evaluated in monetary units. When the knowledge is harnessed by means of knowledge management, knowledge becomes an asset or a product that the company can sell and thus increases the company's value in the market. Earlier, new knowledge was produced in universities or research institutes and then distributed to undergraduates. The role of universities has changed or is changing, now universities listen carefully what the corporate bodies have to say about the curriculum. Further, learning takes place outside universities as well. Knowledge workers are expected to learn at work, and even take responsibility of their own learning in order to stay "desirable" in the labour market. The employer merely offers opportunities for self-development.

2.2 Distributed work

Due to the changes experienced in the working life, knowledge work can be conducted in an increasingly distributed manner. Various studies have examined the distributed features of organisations, and there are many concepts referring to the distributed nature of knowledge work, such as multi-locational work, remote work or telework. Andriessen & Vartiainen (2006, 13) discusses how the variety of these concepts is an understandable outcome of the recent developments in work, which inevitably result in confusion. According to Andriessen & Vartiainen (2006, 6), the term telework is often associated with home-based telework and is strongly related to an individual's preference to do the work on another place than the traditional office. 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 flexible working manners.

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 (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).

2.2.1 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 workers uniquely mobile, as they can take it wherever they go (Drucker 1993, 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, many organisations try to define different mobility stages of their employees. 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 2).

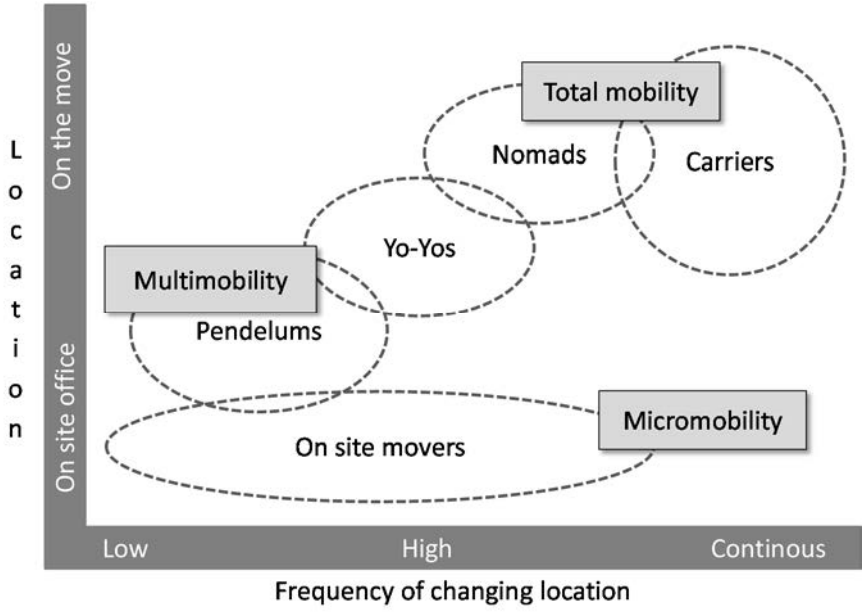


Figure 2. Types of physically mobile employees (Lilischkis 2003, Schaffers et al. 2005, Vartiainen et al. 2007).

Davenport (2005, 35) states that it is a good idea for organisations to have 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. Flexibility is needed in terms of categorising knowledge workers in a distributed work environment.

2.2.2 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 at 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 3). All of these spaces are interlinked with each other.

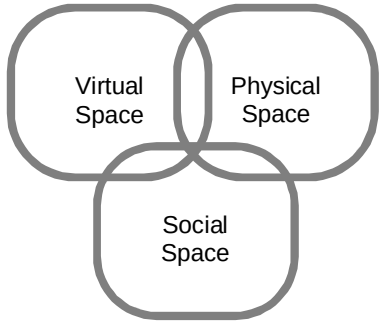


Figure 3. The physical, virtual and social aspects of work (Haapamäki et al. 2010, 13).

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 et al. 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 et al. 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). Vartiainen (2009) has also included another dimension – *the mental space*, which refers to individual cognitive constructs, thoughts, beliefs, ideas and mental states that employees share through communication and collaboration. This brings another complex feature to the entity of the work environment, and 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 Contextual approach to the workspace design

2.3.1 Research approach

The contextual approach that is based on the ideas of ecological psychology is driven by the conviction that technology-oriented approaches have to be complemented by more user-centred approaches of the work environments. We need a user-centred theory of the environment that enables to make links between knowledge of user experiences and needs and conventional business drivers. In other words, a systemic contextual model of workspace and worker behaviour and experience should be developed that is based on ecological-psychological research on environment-behavior relationships..

We propose that we need a contextual approach to tackling the impact of knowledge work on productivity and well-being. According to this approach, New Ways of Working factors (e.g., flexible office, teleworking, use of collaborative tools) are embedded in and influenced by a surrounding set of events, and in most cases, the relationship between New Ways of Working factors and a specific outcome measure (business productivity, job satisfaction) are influenced by surrounding events.

The contextual theory describes the variations that can be seen in the relationships between, behaviours, different types of variables and relevant contextual

factors (Clitheroe Jr. et al. 1998). Context is defined as a specific group of personal, physical and social aspects of an environment and the relationships between them. Clitheroe Jr. et al. (1998) differentiate between focal variables and contextual factors. Focal variables have a direct impact on behaviours that can be identified in the context, and contextual factors refer to aspects of the environment that may affect these focal variables. According to Clitheroe Jr. et al. (1998), the relationships between focal variables are moderated by contextual factors. The key task in contextual analysis is to identify those contextual factors that are most relevant for understanding the target behaviours.

Clitheroe Jr. et al. (1998) have used the term 'prompt' to describe a starting point of a behavioural change process. The process is going on over a specific interval of time and it involves interactions between personal, physical and social aspects of the context. After a particular time period, the process is successfully completed or it may be terminated before completion. Clitheroe Jr. et al. (1998) identified four kinds of personal, social and physical factors that are relevant: personal factors, formal social factors, informal social factors and physical factors. Three attributes of outcomes were called intended or unintended outcomes, reciprocal outcomes and final or intermediate outcomes. According to their model, the context is constantly changing. Contextual shifts are evolutionary changes that do not necessarily change the behaviours; contextual transformations, in turn, are sudden and significant changes that may be caused by dramatic changes in personal, social and physical factors. Contextual transformations may be caused, for example, by the introduction of new technologies and New Ways of Working or office relocation (see Figure 4 which is adapted from Clitheroe Jr. et al. 1998).

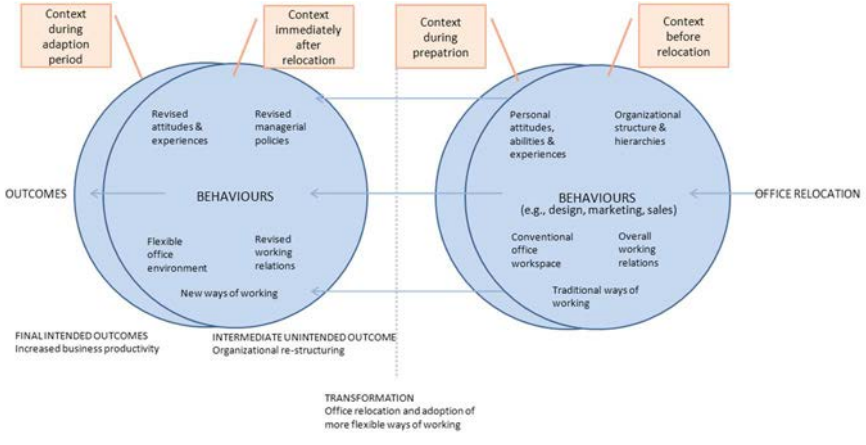


Figure 4. Contextual transformation triggered by office relocation and adoption of more flexible ways of working (adapted from Clitheroe Jr. et al. 1998).

Characteristic features of New Ways of Working (e.g. working at home, flexible office space, mobile work, use of collaborative tools, increased trust) can be

placed on different locations of this contextual model: For example, they can function as prompts that elicit system transformations, or they may be unintended changes of some contextual factors. For example, in the new building the office space can be more flexible, and new collaborative tools can be taken into use. In this case, New Ways of Working can be considered as parts of the prompt. Some of them may also be unintended consequences of the removal to the new building: For example, if the introduction of more flexible office space has detrimental effects on working relations and personal experiences, employees may be more willing to work at home which can be considered as an unintended consequence of the change. This kind of contextual model may be helpful in specifying the effective context of New Ways of Working and in differentiating causes and effects.

User-centred theory of the work environment

Vischer (2008b) has published a theoretical paper presenting a contextual, user-centred theory of the work environment. The paper first proposes that user-centered theories tend to be located along a continuum ranging from social constructivism and environmental determinism. All theories consider the user as an active agent in the build environment and the user's experience as the measure of the environment's effectiveness. The user-environment relationship is dynamic, interactive and reciprocal. The latter adjective suggests that the user's experiences are themselves transformed by the activities the user is performing in the environment. The build environment plays a mediating role between the user and his/her tasks and activities so that the effectiveness of the build environment is related to the degree it supports the user in his/her tasks and activities.

Vischer differentiated three units of user (individual worker, team, and organization) and three levels of environmental comfort (psychological, functional and physical) according to which the worker's experiences can be classified. The temporal dimension of space use has also be taken into account, since the relationship between users and their work environments change over time. One of the merits of the user-centred theory of the build environment is to examine links between users' experience-centred and building procurement centred approaches.

In another paper by Vischer (2008a), the basic parameters and revailing theories of the environmental psychology of workspace were identified. She identifies and reviews the main themes and findings of how people experience environmental conditions at work. A quite general finding is that employees waste time and energy when having to cope with poorly designed workspace; this is also a concern for employers. She coined the term 'functional comfort' and defined it as "environmental support for users' performance of work related tasks and activities". Functional comfort is a term that covers traditional concept of comfort (brightness, temperature etc.) and also links the workers' environmental preferences with concrete outcome measures (e.g. improved task performance and team effectiveness). It is typical that people's experience of functional comfort varies with the tasks' requirements.

According to Vischer (2008a), "surveys of occupant satisfaction in specific buildings indicate which features are preferred and which are disliked by occupants.". Satisfaction is most often measured using post-occupancy evaluation, surveys/questionnaires (likes/dislikes, "perceived qualities"). Instead of asking workers their preferences, it is more important to ask to what degree they are supported in the performance of their tasks. Vischer thought that sense of belonging which affects users' experience of "psychological comfort" seems to be a better outcome measure than satisfaction or effective task performance.

Productivity measures have also their problems: For example, productivity measured by occupants's self-reports can be biased. More objective indicators of productivity have been sought out (e.g. illness rate, accuracy, rate of generation of new ideas and effect of the work environment on the creation and transmission of knowledge in organizations).

Vischer hopes that after the relationships between workspace design and worker effectiveness have been found, employers or building owners do not merely apply a "recipe" for environmental design with the sole idea of guaranteeing a maximum performance from workers. Instead of that, improving environmental design should be seen as investments in work force, and workspace should be a tool for performing work.

2.3.2 Work places at resent: a review of recent research

The next section provides an extensive review of relevant workspace studies from 2000 through 2011. During this time period, critical reviews of previous research have been conducted providing knowledge on general trends and patterns. Roles of different kinds of mediating and moderating factors (gender, age, sense of self, perceived opportunity to creativity etc.) have also been investigated to a larger extent. The following summarises the main themes and the key findings in the reviewed articles.

The effects of the following physical parameters have been studied: open vs. closed office, workspace size, partition/divider height and the number of dividers in the open-plan office, interpersonal distance/proximity, desk position, superior/co-worker visibility, distance from corridor or door, density, openness, accessibility and visibility.

Typical outcome measures in these studies are: individual experience (privacy, concentration, crowding, stress), interpersonal experience (frequency of interpersonal contact, level of collaboration, interpersonal satisfaction, supervisor/co-worker feedback, interpersonal trust), outcome reactions (job satisfaction, self-perceived/supervisor-rated performance, office turnover, motivation).

The most general lesson learned is that all the multiple ways to reduce worker privacy (with various pretences) increase distraction, reduce job satisfaction and quite often also hamper performance. We should not fall into a trap and think that that other promised benefits (“more collaborative culture”, “more favourable work-related attitudes” etc.) could (at least totally) compensate the detrimental effects.

In other words, the negative effects cannot be nullified in the name of all the good provided by knowledge work.

Framework for New Ways of Working

The short paper by Blok et al. (2011) provides an overview of existing evidence of the effects of New Ways of Working on productivity and other measures and develops a simplified framework of the relationships between New Ways of Working measures and business objectives. Based on the literature review, the following features were considered to be characteristic of New Ways of Working: working from home, activity-related working, satellite offices, mobile working, flexible working hours, use of internet and social network services, use of video conferencing, use of collaborative ICT tools and management based on trust and commitment. Based on existing literature, no clear evidence of the effect of New Ways of Working on productivity could be found. Based on existing literature and expert interviews, a simplified framework was developed to describe the relationships between New Ways of Working measures and business objectives. According to the authors, a special care should be taken when implementing New Ways of Working programs in organizations, since there may be complex interactions between above-mentioned characteristics of flexible ways of working.

Facility satisfaction and productivity

The paper by Batenburg et al. (2008) provides a tentative answer to the question of whether work facilities have an impact on employee satisfaction and labour productivity. The results are based on the analysis of a database of the Delft Center for People and Buildings including over 2000 respondents from 17 different office environments. Based on the multivariate regression analyses showed a significant but a quite weak correlation between satisfaction with the physical environment and perceived productivity. However, there was much higher correlation between satisfaction with facilities and workers' estimation of the supporting effect of the work environment on their productivity.

Open plan offices

The paper by Davis et al. (2011) provides an excellent review of research that has investigated workers' interaction with the workspaces. The paper first presents results of studies that have investigated the prospects and limitations of open-plan offices. Next the authors discuss the ways the open-plan offices have evolved to better suit the needs of modern organizations. Finally, the paper tries to identify how research on industrial and organizational psychology can contribute to the discussion on office design solutions. The paper presents a list of pros and cons of open-plan offices. There is evidence of cost savings due to the increased density of office workers and increased flexibility. It has also been proposed that open-plan offices support communication and collaboration between workers and thus lead to reduced conflict and increased job satisfaction and motivation. There is

some evidence supporting an association between open-plan office design and increased interaction. Recent evidence also suggests that open-plan offices support more open and collaborative working practices and less formal organizational culture (McElroy & Morrow 2010, see below). Hall and Ford (1998) showed that the introduction and adoption of open office format leads to improved interaction between individuals and teams.

There is a lot of literature and research that have dealt with the risks associated with open offices like the research by Maher and von Hippel (2005). They conducted an empirical study examining the effect of stimulus screening, inhibitory ability, perceived privacy and task complexity on job satisfaction and performance in open-plan offices at two workplaces in Sydney, Australia. Analyses were based on questionnaire data and inhibitory ability test data. Performance was estimated through manager ratings. Stimulus screening refers to people's ability to cope with overstimulation; inhibitory ability, in turn, refers to people's ability to focus attention to a particular stimulus and inhibit irrelevant stimuli. A total of 109 participants from two organizations participated and objective privacy and social density were measured by the experimenter. Stimulus screening ability was measured with Mehrabian's (1977a) Stimulus Screening Scale; inhibitory ability was assessed through the Stroop (1935) Test; job satisfaction was measured with the general satisfaction scale of the Job Diagnostic Survey (Hackman & Oldham 1975). A series of hierarchical regression analyses were conducted to examine the relationship between expected predictors and dependent variables. It was found that when perceived privacy is low and task complexity is high, office workers with poor inhibitory ability had lower job satisfaction than workers with strong inhibitory ability. This finding means that ability to inhibit distracting stimuli enables people working with demanding tasks with low levels of privacy to prevent overstimulation from different sources in open offices. This study reminds us that individual differences play a role in determining the effects of workplace characteristics on job satisfaction and performance.

Open-plan offices may cause cognitive overload, reduced task performance and increased psychosocial stress. Due to excessive social interaction and distractions workers become easily overloaded or over-stimulated. It has also been found that it is more difficult to conduct confidential discussions in open-plan offices. Overall, open-plan offices seem to reduce workers' environmental satisfaction, and by this way they may also lead to a decrease in job satisfaction. The impact of open-plan offices depend on several individual and contextual factors. There is some evidence that job level and task complexity have an effect on workers' interactions with the workspace: For example, it has been found that managers are less satisfied with environments that reduce their privacy, possibly because they need greater confidentiality in their communication. In addition, workers showed better performance in complex tasks when they worked in enclosed rooms, whereas they performed better in an open-plan environment when the task was simple and repetitive. However, there is inconclusive evidence regarding the effect of task complexity on workers' interaction with the workspace.

In sum, it is necessary to evaluate the pros and cons of different types of office design solutions and ensure that the limitations do not outweigh the potential benefits. Even though there are risks associated with the implementation of open-plan office concept, there are different techniques and methods that can be used to minimize these effects. The authors conclude that it is needed a more rich and nuanced view on the effects of office concepts, and there are trade-offs in the implementation of open-plan concept. Open plan office concept is not the final word: new solutions are developed as the nature of the work is changing. The authors list some characteristics of New Ways of Working that have implications on space design: introduction of new computer-based technologies such as video conferencing, remote network access and reroutable telephone lines. These new technologies allow such new practices as telework and home-working. Knowledge working also requires workspaces that support collaborative activities between team members. Several alternative, more flexible design solutions (such as team spaces, hot-desking, hoteling, satellite offices) are mentioned, and Duffy's (1997) categorization of the office designs into the four classes (den, club, hive and cell) based on the dimensions of interaction and autonomy is presented. There is very little research on the effects of these novel solutions on workers' performance and satisfaction, however.

The paper by Elsbach and Pratt (2007) provides a review on empirical research on the physical environment in professional work settings from the last thirty years. The effects of the following design elements are reviewed: 1) enclosures and barriers, 2) adjustable work arrangements, equipment and furnishings, 3) personalization of workplaces and 4) nature-like ambient surroundings. The paper suggests – but not perhaps very convincingly, since some of the examples are quite far-fetched – that most of the elements and arrangements have both positive and negative implications. Therefore, managers have to deal with trade-offs when choosing and designing physical work environments. The paper proposes that these trade-offs are based on tensions that are inherent to the main functions (instrumental, aesthetic and functional) of physical environments, and it provides some guidelines how to manage these tensions in organisations.

The paper by Oommen et al. (2008) provides a review of textbooks and journal articles on the effects of open plan work environments on employee productivity and job satisfaction. Their primary focus is to analyse the impacts of innovative workplace designs on employees when designing future healthcare facilities. In general, healthcare managers should have a better understanding of both positive and negative consequences of open plan designs. The paper contains a lot of evidence of problems caused by open plan designs (such as the loss of privacy and identity, low productivity, health problems, overstimulation and noise and low job satisfaction). They conclude their paper by saying that health service managers and designers should have better knowledge of, e.g., how employees interact with their working environment, the technologies that are used, issues that are related to aspects of social communication and the organization in which the work is done.

In the paper by van der Voordt (2003) some Dutch studies of the effects of flexible workplaces on productivity and job satisfaction were reviewed. In one study, the Department of Housing, Spatial Planning and the Environment was relocated to a new building with flexible combi offices. Comprehensive follow-up surveys showed that perceived productivity clearly dropped, and older workers' responses were more negative than younger ones. In another study in which the renewal of the office space of Regional Office of the ABN AMRO Bank was investigated, an increase in perceive productivity was found. The employees appreciated the ability to move to a place dedicated to concentrated work and the more efficient creation of archives. According to van der Voordt, these differences can be partly explained by differences in the initial situation and whether the office was relocated or not.

Brill and Weidemann (2001s; cited by van der Voordt 2003) compared 13000 office workers in three different types of office settings, a cellular office, a double office and an open office. They found that productivity was influenced, for example, by the possibility of working individually without being distracted, workplace comfort and ergonomics, availability of room space for spontaneous interaction and gatherings, availability of pleasant relaxation areas, and physically comfortable environment with high-quality lighting, temperature and air quality.

Enclosures and barriers in work settings

Positive effects with enclosures and barriers have been listed as follows: 1) They reduce the effects of disturbing background information and interruptions from other workers; 2) it has been thought that they help signal appropriate status level and increase status among higher status workers, 3) they make it possible to hold conversations without disturbing others and 4) they make it possible to maintain sufficient confidentiality in work. The following negative effects have been found: 1) they inhibit collaboration when continuous dialogue is needed between workers; 2) they make it difficult to identify the source of environmental noise; 3) they may reduce workers' perceptions of task significance and identity; and 4) they may signal undesired status differences between workers.

Adjustable work settings, equipment and furnishings

The opportunity to control task-relevant features of the work environment (lighting, thermal controls) is associated with increased job satisfaction and performance. However, in some cases, performance is better if workers are not allowed to adjust their work arrangements, since workers are not always able to do that in a correct way or they do not do that at all.

Personalisation of work environments

Personalisation helps workers to affirm their workplace and professional identity. It also helps workers to affirm distinctiveness and uniqueness, it has shown to improve mood and reduce psychosocial stress and it may increase workers' organi-

zational attachment. A negative effect is that personalisation may lead to stereotyping at the individual or organizational level.

Nature-like ambient surroundings

There is some evidence suggesting that nature-like ambient stimuli (natural sunlight, use of natural materials) increase job satisfaction and performance. They also elicit positive impressions in visitors.

These kind of stimuli may have negative effects on performance if they provide a too salient contrast to boring task characteristics.

According to Elsbach and Pratt (2007), the above-mentioned trade-offs are grounded in tensions that are occurring between or within the instrumental (performance relevant), symbolic (meaning relevant) and aesthetic (sensory relevant) aspects of physical objects and arrangements. These tensions can be managed in three basic ways: 1) deletion or sacrifice, 2) integration and 3) compartmentalization or segregation. Deletion means that one tension is satisfied but the others are not (e.g., if there is lack of resources, performance relevant functions are satisfied at the sacrifice of aesthetic ones). Integration means that instrumental, symbolic and aesthetic functions are simultaneously satisfied by adjustable design of workspaces. Segregation means that tensions are managed separately, and functions are satisfied differently at different parts of the work environment (e.g. aesthetic functions are satisfied at those parts of the building that are open to visitors, whereas workers' work places satisfy only instrumental functions). The approach provided by Elsbach and Pratt (2007) may be especially useful in designing workspaces for knowledge work. Managers have to try to understand the inherent tensions they are facing, the degree they are manageable and the resources that are needed to resolve them.

Office concepts

De Croon et al. (2005) have summarised a meta-analysis based on extensive literature search started from 1972 (seven databases were searched). The key terms that were used for the search are related to the following office concepts:

1. office location, e.g., teleworking vs. conventional office
2. office layout, e.g., open-space vs. cellular private office
3. office use, e.g., fixed vs. shared workplaces.

According to the conceptual model that was developed for this study, the above-mentioned office concepts influence such aspects of work conditions as job demands and job resources. These work conditions may in turn result different kind of psychological (e.g., job satisfaction) and psycho-physiological (e.g., endocrine reactions) short-term reactions. On the other hand, office concepts may also have a direct effect on these short-term reactions – independently of work conditions. Later, short-term reactions may cause different kind of long-term reactions, i.e., effects on workers' health and performance (e.g. psychosocial stress). Generally accepted criteria were used in the methodological quality assessment of the arti-

cles. Out of 1091 articles, 49 were included in the study for review. The information on office effects were categorized into four levels of evidence on the basis of the quality and consistency of the findings: 1) insufficient evidence, 2) limited evidence, 3) strong evidence, and 4) inconsistent evidence.

The results showed strong evidence that working in open-plan offices reduces the worker's privacy and job satisfaction (De Croon et al. 2005). Limited evidence was found that working in open workplaces increases cognitive workload and reduces interpersonal relations. In addition, limited evidence was found that close distance between workplaces increases cognitive workload and reduces psychological privacy, and desk-sharing improves communication. No evidence was found for an effect of the three office concepts on workers' long-term reactions. Neither was there any evidence for an effect of office location on work conditions or short-term reactions.

This important meta-analysis clearly indicates that innovative design solutions may have an impact on the workers' work conditions and well-being, and this way they may contribute to the organization's productivity and costs (De Croon et al. 2005). Especially, innovative office solutions should provide shelter from noise and harmful visual stimuli, and they should be equipped with enclosed, sound-dampening workplaces. As the authors suggest, the participatory design of workplaces may lead to more favourable solutions and workers' attitudes. Several other aspects of office environment (that may affect worker health and performance) also need to be considered in the futures analyses. These aspects include lightning and thermal conditions, colour and material use, furniture and computer technology.

Indoor environment and stress

The paper by Rashid and Zimring (2008) provides a conceptual framework describing how the physical environment of a building may have an impact on different immediate outcome variables and individual stress through its effects of an individual's needs. The physical environment variables are classified into categories, indoor environmental variables (noise, lighting etc.) and interior design variables (use of space, furniture etc.). Immediate outcome variables include different kind of physiological, psychological, cognitive, psychosocial and social outcomes. The effect of environmental factors to these outcome variables and stress are dependent on personal motives and attitudes, demographic factors and individual needs. In addition, the outcomes also depend on several organizational factors including organizational leadership and culture.

According to the conceptual framework, immediate outcome variables which have some direct associations with stress may be influenced when individual needs and motives are frustrated by some environmental features (Rashid & Zimring 2008). The open-plan office, for example, may endanger the individual's sense of privacy and as a result deteriorate task performance. On the other hand, if the person does not consider privacy as an important need, the effect of new arrangements may be marginal. Since it may be difficult to show direct causal links

between indoor environment or interior design features and stress, research should focus more on the evidence showing links between environmental variables and individual and workplace needs. The conceptual framework is useful in the development of a more dynamic contextual model for the description of interdependencies of workspace design and performance.

Workplace design

The case study published by Peponis et al. (2007) investigated how workplace design and spatial layout affect productivity in a communication design company in the U.S. The company moved from their old office (18 000 m^2) to a new office (16 000 m^2). Community-Based Planning approach developed by Steelcase, Inc. were applied in the design program and in the evaluation of the final solution. Pre- and post location comparisons were made in terms of several measures. About 50 employees from ThoughtForm, a communication design firm, participated in the study.

The Community-Based Planning includes a variety of techniques such as surveys, interviews, ethnographic observations and documentation. Self-assessment questionnaires included several items on employee perceptions of the workplace were filled before and after the move. Another questionnaire asked workers to identify those with whom they interact on a daily-weekly-monthly- yearly basis and specify the nature of the interaction. Network analysis was performed on the basis of the network data. (Peponis et al. 2007).

To estimate the effect of the new design on productivity, accounting documents were analysed to determine the way the spent working and billable hours per each project were accounted for and recorded. Two spatial analysis techniques were applied to describe which properties of the new design are important for possible positive changes in work-related interaction and productivity. (Peponis et al. 2007).

The first technique is based on the representation of the layout reflecting “the fewest and longest circulation lines that are needed to connect all spaces, complete circulation loops and reach into each individual workspace” (Turner et al. 2005). The second technique is based on the analysis of the visibility polygons drawn from each of a grid of tiles covering all accessible areas of the office (Turner et al. 2001). In the final analysis a correlation between the spatial connectedness of workstations in the physical layout and their connectedness in the networks of interaction was calculated based on measures that describe an individual’s position in the network. (Peponis et al. 2007).

According to the self-assessment questionnaire, access to different kind of workspaces (team work spaces, informal relaxation spaces, and quiet work spaces) was improved. Network analysis suggests that after relocation more pairs of people talk to each other at the daily or weekly time period. It also seems to be that those interactions are incorporated in spaces that are associated with work processes themselves. Analysis of the accounting documents provide some evidence that the change in office buildings is associated with positive changes in productivity in creative tasks. The spatial analyses of the two premises suggest

that the new office is more integrated and better connected than the old one. Finally, correlational analysis showed that there is an increased correlation between network and layout measures suggesting that the integration of an individual worker's workstation in the layout as a whole is correlated to the contribution of each worker to the network of interaction. (Peponis et al. 2007).

This is an important study in that different kind of methods and techniques are used to explore the effect of design solutions on performance and interaction patterns. The study shows that layout has an impact on the density of different networks of interaction. Layout can also contribute to productivity by facilitating sharing of ideas, communication and collaboration and sharing of ideas in creative work. Even though there seemed to be some negative evidence, it was not considered to a sufficient degree. Moreover, the designers themselves are disqualified to participate in the evaluation of the final solution. (Peponis et al. 2007).

Control of workspace

Lee and Brand (2005) made an empirical survey examining the effects of perceived distractions, flexible use of workspace and personal control over the workplace on perceived job performance and satisfaction, group cohesiveness and tendencies to work alone or in an enclosed space. A questionnaire development proceeded in several stages, and individual items were adapted from different sources. The final questionnaire includes 23 items covering the above-mentioned themes. Several demographic items were also included. Participants were from five organizations, 7–143 participants per organization. Of 376 total cases, 228 had adequate data were thus included in the analyses. Exploratory factor analyses were conducted to derive a set of constructs, which were tested employing Maximum Likelihood estimation. After a satisfied solution was found, the structural model was tested.

It was found that perceived control had a significant positive influence on job satisfaction and group cohesiveness (Lee and Brand 2005). However, distractions had no effect on perceived performance. The results suggest that providing workers with more control over their workplace may fulfil individual and group needs for flexibility. End-user-friendly workplace design should strive to support both group collaboration and distraction-free individual work. It seems to be difficult to reach both of these aims at the same time.

Future work program in the US

Khanna & New (2008) carried out employee surveys were carried out after the implementation of Future of Work (FOW) program at Capital One in the U.S. The aim of the FOW project was to create a physical environment that was supported by policies and technologies enabling knowledge workers to work when and where they thought that it will be the most effective. More specifically, the aim was to reduce individual work space, make the space more open, increase the possibilities for team collaboration and provide tools to support mobile working. Preliminary surveys were carried out after the implementation of the new design.

Four different work styles were identified: anchor and resident that resides mainly in a single physical location, director/executive that is highly mobile within the area of the company and not working much outside this area, mobile worker that is highly mobile within the company area but working minimal time outside this area and teleworker that is working at home. Moreover, nine activity settings are designed: anchor workstations, executive workstations, resident workstations, mobile workstations, enclosed rooms, quiet-zone rooms, agile project rooms, cafes and lounges and multifunctional devices. For different activity settings a set of technical tools and infrastructure were assigned. (Khanna & New 2008).

Overall, the program increased worker and team satisfaction, organizational performance and productivity and achieved greater real estate utilization and flexibility. For example, there was a 41% increase in overall workspace satisfaction, and a 53% increase in work productivity. Increased collaboration resulted in increased decision making speed: e.g., a 31% reduction in time to get input from colleagues. There was more choice and control over quiet space leading to fewer interruptions, increased concentration and improved productivity. For example, there was a 124% increase in the amount of time spent in working in quiet spaces. Real estate costs per worker were reduced. There was a 50% reduction in the space required per worker. On the negative side, the amount of face-to-face communication was reduced. (Khanna & New 2008).

The study, however, provides only preliminary evidence. The conceptual model shows the basic relationships between workplace design elements, behavioural impacts and organizational outcomes, i.e. workspace design elements have behavioural impacts which in turn affect organizational outcomes that may exert feedback effects on workspace design. Workplace design elements that were identified are the degree of privacy, arrangement and style and size of the space, technology support and HR policy. The key work behaviour elements are collaboration, concentration and control. Organizational outcomes are organizational performance (productivity and innovation), employee satisfaction, cost and flexibility. (Khanna & New 2008).

Effect of layout-scale variables on worker satisfaction

Hua et al. (2010) conducted an empirical two-year field study in eleven office buildings (308 office workers) in the U.S. exploring the effects of different layout-scale and workstation-scale variables on workers' satisfaction with the spatial environment's ability to support collaboration and perceived distraction from others' behaviour. The paper also identified typologies of space layouts for meeting, shared print/copy and kitchen/coffee spaces.

Six layout-scale variables were introduced: 1) distance from individual workstation to nearest meeting space, 2) distance from individual workstation nearest shared copy or print area, 3) distance from individual workstation to nearest shared kitchen or coffee area, 4) percentage of floor space dedicated to meeting spaces, 5) percentage of floor space dedicated to shared service and amenity spaces and 6) openness. Workstation-scale variables were: workstation size,

partition height, distance to the nearest coworker, workstation density and the presence of door to the workstation. The distances were calculated based on 'graph metric' geometry measuring the shortest distance between two points along an orthogonal path passing inside the floor plate. A workspace collaborative environment questionnaire including two scales (perceived support from the work environment for collaboration and perceived distraction from others' interactive behaviour in the work environment). (Hua et al. 2010).

Six layouts for meeting spaces on the basis of combination of number, size, distance and ownership characteristics were identified. Layouts with distributed meeting rooms around the core and distributed meeting rooms around the core and at the corners provide significantly higher levels of perceived support for collaboration and lower levels of distraction than other layouts. Four layouts for shared print/copy spaces and five layouts for shared kitchen/coffee spaces were identified. The level of perceived support was higher and the amount of perceived distraction was lower when copy machines were in distributed but dedicated spaces. If the copy machines were shared and located in vacant workstations or on main aisles perceived distraction was significantly higher. Overall, perceived support was higher and distraction lower when the kitchen/coffee area is in dedicated space and centralized in the core. Perceived support for collaboration was associated with a shorter distance from the workstation to the meeting space, a lower level of floor-plan openness and a higher percentage of floor space dedicated to meeting, service and amenity spaces. Perceived support was also associated with longer distance to the nearest co-worker (!) and lower density. Higher distraction was associated with a shorter distance to the shared service area and a lower percentage of floor space dedicated to service and amenity spaces. Also in this study, workers preferred individual workstations as places for collaborative work and brief interactions with others. (Hua et al. 2010).

The study is one of the few studies investigating the effects of layout-scale variables on worker satisfaction showing that distances from individual workstations to meeting and shared amenity spaces have an impact on perceived support. The study provides typologies of office space layouts and shows links between office layouts and worker satisfaction (perceived support for collaboration and perceived distraction). (Hua et al. 2010).

Privacy-need measures in office environments

Haans et al. (2007) developed two privacy-need measures for office environments were developed and their reliability and validity were evaluated based on survey data. People' privacy needs were compared in different office environments. 204 workers from a Dutch bank participated in the survey. Workers' work environments differed, but the majority (55%) worked in an open-plan office. Workers' privacy needs were assessed with three different measures: 1) Kaya and Weber's (2003) measure, 2) specific measures proposed by Pedersen (1988), and 3) two new scales developed by the authors of the paper, one assessing the Need-For-Privacy and the other one Need-For-Socializing. The Need-For-Privacy measure

assesses people's motivation to withdraw from social interaction; the Need-For-Socializing assesses people's motivation to search for social contacts. (Haans et al. 2007).

There was a somewhat higher need for privacy for those employees working in open offices than those working in mixed office design. Workers who had to share the work desk with others had an even higher need for privacy in open offices. It was also found that people working in open offices had a significantly higher need for social interaction than those working in mixed office environments. The two measures (Need-For-Privacy and Need-For-Socializing) were shown to be quite reliable. The Need-For-Privacy scale also overlaps with earlier developed privacy measures. The results also suggest that Need-For-Privacy and Need-For-Socializing are relatively distinct motives. (Haans et al. 2007).

The study showed once again that the lack of privacy is a real problem with open-plan offices. The new measures developed may be useful in studying the effect of office design on personal space and perceived privacy.

Factors affecting the development of flexible workplace facilities

Hassanainin (2006) studied factors affecting the development of flexible workplace facilities. A literature review was conducted for the purpose of identifying reasons for developing flexible workplace and factors that affect the provision of sustainable and flexible workplace facilities. The review provides a valuable list of factors for flexible workplace design.

Both external and internal sources of changes and pressures have been identified. Some key pressures have been: 1) the increasing pace of change in businesses demands that people have been moved within office buildings to a greater extent, 2) the increase of team-based and project-based work requires more flexibility within office buildings, 3) the increasing demands for more appropriate workplace environments supporting better knowledge work and 4) equipped buildings for the increased use of computers. Eighteen factors for facilitating the provision of flexible workplaces were identified, and they were classified under four categories, 1) planning of the building, 2) layout of the physical workplace, 3) IT networking and 4) building service systems. (Hassanain 2006).

Buildings have to be designed for adaptability, and therefore: 1) organizations' short, medium and long-term objectives and needs have to be better considered; 2) more flexible buildings have to be chosen; 3) the design must be kept simple and 4) the structure of the building has not to restrict future changes required by future clients. In designing the physical workplace it has to be: 1) simplify the workplace, 2) design larger vertical risers floor plates, 3) use mobile interior furnishing elements, 4) create flexible space. (Hassanain 2006).

In IT networking, the following factors have to be considered: 1) networks should be built into the system so that it is possible to have access to its subsystems from each location of the place, 2) smaller lighter computer systems should be used, 3) the telecommunication infrastructure should be easily replaceable, 3) It networks should be divided into separate zones so that each of them can per-

form independently if needed, 4) devices such as printers should be located in central areas in order to be easily accessible from different parts of the workplace. (Hassanain 2006).

Concerning the building service systems, 1) capacity of building service systems should be adequate, 2) it should be provided contingencies to allow people to add new services later, 3) it should be aware of over-congested services and to leave sufficient space to add to them if needed, 4) the building should support subtenanting if required, 5) control strategies should be developed to allow flexible alterations. (Hassanain 2006).

The following summarises the main results from a total of 20 articles investigating the impact of work environment, office types and organisational aspects on job satisfaction/ performance or health & comfort. Also, the impact of gender, generational differences, person's self-schema and territoriality were studied. Table 1 summarises the research methods, participants and procedures in these articles.

Article 1. The developed conceptual model to link environmental satisfaction to job satisfaction included an 18-item environmental satisfaction measure that had a three-factor structure reflecting satisfaction with privacy/acoustics, satisfaction with lighting and satisfaction with ventilation/temperature. Overall, the results suggest that *greater satisfaction with physical environment is associated with greater job satisfaction.*

Article 2. The macro-ergonomic interventions had a positive effect: there was an increase in job control, environmental satisfaction, sense of community, office ergonomics climate, communication and collaboration, and business process efficiency (time and costs) and a decrease in work-related musculoskeletal discomfort. The results suggest that training ergonomic skills allows workers to make useful workstation adjustments and reduce the physical risks and discomfort. *The study shows that effects of office workspace design are not necessarily always negative, and adequate ergonomics training can diminish possible negative consequences among knowledge workers.*

Article 3. Architectural enclosure (divider height) did not consistently predict symbolic attribute (workplace pride, home-like atmosphere) ratings. These symbolic attributes had a clearly larger effect on worker performance than the physical attributes (speech privacy, noise level, lighting, air quality and temperature). *The result suggests that worker performance can sometimes be more easily improved by maximizing the symbolic impact of the office than, for example, by increasing the height of the dividers.* Therefore, it might be useful to offer better opportunities to personalize and tailor workspace environment.

Article 4. There were significant differences in office worker satisfaction and job performance levels regarding privacy, interaction and acoustic quality between office types. People in open-plan offices with high partitions showed lower satisfaction and job performance in relation visual privacy and interaction than both enclosed private or shared office types. They also showed lower satisfaction with noise level and sound privacy and lower job performance perceived by acoustic quality than the other three office types. The three open-plan office types did not significantly differ from each other regarding visual privacy and interaction. How-

ever, workers in the open offices with low partitions showed higher satisfaction with interaction with co-workers. Interestingly, people in the open office with no partitions showed higher job satisfaction and performance than people in open offices with high partitions. The open office with no partitions showed no difference with enclosed shared type office in privacy, interaction, and acoustic quality questions. Perhaps the most interesting finding of this extensive survey was that the *bullpen type office is a quite good alternative for the open offices with partitions in case of limited office space. It also seems to be that partitions do not seem to improve acoustic privacy, regardless of their height.*

Article 5. Several building, social and personal factors have an impact on perceived comfort, and their interactions are complex. It seems to be that the results are somewhat disappointing, and the best the authors could say was that perceived comfort is more than the average of several environmental factors (such as air quality, noise and lighting). They provide some recommendations on how to perform this kind of survey.

Article 6. Irrelevant speech had a significant effect on completion rates, false alarms and mental workload: irrelevant speech increased completion rates and false alarms, and workload was also higher in the irrelevant speech conditions. The paper presents some *ideas of how to train workers to develop strategies to sustain focussed attention in the presence of irrelevant speech and filter irrelevant stimuli.* Some words of cautions were presented concerning the increasing use of speech-based technology in the workplace.

Article 7. An acceptable fit between the hypothetical four-factor measure of territoriality model and the sample data was found. The four different types of territorial behaviour are related but distinct. Preliminary evidence of construct validity of the measure was found. New Ways of Working may change people's territorial behaviours. *Organizations have to learn to deal with issues of territoriality, since people's abilities and possibilities to engage in territorial behaviour may affect their job satisfaction*.

Article 8.*Window proximity had a significant effect on job satisfaction*, and workers whose workstations had an access to a window and higher partitions were the most satisfied with their workstation. In addition, it was found that *males responded more positively to open offices than females*. Workers who had an access to a window, to a view outside and to daylight evaluated the space more positively than those who were sitting far from windows – supporting previous similar findings. An interesting question is whether similar effects can be found by using different kinds of window substitutes (e.g., landscape views presented on large-scale displays).

Article 9. T*here were significant gender differences in terms of satisfaction regarding the behavioural variables.* Men and women also used different personal items in the personalization of their workspace. Women tend to make more changes in their room layout on a temporary basis than men. Gender differences are still apparent, even though they may not be as large as has been previously thought.

Article 10. Results support the view that the self-schema functions as a cognitive filter determining the way people perceive their work environment and situation, and that it has an effect on the ways people judge their work environment and the work they are doing: *Clear differences were found in environmental perception and workspace evaluation between people with a self-schema of professional failure and those with a self-schema of professional success.* According to authors, physical factors of the workspace are not deterministic but relative in their effects on satisfaction and behaviour. That is, their effects are moderated by psychosocial processes and factors.

Article 11. Even though ambient sound level was no direct effect on job satisfaction, organizational commitment or self-reported health, it did interact with job strain to produce a significant effect on the above-mentioned outcomes. When the noise is at a moderate level it helps to moderate the negative effect of job strain on job satisfaction, organizational commitment and self-reported health. *The physical work environment can sometimes be a source of stress, on the other hand favourable conditions can help in coping with stressful events.* Design solutions can thus provide support for health and well-being.

Article 12. It was found that worker satisfaction of all of the measures was reduced after relocating workers from private offices to different-type open offices. More interestingly, they did not become more satisfied even after an adjustment period. Contrary to previous evidence, open office arrangements did not facilitate communication and collaboration among co-workers. On the contrary, the workers seem to feel that open office designs decrease possibilities to confidential communication. *One of the few longitudinal studies showing that the decremental effects of open office designs on job satisfaction and performance do not attenuate over time.*

Article 13. There were significant differences in health and job satisfaction between the seven office types. *Perceived health was found to be the highest in cell offices and flex offices and the lowest in small and medium-sized open-plan offices.* The participants also rated job satisfaction higher in cell offices and flex offices; job satisfaction was the lowest in combi offices. One of the few studies showing that flexible workspaces including different types of spaces for different tasks can promote health and satisfaction and provide to individual and organizations a promising solution to managing changing work needs.

Article 14. The group who was assigned to the redesigned office environment had a significantly higher level of perceived distraction than those who remained in a cubicle environment. However, the youngest age group (the Millenials) had more positive opinions of the new layout than the other two age groups. In addition, workers who moved to the redesigned office had more positive opinions of the organization's culture and more positive attitudes of their work than those who remained in a cubicle office. The study shows that office redesigns may cause both positive and negative changes in worker opinions: while the workers responded negatively to some elements of the new office, they also felt that the new design supported some organizational purposes. *One of the few studies showing*

that generational differences have to be considered when it comes to the effects of office redesigns.

Article 15. There was a positive association between perceived social climate and perceived support for creativity; there was also a negative association between environmental distraction and perceived support for creativity. Perceived support for creativity significantly mediated the relationships between social climate and job satisfaction, social climate and personal stress and environmental distraction and job satisfaction. Both physical and social features of the work environments affect workers' perceptions and experiences of creativity. *One of the few empirical studies showing that the physical environment plays a role in increasing or decreasing creative processes and activities*.

Article 16. Overall, workers are not satisfied with individual control of noise and lighting and with individual privacy. Dissatisfaction with privacy was particularly high in open-plan offices. Moreover, women were less satisfied with opportunities for individual privacy in open-plan offices than men. Concerning furniture design, workers are quite dissatisfied with filing arrangements and storage facilities. On the other hand, workers are quite satisfied with chairs and work surfaces. *The study replicates earlier findings on inadequate provision for individual privacy in open offices.*

Article 17. Two factors contribute to movement in office workplace environments. On the one hand, observed movement flows in a building correlates with spatial integration; on the other hand, the placement of facilities and functions guide people's movements across space. More importantly, it was found that organizations are different in that they react to similar spatial configurations in a unique way: some organizations seem to shape their behaviour by spatial configuration as suggested above, the other organizations, however, seem to be constituted in a way that is less dependent on spatial configuration, i.e., transpatially. *Important study suggesting that spatial configuration is only one factor contributing to organisational behaviours.*

Article 18. Concerning the support for open-plan office, two types of articulations were recognized: One identified open-plan office as an essentially rationale choice for the organisation, the other one characterised academic work as suitable to open plan. In many cases, real input from end-users of the settings is not considered, instead of that, 'knowledge' about users is constructed in the heads of the decision makers without input from users. The authors coined the term 'imagined user' to refer to this situation. That is, the knowledge emerging from the interaction between managers and end-users reflects this interaction and does not necessarily provide an objective description of users' wishes.

Article 19. *Workspace density has a negative impact on job satisfaction when both job complexity and organizational tenure are high at the same time*. For those with high job complexity and low tenure, the level of density had no effect on job satisfaction. It is possible that less experienced workers need help from other workers on how to successfully accomplish their complex jobs. More experienced workers are less dependent on external help, and less densely populated workspaces should be reserved for them.

Article 20. *It was found that high noise impaired the participants' memory performance, and the participants also experienced themselves as more tired and less motivated in high-noise conditions. Restoration experienced through watching a nature movie affected motivation in a positive way.* The results suggest that since noise experienced in open-plan office environments does have negative effects on memory performance and stress, compensatory strategies including access to natural restorative environments are needed.

Table 1. Summary of research approaches in reviewed knowledge work setting studies.

Reference	Method	Participants	Procedure
1. Veitch, J.A., Charles, K.E., Farley, K.M.J., Newshaw, G.R. 2007. A model of satisfaction with open-plan office conditions: COPE field findings. Journal of Environmental Psychology 27, 177–189.	Office environmental satisfaction measure was developed (based on Stokols and Scharf's (1990) Ratings of Environmental Features, REF, measure) and the factor structure of the measures described. A **conceptual model was developed to link environmental satisfaction to job satisfaction.** The study includes to the Cost-effective Open-Plan Environments (COPE) -project, a four-year multidisciplinary investigation of open offices.	Data were collected in nine office buildings in Canada and USA during 2000–2002. 779 open-plan office workers participated.	The questionnaire includes items measuring satisfaction with environmental features, overall environmental satisfaction and job satisfaction. The following physical conditions of the workplace were measured by the experimenter: lighting, thermal, air quality, acoustical conditions and workstation characteristics. Both exploratory and confirmatory factor analyses were performed on the survey responses.
2. Robertson, M.M., Huang, Y.-H., O'Neill, M.J. & Schleifer, L.M. 2008. Flexible workspace design and ergonomics training: Impacts on the psychosocial work environment, musculoskeletal health, and work effectiveness among knowledge workers. Applied Ergonomics 39,	Empirical study investigating the **effect of a macro-ergonomics intervention consisting of flexible workspace design and ergonomics training** among knowledge workers	1250 office workers were invited, 289 of them participated in the final study. Flexible workspace means that workstations are adjustable and there are several meeting places of different sizes which are located at convenient distance from individual work-	The participants were assigned to one of the four conditions: 1) flexible workspace, 2) ergonomics training, 3) flexible workspace and ergonomics training, and 4) no-intervention control group. The second group was excluded from the analysis due to attrition. A quasi-experimental, non-randomized design was applied; one pre-intervention survey and two post-intervention surveys were carried out. The methods used in data collection: workplace environment electronic surveys, ergonomic knowledge tests and Business Process

Reference	Method	Participants	Procedure
482–494.		stations. Ergonomics training encouraged the workers to have a better control over how the workspace was used.	Analysis (BPA). BPA methods were used to measure the time and cost related to ongoing business processes within the company.
3. Goins, J., Jellema, J. & Zhang, H. 2010. Architectural enclosure's effect on office worker performance : A comparison of the physical and symbolic attributes of workplace dividers. Journal of Environmental Psychology 45, 944–948.	**Based on building performance information** from The Center for the Built Environment (CBE) database it was **compared** the effects of some **physical (visual and speech privacy) and symbolic attributes (sense of home-like atmosphere and workplace pride)** of architectural enclosure on worker performance.	Data from 13 buildings were included, the number of respondents was not mentioned in the paper.	Relationships between visual and speech privacy and amount of enclosure and relationships between visual and speech privacy and worker performance were analysed by using logistic regression analysis.
4. Lee, Y.S. 2010. Office layout affecting privacy, interaction, and acoustic quality in LEED-certified buildings. Building and Environment 45, 1594–1600.	Empirical study investigating the **effect of office type on worker satisfaction and job performance** regarding privacy, interaction with co-workers and acoustic quality in personal workspaces. The study used secondary data from the Occupant Indoor Environmental Quality (IEQ) Survey conducted at the Center for the Built Environment (CBE). CBE had conducted on-line survey with office workers in LEED-certified buildings and compiled the	There were 3533 respondents in the five office types in fifteen LEED-certified buildings in the database by 2007.	

Reference	Method	Participants	Procedure
	database of the survey during 2000's. The Leadership in Energy and Environmental Design (LEED) is a standardized green building certification system in the U.S. Office types were categorized into five groups, enclosed private, enclosed shared, open-plan with high cubicles over 5', open-plan with lower than 5' and open-plan without dividers (bullpen).		
5. Bluyssen, P.M., Aries, M. & van Dommelen, P. 2011. Comfort of workers in office buildings: The European HOPE project. Building and Environment 46, 280–288.	Empirical survey included in the European project European Health Optimisation Protocol for Energy-efficient buildings (HOPE) sponsored by the EC in the 5th framework (2002–2005) investigated the **influence of building, social and personal factors on worker health and comfort.**	There were 5732 respondents in 59 office buildings from eight countries (Finland included).	Principal component analysis (PCA), reliability analyses and linear regression analysis were conducted.
6. Peterson, T.O. & Beard, J.W. 2004. Workspace technology's impact on individual privacy and team interaction. Team Performance Management 7/8, 163–172. Smith-Jackson, T.L. & Klein, K.W. 2009. Open-plan offices: Task performance and mental	Empirical mixed factor design study investigating **the effects of two forms of irrelevant speech and individual differences on performance on proofreading task and mental workload.**	54 young participants from an introductory psychology course participated.	Participants carried out an electronic proofreading task under three speech conditions, quiet, intermittent and continuous speech. The auditory distraction was supplied by a stereo system that was located 2.44 m behind the participant. Participants completed two questionnaires, the Expanded Tellegren Absorption Scale (ETAS) and the NASA Task Load Index (NASA-TLX). The ETAS is measuring subjective concentration on the task; the NASA-TLX is measuring

Reference	Method	Participants	Procedure
workload. Journal of Environmental Psychology 29, 279–289.			subjective mental workload. The data were analysed by using the multivariate analysis of variance (MANOVA).
7. Brown, G. 2009. Claiming a corner at work: Measuring employee territoriality in their workspaces. Journal of Environmental Psychology 29, 44–52.	A **measure of territoriality** was developed and its factor structure was studied. Human territoriality can be defined as a set of behaviours and cognitions a person or a group of persons exhibits based on their ownership of a particular space (Bell, P.A., Greene, T.C., Fisher, J.D. & Baum, A., Environmental Psychology). Four types of territorial behaviour have been identified: identity-oriented marking ("Displayed artwork in my workspace"), control-oriented marking ("Created a border around my workspace"), anticipatory defending ("Used locks and passwords so that others cannot access my workspace") and reactionary defending ("Displayed hostility towards an intruder").	106 respondents from several sources (university students, employees from a government agency) participated in the generation of behaviour examples; 663 participants from different industries completed the survey.	The method development proceeded through several phases: 1) generation of behavioural examples of the four types of territorial behaviour, 2) comparison of the generated items to the four definitions and item review, 3) instrument validation by addressing the scales to participants from different sources. Respondents also completed several other scales (psychological ownership, need for power, tolerance for ambiguity and locus of control). Confirmatory factor analysis was used in the validation process.
8. Yildirim, K., Akalin-Baskaya, A. & Celebi, M. 2007. The effects of window proximity, partition height, and gender on perceptions of open-	Impact of **worker access to a window and to daylight** and workstation partition height on three environmental quality measures, planning (e.g., free or restricted space, properly or badly planned space), privacy (e.g., uncrowded or crowded, restful or disturbing) and light-	98 office workers participated, 48 for one of the two companies and 50 for the other one.	A questionnaire asked general information about the workers and information about their perception of the office they were working. A 2 x 2 x 2 factorial design (worker proximity x partition height x gender) was used. Analysis of variance (ANOVA) and multivariate analysis

Reference	Method	Participants	Procedure
plan offices. Journal of Environmental Psychology 27, 154–165.	ing (e.g., good or poor lighting) were investigated in two companies (working in electronic and software businesses) located in the same office building. The partition heights of the open office cubicles were different in the two companies (120 cm vs. 140 cm). Some workers had direct visual access to windows, the others had not.		of variance (MANOVA) were used.
9. Dinç, P. 2009. Gender (in)difference in private offices: A holistic approach for assessing satisfaction and personalization. Journal of Environmental Psychology 29, 53–62.	Empirical survey **examining the effect of gender on user satisfaction** with different environmental variables and on personalization in private offices in the Academicians' Block of the Faculty of Engineering and Architecture of Gazi University in Turkey.	210 full-time academics completed the survey. All of them had a private office.	Questionnaires including 66 items measuring user satisfaction etc. Personalization was measured through personal display items, autonomous behaviour and office layout preferences.
10. Fischer, G.N., Tarquinio, C. & Vsicher, J.C. 2004. Effects of the self-schema on perception of space at work. Journal of Environmental Psychology 24, 131–140.	Empirical survey study examining the **effect of a person's self-schema on his/her perception of the work environment.** The self-schema is a cognitive structure containing generic knowledge about oneself and one's usage of organize, summarize and explain one's behaviour.	50 participants which were white-collar professionals from ten French companies were responded to the survey.	Two questionnaires were used, one measuring professional failure and success and the other one measuring different aspects of the workplace, sense of privacy, job satisfaction and perceived job performance.
11. Leather, P., Beale, D. & Sullivan, L. 2002.	Empirical study examined the **effect of noise on psychosocial stress for office workers** in	128 respondents completed the question-	The questionnaire measured various features of the physical work environment, job design

Reference	Method	Participants	Procedure
Noise, psychosocial stress and their interaction in the workplace. Journal of Environmental Psychology 23, 213–222.	the U.K. The starting point in this study is the idea that features of the physical environment have both a direct effect on outcomes and an indirect effect mediated by either psychosocial work elements and other physical elements.	naires in the offices of a local government finance department in the U.K.	characteristics, attitudes to work and the workplace, and self-reported health and well-being. Objective noise was measured with a sound level meter.
12. Brennan, A.; Chugh, J.S. & Kline, T. 2002. Traditional versus open office design: A longitudinal field study. Environment and Behavior 34, 279–299.	One of the few longitudinal studies **investigating the effect of relocating workers from private offices to different-type open offices** within a large private organization.	21 participants completed the surveys. No control group was available.	A measure was developed for the assessment of worker satisfaction with the physical environment, physical stress, co-worker relations, perceived job performance and the use of office protocols (e.g., “telephone conversation noise”). The surveys were completed at three measurement intervals: prior to the move to the new location, four weeks after the move and six months after the move.
13. Danielsson, C.B. & Bodin, L. 2008. Office type in relation to health, well-being, and job satisfaction among employees. Environment and Behavior 40, 636–668.	Empirical study **investigating the effect of office type** (enclosed cell office, shared room office, small open plan office, medium-sized open plan office, large open-plan office, flex office (including different types of spaces for different kinds of tasks but no individual workstations) and combi office (based on teambase space)) **on workers’ health and job satisfaction.**	469 workers from 26 different companies completed the questionnaire.	The questionnaire including 141 items measures health and well-being, satisfaction with the psychosocial work environment and the work itself, and the physical environment and architectural design. Multivariate regression models were used to analyse these effects with adjustment of the effects of age, gender, job rank and business type.
14. McElroy, J.C. & Morrow, P.C. 2010. Em-	Empirical survey examining the effects of **office redesign and generational differ-**	271 workers responded to the survey in a finan-	The online questionnaire included four scales measuring workspace perceptions (office

Reference	Method	Participants	Procedure
ployee reactions to office redesign: A naturally occurring quasi-field experiment in a multi-generational setting. Human Relations 63, 609–636.	**ences on workers' perceptions** of their workstations, of the organization's culture and attitudes about their work and the organization. The aim of the redesign was reduce costs (less room for individual workers), promote more collaborative culture, increase more positive work-related attitudes and manage more effectively different age generations.	cial service organization in the U.S. Of those 271 respondents, 127 moved to the new office and 144 did not move.	space adequacy, distraction, department layout and meeting space), six scales measured perceptions of the organization's culture (formalization, professional culture, innovation, flexibility of management, altruism and collaboration) and four measured attitudes about work and the organization (overall job satisfaction, co-worker satisfaction, affective organizational commitment and perceived organizational support). Respondents were grouped to three classes Baby Boomers (born before 1965), Gen Xers (born between 1965–1977) and Millenials (born after 1977).
15. Stokols, D, Clitheroe, C. & Zmuidzinas, M. 2002. Qualities of work environments that promote perceived support for creativity. Creativity Research Journal 14, 137–147.	Empirical study examining the **workers' perceptions of support for creativity** at work as a possible mediating factor between objective measures of distracting stimuli and subjective appraisals of social climate, on the one hand, and job satisfaction and personal stress, on the other hand.	97 supervisory and staff-level workers participated in the study at the University of California.	Questionnaires were completed assessing the workers' perceptions of support for creativity, job satisfaction, personal stress and ratings of physical and social features of the workplace. Moreover, objective measures of environmental conditions were performed. Stepwise regression analyses were carried out to study the relationships between predictor (social climate and environmental distraction), mediator (perceived support for creativity) and outcome (job satisfaction and personal stress) variables.

Reference	Method	Participants	Procedure
16. Anjum, N., Paul, J. & Ashcroft, R. 2005. The changing environment of offices. Design Studies 26, 73–95.	Questionnaire survey in the U.K. examining the **responses of office workers to various aspects of the office environment**.	950 office workers responded to the survey.	The questionnaire includes items on 1) appearance of office in relation to work, 2) movement area, 3) proximity or closeness to other employees, and 4) size of workspace.
17. Sailer, K. & Penn, A. 2009. Spatiality and transpatiality in workplace environments. In: D. Koch, L. Marcus & J. Steen (Eds.), Proceedings of the 7th International Space Syntax Symposium. Stockholm: KTH.	Method A multi-layered methodological approach (including evidence from ethnographic observations, short and in-depth interviews and questionnaires) was used to provide information of the **relationship between organisational behaviours and spatial configurations.**	Not mentioned.	A series of case studies was carried out in Germany and U.K. between 2005-2008 including a university, a research institute and four media businesses
18. Ivory, C. & Alderman, N. 2009. The imagined user in projects: Articultaing competing discourses of space and knowledge work. ephemera 9, 131–148.	Case study focusing on discussions within a large university over the choice between **open-plan versus cellular office.** Close reading of the argumentations for and against these alternatives is carried out.	Five senior members of the organisation were interviewed.	In-depth interviews & discourse analysis
19. Fried, Y., Slowik, L.H., Ben-David, H.M. & Tiegs, R.B. 2001. Ex-	Possible moderating effects of **job complexity and organizational tenure (i.e. experience level) on associations between workspace**	93 workers in a large university in the USA.	Workspace density was measured as the total number of workers within a radius of 15 feet of the target worker. Job complexity was as-

Reference	Method	Participants	Procedure
ploring the relationship between workspace density and employee attitudinal reactions: An integrative model. Journal of Occupational and Organizational Psychology 74, 359–372.	**density and job satisfaction** was empirically investigated.		sessed by a questionnaire using ten items from the Job Diagnostic Survey (Hackman & Oldham, 1980). Organizational commitment was measured by items developed by Cook and Wall (1980). Organizational tenure was estimated by the number of years and months the workers have been employed.
20. Jahncke, H., Hygge, S., Halin, N., Green, A.M. & Dimberg, K. (in press). Open-plan office noise: Cognitive performance and restoration. Journal of Environmental Psychology.	Psychophysiological and cognitive effects of office noise and restoration was experimentally investigated in a simulated open-plan office.	47 participants from the University of Gävle, Sweden	Cognitive performance was measured by different kind of cognitive tasks (e.g., cognitive and response inhibition tasks). Fatigue was measured by the Swedish Occupational Fatigue Inventory. Also physiological measures of stress (cortisol and catecholamines) were included.

2.4 Employee well-being

2.4.1 Employee well-being and knowledge-intensive work

There is a huge amount of literature about health and well-being in the workplace. One of the key reasons for the popularity of the theme is the recognization that health and well-being may have negative impacts on employees. Well-being can be viewed as including all the satisfactions enjoyed by individuals in their life (Danna & Griffin 1999). Health is considered as a subcomponent of well-being comprising various psychological and physiological indicators (Warr 1987). Typically, well-being can either refer to the actual physical health of workers as indicated by physical symptomology and rates of physical illnesses or to the mental, psychological and emotional states of employees (Danna & Griffin 1999).

Affective well-being is considered as one component of mental health, as well as competence, autonomy, aspiration, and integrated functioning (Warr 1987). According to Diener (1984), subjective well-being reflects a person's self-expressed happiness and satisfaction with life, and there is excess of positive affect over negative one. Subjective well-being is some kind of ideal condition that people like to aspire, and it can be considered as a synonym to life satisfaction.

Danna and Griffin (1999) consider well-being as a general concept that takes into consideration the whole person. Within organizational research, the term could include both generalized job-related experiences such as job satisfaction and job attachment as a well as more specific dimensions such as satisfaction with salary and co-workers (Danna & Griffin 1999). Various objective and subjective measures are used in well-being research. Commonly utilized self-report indexes include measures of job satisfaction, life satisfaction, anxiety, depression, personality, perceived stress, and psychosomatic symptomology measures.

Occupational stress can be defined as the harmful physiological and psychological responses when the requirements of the work does not match the individual's capacities. According to Cooper and Marshall (1978), occupational stress can be classified into six categories: factors intrinsic to the job itself (e.g., work overload or underload, shift work, travel, new technology), role in the organization (e.g., role ambiguity, role conflict and the degree of responsibility for others), relationships at work (e.g., relationships with superiors, colleagues, and subordinates), career development (e.g., job insecurity), organizational structure and climate (e.g., lack of participation, poor communication, consequences of downsizing) and home/work interface.

According to transactional stress model (Lazarus & Folkman 1984) stress is a result of negative appraisal. According to them, there are two identifiable steps in the appraisal process: 1) a person must decide whether a particular stimulus is positive, negative or irrelevant for one's health and well-being, and 2) the person must decide how to cope with the perceived stress. Two coping strategies have been identified, problem-focused and emotion-focused coping strategies (Lazarus

& Folkman 1984). Problem-focused coping directly confronts the stress-causing event, some aspects of the environment or one's own behaviour; in emotion-focused coping the individual tries to manage cognition and emotions directly. Social support could modulate the effect of stressful life events. According to Lazarus & Folkman's model, the individual's perception and appraisal of a particular situation as well as his/her abilities to cope with demanding factors play a crucial role in the emergence of stress. According to Warr's (1987) vitamin model, there is a curvilinear relationship between an employee's health and increased job demands (amount of collaboration, decision latitude, use of qualifications and skills) – increased job demands is thus considered as a potential risk to overload and stress.

According to the model shown in (adapted from Danna & Griffin 1999), well-being is affected by three kinds of preceding factors. One set of factors are related to the work setting itself including different kinds of hazards that may have a negative impact on well-being among workers. The second set of factors include various personal characteristics which may play a role in determine the extent to which a particular individual will show signs of high or low-levels of health and well-being. Thirdly, occupational stress has also an impact on health and well-being. According to this model, there are also two interrelated sets of consequences of health and well-being in the work context: One set of consequences include various kinds of physical, psychological and physiological consequences; the other set includes various kinds of organizational consequences such as business productivity, absenteeism and health insurance costs. There are also different kinds of interventions which have an impact on preceding factors, consequences and health and well-being as such. (Danna & Griffin 1999).

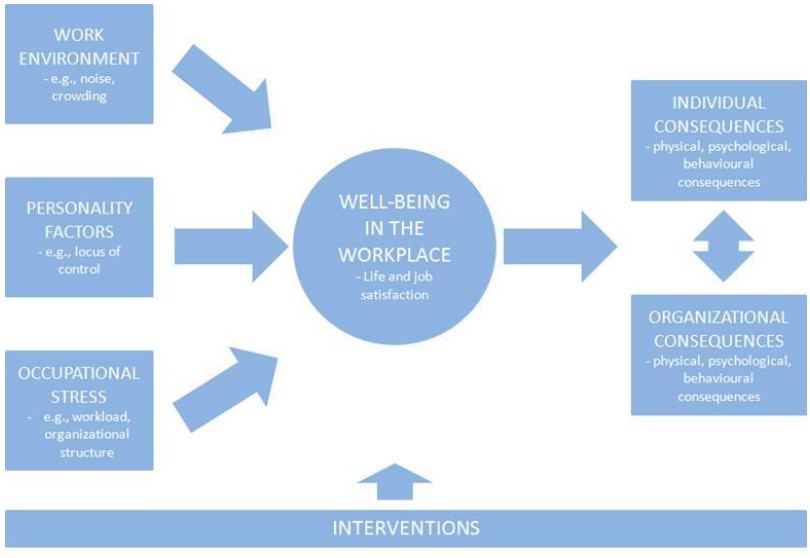


Figure 5. General framework for well-being in the workplace (adapted from Danna & Griffin 1999).

Well-being and New Ways of Working

Telework has suggested to provide a cure for a variety of organizational and social problems in the workplace (Bailey & Kurland 2002). For example, it has been suggested that it provides a route to a better work/private life balance. However, according to Bailey and Kurland (2002), there is little evidence of increased job satisfaction among teleworkers. For example, even though some interview studies suggest that workers enjoy freedom and flexibility of working at home, there is no clear empirical evidence of higher satisfaction among teleworkers. On the other hand, a meta-analysis by Gajendran and Harrison (2007) showed that the correlation between telecommuting and job satisfaction is positive suggesting that telecommuting has a slight positive impact on job satisfaction. One reason for that may be that telecommuting offers greater opportunities to adjust work task with non-work and family activities.

Golden and Veiga (2005) found a curvilinear relationship between the extent of telecommuting and job satisfaction. This finding, supporting Warr's vitamin model, suggests that employees are the most satisfied with their jobs at moderate levels of teleworking. Their findings can be explained by suggesting that at moderate levels of teleworking people have more opportunities to utilize the benefits of social interaction provided by face-to-face interaction and thus fulfil better both individual and organizational needs, whereas at higher levels of teleworking social isolation would increase, reducing thus people's job satisfaction (Danna & Griffin 1999, Virick et al. 2009).

Findings of Virick et al. (2009) support the evidence of a curvilinear relation between the level of teleworking and job satisfaction. Their results also suggest that the relationship between teleworking and job satisfaction depends on which kind of criteria are used in workers' evaluation. When objective criteria (output control) are used, job satisfaction is at the same level regardless of the level of telecommuting; when subjective criteria (e.g., monitoring of employees) are used, job satisfaction is the highest when the level of telecommuting is at the moderate level.

Richter et al. (2006) found that work in virtual teams has more elevated job characteristics which is linked to increased symptoms of stress. There was a curvilinear relationship between health and increased job demands which is in accordance with Warr's vitamin model.

There is thus some evidence that telework may increase flexibility, which has a positive influence on both work and personal life. On the other hand, several characteristics of telework and mobile virtual work may cause mental workload, increased amount of working hours, role conflicts, personal concerns, and especially increasing amount of organizational and procedural regulations and diminishing contacts with colleagues (Richter et al. 2006). Overall, when working at home, the balance between work and private life is important, and people need strategies to separate work life and non-work life (Richter et al. 2006).

2.4.2 Evaluating employee well-being in distributed work

The evaluation of work well-being in a distributed work environment is becoming increasingly important. According to Pyöriä (2009, 39), stress and work exhaustion are extensive issues nowadays for knowledge intensive organizations. The complexity of distributed work adds different strains for the employees than regular onsite work (Kokko & Vartiainen 2006, 22). According to Vartiainen et al. (2005, 89–93) the strains of distributed work include 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. 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). 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. 2007). In order to control the problems arising from distributed work, organisations should carefully plan the work arrangements to support the requirements of the work. In their research in developing an evaluation concept for the well-being of mobile employees, Hyrkkänen et al. (2011) emphasize the role of occupational healthcare, as they discovered that the existing evaluation tools for well-being at work have not considered the changing requirements of the working environment, which is why there was a need to create a concept based on the strains of mobile and distributed work. Hyrkkänen et al. (2011) have created their

evaluation concept around six complexity factors identified in mobile work in terms of well-being; *travelling, multi-locational work, working in different cultures, the shifting of work hours, project work* and *interaction via electronic tools.* If these factors are well managed, the working environment can increase the well-being of employees (Hyrkkänen et al. 2011, 13).

Hyrkkänen et al. (2011) have categorised these complexity factors into straining elements, which should be considered in evaluating the well-being of an employee. In travelling the straining elements are the amount of travel days, the length of travel days, the departure of return from the travel during the hours of 23–06, crossing of time zones, working right after travelling if there is no possibility to rest during the travels and long flight times. In multi-locational work the straining elements are the amount of different workplaces, the distance of the different workplaces, the ergonomics and work conditions of the main office, home, other workplace, transport vehicles and the places meant for spending free time. In working in different cultures the straining elements are communicating and managing with a foreign language and a multi-cultural environment. In the shifting work hours the straining elements are the amount of work hours in a week, the possibilities to influence the work hours, the spreading of work hours, working across different time zones and time spent on recovering. In project work the straining elements are the amount of on-going projects, the amount of new projects starting in a year and the protocols regarding the starting and finishing of projects. In virtual interaction the straining elements refer to the qualities of the virtual tools; their weight, and vision or hearing demands and the psycho-social factors in the virtual space, for example feeling of presence and belonging into a community.

To evaluate these straining elements, Hyrkkänen et al. (2011) have developed a model, in which a basic mapping of the situation is done before going to a more detailed examination of an individuals work. The first step is to identify the organisations and individuals working in a mobile manner. The target is to have a concrete idea about the amount individuals, teams and units working in a mobile manner, so further examination can be done. The second step is to conduct individual and group surveys or interviews regarding the straining elements of mobile work. If there are a lot of straining elements identified, a more detailed and thorough examination on individual employees should be done. For this Hyrkkänen et al. (2011) recommend for example a well-being calendar, where the employee utilizes his or her electronic calendar to evaluate straining and recovering situations during a work week, or a smart phone application designed for the evaluation and recording of emotions and factors affecting the work multiple times a day, or to examine the pulse with a heart rate monitor few times a day during work tasks and discussing the results in a reflective meeting with experts from the occupational health care, so further actions for improving the well-being can be planned.

In their earlier research on mobile work and well-being, Hyrkkänen and Vartiainen (2005, 244–246) emphasised also the importance of discussion and creating guidelines and practises that support an individual's distributed work, and how necessary it is to train and familiarize the employees into their mobile work and agreed work tasks, as the meaning of work time diminishes. This is seen particu-

larly important 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). Also the individual factors, the social support of the work community and functional coping methods help control the stress and increase the well-being in a distributed work environment (Kokko & Vartiainen 2006). The evaluation concept created by Hyrkkänen et al. (2011) is a good start for organisations to consider the strains of the work of their mobile employees; however, more research is needed to ensure the well-being of a distributed organisation in the future.

2.5 ICT for the knowledge worker

ICT has often been named as one of the key ingredients in the very definition of knowledge work, (Pyöriä 2005). Although ICT is often though to reduce manual work and help the worker to concentrate on the contents of their work, ICT has also created new possibilities in which workers can be distracted from their work by interruptions, e.g. in the form of e-mail and social media.

Lees and Thomas (1998) described five basic design principles of how ICT tools could support, be used or are used by knowledge workers. The authors' main idea is that most ICT tools are designed for the "bulk" and thus are a hindrance to knowledge work. The design principles are summarized below:

1. Support the individual to support the organization; systems should support the individual needs of the worker and the work context.
2. Don't automate, support knowledge work; "big" systems can inhibit knowledge work since they are inflexible.
3. Subordinate technology to social processes; take into account the social context and collaboration with peers.
4. Support the on-going action of work; put effort into designing technologies that support the overall process of knowledge work.
5. Individuate technologies to maximise personal benefit; worker gives a personal input to the organisation, and thus technology should maximise the workers personal benefit.

The authors also give examples of information artefacts, i.e. computers, laptops, handheld devices, mobile phones, teleconferencing etc. that could fulfil the design principles. In their conclusions, the authors also suggest further work, including a longitudinal observation study of the technology usage in the course of knowledge work.

McFarlane and Latorella (2002) reviewed experimental and applied evidence of the effects of interruptions on work. Interruptions, whether they be a phone ringing or an e-mail requiring immediate attention, have many reported adverse effects: reduced ability to recall details of an interrupted task or to begin a task after an interruption; reduction of efficiency; and they can also cause personal stress or make people do mistakes. Decreased performance was especially important when

people were engaged in cognitively demanding tasks. People also have individual differences in how well they can cope with interruptions while multitasking or handling human-human communication.

The authors also review interruption management behaviours, which are responses to the onset of an interruption, e.g., oblivious, intentional, or unintentional dismissal of interruption, or performing the interruptive task to completion before resuming original the interrupted task. Computers and their user interfaces could be designed to facilitate handling the timing of interruptions and resuming the task. For example, an e-mail application can give some control to the user over when to read their incoming messages. More advanced, intelligent agent - based interruption handling methods are also briefly described. Humans naturally can manually try to schedule their own work according to expected interruptions.

In a similar manner, an experimental study by Oulasvirta and Saariluoma (2004) showed that interruptions can cause, in addition to forgetting, distortions of main task representations. Erroneous representations can result in frustration and loss of time, and can make people search for information in a wrong place or using wrong methods, ending up with biased or distorted conceptions of the material that they are studying, The authors suggest that people should try to minimize the number of uncontrolled interruptions while working on material requiring attention, although interruption design should also be incorporated in interface design.

Many New Ways of Working, which were described in the previous section, have been at least partly enabled by the development and deployment of ICT. For example, mobile workers have a great need for ICT tools that support their work. Mobile work and ICT has, accordingly, been addressed from several viewpoints, such as the use of mobile phones and palm computers, costs of technology and usability in mobile systems in general (see Andriessen and Vartiainen 2005).

Perry and Brodie (2005) summarized their findings on several technological implications of mobilization of work:

- mobile workers valued lightweight mobile technology for low-effort and quick-to-operate interactions that do not distract from main activity
- mobile workers preferred verbal communication over other forms of interpersonal connectivity
- social awareness should be enabled by mobile technologies although individual privacy should be retained
- mobile technologies should flexibly support work both work practices and individual lifestyles
- mobile workers can be distressed due to social and organizational obligations (e.g. to help colleagues) and accountability of management (e.g. to follow up using location-aware technologies).

Group or virtual work can also be supported by ICT in several ways, mostly by ways of enabling smooth data sharing and facilitating formal and informal interactions between workers. Other themes that emerge from the use of ICT are data security, personal privacy, team awareness, and resuming past work and supporting current tasks.

Teasley et al. (2000) reported of their results about computer supported cooperative work in software development. With collocated teams, there was a need for electronic surfaces to support teamwork. In meetings, people projected electronic images, which they wanted to share with others, on whiteboards and drew on the whiteboard to annotate the images. After the meeting, they wanted to transfer the created material to electronic form. The authors concluded that a smoother transition between shared displays is needed. The transition could be supported, e.g., by combinations of electronic whiteboards, personal workstations or tablets, and large scale printers to print out flip-chart size paper or scanners to input paper-form drawings. For those working remotely, the authors found it important for people to be at work at the same time and be visible and audible through open video connection or video wall for naturally occurring overhearing, and also have collaborative-shared objects available near the audio or video connection. Rosen et al. (2007) have looked into knowledge sharing mechanisms in virtual teams. Knowledge sharing can be done via e-mail, phone, instant or text messaging, electronic bulletin boards and discussion forums, adapting groupware for document dissemination and document repositories, dedicated team webpages, meeting management programs, and chat rooms for informal communications to support social bonds. The authors identified several technology constraints on knowledge sharing such as inadequate technology for archiving and accessing documents, asynchronous communication media hindering decision making, and user unwillingness to use the technology, which caused lapses into old work practices and wasted time. A solution, it was suggested that technology should be simple and user friendly and available to the whole virtual team, and users should be provided with training on new technologies to motivate their use. In addition, use of richer and more sophisticated technologies than e-mail when discussing complex matters should be actively supported.

Streitz et al. (2007) have experimented with office spaces augmented to be shared work environments and how they can be transformed to support communication and cooperation of individuals and teams. The authors implemented ambient led displays to show information of others' activities without constantly demanding their full attention. The purpose was to strengthen social affiliations through enhanced awareness of people's activities, and to develop support for informal communication, chance encounters, coordination and collaboration between collocated and remote teams. The test environment had two remote work spaces of a distributed project team. The participants carried a mobile device, which could be used to control how they appeared to their remote colleagues: visible or invisible, and in which "social role". Instead of video image, the participants were visualized as patterns of dots on a large-scale ambient display. The patterns of dots visualized the general mood of the remote team, the general activity of the remote work space and presence and availability of the team members and their interest in communication. Questionnaire data showed that more interaction took place than before. The participants appreciated feeling the remote site's atmosphere, knowing the number of people present and being aware of them without having a disturbing effect of others' privacy and workflow.

Bødker and Christiansen (2006) examined social awareness in flexible work. They used three prototypes in an open office setting: public and private itineraries, personal panels and ambient awareness cues. The participants were a small group of researchers and teachers or consultants. The authors aimed at creating personal places through electronic panels; in the prototypes, cardboard displays and traditional whiteboards were used to mimic panels, desktop and wall displays. The idea was to display personal information, e.g. itineraries and personal photos, in a non-intrusive way while maintaining the opportunity to share selected information to selected groups of people while preserving privacy. The wall display was found most communal and work well for shared project spaces but least support of individual user attention. Desktop-embedded screen worked for personal use but not for supporting awareness of others. A panel (an extra desk display), was in-between the two other solutions, and thus visible to the user and passers-by. The authors also discussed ways to create ambient awareness of inhabitants of the office while hot-desking and leave traces of presence in virtual world. In their summary, Bødker and Christiansen (2006) concluded that in their prototype findings, technologies such as personal panels could be used to leave traces of current and pending activities for people themselves to return to or share to their colleagues. The authors also reviewed literature on the use of IT in flexible work. Literature often addresses awareness in general; and that the use of technologies focuses on reporting and recording, instead of, for example, creating opportunities for new ways of interacting. Storing of information can also have adverse effects when the stored data is accessed outside of, or even long after, the social context it was intended for and privacy of those involved can be jeopardized.

Mynatt et al. (2003) also studied the usage of whiteboards in conveying awareness information to others. The authors wish to design offices systems that support knowledge workers, and especially look into whether and in what situations the large displays could prove useful. In this paper, the authors examined the usage of traditional whiteboards in offices vs. in public spaces and found that the purpose is different.

A "personal" whiteboard was more likely to be used for very heterogeneous tasks (or writings of different people or at different times) which were naturally clustered in segments. The writings were very context dependent: whereas the writer could use writings indecipherable to others, the writer would easily recall the context when it was written.

An augmented whiteboard was implemented with a touch sensitive surface and projected display. The idea was that the smart board would work like a traditional whiteboard but, in addition, it would recognize different segments and save the data shown – and the context when it was written – so that the user could easily retrieve any data without having to e.g. save the contents in a file and later try to recall a filename. The screen would also allow for flexible management of whiteboard space. Mynatt et al. (2003) also integrated a whiteboard and a desktop. The users would have two desktops, one shown on their own screen and another projected on office walls. A large display would hold a montage of images

("thumbprints") to visualize past activity of the user in a certain context. It would relieve the user of some cognitive load. Several montage designs were attempted.

Semi-public, i.e. available to a limited and known number of people, displays were studied in order to find whether group members could be helped to "maintain an informal work or social awareness of each other's activities". A prototype display included collaborations space, a portrait of group members showing presence/absence, attendance panel and reminders.

2.6 Benchmarking study

2.6.1 Introduction

New WOW has completed two previous benchmark surveys of alternative workplace strategies. The previous survey, conducted in 2009, encompassed 103 companies and covered over 30 questions, from drivers, to approaches, benefits, measurements and change management. The New WOW benchmark survey conducted in 2011 included an addendum with specific questions for the RYM SHOK project for respondents who have implemented New Ways of Working at the next level of detail:

- How important are the following management policies for groups using alternative workplace programs as compared to those not using the programs?
- How important are the following work practices for groups using alternative workplace programs as compared to those not using the programs?
- What are the standard equipment / services provided and paid by your company for employees with assigned versus unassigned workstations (mobile / home-based)?
- What are the common problems your group experiences in alternative work programs?
- What metrics do you use to measure the success of your alternative workplace program?
- How is employee productivity measured in your alternative workplace program?

2.6.2 Research objectives

The research objective is to understand the actual usage of new ways of work by organizations. The study addressed the following questions and goals of the RYM-SHOK project:

Q1. What are the work requirements that are based on business success factors and key performance indicators?

Q2. How do the ways of working and workplace arrangements affect productivity positively/negatively?

Goal S1. To develop methods for the definition of work requirements and work profiles.

Goal S2. To develop methods for the management of change processes from the viewpoint of space management, taking into account the end user perspective.

2.6.3 Research methods

3The New Ways of Working Alternative Workplace Benchmarking Survey, a web-based survey, took place from May 30 to July 15, 2011. The survey was distributed mainly by contacting participants of the 2009 Alternative Workplace Benchmarking Study, and distributing it via the websites of NewWoW and Haworth, as well as with the help of the Workplace Community of CoreNet Global (a leading association of corporate real estate executives). Consequently, the responding organizations are heavily skewed towards the workplace and corporate real estate communities with 61% of them affiliated with CoreNet Global and 43% affiliated with IFMA (international Facilities Managers Association).

143 respondents completed the entire survey, while 74% of them, 106 had an AW program (formal or informal) in place. These respondents represent many Fortune 500 and 100 companies.

TOP FOUR INDUSTRY SECTORS
(These comprise more than half of the survey sample:)

1. Architecture & Design/Construction/Real Estate (25%)
2. Banking/Investment/ (13%)
3. Communications/Computers/Telecom/
4. Information Systems (12%)
5. Manufacturing (12%).

Participation of the A&D/CRE group increased three-fold from 2009 (8%); Manufacturing increased two-fold (2009: 6%), while Banking / Investment/Insurance (2009: 23%) and Communications/Computers/Telecom/IS (2009: 25%) decreased to about half.

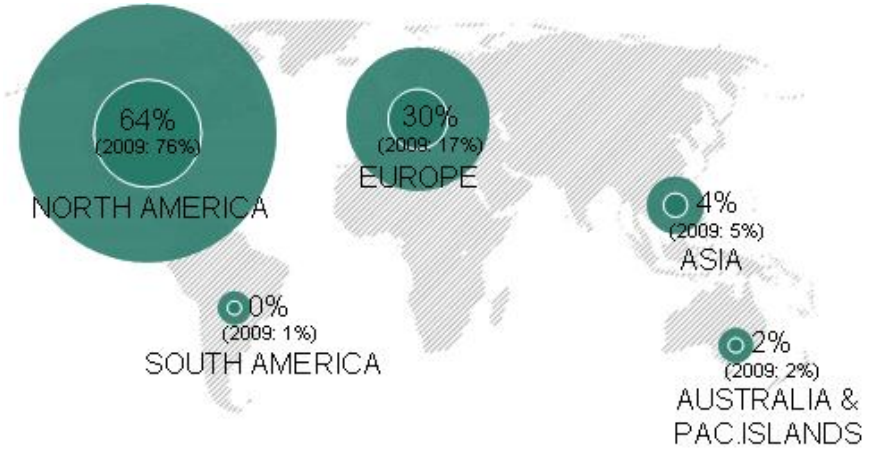
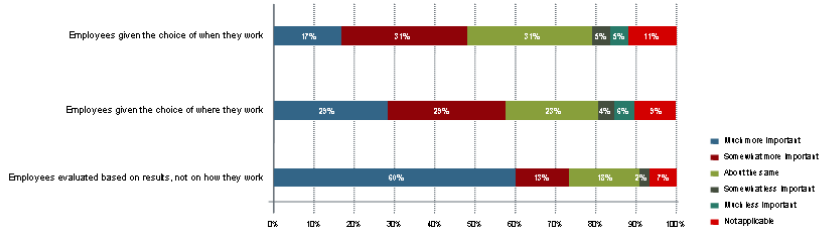


Figure 6. Global distribution of NewWoW Benchmarking study 2011.

2.6.4 Results

2.6.4.1 Important changes in management policies

The chart shows the importance of three management policies for groups using alternative workplace programs, as compared to groups not using the program. Most organizations agree that these management policies – how, where and when employees should work – are more important for groups using AW programs. How these employees work seems to be the most important, however, the majority of organizations (73%) reported that it was much more important or somewhat more important to evaluate employees in AW programs based on results, not on how they work. Where these employees work seemed to be the second most important, as the majority of organizations (58%) reported that giving the choice to employees in AW programs of where they work was much more important or somewhat more important. While still important for 48% of the organizations, when these employees worked seemed to matter the least.



Takeaway

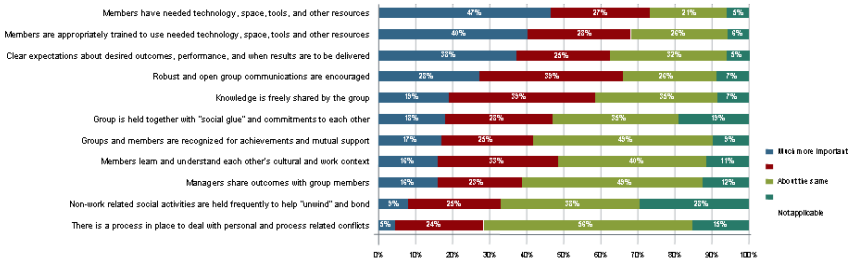
Results matter the most. While it is important to provide choices when and where employees in AW programs work, results matter the most, not how they work.

Recommendation

Measure results with objective metrics and encourage business groups to have management policies that support and reinforce the employees' choices of how, where, and when to work.

2.6.4.2 The importance of work practices for groups using AW programs

The three most important work practices for groups using AW programs were providing employees with technologies, space, and tools; training them to use such effectively; and, providing them clear expectations about desired outcomes, performance, and when results are to be delivered. Just because AW programs are used, it does not mean that space is no longer important. Having technology, space, tools, and other resources was ranked first of all work practices. Although ranked only after space and technology, The "people" factor: clear expectations of outcomes through open communication and free knowledge sharing, is equally important. The remaining work practices were rated by 50% of the organizations as "about the same or somewhat less important."



Takeaway

Clearly, organizations recognize the importance of changing or improving work practices for groups working alternatively. The results suggest that organizations value work practices that are more easily defined and put into practice more highly

than the vague and imprecise. However, the easily defined are not necessarily the most essential: “Clarity of expectations” is the starting point of success factors, and with “An environment of trust,” point to the other work practices. All these work practices are highly interdependent and can reinforce or erode trust. (See Richert 2008).

Recommendation

Providing the necessary technology, space, and tools is essential for alternative work, but don’t overlook changing or improving other essential work practices.

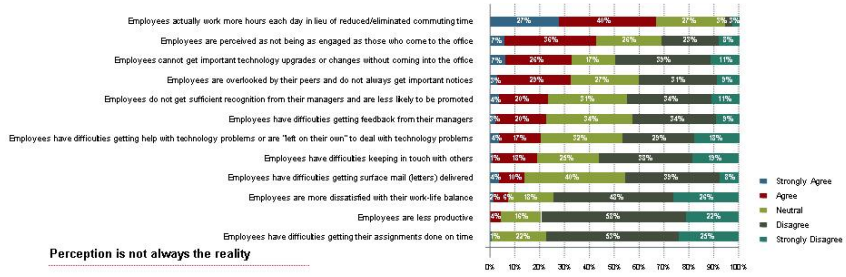
2.6.4.3 Common problems that groups experience with AW programs

Perception is not always the reality

Organizations rated “employees actually work more hours each day in lieu of reduced or eliminated commuting time” as the biggest common problem for alternative work programs. The worry of many managers that workers will “loaf along” when they are not being directly observed is misplaced. Interestingly, organizations with informal programs did not perceive this as serious a problem as organizations as a whole. Could it be that employee problems such as this do not get back to managers due to the informality of the programs?

The other two commonly held anxieties of “remote employees are less productive” and “remote employees have difficulties getting their assignments done on time” were not shared by most of the respondents. These two problems scored as the least common problems (89% and 78% disagreed or strongly disagreed that they were problems, respectively). More respondents (strongly) agreed than (strongly) disagreed to only the top two items in the above chart; this means only these two were perceived as “real” common problems.

The second “real” common problem being “employees are perceived as not being as engaged as those who come to the office is interesting, since although remote workers are “perceived” this way, they definitely do not have problems getting things done on time or being productive (the last two items) – so while engagement is low, this could be explained by the fact that they are not around that much, and are engaged virtually, which is less visible. So this is mainly a problem of perception. Some other “myths” such as “employees have difficulties keeping in touch with others” or they “have difficulties getting feedback from their managers” or “they are less likely to be promoted” were largely disproved, as more respondents (strongly) disagreed with these statements than those who (strongly) agreed. While common problems did not show much difference between organizations with formal and informal AW programs in place, the above mentioned "myths" were stronger at organizations with younger AW programs.



Takeaway

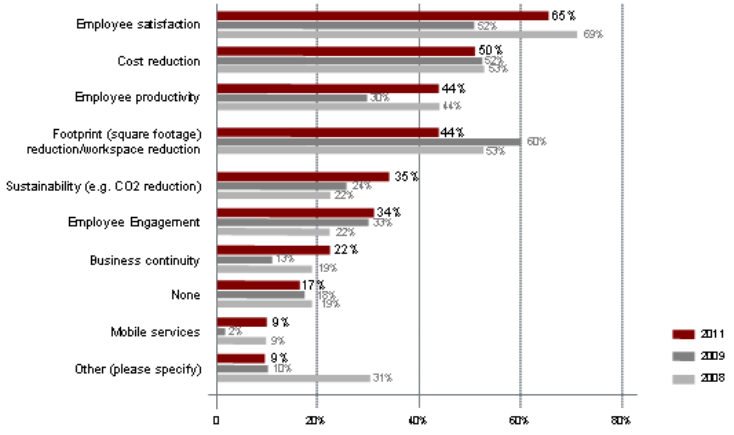
Several of the "myths" associated with remote work, such as remote workers work less hours, are less productive, and are less likely to be promoted, were clearly disproved by data collected from organizations already having AW programs in place. Other research (such as by Gallup Consulting, ”Impact of Globally Distributed Workforce on Employee Engagement,” New Ways of Working, Tertulia, September 21, 2006) suggest that remote employees are engaged as much or slightly more than those working in traditional offices.

Recommendation

Disprove common "myths" associated with remote work by collecting your own data for proof and communicate your results. This will help you remove the guesswork or the "myths" usually associated with remote work. Also, be patient and persistent communicating results,

2.6.4.4 Metrics

Employee satisfaction metrics are back on top in 2011. During 2009, workspace and cost reduction ousted employee satisfaction as the top two metrics to measure success. Cost reduction is still significant however, as it was reported by half of the organizations. Footprint reduction is much less of a metric now than ever before. Employee productivity returns to 2008 level as well.



Takeaway

Gains in footprint reduction have now probably been achieved by most organizations, so the attention returns to employee satisfaction as the war for talent grows even during continued recessionary times. Nevertheless, hard data on cost remains a steadfast necessary metric to gain support for AW.

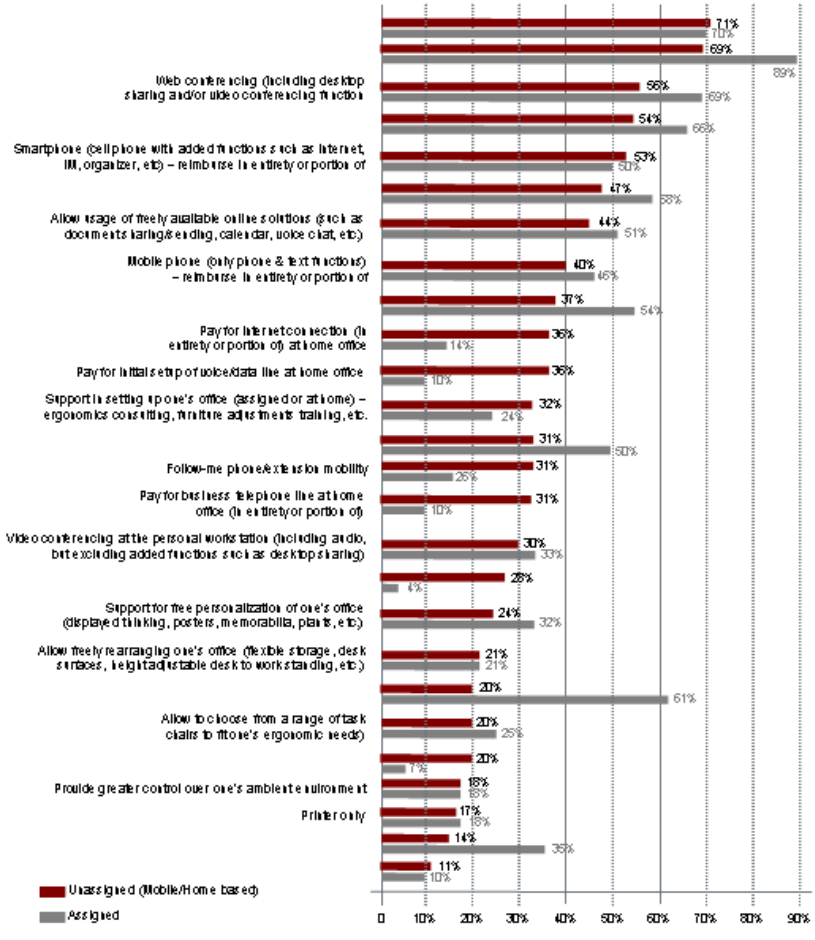
Recommendation

Employee satisfaction, a key metric for retention of employees, is paramount for most companies as the war for talent continues and footprint reduction no longer provides returns due to difficulty in sub-leasing or selling off excess space. However, regardless of this key indicator of success, costs must still be understood for senior management to fully understand AW value.

2.6.4.5 Supporting technologies

Assigned workers already "armed" with mobile technology tools

For unassigned employees, laptop (notebook) computer, email, web-conferencing, instant messaging, and smartphone represented the top 5 categories: these equipment/services were provided to unassigned employees by 71% of companies. By contrast, for assigned employees the top 5 categories were email (89%), web-conferencing (69%), instant messaging (66%), desktop computer (61%), and audio-only conferencing (58%). The top 5 categories were the same from 2009 to 2011.



An unanticipated but understandable finding was that more assigned employees (89%) were provided email than unassigned employees (69%). It may be that unassigned employees use others means to communicate, such as IM or text messages on their smart phones. Another interesting finding was that It is It is interesting to note that email, web-conferencing, and instant messaging were in the top 5 categories for both unassigned and assigned employees – the only difference between these two groups was that assigned employees have desktop computers instead of, or in addition to, laptops or notebooks, and that they use audio-only conferencing more than smart phones (logical, given that they are more "tethered" to space). Not surprisingly, the biggest gap between what was provided for assigned and unassigned employees were desktop computer (41% difference), landline phone set (21% difference), and multi-functional printer/scanner/copier device (19% difference). while those organizations with informal AW programs are less likely to support setting up employees' home offices, as compared to organizations with formal AW programs – the former pays for setup and usage of home

internet and phone almost in the extent of the latter. They might not have such supporting services formally in place, but seemingly employees find a way to get reimbursed for such "incidental" costs. There is no significant difference of equipment/services priorities for organizations with informal programs.

Takeaway

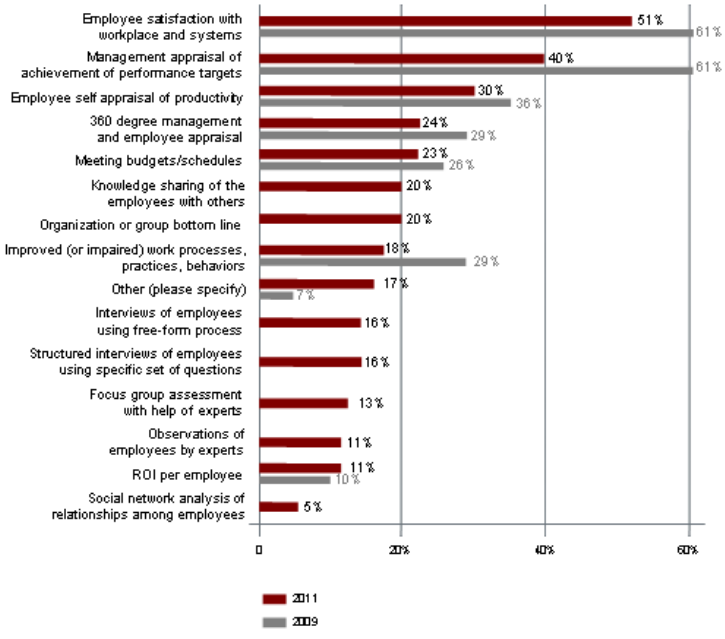
Assigned employees already have most of the technology support tools that unassigned employees have. This is good news, when a potential trial for AW program is under consideration. Other data (see the Barriers to Program Development and Expansion chapter) also support this, as technology/IT support was less of a barrier for the development or expansion of AW programs.

Recommendation

Think longer term when providing technology support for all workers. A dollar saved today by providing desktop computers and landline phones to employees might be a huge expense when changing these to laptops and smart phones tomorrow to support a potential alternative workplace program roll-out. Standardizing technology equipment based on mobile workers can pay off, even if a formal AW program is not under consideration, as it not only enables more internal mobility, but also standardizes IT support and procurement. If you want to accurately measure true overhead costs for AW programs, do not restrict reimbursing mobile workers for various expenses (internet and/or phone at home), as they are already expensing such costs.

2.6.4.6 Measuring productivity

Forty-four percent of responding organizations use employee productivity for measuring the success of their AW programs. Methods for measuring productivity, however, remain mixed, but results are similar to findings of the 2009 survey, however, there is some notable uptick in employee knowledge sharing, use of employee interviews, focus groups, and observations of employees. This aligns with increased focus on the employee value proposition as a driver for AW. Results and discussion



Takeaway

As employee satisfaction returned as the key success metric in 2011, the importance of understanding how employees work leveraging AW options becomes more critical.

Recommendation

Gathering employee data regarding how employees leverage AW options to achieve success and report satisfaction is critical for driving program improvements and growing support with senior management. Direct employee data helps build a more robust benefit statement that can then be compared to cost.

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- Workplace Productivity Consortium.

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Dirks (Better Workplace) Jim Creighton (New Ways of Working) Joe Aki Ouye (New Ways of Working) Marg Long (HP) Nils Gersberg (Zurich University for Applied Sciences) Reza Ahmadi (Jones Lang LaSalle)

In keeping with the spirit of the study, the team met entirely virtually using teleconferencing, Webex, Google Documents, and Dropbox. Joe Aki Ouye, NewWoW, and Gabor Nagy, Haworth led the study. Nils Gersberg, ZHAW prepared the final survey, analyzed the outcome and prepared the initial results. Joe Aki Ouye and Gabor Nagy prepared the final report. Tina L. Tilton, Haworth did the copywriting and copyediting work, and Ben Smith, Haworth prepared the graphic design for this final report. Finally, we are especially thankful to all the people and organizations who responded to our survey. We welcome your comments, especially your advice for improving our next (2013) biannual Alternative Workplace Benchmarking Study. Please go to www.NewWoW.net to post your comments.

3. Approach for developing New Ways of Working

When talking about methods in social and behavioural sciences different things can be meant. On the one hand, we have methods that can be used in gathering knowledge and evaluating the designed system. These different ways to collect data, and analyse and evaluate it are typically called research methods. Research methods can be classified in many different ways; one of the most typical distinction is between quantitative and qualitative methods. Quantitative methods concern manipulation and analysis of numerical data by using statistical estimation or interference. Qualitative techniques are subjective methods that emphasize the meanings of the information which has been acquired. On the other hand, we have methods that are used in system design. Typical methods that are used in the design phase are prototyping, scenario based design, task-centered design and participatory design.

In the development of work environments and practices all kinds of research methods can be used to measure different types of variables. First, we can measure things either from an objective perspective irrespective of people's evaluations or from the subjective perspective of an individual or a group of people. Subjective measures are based on people's conscious and introspective judgements and descriptions. Questionnaires, interview techniques, ethnographic methods and focus groups are typical tools that provide subjective estimates of different types of variables. Second, we can focus our analysis on individuals or some group of individuals (Stokols 1987). Our perspective is dependent on the issues we are trying to explain. For example, if we are interested in the effects of teleworking on an individual's job satisfaction and productivity, our focus is on an individual employee; but if we are looking at the effects of teleworking on a company's business productivity, teleworking can be considered as an intrasystem factor (Stokols 1987). Thirdly, we can consider individuals and environmental factors as independent entities and analyse the interactive effects of individual and environmental factors on various attributes of satisfaction, well-being and productivity. Another possibility is that we consider individuals and their environments as tightly interrelated within a specific system (Stokols 1987). In the latter case, key unit of analysis represent the interdependencies between individual employees and their environments (e.g., social climate, human-technology fit).

The research was done by reviewing existing literature on knowledge work and New Ways of Working.

A lot of references were identified, of which the most relevant were chosen for this report. Key concepts were identified in the introduction and they are presented in Appendix A.

3.1 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. According to Myerson et al. (2010, 22), companies around the world have begun experimenting heavily with workplace redesign in recent years. 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 & 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 & 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).

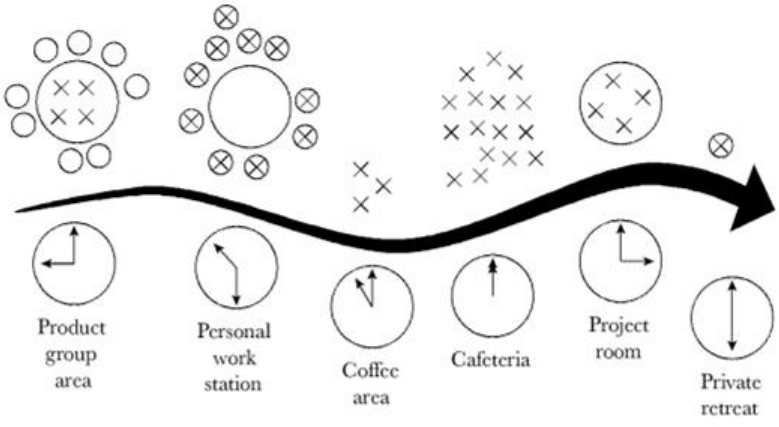

Figure 7. An Activity-Based Workspace (Becker 2004, 32).

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.

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.

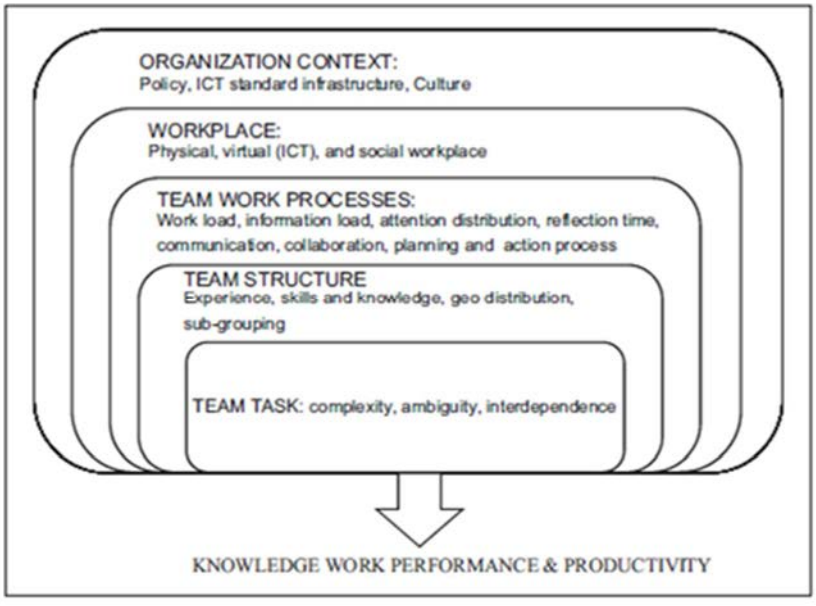

Figure 8. Factors affecting knowledge work in distributed collaboration (Bosch-Sijtsema et al. 2011).

Bosch-Sijtsema et al. (2009b, 2011) identify the main hindrances and enablers of Knowledge Work Productivity (KWP) for geographically distributed teams in global technology companies. Their analysis framework is built around five key factors which influence the performance and productivity of those teams:

1. Team tasks (individual and collective)
2. Team structure and composition
3. Team work processes
4. Workplace (physical, virtual, social and mental workspaces)
5. Organizational context.

Knowledge workers' productivity varies greatly. The sources for this variation are threefold: firstly, the task type ranges from routine to problem-solving and creative kinds; secondly contextual factors both hinder and facilitate the realization of the task at hand and thirdly individuals differ in terms of their knowledge, skills and competencies. Contextual factors range from the elements associated with the physical and virtual environments such as the workspace and communication technologies to those elements emerging from organisational and social spheres such as culture, rewards and leadership.

It is already difficult to observe and measure KW due to its intangible properties and the several intervening factors including team processes that play a part in the daily context of knowledge work. It becomes even more challenging as KW tasks

change from being less individual, routine and fixed to becoming more variable, complex, ambiguous, interdependent and distributed.

1. **Team Tasks** set the resource requirements from team members and determine the workflow structure. In new work contexts, knowledge workers juggle multiple tasks which may have different goals. This situation contributes to heightened cognitive and emotional demands. Task Interdependency refers to the degree of interaction among group members. It is common in project-based KW and is generally determined when the task is being planned. The mode of working (for instance face-to-face or virtual) is another aspect to consider when evaluating the productivity of distributed teams. The authors point out that high task interdependence can be an enabler especially at the start of distributed team work because it would support team connectedness by increasing communication, cohesion and trust.
2. **Team Structure** refers to the properties of the team and its constituent members. It includes such properties as size, diversity, location (time & space), tenure, cultural background, prior experience. These properties affect both team effectiveness and performance. The authors refer to various studies which report on enablers and disablers of KW productivity when considering team structure and composition. For instance, cultural and language diversity in global distributed teams can both facilitate and hinder. These differences may lead to coordination difficulties and at times prevent effective communication. The authors warn that the effects of diversity are not conclusive and advise in favour of a balanced diversity within teams.
3. **Team Processes** refer to interactions whereby resources are pooled to meet task demands. Such processes can be cognitive, affective or behavioural. Bosch-Sijtsema et al. (2011) focus on the behavioural aspects such as coordination, cooperation and communication of team members. The authors highlight three team processes as enablers of KW in distributed teams, namely: interpersonal relations (eg. trust, identity, cohesion), clear planning (eg. goals, roles, norms) and activity processes (eg. coordination, communication, participation).
4. **Workplaces** combine interdependent physical, virtual (technological) and social aspects. In Distributed and Mobile Work – Places, People and Technology, Vartiainen et al. (2007) add a fourth dimension, the mental space in order to include the feelings and thoughts making up each individual's personal space through which we perceive and interpret the other spaces. Not surprisingly, Bosch-Sijtsema et al. (2009b) recommend an alignment of the physical, virtual, social and mental spaces to the work activities and requirements of the KW performed.
5. **Organizational Context** refers to the broader organizational system which hosts the team and provides it with an environment to perform the task. Such provisions range from the ICT Infrastructure to Human Re-

sources policies. The authors refer to previous empirical studies which concluded that the quality of the technology provided is positively correlated with team effectiveness, efficiency, performance, commitment and trust among other outcomes. On the disabler side, it is claimed that novel technology may negatively impact team performance, presumably because of the time needed to update learning and adopting use. The authors add that organisational belonging (feeling of identity) along with reward systems which support knowledge work processes at individual, team and organisation levels would constitute enablers of KW as part of a structure, culture and strategy which favours sharing and re-utilisation of knowledge.

Bosch-Sijtsema et al. (2011) applied this framework to 8 collaborative, distributed knowledge work teams from 2 global high-tech companies. Traditional KWP methods were extended with context factors and the results revealed specific challenges for distributed KW in new working contexts. The main inhibitors of KWP are summarised below:

a. **Asymmetry of team configuration:** dynamic and distributed contexts created by New Ways of Working impact team configuration and cooperation mechanisms. In terms of team configuration, it was found that diversity of skills, knowledge, competencies and experiences negatively impact work processes, knowledge transfer, collaboration and increase task ambiguity. In this study a balanced mixture of diversity in the team benefited work processes and increased team satisfaction in collocated rather than distributed teams.
b. **Lack of time and access to resources:** Work processes of distributed teams are also influenced by the context of KW. The 8 case studies testified that team members needed to adapt and readjust their way of working as the workplace context around them changed. Switching between projects, tasks and locations caused cognitive and affective overload. In addition high work and information loads together with a lack of reflection time proved to be detrimental to KWP. Within this study, distributed work settings were disablers of KWP in that task ambiguity and complexity increased, task realisation took longer and face-to-face interactions which normally would enable the coordination of distributed work was scarce.
c. **Impact of physical, virtual and social workplace:** Geographical spread and the changing nature of the workplace due to mobile and multi-location work influence KWP of distributed teams. In the cases under observation, the companies offered a choice of workplaces for KW thereby adjusting the workplace to suit specific tasks thus easing the burden of adaptability on the knowledge worker. Flexible workplaces that support specific tasks, both individual and collaborative, are enablers for effective KW. The authors advise that depending on the task content, complexity, ambiguity and interdependency, team members should be able to choose from a set of workplaces which are integrated into a flexible workplace policy.

d. **Organization context:** The studied use cases provided evidence that ICT infrastructure and workplace policy could be both enablers and disablers. The authors conclude that an organization context which supports distributed collaboration by offering flexible workplaces for remote work, easing knowledge transfer and information sharing while supporting remote team connectivity would be an enabler for distributed, mobile and multilocational KW.

The presented framework focused on 5 key factors which challenge KWP in new work contexts. The authors emphasise the importance of strategic alignment and integration of the organisational units which are responsible for the domains captured by the framework.

3.2 Measuring the impacts of New Ways of Working on knowledge work productivity

3.2.1 Introduction

Research approach

The starting point of this section is the need to prove the impacts of NewWoW change initiatives on knowledge work productivity. A literature review was conducted and the key factors in measuring knowledge work productivity and performance were identified. Hundreds of papers were reviewed from 2000–2011 and the most fundamental ones were selected for a more detailed study. These were examined profoundly and the most important themes are presented in this section. The literature review creates a foundation to this section and other aspects are included to support the entity.

Prior evidence

One important thing learned from the literature is that the nature of knowledge work is multidimensional and complex and very often intangible which has a great impact on measuring and assessing its productivity making it even more difficult. However, there are multiple different approaches and frameworks to measure knowledge work productivity.

Nature of the current studies/What the present research adds to prior research?

Previous literature has focused on studying whether facilities and ICT solutions are appropriate from the viewpoint of an individual knowledge worker. However, there is a lack of studies focused on the actual business impacts of different working arrangements. Also the nature of knowledge work and the factors affecting knowledge work are discussed rather much in the current literature. Although the importance of knowledge work productivity measurement has been emphasized in

the prior research, there is still a lack of the actual generally approved and used measures to asses these various factors.

Background

Knowledge work provides possibilities for remote work, enables time and place independency of work and empowers highly skilful employees to more efficiently create, distribute and utilize their knowledge through various virtual, for example mobile channels (e.g. Markova et al. 2008, Vuolle et al. 2008, Heinonen & Pura 2006). On the other hand, continuous improvement of knowledge work productivity also necessitates new working methods, such as innovation spaces or other physical spaces that support collaborative working methods by bringing people together (e.g., Davis et al. 2011, Elsbach & Pratt 2007, De Croon et al. 2005). New Ways of Working are considered to increase employees working motivation, job satisfaction and most importantly their productivity (e.g., Vuolle 2010, Peponis et al. 2007, Veitch et al. 2007, Robertson et al. 2008). However, also negative impacts, for example, on employees' perceived privacy and job satisfaction have been reported (e.g., De Croon et al. 2005; Maher & von Hippel 2005). The earlier literature points out that positive impact of NewWoW initiatives are not self-evident. Instead, there is a need for empirical evidence on whether a certain way of working is actually increasing employees' or organizations' productivity or not.

The following synthesizes the existing literature on measurement of knowledge work productivity and identifies some key prerequisites and restrictions that should be taken into account when measuring the impacts of organizational change, such as New Ways of Working practices.

3.2.2 Knowledge work productivity measurement

3.2.2.1 Factors affecting knowledge work productivity

Despite the known importance and challenges in measuring knowledge work productivity, there are surprisingly few studies on the topic (Ramirez & Nembhard 2004, Takala et al. 2006, Thomas & Baron 1994). An underlying challenge is the complex nature of knowledge work. Consequently, the nature of knowledge work and various factors affecting knowledge worker productivity have been discussed rather lot in the existing literature. The factors affecting productivity are commonly classified into inputs, processes (transformation of inputs into outputs) and outputs (e.g. Hannula 1999, Stainer & Stainer 1998). It has been regarded as important to examine knowledge work productivity both at the levels of whole organizations and individual employees (Antikainen & Lönnqvist, 2005). Table 2 summarizes the current understanding on the factors affecting productivity of knowledge work.

Table 2. Knowledge work productivity phenomenon.

Perspective	Productivity factor
Inputs	Innovativeness (Drucker 1999, Erne 2010) Personal factors, e.g. satisfaction and motivation (Miller 1977) Knowledge management infrastructure (Mills & Smith 2010) Working environment (Greene & Myerson 2011, Maier et al. 2008) Physical location, virtual (IT) and social workplace (Bosch-Sijtsema et al. 2009b) ICT (Davenport 2008, Maier et al. 2008) Organizational culture and structure (Bosch-Sijtsema et al. 2009b)
Processes	Management of professional's own work (Drucker 1999) Organization of work (Erne 2010) Tasks (Bosch-Sijtsema et al. 2011) Timeliness (Ramirez & Nembhard 2004) Quality of interaction (Erne 2010) Knowledge sharing (Najafi & Afrazeh 2010, Laihonen & Lönnqvist 2011) Team structure/composition (Bosch-Sijtsema et al. 2009b) Continuous learning (Drucker 1999, Erne 2010, Miller 1977) Setting and communication of goals (Miller 1977) Knowledge acquisition (Najafi & Afrazeh 2010) Efficiency and effectiveness (Ramirez & Nembhard 2004)
Outputs	Output quantity (Ramirez & Nembhard 2004) Quality of results (Erne 2010, Drucker 1999) Customer satisfaction (Ramirez & Nembhard 2004)

Many of the above-mentioned factors are by nature intangible and qualitative. Quantity of outputs is rarely specifically mentioned in the literature despite its obvious role in many knowledge work contexts. Qualities of employees, innovation capability and learning as well as outcomes perceived by customers are considered more important. An important issue to note is also the high emphasis of the earlier literature on the process of carrying out knowledge work activities.

3.2.2.2 Measurement challenges and proposed solutions

A fundamental challenge in the discussion on knowledge work productivity measurement is the ambiguous definition of knowledge work and the continuously changing role of knowledge worker (El-Farr 2009, Mládková 2011). Since the content of work varies a lot among personnel, productivity of all the workers is difficult to capture with a single measurement method. At worst, some employees cannot affect the results of collective measures.

There are also several challenges in the technical design of knowledge work productivity measures (Table 3). Many of the measurement challenges are related to capturing outputs. It is difficult to define a standard output unit for a work the content of which constantly varies (Ojasalo 1999). In addition, there is no sense in

ignoring the quality of outputs in knowledge work productivity measurement (Davenport 2008; Drucker 1999), since outputs often have an intangible and qualitative nature. However, despite the quality of outputs is commonly acknowledged as an important factor of knowledge work productivity, it is rarely a part of measurement (Ramirez & Nembhard 2004). In case the outcomes of knowledge work are to be measured there are specific kinds of challenges such as obtaining measurement data from customers who are expected to be impacted.

Table 3. Measurement tools and frameworks in the literature.

Description of the measurement approach	Measurement tool/method	Source
Subjective	Interviewing	Drucker 1999, Ramirez & Nembhard 2004
	Survey/questionnaire	Deakins & Dillon 2005, Janz et al. 1997, Lettice et al. 2006
	Combination of questionnaire and focused interviews (SPM method)	Antikainen & Lönnqvist 2005
Output measurement	Output weighting method	Häkkinen 2008; Jääskeläinen & Lönnqvist 2010
	Monetary output measurement	Grönroos & Ojasalo 2004; Klassen et al. 1998
	Measurement of outcomes/customer value	Merrifield 1994, Sherwood 1994, Ray & Sahu 1989
	Completion rate of defined (performance) goals	Chang & Williams 1999; Ray & Sahu 1989
Multidimensional (performance) measurement	Matrix method	Jääskeläinen & Lönnqvist 2010
	Multi-dimension measurement process (MDMP)	Takala et al. 2006
Statistical methodologies	Data envelopment analysis (DEA)	Paradi et al. 2002

Subjective measurement including both interviews and surveys has been presented as a way to solve some of the challenges regarding productivity measurement in the knowledge work context. Subjective measures are regarded as a pragmatic way to capture complex and intangible phenomena (Lönnqvist 2004). Subjective approach can capture comprehensively various factors affecting productivity instead of the mere calculation of outputs and inputs.

Defining and capturing outputs is a fundamental challenge in knowledge work productivity measurement. Since the measurement of output quantity is rarely enough, various methods have been presented in order to take the qualitative aspects into account. For example, different output types (the diversity of work) may be classified in relation to time needed and weighted correspondingly. A

rather practical way in some instances (e.g., in consulting) is to monitor the completion rate of performance goals defined by customers before service activities.

It is difficult to design a single index comprehensively capturing all the aspects related to the productivity of complex services (Gupta 1995). Even if this is achieved, there is a risk that the result is too complex and difficult to use in daily management. Various productivity measures may act as a part of balanced performance measurement systems based on frameworks such as Balanced Scorecard. With a multidimensional measurement approach it is easier to simultaneously examine quantity and quality as well as tangible and intangible aspects of service provision. This also enables the combination of subjective and objective measures which may not by themselves provide sufficient information. (Jääskeläinen & Lönnqvist 2010) Multidimensional measurement is likely to include surrogate measures of productivity which capture aspects highly correlated with productivity (e.g., absences of employees) but not directly the ratio between outputs and inputs.

Finally, sometimes statistical methods such as DEA have been proposed as a way to analyze productivity of knowledge work. This requires a work context where measurement information can be gathered from a large number of knowledge workers in similar working roles. This is rarely possible in practice.

3.2.3 Measuring the impacts of change

Measuring the productivity impacts of NewWoW intervention is a very specific measurement challenge bringing along its own specific features. The scattered group of studies on the topic of measurement in change settings have examined, e.g., change management interventions (Scharitzer & Korunka 2000), indoor air improvement (Antikainen et al. 2008), implementation of ICT (Davern and Kauffman 2000, DeLone & McLean 2003) and mobile services (Vuolle 2010) and impacts of R&D projects (Herath & Park 1999). Common measurement challenges can be condensed into four points:

- how to identify which factors are actually impacted (Bailey 2011)
- how to take into account the fact that impacts may vary regarding the working role (Antikainen et al. 2008) and organizational level in question (Vuolle 2010)
- how to distinguish the impact resulting from the change in question in comparison to other factors affecting productivity (e.g. changes in business environment) at the same time (e.g. Hill 1977, Kujansivu & Lönnqvist 2009)
- how to deal with the time lag between the change and the realization of impacts (e.g. Davern & Kauffman 2000, Miller 1977).

Measuring the impacts of various changes in organizations is a common setting in academic studies. However, the literature on performance measurement and management has paid rather little attention on the examination of change pro-

cesses (Barbosa & Musetti 2011). Dependent on the content and context of change, performance impacts may be measurable instantly, after a short time or after a long time. Sometimes the impacts are not realized at all. A general aspect independent from the content of change or organizational context is related to the way measurement is carried out as a process. It has been stated that in examining the impacts of change interventions there is a need for measurement before and after the change (Bailey 2011). Scharitzer and Korunka (2000) propose that the impacts of change management should be measured in three phases: one month before intervention, directly after the change and one year after.

In addition to the actual measurement process, the measurement of impacts in a change setting can be examined from the perspectives of what and how to measure. According to Kujansivu and Lönnqvist (2009), the impacts may be examined both from qualitative and quantitative as well as tangible (e.g. increased profit) and intangible (e.g. new skills) aspects. Furthermore, both strategic and operational level effects should be taken into account. Productivity impacts can be examined at various levels such as firm, business process and individual (Davern & Kauffman 2000). Subjective examination including interviews and questionnaires is a common and practical way to approach the issue (e.g., Sitlington & Marshall 2011, Vuolle 2010) due to the complexity of measurement object and the non-repetitive nature of measurement.

In general, performance measurement related to outcomes or impacts is a challenging task. It has been proposed that in knowledge work productivity measurement the focus should be in surrogate measures closely related to the actual working processes (e.g. working atmosphere) (cf. Okkonen 2004) due to challenges in output/outcome measurement. Similarly with the measurement of organizational changes, Taskinen and Smeds (1999) suggest that both the change itself and the impact of change should be measured. As Adcroft et al. (2008) point out, in order to understand a change process there is a need to examine events that trigger the change (reasons for the change, desired results), change program and its management as well as the results from change. Hence, measures related to management of change process may be a practical way to provide relevant information on factors (e.g. the achievement of determined milestones) supporting the route towards the desired impacts.

3.3 Profiles

3.3.1 What is work profiling and why it is done?

As the world of work is changing towards to a knowledge-based on and the type of work is nowadays more based on collaborative and unpredictable environment, the design of the office environment and the style of work should be considered again. The work has a culture of exploration, autonomy and initiative, which is more creative way of working and requires more flexible work environment.

Organisations are wasting a lot of money and effort in putting knowledge workers into one homogenous group thinking that they all work in the same way. Therefore the classification of different type of knowledge workers with different needs has been done. (Greene & Myerson 2011, 19–21.)

What profiling in this case doesn't mean is the segmentation according to role or task. Work profiling is more about individual, creative and autonomous characteristics of the knowledge work and its mostly based on how employees do their work and how do they use their workplaces (Greene & Myerson 2011, 19–21, Rasila et al. 2011, 104).

3.3.2 Basis of work profiling

Profiling or grouping workers can be based on different aspects. It could be done according to generations: Traditionalists(born before 1945), Baby Boomers(born 1946–64), Generation X(born 1965–77) and Millenials(born 1978–1999). According to multiplicity of studies and research by appreciating each age group´s work style, the work productivity can be maximized. All generations have different backgrounds, which mostly affects on expectations, work ethics, attitudes, perspectives and motivators. For example the Generation X and Millenials prefer working from remote locations or telecommunicating while Baby Boomers value more face-to-face communication. (Steelcase 2006; Glass 2007, 99.)

Rasila et al. (2011, 104) is profiling workers by categorizing individual workers based on how they talk about their working environment. The main goal is to understand the end-users needs and through that to help the development of new office environments or improve the existing ones.

The mobility of the work defines the way work is done, which is the reason why it is the mostly used grouping factor. Profiling workers, based on their pattern and characteristics of work has resulted a means to create working environments that take different needs into consideration. (Greene & Myerson 2011, 19–21). Greene and Myerson argues that by separating different levels of mobility, it will be easier for employer to fulfil their needs and to employee to work more efficiently, productively and most probably be more satisfied.

Grouping workers can also be done based on the flexibility of the work like Gibson (2003, 15) argues. She divides employees from the organizational perspective into three types: contractual flexibility, time flexibility and locational flexibility. In contractual flexibility employees have fixed term contracts or are self-employed consultants and outsourced contractors while time flexibility means suitable working hours for both the employer and the employee. Locational flexibility allows employee to work in the most suitable location for himself. (Gibson, 2003, 15.)

3.3.3 Methodology

Rasila et al. (2011, 105) used discourse analysis and content analysis in order to find out different types of employees. The main method in discourse analysis is

simply talking and writing. Writing can also include pictures, photographs or artifacts. In this case the discourse was created from the conversation between a researcher and an interviewee, which makes the researcher part of the study. Content analysis starts with identifying key concept and variables as defined categories. After making the operational definitions, the interviews are done. The base of the content analysis is the data – in this case interviews. Interviews were gone through and defined comments were sorted out. The comments that connect with the first impressions are highlighted and coded using the predetermined codes. (Rasila et al., 2011, 105.)

Greene and Myerson (2011) used five different methods to develop basic profiles. The literature search comb through the previous studies to find out how and based on what knowledge workers have been differentiated. User research was made in two stages. In first stage the knowledge worker profile scenarios were discovered and created interviewing users and in second stage classification was tested by interviews, ethnographical research and user workshops. Graphic tool were used to find out employee mobility by drawing in the paper how they use the office building. Ethnographic studies consist of observing and photographing people over several hours while they were working. All the results were finally tested on user workshops. Participants represented four different work profiles and they needed to define their work patterns and needs. (Greene & Myerson 2011, 21–22.)

3.3.4 Theoretical work profiles

By discourse analysis and qualitative content analysis Rasila et al. (2011, 105) described four different orientations: system orientation, territory orientation, people orientation, and object orientation. Orientation describes from which perspective people perceive their working environment. For example persons with object orientation see the object and the qualitative attribute in the main role. System orientation is mainly the same as object orientation, but it includes the reasoning between the phenomena and the causes. (Rasila et al. 2011, 109–110.) Persons with people orientation reflect the working environment in a social context and perceive the office setting positively even if there are some problems (Ahokas 2011, 32) while territory oriented persons has a tendency to make a big difference between different workplace actors. (Rasila et al. 2011, 109–110.)

Greene and Myerson (2011, 23) defines four key types of worker profiles based on their mobility: the Anchor, the Connector, the Gatherer, and the Navigator (Figure 9).

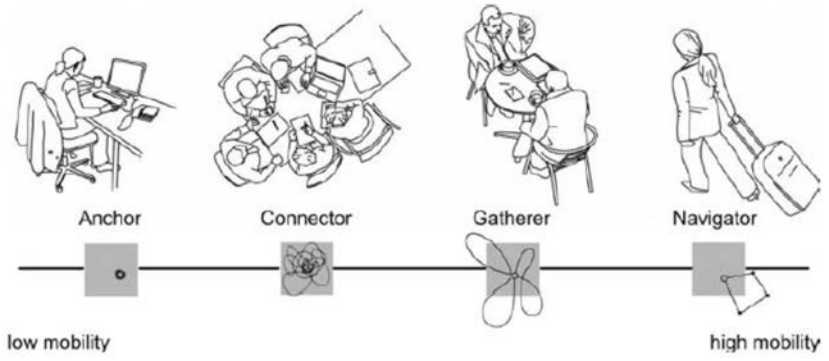

Figure 9. Four profile types based on the article by Greene and Myerson (2011, 24).

- Anchors primarily use their own desks as well as its immediate surroundings, which makes this profile to have the lowest mobility of the four types. Because of the consistent presence at the office, the Anchor is an important source of information. However the Anchor also receives information and processes it.
- Connectors use their own desk space about half the time and the other spaces of office the rest of the time. When Connectors are not at their own desk, they are attending meetings or talking to colleagues. They ensure the flow of information by gathering and distributing it – primarily within their own company.
- Gatherers use their entire offices, yet also move around quite a bit outside of it. The gatherer spends about half of their week outside the main office. They can be found from customer offices or in cafeterias, trains or airports. They are intersection points for knowledge. They collect a lot of information and material in their travels and process that finally at their main office. The gatherer puts great importance on working technology, as they are on the move a lot. They need quiet space for concentration while they are at the office and also spaces for sharing information.
- Navigators rarely use their own offices and often don't even have a desk of their own there. The office has a role of a node in the Navigator's network. They are underway regionally and globally and come to the office to exchange information and attend meetings. A Navigator holds valuable information and their life consists primarily of communication. (Greene & Myerson 2011, 19–30.)

3.3.5 Conclusion

Greene and Myerson (2011, 29) noticed that grouping workers creates better understanding of many different ways of working. Categorization in general is useful in developing and providing suitable workplace solutions and finding out new tools which will match into a variety of worker preferences (Rasila et al. 2011, 109–110). The characteristics of each group create a better picture of employee needs. Considering the needs of all these four types, we have to think something different than just a traditional office space. With one traditional office space it is impossible to respond into anchor´s need for comfort, connector´s call for different type of spaces, gatherer´s demand of reliable technology and networks and navigator´s necessity for feeling welcome. Knowing the needs makes planning the workspace much easier. Considering all these different characteristics and needs the office should be seen more as a complete service with physical, virtual and social aspects. (Greene & Myerson 2011, 27–30.)

3.4 ICT solutions for the future knowledge work

You are late. Your palm-held computer is beeping to remind you of your timetable. You could have stayed at home to attend the virtual meeting, but you decided to take the shuttle bus to a hub centre, where you later plan to have lunch with some old friends. Besides, the hub has state-of-the-art 3D rooms[1] which allow you to use haptic sensors on your hands without the need to use an old-fashioned, clumpy but cheap mouse or touchpad interface.

Your palm computer vibrates. It's connected to the GPS system of the bus and wants you to get off on the next bus stop. The hub centre area is huge. There are multiuse buildings everywhere; atrium yards and street level floors are mostly occupied by lunch restaurants, coffee shops and step-in-step-out hairdressers. Upper and below ground-level floors have dedicated spaces that can be used for hoteling. Since the hub areas are important for people doing both business and informal affairs, most places offer a wide selection of ICT services such as displays embedded on tables in cafés and broadband wlan, in case an unofficial meeting turns out to require ICT[2].

You raise your palm computer to your face level and let it scan the scene. It shows you the HD resolution videostream enhanced with arrows[3] which tells you where to go. If you wanted, you could listen to audio instructions or could have watched the route as a video beforehand.

You arrive at the building which has a contract with your multinational company. The contract includes details about data and physical security and access to certain parts of the building. You like to use hubs like this because you can instantly get to the core of your work without having to bother yourself with practical details[4] such as setting up secure connections. Approaching the outer door, you quicken your pace to take some extra seconds to see if your lunch dates have already gotten to the hub centre area and made suggestions on the lunch place.

The door opens while you approach, recognizing your electronic company tag and id. Once inside the building, you are greeted by a display introducing a mobile agent[5], an interactive computer program at your service which assists you with all your practical issues while you visit the hub. You take a moment and look directly at the screen, allowing the embedded camera to do an iris scan confirming your identity. The agent immediately asks for your approval to retrieve your recent messages and agenda for the day, which you acknowledge with a slight nod. The desktop of the display looks exactly the way you like it, since the agent follows the same standard protocol as most hubs do. You check your messages and nod again to your agent to confirm you are ready to go. The display turns dark, and arrows on wall displays start lighting up leading to the room you booked. Without thinking you allow the agent to lead you to your room.

Once you enter the room, your agent asks if you want a replay of the virtual tour of the available 3D equipment. You refuse the tour since you have used the hub before and know you can rely on the agent to help you online should you need assistance.

The room you selected is plain. Some spaces have cosy armchairs which resemble a dentist's chair that can be tilted back, except there are displays surrounding the head area[6], but this room is furnished only with a chair and a rack for your personal items. All wall surfaces are basically displays or projector screens, including the door, and equipped with speakers to give you a full 3D experience of the ambient virtual meeting place. You decide to go for haptic gloves and sit down. The gloves serve two purposes: there are sensors that track your hand movements while the gloves simultaneously give haptic feedback by lightly vibrating when you touch a virtual object. The gloves provide fast and precise interaction that surpasses that of the motion detection cameras[7] strategically placed on the walls and the ceiling.

Your hub agent informs you all secure connections to your partners are established, including a connection to your own personal mobile agent in the cloud[8]. You allow the agents to organize the wall screens to your usual liking[9]. Then you disconnect the hub agent in order to follow your company's procedure on data security. Without the agent interacting with the hub centre, you are merely using the hub gateway to transmit encrypted data. Your agent in the cloud fetches all relevant files based on your agenda and other contextual information[10] related to work done earlier with the same partners. You also get links to other files that might turn out to be needed. The files automatically visible[11] to your partners are only those that are tagged with their information, although you can manually choose to distribute them further.

The meeting can finally start. Most of the meeting partners appear as they are, but some have chosen to use an avatar[12], most likely because they are from other time zones and work directly from home at late night or very early morning. Nevertheless, an avatar is always preferred over an audio phone connection since facial expressions can be passed on to avatars using personal cameras equipped with facial expression algorithms. You can even virtually shake hands with others wearing gloves.

Since this is not the first meeting with your meeting partners, you have already established joint work practices that best support your work. You have agreed on the use of a shared desktop in the middle of one wall. The desktop displays a montage of images visualizing the previous activities of your current project which helps in resuming the work done earlier[13]. The joint display can also be used like traditional whiteboard for taking freehand notes or presenting ideas to others. Items can be easily scaled for more careful inspection or thrown aside or copied to one of your own walls or palm computer for private use. Printable media is hardly ever needed, because data transfer between all types of computers and display devices is no longer an issue[14]. Writing down or typing notes depends on individual preferences, but all meetings are audio- and videorecorded and sound recognition is used both for voice commands as well as for auto-transcribing[15].

Your meeting is over. Your personal cloud agent updates the files you used during the meeting with contextual tags and calls your hub agent to close all network connections. You get to the lift, lead again by the arrows the hub agent provides, look at the screen on the wall and notice that you have a private message from your friends: the weather is so nice that they decided to eat outside. You acknowledge the message, and your palm gives you new augmented video-image directions to the lunch place.

***

The imaginary scenario depicted above does not have to be science fiction much longer. Most of the devices are already used every day, but the extent of their full capacity in work life is yet to be seen. Some of the devices have been implemented in laboratory surroundings. Creating opportunities for workers for their utilization as depicted above needs shaking the current working practices, but could benefit knowledge workers greatly. Some of the benefits of efficient utilization of the described ICT tools are described below.

[1]Virtual reality environments and 3D labs are already being developed, for example in University of Michigan 3D Lab MIDEN, Michigan Immersive Digital Experience Nexus (Virtual Reality MIDEN 2011). In MIDEN, a user can experience a life-sized stereo virtual environment and interact with virtual objects, e.g. a user can touch a virtual object and feel it by receiving haptic feedback through haptic gloves.

[2]In some stage, computers do a mental disappearance in the sense that augmented everyday objects, which have interactive, communicative or cooperative aspects, are no longer thought of being computers, for example tables need not to be thought as tables with embedded computers but merely as interactive tables (Streitz et al. 2007). The objects can serve dual purposes, both the physical one, e.g., placing a steaming coffee cup on table, and a virtual one, e.g., moving virtual objects on the table. The table then acts as an affordance for naturally occurring interaction, that is, placing objects on it and moving them around.

A casual or informal encounter (e.g. in a café) can turn into a focussed conversation which again requires whiteboards or other tools for visualizing and sharing

ideas. Availability of ubiquitous ICT can facilitate the transition of people from a public place to a private meeting room without the need to worry about cumbersome data transfer from paper to digital.

Bjerrum and Bødker (2003) reviewed nine case studies on new offices, mostly open plan offices but also other more experimental workspaces. They found that the new offices often lack places to dwell and meet coincidentally. Most theories of new office focus on designing space and rooms to support work activities and processes. However, new office seems problematic and appropriate technology is lacking behind. In many offices, peripheral overseeing and overhearing or "at a glance" visibility of group activity constitute to problem solving and teams working. Open office has potential for legitimate peripheral participation, i.e. supports overhearing and -seeing, but lack of shared artefacts (sketches, drawings) can hinder cooperation. Working patterns differ and workplace needs to be rethought since mobile and nonmobile workers need the different office solutions (rooms, furniture, technology). The more people are away, the more important they find their workplace, which provide possibilities for professional and social contact to colleagues. The authors also comment that the transition from a casual place to a more private place needs to be supported. Proposals for technology (wall mounted screens, file transfer, white boards etc.) exist in CSCW (computer supported cooperative work) literature. Other items the authors list that might be needed in new offices are access to peoples itineraries (whether in office or not); personal space (identity, leave material out etc.); project space (e.g. to remind project member of the project state); and right kind of displays for personal or shared access (panel, desktop, wall).

[3]Augmented reality has many applications. The example used here was of a camera image of a scene that was augmented with superimposed information about walking instructions (see e.g. Feiner et al. 1997, Harviainen et al. 2009). Using the camera, the objects in the scene could also be touched virtually by extending your finger. In addition to using the plain camera image itself, camera movement patterns can also be utilized for input.

Benefits of augmented reality applications in areas where visualization is important, such as design and architecture, surgery and medicine etc., are self-evident, although auditory and olfactory senses could also be utilized. Applications could also be benefited from in teaching and learning, as well as in communication media (e.g. a video call of multiple users with augmented information on the participants' identity). The applications for knowledge workers are not so plentiful, and it remains to be seen how augmented reality could be exploited in the future.

In the ICT field, however, augmented reality offers a possibility to reduce the need for physical interfaces for computers, such as keyboards, since any object can act as an interface, let it be a ventilation grid to represent a scroll bar or buttons of a shirt to represent mouse buttons that can be clicked. The current use of PC graphical interfaces can move into the world being an interface (Ishii and Ullmer 1997). A problem that remains with many vision based augmented reality controls is how to convey the information to the user. Goggles portraying video

image can be cumbersome, but mobile phones or any device equipped with a camera and a display or projector could be used as well.

[4, 5]The overall process of doing knowledge work should be supported, including the ICT being an enabler instead of a hindrance in the on-going action of work (Lees & Thomas 1998). Many practical issues related to routine tasks a user has to perform manually with computers could be alleviated with personal digital assistants, or agents.

Bagci et al. (2007) successfully implemented a smart doorplate system in an office building. The regular doorplates in an office building were replaced by touch screens which acted as an interface between the user and a mobile agent. Each user had a virtual mobile agent (possibility for multiple agents was not excluded) that could be given instructions to perform in their name. There were four tasks that the agent (smart doorplates) could be used for: navigating in the building (arrows shown on the doorplates as the user moved in the building, tracked with infrared or radio positioning), receiving notifications of e-mail, reading files and fetching files. Utilizing a service required the user to stop in front of any doorplate and give instructions. The authors also discussed and had considered security and privacy concerns related to using mobile agents.

[6]Dalton et al. (1998) have designed and implemented a personal working environment, a prototype of a smart chair with flat bent screen and touch panel. Mobile knowledge workers could benefit from cheap but smart working capsules in a similar manner as airport sleeping capsules are used for napping.

[7]Motion detection is already available to consumers in game consoles (see also Virtual Reality MIDEN 2011). Ease of interaction is especially useful in office environment where workers need to focus on a project instead of technology (Cook & Das 2007). Examples are gaze-aware interfaces and multi-modal sketching (saving data on both speech and writing on whiteboard), identified gestures and activities to retrieve project information, process images of human hands to use them as virtual mouse, retrieve and display useful information.

Cook and Das (2007) reviewed state of the art of smart spaces and products. Lots of examples of different smart home hardware, applications and products were listed. The authors dedicated a whole section for discussing natural interfaces for smart environments, including motion tracking, gesture recognition, speech processing, and an interactive whiteboard, which stores content in database. For example, an intelligent classroom can infer the speaker's intent and control room settings (lights etc.) or display slides.

The authors speculate that smart environments will pervade our entire lives and increase the productivity of work, and finally save resources, such as water and electricity, since tasks are performed more efficiently. They believe it beneficial if smart environments cover all sorts of spaces, homes, roads, vehicles, airports, offices etc. The smart spaces have a dual task: they adjust according to the individual but can also influence the individual's activity patterns, mood or even state of health and mind. Privacy issues should not be forgotten. Performance measures of smart environments are to be established; measures exist for individual technologies but not for the whole.

[8]Cloud computing relieves the user from carrying around stored data or computing power. It is quite commonly used even though users might not knowingly do so when they use internet services such as webmail or online data backup. Cloud computing, however, has security risks related to data confidentiality, integrity and availability, as well as legal issues (Kaufman 2009).

[9]Personalization of workplace has been found to have an association with employee well-being (Wells 2000). When a workplace is mobile, personalization can no longer be in the form of physical objects. Bødker and Christiansen (2006) have prototyped displaying personal information, e.g. itineraries and personal photos, on electronic panels.

[10, 11]Saving and sharing files is another example of practical computer routines a knowledge worker has to do. The current practice is that the users manually name a file based on what they think best describes the content; however, recalling the name later might be difficult. Mynatt et al. (2003) suggested using informal and context-dependent information (e.g. time, people present) instead of file names. In a similar manner, Streitz et al. (2007) described a smart space which can collect information on what is happening and later suggest that the information might be useful in the current situation. They also address issues related to the boundaries between public and private, which are especially important in smart environments. Users can feel uneasy if they are not aware of what information is shared and with whom. Privacy of ubiquitous computing has been addressed in Lahlou et al. (2005).

[12]Avatars are used as digital representations of people in virtual worlds such Second Life and SmallWorlds. Although avatars and virtual worlds are commonly thought to be for entertainment only, they are nonetheless a means to interact with other people online (e.g. attend seminars, see All things virtual 2011).

[13, 14]Knowledge workers could benefit a lot from ways of supporting the process resuming work (Mynatt et al. 2003, Cook and Das 2007). One aspect is the facilitation of data transfer between computers if work is continued in a different place where it was started (Bjerrum & Bødker 2003).

[15]Auto-transcription and speech recognition are important especially in smart spaces although there are still difficulties with the implementation. Knowledge workers that work with data in the form of audio or speech are likely to benefit from speech recognition since text is easier and faster to search than audio.

Perhaps the greatest benefits ICT can offer to knowledge workers are those that reduce the effort needed to do side tasks, which distract and interrupt the knowledge worker. Side tasks related to ICT can be naming, finding, transferring and sharing files, compatibility issues with files made with different programs or operating systems, and practical things such as making wi-fi connections work or usability issues with programs.

ICT can facilitate communication between people in physically different places and help in sharing ideas through shared virtual desktops. Mobile workers may find cloud computing a solution to safely work outside a stationary office. Those knowledge workers who work with design or need visualization can benefit from augmented reality applications.

A problem with ICT remains with the design of proper user interfaces, whether they are physical or virtual in nature, and usability of ICT in general. Practical matters such as differing file formats between operating systems and even programs cause unnecessary load on users. Knowledge workers need to find the ICT tools that they find best support their own core work. Working with selected ICT tools, however, also require a place to use them. Paperless offices are not likely to appear unless there are means to display the same data in electronic form. In addition, new tools require learning and getting accustomed to New Ways of Working.

4. Conclusions – future needs and opportunities

The distribution of work is seen in this study as being an increasingly critical part of knowledge work in the modern working environment. Distributed work has expanded the concept of 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. Technology has made it possible to be constantly online, which enables the employees to conduct their work tasks wherever.

It has been estimated that distributed knowledge work will increase in the future, which is why organisations should seriously begin renewing their workplace strategies and acknowledge the benefits and challenges distributed knowledge work brings along.

Designing for distributed work places a new challenge for workplace managers and designers. Knowledge workers no longer focus only on one particular task during a work day; the day is composed of different tasks in terms of collaboration and complexity. A concept of activity based workspace has been suggested to support the different tasks conducted during a workday; giving the possibility to work in solitude, or social spaces or group spaces – according to the task at hand. The complexity of the workplace increases, because it is no longer seen only as physical space; the social and virtual aspects need to be considered as well. The challenge of arranging the workspace supportive of mobile and distributed workers should be approached by examining the work requirements of knowledge workers and understanding the work tasks.

Evaluating employee well-being in a distributed work environment is important, as the distribution of work and mobile work add different strains to employees, especially when comparing to regular on-site work. The role of the organization and occupational health is crucial in ensuring the successful conducing of work tasks in distributed work. The complexity factors of mobile and distributed work should be considered accordingly. Organizations should focus on planning the arrangements for distributed work so that they support the employees. It is also important to involve the occupational health in evaluating the well-being of mobile

and distributed workers. Though as evaluation concept has been created, more research is needed in this area.

The core of knowledge work is non-routine problem solving. Knowledge workers are characterized by need to handle abstract knowledge and constantly learn and adopt new knowledge. Knowledge workers do not necessarily need ICT, although ICT is already an integral part of many knowledge workers' everyday work. With the evolving society, physical matter becomes less important and knowledge that workers possess becomes an increasingly valuable asset.

ICT has enabled many New Ways of Working, especially those related to mobile and distributed work. Although ICT has relieved the knowledge workers from many routine tasks, it has created new tasks related to hard-to-understand computer programs that do not fit the task at hand, data sharing, storage and security, or new requirements related to being constantly available to the employer. Currently, the focus is on usability and 'fancy new pad computers'; in the future, the focus will likely shift from the technology itself to how it is used best to support the core work. Perhaps the greatest benefits ICT can offer to knowledge workers are those that reduce the effort needed to do secondary, interface manipulation tasks, which distract and interrupt the knowledge worker.

Since there is a need to describe and study the interactions between people and their work environments, a more complex contextual perspective is needed. By this way decision makers can better take into account all the relevant factors that contribute to their decisions. Analyses based on a contextual perspective could, for example, show that there are complex interactions between different characteristics of New Ways of Working. All the possible implications should be carefully considered when implementing New Ways of Working programs.

The existing literature provides some general ideas for measuring knowledge work productivity as well as the impacts of change interventions. However, there are few studies examining these issues combined, i.e. productivity impacts of change interventions in knowledge work context. A key challenge seems to relate to the elimination of other affecting factors when measuring the impacts of a certain NewWoW intervention. However, in-depth interviews, observation and possibly some statistical approaches might provide a way forward. Future research should concentrate on empirical examinations, since based on the literature review it seems that the actual measurement practices and reported solutions are mostly missing.

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Appendix A: Key concepts

Key conceps are devided in 6 areas

- Nature of knowledge work and its changes
- Work environment
- Employee well-being
- Information technology and the usage of ICT in workplaces
- Organization and management
- Workplace management

1. Nature of knowledge work and its changes

Knowledge work

The creation, distribution, learning, processing or application of knowledge by highly skilled, autonomous workers or teams using tools and theoretical concepts to produce novel, innovative, complex, intangible and tangible results.

Telework

Working arrangement in which workers work off a central office from other remote office or from home, often utilizing ICT technologies for telecommunication with the workplace.

Mobile work

Working arrangement in which workers work off a central office and utilize mobile and other ICT technologies which enable working on the road; in a café, in a hotel lobby, in public transport etc.

Work performance

Refers to the level of workers'job performance. Work performance can be characterized as a multidimensional concept consisting of several kinds of behaviour (e.g., task-specific and non-task-specific behaviours, communication, leadership and managerial skills).

2. Work environment

Physical space/place

A built, tangible environment. Physical places are made for different purposes and different uses, e.g. in the office building one has meeting rooms, office areas, cafeterias etc. When these spaces are in use they are places, which can be classified in many ways: private, semi-private and public places, quiet places, etc.

Virtual space/place

An electronic collaborative working environment or virtual working space. The internet and intranet provide a platform for working places for both simple, e.g. e-mail, and complex communication tools, e.g. collaborative working environments. Virtual places are accessed by different interfaces and there are both individual and collaborative activities one can perform.

Social space/place

Interactions for building shared mental spaces, which requires communication and collaboration, for example, exchanging ideas in face-to-face or virtual dialogues. 'Awareness', 'Presence' are important concepts linked to social spaces. Creation and forming of shared workplaces provide social places for interaction.

Mental space/place

Mental space consists of cognitive constructs, thoughts, beliefs, ideas, and mental states like emotions and sensations. They can be shared with others.

Alternative workplace (AW)

The combination of nontraditional work practices, settings, technologies, and locations that supplement or replace traditional offices.

Social ICT

Information technology that is used in different social areas.

Open-plan office

a large office area with flexible walls; aiming to support collaborative activities

Hotelling (or hoteling)

Reservation-based seating in office environment; workers do not have assigned workstations.

Hub (office hub)

A working facility or office space for mobile or flexible workers offered by a third party; typically equipped with broadband connections.

3. Employee well-being

Job satisfaction

Refers to people's positive or negative attitudes or emotions towards their job. Different aspects of workspace design (closed vs. open office, size of personal space, opportunities to workplace personalisation etc.) have shown to have an impact on job satisfaction. Job satisfaction is typically measured by questionnaires where workers are asked to evaluate their reactions to their jobs.

Career well-being

Well-being can be defined as a person's satisfaction and happiness with life in general, and career well-being refers to affective satisfaction with one's work. One

possible approach is to differentiate three key experiences of well-being, displeasure - pleasure, anxiety – relaxation and depression – vitality.

Occupational stress

Refers to multidimensional effects of work life on workers' well-being. Typically, it refers to negative emotional responses that are caused by discrepancies between work demands and one's ability to manage and meet these demands.

Engagement

Engagement is related to well-being, employee commitment and organizational citizenship behaviour, but it is broader in scope. Engaged employees feel they are attached to their organization emotionally and are willing to do more than it says in the contractual agreement. Engagement is beyond simple satisfaction with the employment arrangement or loyalty to the employer.

Empowerment

One definition is that empowerment is delegation of responsibility down the hierarchy. This way management is able to increase the decision-making authority of employees regarding the execution of their main responsibilities. The more recent approach, which also applies better to this context, defines empowerment as the feelings that are positively valued. These positively valued feelings can be derived directly from a person's cognitions about him- or herself in relation to the task. Empowerment affects individual intention to act, but it might not generate behaviour outcomes directly.

Mental space consists of cognitive constructs, thoughts, beliefs, ideas, and mental states like emotions and sensations. They can be shared with others.

Privacy

Can be defined as one's ability to control amount of contact with others, i.e. one's ability to reveal or conceal oneself selectively.

Territoriality/territorial behaviour

Refers a set of behavioural and cognitive responses that are based on perceived ownership of physical space.

Wayfinding

The adaptive behaviour that allows one move through an environment efficiently in order to find some valuable items in the destination.

4. Information technology and the usage of ICT in workplaces

User interface

A user interface is the system through which people communicate and interact with technology. It includes both hardware and software components. A user interface displays (visual, audio, tactile) information for the user and the user control the system with a control device such as a keyboard.

Mobile technology

Technology which is not stationary and enables working "on the road", i.e. without being dependent on external power supply or network cable.

Smart environment

An environment is to be considered "smart" if it enables certain self-directed (re)actions of individual artefacts (or by the environment in case of an ensemble of artefacts) based on previously and continuously collected information.

Ubiquitous computing, pervasive computing

Information prosessing which is completely integrated into everyday objects.

Human technology interaction

Human–computer interaction (HCI) is the study, planning and design of the interaction between people (users) and computers or other technology.

Computer-supported co-operative work

An academic field focussing on how collaborative activities of co-operating individuals or groups can be supported by means of computer-based systems.

Usability

Refers to the extent to which a system can be used "to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". Usability has thus three main components: 1) effectiveness means accuracy and completeness with which a specific goal can be achieved; 2) efficiency refers to the resources that are spent to achieve the goals, and 3) satisfaction is related to comfortability and pleasure experienced in the use of the system.

Ergonomics

Uses knowledge of human abilities and limitations to the design of systems and organizations to support safe, efficient and comfortable usage.

Physical ergonomics

Refers to the physical interactions people have with technical systems, and how human anthropometric and physiological characteristics affect their performance.

Cognitive ergonomics

Refers to mental processes (e.g., perception, memory and learning) involved in human-system interaction.

User experience

Refers to people's feelings about using a system within a specific context of use, iincluding different kind of emotions, beliefs, preferences, perceptions, responses and behaviours that users have while they are using the system.

User acceptance

Refers to the users' willingness to use technology for the tasks it is designed for.

Technology Acceptance Model (TAM)

Describes the way the perceived usefulness, perceived ease of use of a system and people's attitudes towards it affect their likelihood to use it.

Task-technology fit

Refers to the degree to which a specific technology supports the accomplishment of a set of tasks. Task-technology fit has been specified as the agreement between task requirements, users' abilities and preferences and the functionality of the technology.

Tailorability

Refers to people's ability to adjust a system towards his/her personal preferences, requirements of the task or context of use. Closely related concepts are customisation, personalisation, adaptability and adaptivity.

Customisation

Refers to the modification of the system by its user; in personalisation the change is driven by the system which tries to better serve the user.

Adaptability

Refers to the user's ability to change and adjust particular properties of the user interface

Adaptivity

Means an automatic modification of the user interface.

Social presence

Can be defined as the degree to which people have a feeling of being socially present with other people located at the remote location.

5. Organization and management

Productivity

Productivity is the ratio between output and the input used to produce output. Output refers to the quantity and quality of products or services. Input refers to the type and quantity of inputs used to produce output. (Hannula & Lönnqvist 2002.) This classical definition is valid also in the case of modern knowledge-intensive and service-oriented organisations. However, the characteristics of different contexts need to be taken into account while operationalizing the concept in modern environments. For example, in case of services customer perspective needs to be emphasized.

Partial productivity

Partial productivity is the ratio between output and one type of input used to produce the output. Labour productivity (total output per labour input) is a typical example in this category (Hannula & Lönnqvist 2002).

Total productivity

Total productivity is the ratio between all outputs and all required inputs (Hannula & Lönnqvist 2002).

Profitability

According to Hannula & Lönnqvist (2002) there are two types profitability: there is absolute profitability, which is income minus costs, and there is relative profitability, the ratio between the income minus costs (see above) and the capital input used to achieve income. Although productivity and profitability are closely related concepts, the connection between them is not always unambiguous (Jääskeläinen 2010). For example some external factors (e.g. inflation) may influence profitability even if there are no changes in productivity (Stainer 1997).

Efficiency

Efficiency is the ratio between realized and actual output and the output level, set as a target (Hannula & Lönnqvist 2002). Efficiency can also be seen to be related to utilization rate (Jääskeläinen 2010) and how well inputs are used.

Effectiveness

"Effectiveness pertains to that particular quality of a product or service or process which enables it to achieve the desired change." (Hannula & Lönnqvist 2002). Compared to efficiency, effectiveness takes the quality aspect into account. Effectiveness may also be defined as the ability to reach desired objectives (Jääskeläinen 2010).

Performance

"Performance is a measurement object's ability to achieve results." Performance is always a multidimensional phenomenon and can be examined from different perspectives. It can also be seen widely as a company's ability to maximize profit for all the key stakeholders. (Hannula & Lönnqvist 2002.)

Performance measurement

"Performance measurement is a process used to determine the status of an attribute relevant to the performance of the measurement object." The measurement process includes various phases, such as selecting measures, setting performance goals, calculating the results, reporting the results and acting based on the results and regularly assessing the measures. (Hannula & Lönnqvist 2002.)

Quality

Quality is a success factor which may refer to different characteristics related to products, services or processes of a company. Quality often refers to the ability of a product or service to fulfil customer needs. (Hannula & Lönnqvist 2002.)

Surrogate measurement

Sometimes the factor in the focus of interest, e.g. knowledge work productivity, is too difficult to measure as such. In these cases, it is common to use indirect or surrogate measures. These measures do not capture the focal factor but instead other factors which are known to correlate with it. For example, the motivation and welfare of a knowledge worker are probably related to his / her productivity.

6. Workplace management

Workplace management

Management of workplaces as quantitative resource including processes in design, change and use of workplaces.

Workplace resource management

Integrated workplace management between the stakeholders of physical, virtual and social place, using the defined programs in order to manage the workplace

resource as the process enabling the core organization's goals and processes to achieve their goals.

Change management

"Change management means actions intended to change how the organization works." It has also been said that all management is change management in some way. (Hannula & Lönnqvist 2002.)

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Title	**New Ways of Working –** **State-of-the-Art Report on Knowledge Work**
Author(s)	Iina Aaltonen, Paula Ala-Kotila, Helena Järnström, Jari Laarni, Hannamaija Määttä, Esa Nykänen, Ingrid Schembri, Antti Lönnqvist, Jenna Ruostela, Harri Laihonen, Aki Jääskeläinen, Joe Oyue, Gabor Nagy
Abstract	This report is a State-of-the-Art survey on the main findings of "New Ways of Working". i.e., ways of working that are adapted to the needs of knowledge workers. The introduction of the report presents some background information as well as the grouping af all the concepts found in the references used in this report. The comprehensive list of concepts is presented in the appendix. The report is divided to two main parts. The first part is "The Knowledge Work Environ-ment" including chapters for distributed work, Contextual approach to the workspace design, Contextual approach to the workspace design, ICT for the knowledge worker and Benchmarking study. The bencmarking study is the biannual study made by NewWoW (USA) including this time six additional questions for this Finnsih RYM SHOK NewWoW project. Among the chapters, especially the "Work places at present: a review of recent reseach" chap-ter, includes an insight into recent findings concentrating to 20 carefully selected articles both in a text and table format. The secondon part is "Approach for Developing New Ways of Working" including chapters of workspace management, Measuring the impacts of New Ways of Working on knowledge work productivity, Profiles and ICT solutions for the future knowledge work. The second part also summarizes the key concepts and issues in developing New Ways of Working, including the challenges of measuring impacts. Our results suggest that the core of knowledge work is non-routine problem solving. Knowledge workers are characterized by a need to handle abstract knowledge and constantly learn and adopt new knowledge. Knowledge workers do not necessarily need ICT, although ICT is already an integral part of many knowledge workers, everyday work. With the evolving society, physical matter becomes less important and knowledge that workers possess becomes an increasingly valuable asset. Organizations should focus on planning the arrangements for distributed work so that they support the employees. It is also important to involve the occupational health in evaluating the well-being of mobile and distributed workers. Though as evaluation concept has been created, more research is needed in this area.
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