Tampere University

MIIKKA PALVALIN

Knowledge Work Performance Measurement in the New Ways of Working Context

Tampere University Dissertations 47

Tampere University Dissertations 47

MIIKKA PALVALIN

Knowledge Work Performance Measurement in the New Ways of Working Context

ACADEMIC DISSERTATION
To be presented, with the permission of
the Faculty Council of the Faculty of Engineering and Natural Sciences
of Tampere University,
for public discussion in the auditorium Pieni Sali 1
of the Festia building, Korkeakoulunkatu 8, Tampere,
on 26 April 2019, at 12 o'clock.

ACADEMIC DISSERTATION
Tampere University, Faculty of Engineering and Natural Sciences
Finland

Responsible supervisor and Custos	Professor Nina Helander Tampere University Finland	
Supervisor	Dean Antti Lönnqvist Tampere University Finland	
Pre-examiners	Professor Tale Skjølsvik OsloMet/University of Southern-Eastern Norway Norway	Assistant Professor Daniela Carlucci University of Basilicata Italy
Opponent	Matti Vartiainen Aalto University Finland	

Cover design: Roihu Inc.

ISBN 978-952-03-1054-7 (print)
ISBN 978-952-03-1055-4 (pdf)
ISSN 2489-9860 (print)
ISSN 2490-0028 (pdf)
http://urn.fi/URN:ISBN:978-952-03-1055-4

PunaMusta Oy – Yliopistopaino
Tampere 2019

ACKNOWLEDGEMENTS

I am happy and relieved that the dissertation is finally ready. The process has not felt extra difficult or anything, but it feels very good to have it off the list. I am grateful for all the support I have gotten and all the opportunities that have made it possible for me to work with something I am really interested in. Writing a dissertation is a very educational experience as it gives you a wonderful opportunity to be responsible for a large project and do all the work needed to be done. For me all the planning, thinking and creating was very motivating and felt effortless. However, the dissertation project took long, much longer than I expected, because there were also more difficult tasks. I needed to learn how to manage myself to do the tasks that are not very motivating and require a lot of work before something is ready. Especially the writing part was not my favourite nor something I was very good at. During the process I have improved in writing a lot and even started to like it a bit. The other reason for this process taking up so much time is that the dissertation never was my main goal. It has always felt more like a nice bonus for being able to do interesting research work.

First, I want to thank the supervisors of this research Professor Nina Helander and Dean Antti Lönnqvist. You both made it possible for me to learn how to do research and write a dissertation. I am very grateful to you Nina for your support and guidance during the second half of the process. Your positive and supportive attitude made me feel comfortable while the long days of writing were very strenuous. Antti, you were the one who hired me to do a master's thesis related to a research project. I really appreciate that because without it I probably would not have ever realized that doing research is one of the things I really like. The greatest things about doing research and writing articles, I have learned from you.

Second, I want to thank the pre-examiners of my dissertation, Professor Tale Skjølsvik from OsloMet / University of Southern-Eastern Norway and Assistant Professor Daniela Carlucci from University of Basilicata for your valuable feedback to my manuscript and for recommending it to be published. I appreciate your supporting feedback that made me rework the text one more time to make it even more consistent.

I am very grateful and lucky that I got to join to the Performance Measurement Team because I wouldn't be writing this without it. Virpi Sillanpää, Maiju Vuolle, Aki Jääskeläinen, Harri Laihonen, Henna Salonius, Jonna Käpylä and other colleagues that I got to work with shorter periods of time. We formed the team that I am still remembering with fondness because everything was working so well, we got good results and it was fun. The goal-oriented attitude and continuous encouragement of the team is something I will try to carry with me to future teams I am part of. You are all awesome personalities and it was very easy for me to join the group and start learning how to do research, and I can tell you I learned a lot. I am very happy I got to meet you and really appreciate all the support and encouragement I got from all of you during the years.

I would also like to thank all the other colleagues at the Unit of Information and Knowledge Management. It is always nice to come to work, as the atmosphere is friendly and supportive without forgetting a good sense of humor. My dissertation work started at the Performance Measurement Team at the Department of Information Management and Logistics at the Tampere University of Technology, since then we have had many different names and now I am graduating from the Unit of Information and Knowledge Management at the Tampere University. Fortunately, the administrative and practical support has been very good through the years.

Research cannot be conducted without funding and I am very grateful for all the funding received for doctoral studies and dissertation work. Especially I would like to thank the Finnish Work Environment Fund for the grants that allowed me to focus only on doing this dissertation. Business Finland (formerly TEKES) has been the other major financer through the research projects that allowed me to start doing research. I would also like to thank the Senate Properties (Senaatti-kiinteistöt) for believing in the SmartWoW questionnaire and implementing it as a part of their work environment change process. Your valuable feedback has also made SmartWoW better for practical purposes and the data set would not be as large as it currently is without your help.

Last, I would like to present my most sincere thanks to all my friends and family members. Floorball has a major role in my life and it has been wonderful to meet all of you guys from Soittorasia, of which many of you have then become very good friends of mine. Especially it has been awesome to get company for the lunch breaks to get a break from research work when needed. My parents, Terttu and Tuomo Palvalin, you have had the biggest impact on who I have become and I really appreciate your support for everything I do. My deepest gratitude goes to my wife

Josefina, your support and can-do attitude has allowed me to do the things I like. I have learned many things from you and you have been a great help for finalizing this project and perfecting my English. I also want to thank my two children Lilian and Alvin for reminding me of what is most important in life and simply for being awesome.

Tampere, March 28th 2019

Miikka Palvalin

ABSTRACT

Organisations have always looked for ways to improve their activities in order to remain competitive. To be able to be successful in the long term, it is essential that the plans and decisions are made based on relevant information and knowledge. Performance measurement can offer information for the managers where the biggest potential for improvement is in the current situation and to know after the change whether it has worked out as it was supposed to do. The current need for new performance measurement information has risen as more and more organisations have started to consider their knowledge workers as an asset instead of a cost. The New Ways of Working (NewWoW) concept is created to describe changes where the knowledge worker has the autonomy to choose how, when and where the work is done.

The need for general performance measurement is high as the NewWoW concept is still quite new and there are hardly any previous studies measuring the effectiveness of NewWoW practices. The literature contains many examples of how performance measurement has been examined in specific interventions in many research areas, for example facilities management or information technology. However, while the NewWoW context covers many research areas it should be managed and measured as a whole. Previous literature offers a good framework for research as performance measurement; knowledge work performance and typical measurement challenges are well known. However, there are not many empirical examples for measuring knowledge work performance, especially in the NewWoW context. There are some measurement tools for knowledge work performance, but the measurement focuses on results and the measures for drivers are mostly missing.

The purpose of this study is to understand how to measure knowledge work performance in the NewWoW context and to construct an analytical managerial tool to help measure the organisation's current work practices and the impacts of NewWoW initiatives. In the theoretical section, this study builds a framework for knowledge work performance. The framework suggests that the areas of physical environment, virtual environment, social environment and individual work practices are drivers for well-being and productivity. The thesis uses previous performance measurement literature to build up measures for the context of new ways of working;

secondly, it reflects on how the knowledge work performance measurement practices function in the new context. The study utilizes case studies and a constructive research approach to find solutions to the research problems. Pragmatic philosophy guides the research to provide practical tools for managers. This thesis summarizes the results of five research articles.

The thesis has two main results that fulfil the two purposes of the study. Firstly, the study presents a measurement model based on a general performance measurement development process with adjustments made to meet the special requirements of the NewWoW context. A theoretical framework for knowledge work performance is essential for understanding the context and thus, successful measurement in this context. Secondly, the study constructs and validates a SmartWoW (Smart Ways of Working) tool to support the planning and measuring of NewWoW initiatives. The tool is a survey-based measure, which is easy to adapt for different sizes of workplace initiatives. The tool has proven to have a high practical value as 40 organisations have chosen to utilize it.

The contribution of this thesis is that it presents performance measurement practices in the NewWoW context and offers empirical evidence on how it can be used to identify what should be changed and measure the impacts of changes. The theoretical knowledge work performance framework has been a critical success factor in adjusting general measurement practices to this context. Another contribution of the thesis is the SmartWoW tool and how it can overcome some of the recognized challenges of measurement and provide the necessary information. While both of the results fill the gaps left by previous studies, their value for managers is also high. Both of the results can be adopted as part of continuous management activities.

Keywords: performance, productivity, measurement, knowledge work, management, workplace, change, new ways of working

ABSTRACT IN FINNISH (TIIVISTELMÄ)

Organisaatiot ovat aina etsineet keinoja kehittää toimintaansa pysyäkseen mukana kilpailussa. Jotta organisaatio voisi menestyä myös tulevaisuudessa, on tärkeää, että kehityssuunnitelmat ja –päätökset perustuvat mahdollisimman hyvin tietoon. Suorituskyvyn mittaaminen tarjoaa tietoa johtamisen tueksi missä työympäristömuutoksissa olisi suurin potentiaali tällä hetkellä, sekä tietoa ovatko tehdyt muutokset olleet onnistuneita kuten oli suunniteltu. Nykyinen kiinnostus ja tarve uudelle mittausinformaatiolle on syntynyt, kun yhä useampi organisaatio on alkanut ajatella työntekijöitään voimavarana pelkkien kulujen sijaan. New Ways of Working (NewWoW) –käsite on kehitetty kuvaamaan työympäristömuutoksia, joissa tavoitteena on lisätä tietotyöntekijöiden mahdollisuutta itse vaikuttaa siihen, miten, koska ja missä työnsä tekee.

Tarve yleiselle suorituskyvyn mittaamiselle on korkea koska tällaiset isommat työympäristömuutokset ovat edelleen melko uusi juttu, eikä aiempaa kirjallisuutta tämän tapaisten työympäristömuutosten vaikutuksista ole kovin paljoa. Aiempi kirjallisuus sisältää paljon esimerkkejä yksittäisten työympäristömuutosten mittaamisesta monilla eri tieteenaloilla, esimerkiksi tilankäytön tai teknologian hyödyntämisen osalta. Kuitenkin kun puhutaan laajasta työympäristömuutoksesta, jossa koko johtamisen luonne muuttuu kontrolloinnista luottamukseen, on tärkeä, että muutosta johdetaan ja mitataan kokonaisuutena, jossa yhdistyvät mm. tilat, teknologia ja johtaminen. Aiempi kirjallisuus antaa hyvät lähtökohdat tutkimukselle, sillä suorituskyvyn mittaaminen, tietotyön suorituskyky ja mittaamisen haasteet ovat hyvin tiedossa. Kuitenkin käytännön esimerkit siitä miten tietotyön suorituskykyä mitataan ovat vähissä, varsinkin työympäristömuutosten osalta.

Tämän tutkimuksen tarkoitus on lisätä ymmärrystä miten tietotyön suorituskykyä voidaan mitata työympäristömuutosten (NewWoW) kontekstissa ja kehittää analyyttinen johtamistyökalu, jolla voidaan saada tietoa organisaation nykyisistä työskentelytavoista ja mitata muutosten vaikutuksia. Työn teoreettinen osuus rakentaa aiemman kirjallisuuden pohjalta viitekehyksen tietotyön suorituskyvystä, jonka mukaan fyysinen, virtuaalinen ja sosiaalinen ympäristö sekä yksilölliset työskentelytavat vaikuttavat siihen työntekijän työhyvinvointiin ja tuottavuuteen. Työssä hyödynnetään aiempaa suorituskyvyn mittaamisen kirjallisuutta ja testataan,

kuinka yleisesti käytetty mittaamisen prosessi soveltuu tähän kontekstiin. Työssä hyödynnetään case tutkimusta ja konstruktiivista tutkimusotetta tutkimuskysymyksiin vastaamisessa. Käytännönläheinen tutkimusfilosofia ohjaa tutkimusta kohti käytännönläheisiä johtamistyökaluja. Väitöskirja vetää yhteen viisi aiemmin julkaistua tutkimusartikkelia.

Väitöskirjalla on kaksi keskeistä tulosta, jotka vastaavat tutkimuksen tarkoitukseen. Ensimmäiseksi työ esittelee tähän kontekstiin mukaillun mittaamismallin perustuen yleiseen suorituskyvyn mittaamisen prosessiin. Keskeisessä osassa mittausprosessia on kirjallisuuden pohjalta rakennettu tietotyön suorituskyvyn viitekehys, joka auttaa hahmottamaan mittaamisen kokonaisuuden. Toiseksi työ kehittää ja validoi SmartWoW (Smart Ways of Working) työkalun tukemaan työympäristömuutosten suunnittelua ja vaikutusten mittaamista. Työkalu on kyselypohjainen ja se on helposti sovellettavissa eri kokoisiin työympäristömuutoksiin. Työkalu on osoittautunut hyödylliseksi käytännön johtamisessa, sillä sitä on käytetty jo 40:ssä organisaatiossa.

Väitöskirjan kontribuutio on siinä, että se esittelee suorituskyvyn mittaamisen käytäntöjä uudessa kontekstissa ja tarjoaa käytännön kokemuksia siitä, miten sitä voidaan käyttää tunnistamaan kehitystarpeita ja mittaamaan kehitystoimien vaikutuksia. Teoreettinen viitekehys on ollut keskeisessä roolissa siinä, että yleisiä suorituskyvyn mittausperiaatteita voidaan hyödyntää tässä kontekstissa. Toinen kontribuutio on SmartWoW työkalu ja kuinka sen avulla voidaan aiemmassa kirjallisuudessa esitettyihin mittaamisen haasteisiin ja tuottaa johtamisessa tarvittavaa tietoa. Vaikka työ täydentää hyvin aiemman tutkimuskirjallisuuden aukkoja, sen arvo myös käytännön johtamiseen on suuri. Molemmat työn keskeisistä tuloksista ovat suoraan otettavissa käyttöön päivittäisessä johtamisessa.

Avainsanat: suorituskyky, tuottavuus, mittaaminen, tietotyö, johtaminen, työympäristö, muutos, new ways of working

CONTENTS

List of Figures

List of Tables

ORIGINAL PUBLICATIONS

Palvalin, M., Lönnqvist, A., & Vuolle, M. (2013), Analysing the impacts of ICT on knowledge work productivity, Journal of Knowledge Management, Vol. 17, No. 4, pp. 545-557.

Palvalin, M. & Vuolle, M. (2016), Methods for identifying and measuring the performance impacts of work environment changes, Journal of Corporate Real Estate, Vol. 18, No. 3, pp. 164-179.

Palvalin, M., Vuolle, M., Jääskeläinen, A., Laihonen, H., & Lönnqvist, A. (2015), SmartWoW – constructing a tool for knowledge work performance analysis, International Journal of Productivity and Performance Management, Vol. 64, No. 4, pp. 479-498.

Palvalin, M. (2019), What matters for knowledge work productivity?, Employee Relations, Vol. 41, No. 1, pp. 209-227.

Palvalin, M. (2017), How to measure impacts of work environment changes on knowledge work productivity – validation and improvement of the SmartWoW tool, Measuring Business Excellence, Vol. 21, No. 2, pp. 175-190.

In joint papers I-III, the author's contributions are the following. In paper I, the paper with Antti Lönnqvist and Maiju Vuolle, the personal contribution was mostly related to the empirical part of the paper including the majority of the collected and analysed data. In reporting, the contribution also focused on methodological and empirical parts of the paper with additions to other sections. In paper II, a joint paper with Maiju Vuolle, the personal contribution focused especially on methods 2 and 3 by developing the methods and collecting data. In reporting, the contribution focused on analysing and reporting the methods. In paper III, a joint paper with Aki Jääskeläinen, Harri Laihonen, Maiju Vuolle and Antti Lönnqvist, the focus was on developing the SmartWoW questionnaire. The personal contribution included collecting examples from previous studies on the topic and forming a SmartWoW framework and survey with other authors. Collecting, analyzing and reporting empirical data were also personal contributions with assistance of the other authors. The papers IV and V do not have any other authors.

1 INTRODUCTION

1.1 Background and motivation for the study

Since the days of Taylor, organisations have tried to increase their workers' productivity. Knowledge work productivity is a relatively new topic, but it has been researched both directly and indirectly for several decades (Pyöriä, 2005). Drucker (1999) has even stated that knowledge worker productivity is the biggest challenge for modern work life. Other researchers have also discovered that the performance of an individual knowledge worker is the most important factor for organisational success (e.g. Miles, 2005; Groen et al., 2012). One important change in thinking took place in 1999 when Drucker urged management to see knowledge workers as an asset instead of a cost that needed to be controlled and reduced as Taylor had considered manual workers (Ramirez & Nembhard, 2004). However, to manage this important resource, it must first be accurately measured (Drucker, 1999).

Measurement information on knowledge work performance is needed both in daily managerial activities and in demonstrating the impacts of development initiatives. Investments are usually measured in order to compare between different projects, rank projects in terms of organisational priorities, justify investment requests by management, control expenditure, benefits, risk, development and implementation of projects, provide a framework that facilitates organisational learning, and facilitate mechanisms to decide whether to fund, postpone or reject investment requests (Irani and Love, 2002). It has been suggested in the knowledge work context that the purpose of measurement should be oriented towards facilitating the employees' performance instead of formal control (Amir et al., 2010; Groen et al., 2012).

Increasing competition and a constant need to increase productivity are concerns for organisations, government and media. Recently, in Western cultures, an increasing number of organisations have initiated large-scale changes as a solution to increase productivity (Appel-Meulenbroek et al., 2011; Ruostela et al., 2015). This concept is called New Ways of Working (NewWoW) and the idea involves giving the knowledge worker more responsibility for how work is done, while management

focuses on results; thus, the knowledge worker has more autonomy and the flexibility to choose how, when and where the results are created (Van der Voordt, 2004; Van Meel, 2011). This solution is fairly topical as the level of information and communications technology has reached a certain height in many organisations. Flexible working requires that all workers have mobile tools that easily facilitate access to their organisation's information systems, regardless of location (Ruostela et al., 2015; Van der Voordt, 2004). Use of NewWoW could make massive changes in organisations, covering the entire work environment (physical spaces, technology and management practices). Typical NewWoW change starts with changes in the physical environment, where personal desks are changed to shared desks and different zones. This change requires many changes in management and work practices. Organisations are willing to initiate these changes as they will receive direct benefits through decreased occupancy costs (Ruostela et al., 2015) and, at least in theory, more satisfied and productive workers (Kattenbach et al., 2010). Assessing the last, however, is still somewhat unclear because the measurement of the effects of changes in the work environment on knowledge work productivity is challenging (Drucker, 1999; Laihonen et al., 2012). This has made understanding knowledge work productivity and its drivers in a more comprehensive way a topical issue.

Current interest towards improving work life has raised the need to measure the work environment and work productivity to understand the phenomenon better. From the scientific point of view, current enthusiasm about making major changes to the work environment and especially implementing activity-based offices are very interesting. However, there is little to no evidence about how this might affect knowledge work (Ruostela et al., 2015). The magnitude of these types of changes for organisations is so big that they should not be undertaken without clear evidence that the result will be good (Duffy, 1999). In practice, organisations still make many changes when they believe that the result will be good. This is not very wise, as Fitzgerald (1998) shows that, for example, it is not self-evident that a certain information and communication technology (ICT) service will have a positive impact on productivity. Laihonen et al. (2012) have explored the measurement of the impacts of NewWoW and developed some conceptual measurement models, but the literature lacks empirical experience on applying these measurements in practice.

The literature contains examples of how NewWoW has been examined in specific interventions for example in the physical environment (Haynes, 2007; Gorgievski et al., 2010), virtual environment (Jacks et al., 2011) or social environment (Halpern, 2005; Kelly et al., 2011). As highlighted above, productivity is a common dependent variable in many research areas. However, Drucker (1999) has argued that knowledge

work productivity should be managed as a whole. To be able to manage as a whole, it is also needs to be measured as a whole. Davenport et al. (2002) support Druckers idea and they have recognized the importance of workplace, technology and management as knowledge work drivers, which should be managed and studied together. Nevertheless, the number of studies which include several knowledge work productivity drivers is very low (Riratanaphong & van der Voordt, 2015). A lack of understanding of the holistic implications of adopting new technology or other interventions may lead managers to invest in unproductive changes while refusing to invest in something that would give them competitive advantage. Many researchers (e.g. Adcroft et al., 2008; Taskinen and Smeds, 1999) have found that there is a need to measure both the change itself and its impacts to be sure that the impacts are the result of the current change, not of some random factors. Laihonen et al. (2012) and Okkonen (2004a) for example argue that in the context of knowledge work it is necessary to gather information not only on productivity but also on productivity drivers, for example, work practices. Barbosa and Musetti (2011) agree that the performance measurement literature focuses mainly on the outputs and outcomes and has paid less attention to measuring the change process itself.

The need for general performance measurement is great as the theme is still quite new and there are very few previous studies measuring the effectiveness of NewWoW practices. There is also a need for practical tools for analysing and managing the performance of knowledge work from the NewWoW perspective. Organisations are still planning and making NewWoW changes, without clear evidence of their benefits and without any measurement information. The problem is that the context has proven to be difficult to measure, but measurement is needed to be able to know whether the decisions and changes have been successful or not (Laihonen et al., 2012).

1.2 Purpose of the study and research questions

The purpose of this study is to increase understanding about measuring NewWoW and knowledge work performance. The purpose is two-fold; firstly, the thesis uses previous performance measurement literature to build up the measurement process and measures for the context of new ways of working; and secondly, it reflects on how the knowledge work performance measurement practices work in the new context. The focus on measuring change is strong as NewWoW requires organisations to identify and develop their processes.

The study also has a strong practical purpose to support measurement in organisations by providing practical tools for managers. In the context of new ways of working, managers need information about what should be changed to increase the performance of knowledge workers. Measurement information is also needed to evaluate the impacts of the changes.

RQ 1: How can knowledge work performance be measured in the NewWoW context?

RQ 2: What kind of analytical managerial construct can help measure the organisation's current work practices and the impacts of NewWoW initiatives?

This study finds answers to these research questions by conducting a literature review and providing practical methods from the published research studies. The purpose of the first research question: *How can knowledge work performance be measured in the NewWoW context?* is to find out how performance measurement practices work in the NewWoW context. It includes the performance measurement process identified in the previous studies and test how they work in the NewWoW context. The purpose is to find out what modifications and special characteristics should be taken into consideration in order to succeed in measuring in this context. For example the contexts of knowledge work and NewWoW needs to be understood before building measures. Theoretical framework for knowledge work performance is built using previous literature and it is also tested with empirical data. Typical measurement challenges are well recognized in the previous literature, so the results of this study need to find ways to overcome these challenges. Three methods for measuring knowledge work performance in the NewWoW context are tested and their suitability is reviewed using case studies. The focus is on testing the performance measures. The actual results from NewWoW initiatives are secondary.

The second research question is more practical: *What kind of analytical managerial construct can help measure the organisation's current work practices and the impacts of NewWoW initiatives?* Researchers have presented some ways to measure knowledge work performance, but fewer in the NewWoW context. The purpose of this research question is to create and test practical ways for measuring performance in order to recognize how it could be improved and also to measure the impacts of the change. The measurement approach needs to be available and practical for the managers in the organisations of different size. This research question is answered by using the constructive research approach, which is used to build SmartWoW questionnaire.

The construct will be validated using a constructive research approach market test and statistical tests for convergent and divergent validity. Reliability will be tested using Cronbach's alpha.

1.3 Positioning, scope of the study and key concepts

This thesis belongs in the field of management science and the scope of the study is illustrated in Figure 1.3.1. The contribution of this study is at the crossing point of performance measurement, knowledge work and New Ways of Working. While these three are only narrow research topics themselves, they are part of larger research fields, e.g. operations management and organisational studies. NewWoW is a special case of organisational change; it is not an actual research field, but more like a concept which combines the new purposes of change. Inside the NewWoW "bubble" there are five research areas which are included in the NewWoW discussion as the idea is to deal with them together.

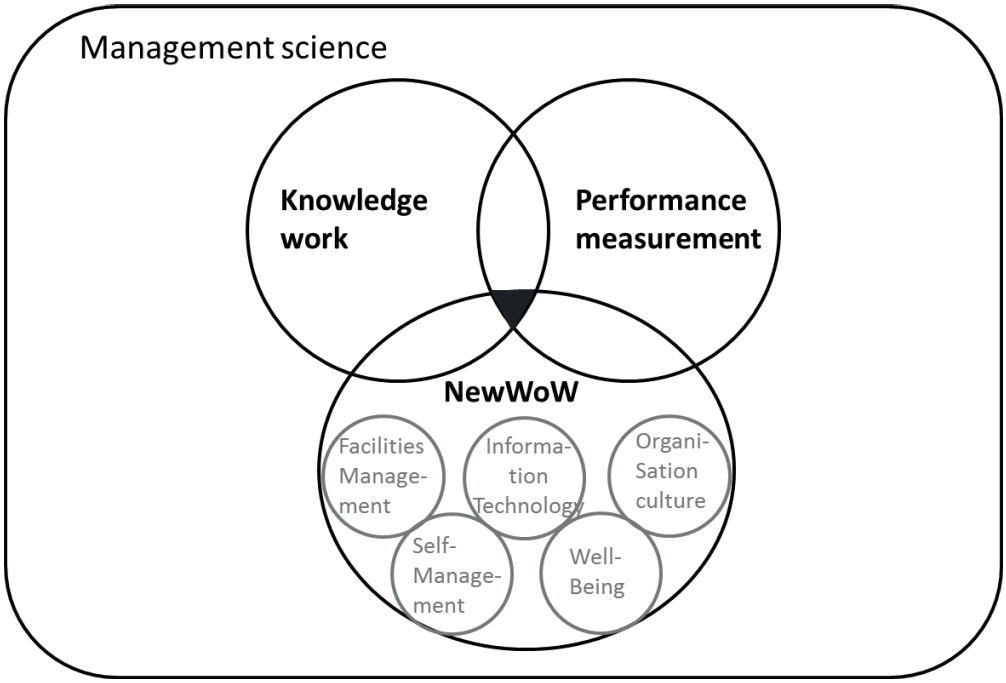


Figure 1.3.1 Scope of the study.

This study contributes to the cross-section of performance measurement, knowledge work and New Ways of Working. The result will be an answer that has to be taken into account when performance measurement is used in knowledge work and especially in NewWoW changes. Previously there have been very few empirical examples of how to measure performance in this context, but this study offers those examples and creates a measurement tool that can be used. The topic of the performance of knowledge work has not been widely studied either and this study will also contribute to that discussion by presenting a framework and testing it with empirical data. The main focus in this study is on the individual knowledge worker. While knowledge work is commonly made in teams and workers are dependent on colleagues and other people, the basic unit remains the individual. Naturally, the focus is also on the organisation formed by the individuals and the results of the individuals are summed together in the organisation.

Performance measurement

Management science has many hierarchical and overlapping concepts and research areas. It all started in the late 19th century when Taylor started using scientific methods in management. Since then, management science has evolved through different phases to its current form. The main focus of this thesis is on performance measurement, which is part of performance management and operations management. The purpose of operations management is to improve production in manufacturing and services (Stevenson & Hojati, 2007). It has been improved through several well-known concepts e.g. lean, Six Sigma and business process re-engineering (Wormack et al., 1990; Pande et al., 2000; Hammer & Champy, 1993).

Due to its background, the concept of performance measurement was originally related to industrial manufacturing and agriculture (Tangen, 2005). According to Tangen (2005), performance can be seen as an umbrella term for all of the concepts that involve examining the success of organisations, e.g. productivity, efficiency, quality, effectiveness, although performance and productivity are very close to each other and depending on definitions they could be seen as synonyms (Koopmans et al., 2011). Productivity is usually defined as the ratio of outputs and resources (Craig and Harris, 1973). This definition of productivity is very close to the concept of efficiency, but differs from it in that the quality of the outcomes is also important in productivity (Drucker, 1991; Parasuraman, 2002). According to Jääskeläinen (2010), the discussion on performance measurement is more established than that on productivity measurement. Kaydos (1999) defines measurement as a way of

providing meaningful and reliable information for managers. Lönnqvist (2004) presented the following definition: "performance measurement is a process used to determine the status of an attribute or attributes of the measurement object". Measurement can be used as part of various managerial activities, for example control, planning and forecasting (Jääskeläinen, 2010). This 'modern' or evolution of balanced performance measurement started in the late 1990s when it was realised that the traditional financial measurements were narrow, history-based and short-term (Neely et al., 2000; Bourne et al., 2000; Vuolle 2011). Since then the evolution has been towards performance measurement, which has focused on the organisational level (Folan & Browne, 2005). Recently, there have been more attempts to apply this type of balanced performance measurement to the individual level as well (e.g. Rampersad & Hussain, 2014).

In this thesis, productivity is seen as a part of performance with productivity drivers. Different research fields use different terms (e.g. measurement, evaluation, assessment and appraisal) to refer to the same process of making a measurement object explicit (Vuolle, 2010). In the field of business research, measurement has been stabilized and is defined as the process of quantifying the action or the results of that action (Neely et al., 1995).

Knowledge work

The concept 'knowledge work' was introduced by Drucker in 1959. It was created to describe the work of employees who use intangible resources as their primary assets. It was also created to distinguish knowledge workers from manual workers. It has been studied in conjunction with the topics of white-collar work and office work, with the term 'knowledge work' becoming established only recently (Okkonen, 2004a; Dahooie et al., 2011). Knowledge work is a relatively new topic, but it has been researched both directly and indirectly for several decades (Pyöriä, 2005). For example, white-collar work was a popular research topic in the late 1980s and early 1990s. While the term knowledge workers has been used to highlight the difference in the workforce compared to manual workers, many research areas study knowledge workers without using the term or as part of the workforce in general. Knowledge is typically defined as something that human beings wish to have; it is information that has some value to someone (Nonaka, 2008). Thus, managing knowledge means managing knowledge workers. The field of human resources management studies many topics and many types of workers and knowledge management is one of them (Soliman & Spooner, 2000). The purpose of human

resources management is to maximize long- and short-term employee productivity (Huselid, 1995). All the previous concepts are about managing human beings in organisations, which is also studied from the angle of industrial and organisational psychology (Den Hartog et al., 2004).

The line between knowledge workers and manual workers is still quite unclear, and some jobs include elements of both (Drucker, 1999). Since Drucker, many scholars have created their own definitions of knowledge work, without reaching a clear consensus on what it actually is (Dahooie et al., 2011; Kelloway & Barling, 2000). Davenport and Prusak (2000), for example, defined knowledge workers as those who create knowledge or those who use knowledge as their primary resource at work. Nickols (2000) also gave a simple suggestion: knowledge work does not involve converting materials from one form to another but rather converting knowledge from one form to another. Thompson et al. (2001) provided a wider definition. According to them, a knowledge worker is a person who has access to, learns and is qualified to practice formal, abstract and complex knowledge.

As stated before, knowledge work can be defined in many ways. This is mainly because knowledge work consists of a wide variety of different professions (Dahooie et al., 2011). For a better understanding, researchers have started to categorise different types of knowledge work. A commonly used classification was created by Davenport (2005), where knowledge work is divided into four types (transaction, integration, collaboration, expert) based on the degree of expertise and the level of coordination involved. Haner et al. (2009) also created a classification for different kinds of knowledge workers. According to Haner et al., three distinctive characteristics of knowledge work exist: complexity, autonomy and newness. Using these, they proposed a very similar classification to that of Davenport (2005). Margaryan et al. (2011) tested Davenport's (2005) classification and argued that 'expert' is the only distinct type of knowledge work. The other classes were not found to be clear in practice. It is common for all knowledge workers that the work involves concentration and collaboration, with the distribution between the two potentially varying considerably (Alvesson, 2001). Even if it is not clear what knowledge work is and how it should be classified, it is possible to recognize some attributes of knowledge work (Dahooie et al., 2011). According to the classifications above and to Pyöriä (2005), knowledge work is unpredictable and needs innovativeness. Collaboration also seems to be important, but at the same time, a balance in concentration is needed (Greene & Myerson, 2011).

At the 'expert' level of knowledge work, everything is intangible, the resources and the outputs (Davenport, 2005). This means the only input or 'resource' is the

knowledge worker himself or herself. Knowledge workers' resources have been studied in the field of organisational psychology, and Campbell in 1990 presented one of the common approaches (Viswesvaranha and Ones, 2000). Campbell (1990) suggested that knowledge worker resources (or input) are a combination of three components: declarative knowledge, procedural knowledge and skill, and motivation. Declarative knowledge is knowing the facts, principles and objectives. Procedural knowledge and skill refer to knowing how to do something. Motivation reflects the persistence and intensity of the effort. If the knowledge worker has all of the resources above, producing the outputs involves concentrating on the task and performing it, but this is not the reality. In current organisations, knowledge work is rarely done alone due to the size of the outputs or the skills required to produce these outputs. Information is also usually scattered among the employees and interest groups.

New Ways of Working

Change is needed in organisations to evolve from A to B as the environment changes (Kotter, 1996). The New Ways of Working is a special type of organisational change, thus it is only a part of research fields of organisational change and change management and further a part of organisational behaviour studies (Griffin & Moorhead, 2011). The concept of New Ways of Working (NewWoW) was created in the field of facility management as the opposite of traditional work practices (Van der Voordt, 2004). The concepts of flexible working, activity-based workplace and workplace change are closely related to NewWoW and have the same kind of purposes (Van der Voordt, 2004, Van Meel, 2011). The concept arises from the needs of modern companies to provide flexible work arrangements and more cost-efficient and creative office environments in order to support competitiveness and employee productivity without decreasing job satisfaction (e.g. Van der Voordt, 2004, Beauregard and Henry, 2009; Kattenbach et al., 2010). Since then, it has evolved to consist of work in information technology, work in management and personal work practices in addition to facilities management (Gorgievski et al., 2010; Van Meel, 2011; Ruostela et al., 2015). New Ways of Working is about change, but the size of the change can vary from very small, like a very specific IT service, to comprehensive change like the whole work environment.

The ideology behind the new ways of working is that good productivity and high satisfaction (and well-being) can be achieved by increasing the autonomy and flexibility of knowledge workers so that they are able to find the best ways of working

for themselves (Van der Voordt, 2004; Aaltonen et al., 2012). Increased level of autonomy requires managers to trust their employees and focus on results instead of how and when the employees are doing their work. (Figure 1.3.2) The NewWoW initiative may have a wide impact on the whole working environment, including physical, virtual and social dimensions. For example, conventional offices are turning into activity-based workplaces to support both concentration and collaboration (Appel-Meulenbroek et al., 2015; De Paoli et al., 2013; Halford, 2005), and some of the tasks can be done in multiple locations, such as home, coffee shops and working hubs (e.g. Koroma et al., 2014). Some aspects of e-mail interactions have moved towards instant messaging and social collaboration tools, and meetings are being held via videoconferencing tools to minimise travelling. Moreover, flexible work policies and trust-based managerial principles have been introduced to support autonomy, progress and the work-life balance (Perlow & Kelly, 2014; Peters et al., 2014). The NewWoW idea consists of applying novel practices and open-minded testing of different options rather than doing things as before without questioning the suitability of existing practices.

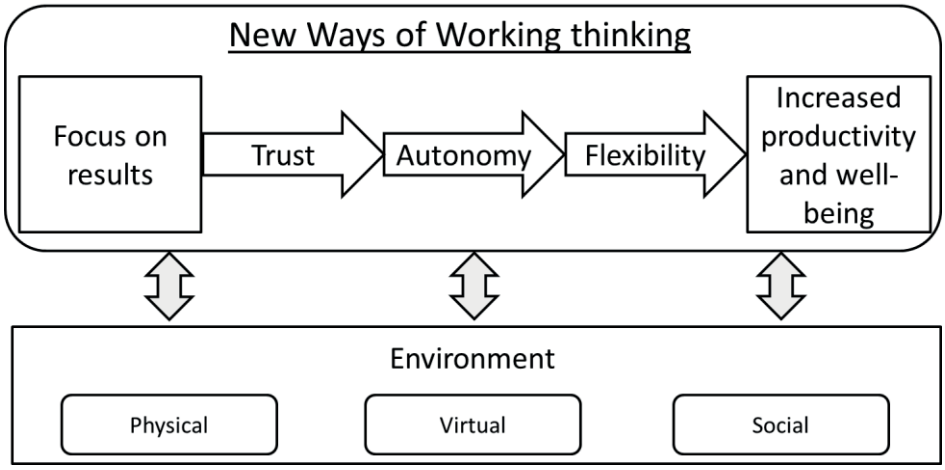


Figure 1.3.2 New Ways of Working thinking, from trust to increased productivity (based on Van der Voordt, 2004; Aaltonen et al., 2012; Perlow & Kelly, 2014; Peters et al., 2014).

As described above, NewWoW is a concept that combines several research areas. The size of the change may vary, but in many cases NewWoW refers to a large organisational change, which changes the way of thinking.Typically, NewWoW change starts with redesigning office as it can be a powerful agent in achieving

organisational and cultural change if used right (Duffy, 1999). The change in thinking is the reason why NewWoW is a relevant term compared to the others. Drucker (1999) stated that knowledge workers should be treated as an asset not a cost and NewWoW highlights this by trusting the employees to know the best way to do the job instead of controlling them (van der Voordt, 2004). After a change in thinking (and probably a larger change), continuous change is needed to find better ways of working.

1.4 Earlier studies on knowledge work performance measurement and the research gap

Practical need was a strong driver for creating the research questions. The scientific need was not as clear when the process started and more investigation was required to see if there were already answers to the research questions. To obtain better understanding about the current knowledge and the research gaps, the literature was reviewed using a Scopus document search as it covers most common journals in the scope of this study. A search was made using all the key terms of this thesis in addition to related terms. Knowledge work was searched using the terms "knowledge work/-er", "office work/-er", or "white-collar work/-er". New ways of working was searched using both "new ways of working" or "flexible work". Performance measurement was searched using both performance or productivity and measur* terms. The results of the search revealed that performance measurement is a much deeper research area than the others, with more than 100-times more hits (over 440 000). In combination with knowledge work and/or new ways of working, the number of studies drops significantly into the low hundreds. The articles were then scanned through (topic and abstract) and articles providing answers to the research questions were selected for more specific examination.

As a conclusion, **previous literature** offers a good framework for research question 1 with performance measurement process and typical challenges, but does not answer it directly. There are not many examples of measuring knowledge work performance in the NewWoW context. Only Laihonen et al. (2012) clearly deal with this question and even that is only on a theoretical level. Ruostela et al. (2015) bring some empirical evidence, but the study lacks a theoretical perspective. De Been & Beijer (2014) and Riratanaphong & van der Voordt (2015) have presented some empirical evidence, but the focus is heavily on facilities management and less on other dimensions of NewWoW. Okkonen's (2004b) approach is from the virtuality

perspective, which he studies through a case study. Understanding the NewWoW context is an important starting point for measurement and there are some attempts to illustrate it (e.g. Duffy, 1999; Maarleveld et al., 2009; Bosch-Sijtsema et al., 2011). For example, Bosch-Sijtsema et al. (2009) have recognized that knowledge work productivity is difficult to measure, but there is some consensus found on what elements affect it on team level. Their purpose is to expand understanding of knowledge work productivity in distributed teams which are part of the NewWoW context. The concluding remarks are that knowledge work productivity is dependent on the team task, team structure and process, and the physical, virtual and social workplaces in the organisation context. The other models are similar but there are some differences so these need to be synthesized into a theoretical framework for this thesis (see 2.2.3).

The performance measurement process is well known in general (Laihonen et al., 2012), but the discussion in the knowledge work context has not found a common understanding (Ramirez & Nembhard, 2004). Some examples can be found from the context of knowledge work performance measurement (e.g. Ramirez & Nembhard, 2004), which can be used as a starting point for this thesis. However, measuring knowledge work performance in the NewWoW context needs more empirical evidence. The typical challenges need to be identified in order to be able to find a solution that can be applied in the NewWoW context. Challenges are well known and identified in the previous studies, but they do not offering many solutions to the challenges (e.g. Ramirez & Nembhard, 2004; Laihonen et al., 2012).

For research question 2, the previous literature does not offer many answers either. While the number of articles dealing with measuring knowledge work performance in the NewWoW context is low, the number of articles actually presenting practical methods is even lower. However, papers from Ruostela et al. (2015) and De Been & Beijer (2014) present actual measures in this context. Ruostela et al. (2015) have described a case study on how the organisation adapts to the new ways of working. The focus is on measuring the impacts of the change and producing information on how new ways of working impact organisation performance. In the case study, the organisation changed its way of working from singular/open office to an activity-based office layout and at the same time changed the management to support flexible working. The case is a longitudinal study between the years of 2008 (old office) to 2011 (new office). Measurement used in the study were space usage efficiency, occupancy costs, environmental impact and a personal survey of how employees experienced the new office. The work environment changes had a positive impact on each measurement. The paper does not explain why these

measurement were chosen and whether there were any other measures. De Been & Beijer (2014) compared the satisfaction with the working environment of nearly 12 000 knowledge workers in the Netherlands. They collected data using a WODI survey (Maarleveld et al., 2009). The WODI toolkit measures employee (knowledge work) satisfaction and perceived labour productivity as affected by different workplace strategies. As promised, the toolkit relies heavily on the physical workplace and its impacts on satisfaction and productivity. The tool includes 39-200 questions (depending on the modules) using the five-point Likert scale. The study by De Been & Beijer (2014) is one of the first to compare specifically activity-based offices (NewWoW) to traditional individual and shared room offices. The paper is very straightforward focusing mainly on the results, but gives lesser weight to the methodological part. Both of these papers focus heavily on the field of facilities management, ignoring other dimensions of knowledge work performance. Utilizing general knowledge work performance measures is also an option and there are many examples of how to measure it. The adaptability of those measures varies from easy (e.g. Koopmans et al., 2012) to very complex systems (e.g. Ramirez & Steudel, 2008).

The previous studies offer a good starting point for this study. However, there are also some **research gaps**. There are some examples and related studies, but no direct answers to the research questions. What is known and where the gaps are concerning the both research questions are summarized in Table 1.4.1.

For research question 1 on how can knowledge work performance be measured in the NewWoW context, clear consensus has been found in previous studies on general performance measurement process and several measurement challenges have been identified. However, only Laihonen et al. (2012) directly answers the questions, but their approach is theoretical and they request more empirical evidence. Empirical evidence in the NewWoW context is offered in few papers, but a more systematic approach is needed with a stronger theoretical perspective. There is a need for combining information about knowledge work performance measurement and building a framework that includes all different dimensions. More empirical evidence is also required in order to test how the existing measurement practices fit this context.

For research question 2, there are only few constructs for the NewWoW context to measure the current work practices and to measure the impacts, but that leans heavily on facilities management while giving less weight to other dimensions. There are also several general knowledge work performance measures which can be used as examples. However, the general knowledge work performance measures do not take into account the context, which means that they do not help to identify what

should be changed nor what has changed. These can be applied in the productivity dimension, but the requirements of NewWoW and knowledge work performance needs to be taken into account.

Table 1.4.1 Summary of the research gap and projected contribution.

Research question	The research gap	Projected contribution
How can knowledge work performance be measured in the NewWoW context?	Empirical evidence is mostly missing on how performance measurement works in the NewWoW context.	Testing performance measurement process in the NewWoW context.
	There are only a few papers measuring NewWoW and even less explaining measures.	Presenting and testing three measurement approaches for the NewWoW context.
	Typical measurement challenges are well known, but only few research papers focus on overcoming measurement challenges.	Presenting measurement solutions that have the ability to overcome some of the typical challenges.
What kind of analytical managerial construct can help measure the organisation's current work practices and the impacts of NewWoW initiatives?	Research is mostly missing on knowledge work performance frameworks that combine both productivity and driver dimensions while both alone are common themes.	Combining previous literature in order to create a theoretical framework for knowledge work performance. The framework is tested with empirical data.
	The current constructs focus more on one of the dimensions of NewWoW, e.g. facilties, while a comprehensive and balanced approach is missing.	The construct is presented based on theoretical framework for knowledge work performance.
	There aren't many constructs that are validated through statistical analysis or market test.	The construct is validated using statistical analysis and market test.

There is a need for an analytical managerial construct that could be used in organisations to collect information for the NewWoW change. In the next section, a knowledge work performance framework is created using the previous literature. The purpose is to construct a framework which explains knowledge work performance and considers the dimensions of NewWoW, the physical, virtual and social environment together with individual work practices and well-being.

2 THEORETICAL BACKGROUND

2.1 Performance measurement process

The purpose of this section is to form a theoretical background for the empirical part of the thesis. Previous literature is used as a base to understand the performance measurement and what needs to be taken in consideration in order to succeed in measuring the NewWoW context. Section 2.1 introduces the performance measurement process in general i.e. 'how to measure', while section 2.2 forms a base for understanding the context i.e. 'what to measure'. Section 2.2 also presents the theoretical framework for knowledge work performance which is a crucial part of the solution for measuring in the NewWoW context.

Performance measurement literature includes tens of thousands of articles and books which all have more or less similarities. Based on that literature, Bourne et al. (2000) have built a theoretical framework measurement process model for business performance and tested it with three longitudinal case studies (how to measure). Many researchers have agreed with Bourne et al. (2000) and the process model has been used in many performance measurement studies (Jääskeläinen, 2010). **Performance measurement process** consists of the following steps:

1. Defining the measurement task in question (i.e. what is the purpose of the measurement?)
2. Identifying the factors to be measured
3. Planning the actual measurement and choosing the measures to be used
4. Implementing the measures (the execution of which is based on the choices made during the previous steps)
5. Analysing and reporting the measurement results.

Bourne et al. (2000) highlight the fact that the measurement process is continuous and needs to be re-evaluated from time to time. Laihonen et al. (2012) agree on the measurement process and have suggested it for workplace measurement purposes. In the first phase of the process model, the purpose of the measurement is defined.

As in the other studies mention below, there can be several reasons or different purposes for measurement, which have different requirements for measurement. In the second phase, the measured factors need to be identified to understand what changes and the probable cause. Understanding the context is essential for identifying the factors to be measured (what to measure). In the third phase, the actual measured factors are developed or selected from the existing ones. The fourth phase is implementing the measurement, which also reveals if the measures are working or not. The last phase is analysing the results and utilizing them in decision-making.

The purpose of the measurement, Sink (1985) has stated that performance management includes four dimensions, all of which include measurement in some form: measuring performance, planning for performance improvement and control, making control and improvement interventions, and measuring the impact of interventions. Rosen (1993) also has a strong vision that measurement is an important part of all management activities. To increase productivity, the work, worker and management needs to be measured and then they can be improved. Simons (2000) has listed eight purposes of measurement: for strategy management, decision-making, planning and forecasting, control, guidance, communication, influencing behaviour or education, learning and improvement. Irani & Love (2002) believe that, in investment projects, the purpose can be to compare different projects, justify investment requests, control expenses and benefits or provide a framework for facilitating organisational learning. Taskinen & Smeds (1999) suggest that, in any organisational change, both the change and the impacts of the change should be measured.

Several balanced performance frameworks have been created to support the identification of measurement objects. Naturally these are dependent on the purpose of the measurement, but what they have in common is that they are intended to be based on a theoretical framework. For example, the framework of Ramirez and Nembhard (2004) focuses on productivity dimensions and provides several aspects to be considered in measurement: quantity, costs, profitability, timeliness, autonomy, efficiency and many others are recognized as the drivers of knowledge work productivity. Takala et al. (2006) propose a structured framework for measuring white-collar performance. Koopmans et al. (2011) compiled a broad literature review about individual work performance, where they also included many articles on knowledge work productivity. These and other frameworks for knowledge work productivity are presented in the next section and those will be used to form a framework for knowledge work performance in the NewWoW context.

There are basically two types of performance measures, those that measure the level of performance and those that measure the change in performance (Sink, 1985). Kaydos (1999) and Simons (2000) have listed several options which should be taken into account when designing measures. Measurement can be done using direct or indirect measures and the latter can be objective or subjective and tangible or intangible. Direct measurement is always intentional, but sometimes it is not possible to measure something, e.g. productivity, directly by comparing all the outputs with all the inputs, as they are difficult to define due to their intangible nature. Indirect measurement can give some evidence when it is not possible to use direct measurement, e.g. measuring job satisfaction through absence rates (e.g. Uusi-Rauva, 1996; Lönnqvist, 2004, Vuolle, 2011). Direct measure are typically objective and it is always better to use direct objective measurement if possible (Misterek et al., 1992). Although, in many cases it is impossible to use objective measures due to financial limitations. Subjective measures are for example surveys or interviews, which are based on the personnel's subjective assessments (Lynch and Riedel, 2001). For example, productivity is measured by statements related to work efficiency and effectiveness, achieving results, goals, utilizing skills, quality of work, customer satisfaction and team performance (e.g., Ramirez and Nembhard, 2004; Koopmans et al., 2012).

Performance measurement has been recognized as a challenging task in many articles and the knowledge work context adds to the difficulty (e.g. Laihonen et al., 2012). Typical challenges are listed in Table 2.1.1. In knowledge work, the output is usually qualitative and intangible which cause challenges when measuring it. For example Davenport (2008) and Ramirez & Nembhard (2004) have reported the challenges for measuring outputs in knowledge work. However, most of the challenges appear to begin when something has changed and the impacts should be measured. It seems to be difficult to identify when and which outputs should actually be measured when something is changed. The time lag between the change and the results also seems to present an interesting challenge. Torkzadeh & Doll (1999) and Kujansivu & Lönnqvist (2009) pointed out the difficulty of making sure that nothing else happened in the meanwhile, which may have impacted the results. Mettänen (2005) studied the design and implementation of performance measurement systems for a research organisation. Performance measurement systems were studied in research organisations, as there are fewer studies in that context and the intangible nature of the work makes it challenging. As a result, Mettänen (2005) found that designing and implementing a measurement system did not differ much from traditional methods, but there are some challenges in acquiring information and the

design process needs many iterations. Laihonen et al., (2012) remark that subjective measures like interviews and surveys have been proposed to solve some of these challenges.

Table 2.1.1 Challenges in knowledge work performance measurement.

Theme	Measurement challenge	Reference
Output	The qualitative and intangible nature of knowledge work outputs.	Davenport, 2008; Drucker, 1999; Ramirez & Nembhard, 2004
	The difficulty of capturing the impacts on customers.	Deakins & Dillon, 2005; Mettänen, 2005
Change	Distinguishing the impact resulting from the change in question in comparison to other factors simultaneously affecting productivity.	Torkzadeh & Doll, 1999; Kujansivu & Lönnqvist, 2009
	Time lag between the change and the realisation of the impacts, including the learning curve.	Davern & Kauffman, 2000; Love & Irani, 2004; Jones et al., 2011
	Identifying which factors are actually impacted.	Bailey, 2011
	In some cases, it might also be a challenge to achieve any observable impacts.	Devaraj & Kohlli, 2003
	The impacts may vary depending on the working role.	Antikainen et al., 2008
	The impacts may vary depending on the organisational level.	Torkzadeh & Toll, 1999; Vuolle, 2010

Jääskeläinen & Laihonen (2013) focused on measurement challenges in knowledge-intensive organisations and especially how to overcome those challenges. The challenges are listed in many articles (see Table 2.1.1), but this study is rare as it systematically tries to overcome the challenges. They identified four typical measurement challenges from previous literature and use three case studies to find solutions to the challenges. The main contribution of their paper is that the measurement should take into account the perspectives of the individual knowledge worker, the customer and the organisation as a whole, unlike in previous studies which rely only on organisational perspectives.

As a conclusion the performance measurement process presented by Bourne et al. (2000) seems to suit the NewWoW context well after the knowledge work performance framework is built. Laihonen et al. (2012) support the idea and give other suggestions for the measurement. Due to the nature of NewWoW, the purpose and focus of measurement are on the change process. They have created a

framework for capturing the impacts of a NewWoW initiative. All the phases are required to be able to evaluate the actual impacts of the NewWoW initiative. They suggest measuring the following three factors:

1. Was there a change in productivity? (before-after)
2. What changed in the way of working? (before-after)
3. Was the change induced by the NewWoW initiative? (after)

Laihonen et al. (2012) have also listed some examples of measurement approaches from the literature that can be used in the NewWoW context. These are divided into four categories: subjective measurement, output measurement, multidimensional measurement and statistical methods. Laihonen et al. (2012) highlight the fact that future research should focus on empirical examinations, as they seem to be scarce. Sitlington & Marshall (2011) and Vuolle (2011) support the fact that subjective measures like surveys are a common way to approach measurement due to the uniqueness and complexity of change. Although the measurement of the impacts of interventions in organisations is a common setting, the literature has paid little attention to change itself, especially from the viewpoint of when to measure the impacts, immediately after the change or later (Barbosa & Musetti, 2011; Bailey, 2011).

2.2 Knowledge work performance

The purpose of section 2.2 is to form a theoretical framework in order to enable the measurement process in the NewWoW context. Knowledge work performance is built on knowledge work productivity (2.2.1) and knowledge work productivity drivers (2.2.2). Section 2.2.3 combines the understanding and presents the actual framework which has been used also in papers III-V.

2.2.1 Knowledge work productivity

Knowledge work productivity is defined as productivity in general, but the knowledge work context poses some challenges (Davenport et al., 2002). The intangible nature of knowledge work is the biggest reason why the context of productivity cannot be applied directly from manufacturing. The definition of

productivity is similar, but in knowledge work, the challenges start when the inputs and outputs have to be measured (Bosch-Sijtseva et al., 2009). While inputs and outputs are tangible and easier to measure in manufacturing, for example, in weight or in pieces, both resources and outcomes can be intangible in knowledge work (e.g. Ramirez & Nembhard, 2004; Antikainen and Lönnqvist, 2005). Due to this, knowledge work productivity has proved to be a challenging context, and many researchers have tried to solve the problem by dividing the measurable object into smaller pieces (Drucker, 1999; Ramirez and Nembhard, 2004; Koopmans et al., 2011). Antikainen & Lönnqvist (2005) stress that it is important to measure knowledge work productivity at both organisational and individual levels.

Drucker (1999) divided knowledge work productivity into two: 'doing the right things and doing things right'. The second, 'doing things right', focuses on the use of resources and the work process. It means everything should be done in the best way possible and with minimal resources. Many research papers focus on measuring this side of productivity, e.g. Ramirez and Nembhard (2004) and Koopmans et al. (2011). The first, 'doing the right things', is related to the other side of productivity, the outputs. An output needs to be valuable to the customer. It does not matter how efficient the organisation is; if the value of the output is zero, the productivity is zero. On the other hand, if the organisation is making a profit, it is most likely 'doing the right thing', and the productivity development could focus more on 'doing things right'. Bosch-Sijtseva et al. (2009) emphasised that knowledge work productivity is not standard. It may differ largely depending on the task, on contextual factors and on the knowledge worker's individual capabilities. Due to the individual nature of knowledge work, the workers are usually the best at recognizing the factors that increase or decrease their productivity (Dove, 1998).

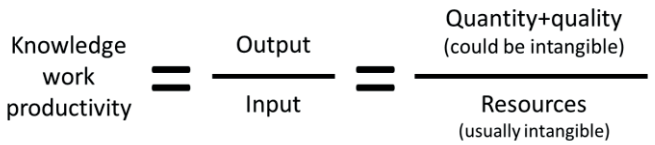


Figure 2.2.1 Knowledge work productivity (Craig and Harris, 1973; Drucker, 1991; Parasuraman, 2002, Davenport et al., 2002).

Misterek et al. (1992) take a mathematical approach and they have identified five different circumstances where productivity can be improved: more output with less

input, more output with the same input, the same output with less input, output increases faster than input, output decreases less than input.

Drucker (1999) also identified six factors that affect knowledge work productivity. The list highlights the difference in productivity between knowledge and manual workers and illustrates the nature of knowledge work.

1. Knowledge-worker productivity demands that we ask the question: "What is the task?"
2. It demands that we impose the responsibility for their productivity on the individual knowledge workers themselves. Knowledge workers have to manage themselves. They have to have autonomy.
3. Continuing innovation has to be part of the work, the task and the responsibility of knowledge workers.
4. Knowledge work requires continuous learning on the part of the knowledge worker, but equally continuous teaching on the part of the knowledge worker.
5. Productivity of the knowledge worker is not – at least not primarily – a matter of the quantity of output. Quality is at least as important.
6. Finally, knowledge worker productivity requires that the knowledge worker is both seen and treated as an "asset" rather than a "cost." It requires that knowledge workers want to work for the organisation in preference to all other opportunities.

Like Drucker (1999) highlights, it is important for knowledge workers to have autonomy and to be seen as an asset. This kind of thinking sets requirements also for the measurement, which purpose should be e.g. improving and learning instead of on controlling knowledge workers.

Measuring **knowledge work productivity** requires **a theoretical framework** and many researchers have created one. Koopmans et al. (2011) compiled a broad literature review about individual work performance, where they also included many articles on knowledge work productivity. As a conclusion, they created an individual work performance framework. In their framework, they divided performance into four categories: task performance, contextual performance, adaptive performance and counterproductive work behaviour. Task performance includes factors such as completing job tasks, the quantity and quality of the work, job skills, etc., related

directly to output. Contextual performance consists of co-operation, effective communication, proactivity and enthusiasm, all of which are part of the work environment. Adaptive performance consists of generating new ideas, being flexible and being open-minded — everything needed to develop and increase productivity. Counterproductive work behaviour includes off-task behaviour, doing tasks incorrectly and everything else that may decrease productivity or even harm the organisation. Takala et al. (2006) propose a structured framework for measuring white-collar performance. Their framework approaches the performance of strategic work from four aspects: results, process, behaviour and physiology.

Ramirez and Nembhard (2004) completed a literature review about knowledge work performance and found more than 20 methodological approaches to measuring performance and productivity in knowledge work. The authors used previous studies to identify productivity dimensions and found a total of 13 dimensions: quantity, economic factors, timeliness, autonomy, quality, innovation/creativity, customer satisfaction, project success, efficiency, effectiveness, responsibility/importance of work, the knowledge worker's perception of productivity, and absenteeism). They found that there are no universally accepted methods or even generally accepted categories. On average, only two or three of these dimensions are used in each measurement model. In most methods, productivity is not measured directly; rather, it is split into parts of productivity, for example, efficiency or quality (Blok et al., 2011). This type of splitting reflects the existing productivity challenges of knowledge work (Davenport and Prusak, 2000). In many cases, it is easier to understand and evaluate the parts of productivity than productivity itself.

It is also possible to find several **methods and empirical examples** on how researchers have attempted to measure knowledge work productivity. According to Ramirez & Nembhard (2004), the most common approach for practical methods is to try to measure inputs and outputs, e.g. Najafi et al. (2011). For example, Ramirez & Steudel (2008) created a knowledge work quantification framework to measure knowledge work. Their purpose is to define mathematically the quantity of each input and output based on the dimensions found by Ramirez & Nembhard (2004). Riratanaphong & van der Voordt (2015) turned the situation round and studied the performance measurement systems found in the literature and explored three case organisations in order to compare the measurement in practice. They found that, apart from the balanced scorecard, no other performance measurement systems were applied literally, but almost all common metrics were found in isolation.

According to Riratanaphong & van der Voordt, these measures can be used as input to the value adding management of facilities.

Schroeder et al. (1985) studied white-collar productivity by creating nominal group sessions with 39 executives, managers and academics. The paper presents the answers from the respondents to five questions on productivity measurement: Why, Who, What, How, and What are good characteristics? In summary, the article contributes to three areas. It discusses the use of individual and group measures related to the purpose of measurement. It presents a list of 11 measures and makes many practical suggestions on how to measure knowledge work productivity. Takala et al. (2006) created a framework for measuring white-collar workforce performance. The paper presents the multi-dimension measurement process (MDMP) and compares the method to other measurement techniques. The method has been created by combining existing performance measurement techniques and tested with a limited sample, i.e. 16 organisations from the accounting and finance sector. The main questions this study wishes to answer are what should be measured, how it should be measured and what is the impact of cultural differences. The paper proposes MDMP as an answer, but does not explain the actual performance measures. Erne (2011) wrote a research paper on the topic of what productivity in knowledge work is. With cross-industrial research in five knowledge-intensive organisations, Erne suggests that, instead of traditional productivity, there are multiple performance indicators: the quantity/quality of results, quality of interaction, innovation behaviour, compliance with standards and skill development.

Koopmans et al. (2012) developed a questionnaire for measuring individual performance for all types of workers. The questionnaire is based on a framework which includes four dimensions of performance: task performance, contextual performance, adaptive performance and counterproductive working behaviour. The questionnaire consists of 47 items which are divided into the categories of the contextual framework and is validated using Rasch analysis. Another questionnaire-based measuring approach was validated by Kujansivu & Oksanen (2010), who focused on identifying problems related to the knowledge work productivity in the Finnish context. They used the KWPA method created by Antikainen & Lönnqvist (2005) in order to verify whether white-collar workers' productivity drivers can be identified at macro-level. The KWPA method includes productivity drivers from organisational and personal perspectives, e.g. intellectual capital, working environment, motivation and physical fitness. Kujansivu & Oksanen (2010) collected survey data from 840 Finnish white-collar workers including different professional groups. The results validate KWPA as a method for use in scientific

research while the main contribution is that the biggest challenges for productivity improvement are reward policies and feedback practices.

As a summary, there is no clear consensus of how knowledge work productivity should be measured, which indicates the difficulty of the task. Objective and subjective measurement have both been tried and subjective measurement seem to be easier to apply. It is characteristic for different measurement approaches that the factors affecting performance are typically divided into inputs, processes and outputs (Laihonen et al., 2012; Riratanaphong & van der Voordt, 2015), although in knowledge work the line between the inputs and the process is not clear (Laihonen et al., 2012). In the service business, quality and productivity cannot be dealt with separately (Sahay, 2005). Knowledge work productivity is a result of the working process and practices. In the next section the productivity drivers are examined.

2.2.2 Knowledge work productivity drivers

Productivity drivers are the factors that matter in a process where inputs are used to create outputs (Davenport et al., 1996). Syed (1998) presented a model of how the knowledge worker works and interacts with other knowledge workers. The model suggests that productivity is driven by physical resources, for example, facilities and plants; procedural resources, for example, processes and management systems; and intellectual resources, for example, technologies and culture. Davenport et al. (2002) developed a similar model, but their focus was on the work environment. According to them, knowledge work productivity is determined by these three major factors: management and organisation, information technology and workplace design. Bosch-Sijtseva et al. (2009) also agreed that these three are the main components of knowledge work performance. Hopp et al. (2009) examined the problem at the individual, team and organisational levels and ended up with similar results. It is not a coincidence that NewWoW changes happen to impact these dimensions as they are recognized by several researchers as knowledge work productivity drivers, i.e. things that matter for productivity.

The three dimensions of work environment, work practices and their impact on knowledge work performance have been well studied separately in the previous literature, for example, the physical environment in the field of facilities management and the virtual environment in the field of information technology etc. These dimensions are examined more precisely in the following paragraphs. **The physical environment** consists of an organisation's offices and all of the spaces there, for

example, rooms for working, negotiation and coffee breaks. It also includes the desks, chairs and other pieces of furniture. In an effective physical environment, knowledge workers are able to concentrate on their tasks (Maarleveld et al., 2009). Interruptions distract knowledge workers to a greater or lesser extent, so the level of interruptions should be low when their tasks require concentration (Jett and George, 2003). Interruptions could be caused directly by their colleagues' asking them questions, but a high level of noise or someone who is moving in a knowledge worker's field of vision could also be distracting (Mehta et al. 2012; Haynes, 2007). Knowledge work sometimes requires intense concentration on the task and involves a lot of collaboration with co-workers (Heerwagen et al., 2004). Information and knowledge should flow from one person to another. Formal and informal meetings are typical in almost every type of knowledge work and require suitable spaces to avoid interrupting other people (Vischer, 2005). Between concentration and collaboration on tasks, a lot of spontaneous interaction takes place among workers, which is good for creativity, satisfaction and productivity (Hertel et al., 2005; Heerwagen et al., 2004).

An organisation's **virtual environment** consists of information and communications technology and everything related to it. Productivity improvements from information technology come mainly from the automation of work tasks and from making information more accessible (Jacks et al., 2011). The basic requirement for a productive virtual environment is the use of appropriate tools depending on what kind of knowledge work is in question, and the usability of information technology and software should not cause any dissatisfaction (Brynjolfsson, 1993). With current technology, a basic requirement would be that the worker could access the required information regardless of his or her location, so he or she could use, for example, travelling time to get work done effectively (Vuolle, 2010). All of this increases knowledge workers' ability to control how, where and when they work (O'Neill, 2010). Communication and collaboration tools are becoming more important as the work being performed is less dependent on location (Vartiainen & Hyrkkänen, 2010). Instant messaging tools enable workers to have quick access to colleagues' knowledge and, when used correctly, may also help with managing interruptions (Garrett and Danziger, 2007). In addition, instant messaging and virtual negotiation tools can reduce travelling and hence save time (Holtshouse, 2010). The virtual environment also includes electronic teamwork tools that allow simultaneous document editing by all of the team members, for example.

The social environment covers everything related to human relations in the work environment. There are two main aspects of the social environment; the first

is management, for example, the relationship between the knowledge worker and the supervisor (Drucker, 1999). The second is the atmosphere in the organisation, for example, the relationships among colleagues, culture and work practices (Vartiainen, 2007; Bosch-Sijtsema et al., 2009). The following management practices have been suggested to have a positive relationship with productivity. Knowledge worker tasks should constitute a reasonable whole, and the goals for the work should be clear (Drucker, 1999; Ramirez and Steudel, 2008). Knowledge workers need high levels of autonomy (Drucker, 1999) and should be able to choose the methods and times that best suit them (O'Neill, 2010; Origo and Pagani, 2008; Kelly et al., 2011). Organisational work practices, for example, meeting practices, information technology and communication guidelines and an innovative climate, may all help knowledge workers to save time and be productive (e.g. Elsayed-Elkhouly et al., 1997; Wännström et al., 2009). A good atmosphere consists of open and transparent decision-making and communication, supportive feedback and quick interference in conflict situations (Wännström et al., 2009; Dallner et al., 2000).

While the focus in previous NewWoW discussion has been mostly on working environments, other researchers have highlighted that in knowledge work, the employee has the biggest impact on productivity (Drucker, 1999). Vartiainen (2007) agreed with the other researchers on the importance of the work environment but pointed out that the knowledge workers' 'mental space' also has an impact. Ruostela and Lönnqvist (2013) additionally highlighted the fact that knowledge workers' **individual work practices** also have a major impact on knowledge work productivity. An organisation can offer people opportunities to work productively, but the productivity level is ultimately dependent on the knowledge workers' own work practices, for example, whether or not the opportunities are utilized (Ruostela and Lönnqvist, 2013; Koopmans et al., 2012). A weak flow of information, inefficient meetings and interruptions are all typical complaints in organisations, but knowledge workers are able to influence these through their own actions. Another dimension in individual work practices is self-management (Drucker, 1999). An organisation should be setting knowledge workers goals, but it is the knowledge workers' own responsibility to achieve them and to choose how to do it. Planning and prioritizing are important in a world where available time is limited (Kearns and Gardiner, 2007; Claessens et al., 2004). Knowledge workers' responsibility for their own work includes the development of their own work practices as well, for example, by trying to seek out and test better tools and ways of working (Drucker, 1999).

The major driver for effective individual work practices is good motivation (Campbell, 1990). Personal well-being and **well-being at work** are widely researched topics (Judge et al., 2001). The most common part of well-being at work is job satisfaction. The link between job satisfaction and work performance has been pursued for almost as long as manufacturing has existed (Judge et al., 2001). At present, researchers are quite unanimous in asserting that the link exists, but the exact magnitude is not clear (Judge et al., 2001). A recent topic in the debate on well-being at work is work engagement (Schaufeli et al., 2006). Knowledge workers who find their work meaningful and are enthusiastic about their jobs are known to work harder, be more creative and more productive (Bakker and Demerouti, 2008, Bakker, 2011). Well-being at work has a dual role, since it operates as a result factor of work environment drivers (e.g. Kelly et al., 2011; Halpern, 2005), but at the same time, it is itself a driver for productivity (e.g. Wright & Cropanzano, 2000; Schaufeli & Salanova, 2007). In this section, knowledge work performance drivers were identified for use as a basis for the performance framework. The NewWoW thinking seems to be related to all the performance drivers.

2.2.3 Framework for knowledge work performance measurement

The purpose of this section is to summarize the findings in sections 2.2.1 and 2.2.2, which will be used in the empirical part of the thesis. Figure 2.2.2 **presents a theoretical framework for knowledge work performance** which summarizes the key dimensions of productivity drivers and the results and outcomes. The framework was created on the basis of reported and hypothesized knowledge work and NewWoW impacts in previous studies. The framework is based on the idea that the inputs are processed in some way to obtain the outputs (Laihonen et al., 2012), which means that there are productivity drivers (input and process) that affect the results and outcomes (output). Knowledge work performance is dependent on the work environment (physical, virtual, social) and the knowledge worker, who does or does not utilize the opportunities (Bosch-Sijtsema et al., 2009; Laihonen et al., 2012). In knowledge work, the output is usually knowledge which is created by the knowledge worker by combining current information and knowledge (Drucker, 1999; Davenport et al., 2002). Thus, the productivity is dependent on individual work practices and skills, well-being at work and motivation, and the knowledge of the knowledge worker (Campbell, 1990). Well-being at work has a dual role in this model as, while it is an important driver for productivity, good well-being and motivation

can result in a satisfying work environment and good working skills (van der Voordt, 2004; Ruostela et al., 2015). The new theoretical framework enables utilization of knowledge work performance measurement practices in the NewWoW context. It offers a partial theoretical answer to both research questions. The framework was created and updated during the thesis work so it has slightly different forms in different publications.

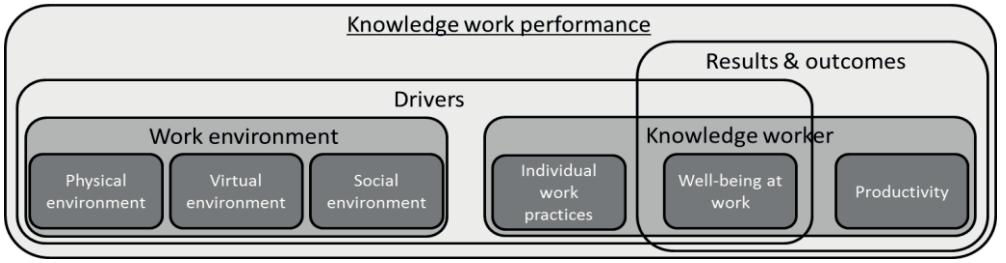


Figure 2.2.2 Knowledge work performance framework (Papers III-V).

The starting point for the empirical research is the literature review by Laihonen et al. (2012) on measuring knowledge work productivity and the identification of some key prerequisites and limitations that should be taken into account when measuring the impacts of organisational change. They conclude that the actual measurement practices and reported solutions are mostly missing so that practical experience is required. The purpose of this study is to provide actual measurement solutions and test the measurement process in practice in this context utilizing the framework shown in figure 2.2.2. Previous literature has also identified several challenges for measuring change, which are also taken into account. Chapter 3 describes the research design and empirical research. Chapter 4 summarizes the results of the empirical studies to take the theory one step further.

3 RESEARCH DESIGN

3.1 Research strategy

The research paradigm and research approach is described using the model created by Saunders et al. (2009). The well-structured model (Figure 3.1.1) has different layers for the different parts of the research strategy. The research philosophy is in the outermost layer and, step-by-step, the layers lead to the innermost layer of practical techniques and procedures. The methodological choices for each layer are described one by one in Figure 3.1.1.

3.1.1 Research paradigm and research approach

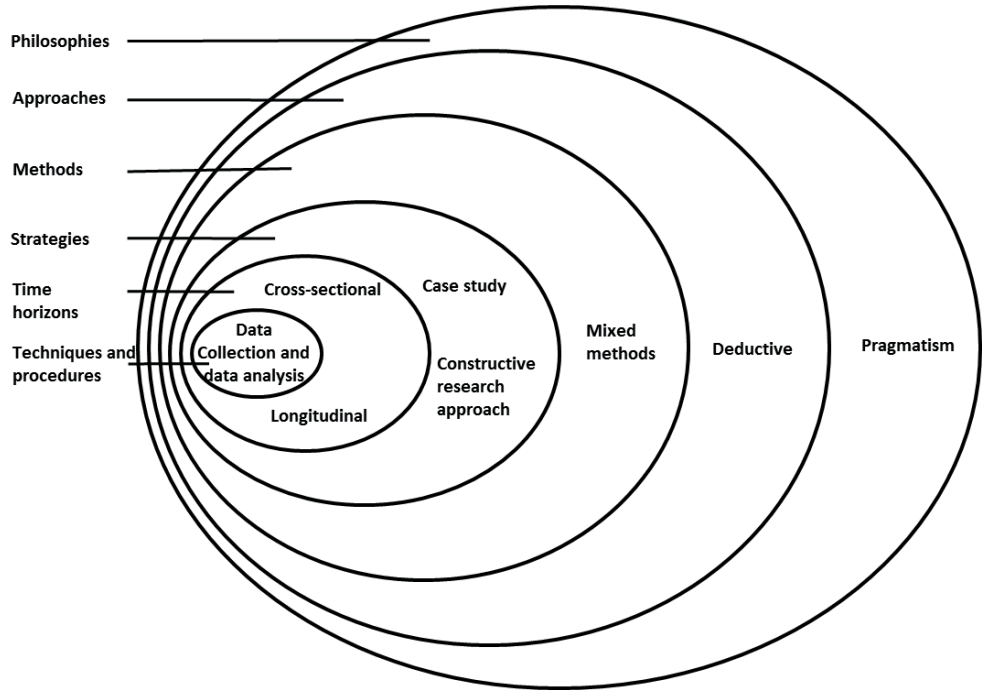


Figure 3.1.1 Research strategy (modified from Saunders et al., 2009).

The starting point for this thesis was very practical. The need to solve the challenges of real organisations has guided all the work done during the making of this thesis. Thus, **the research philosophy** in this thesis is mostly pragmatic. Saunders et al. (2009) emphasize that pragmatism strives to reconcile both objectivism and subjectivism, facts and values, accurate and rigorous knowledge and different contextualized experiences. The pragmatism in this thesis leans strongly on the philosophy of realism, as it tries to be as objective as possible, although this is impossible at some points. The thesis is also value-laden, while again trying to stay as objective as possible. Although the pragmatism research philosophy leaves many options for the researcher to collect data, it does not mean that it is always multiple-method (Saunders et al., 2009). According to Kelemen and Rumens (2008), the method or methods are selected by their ability to give the most appropriate data to advance the research.

The approaches level in the model by Saunders et al. (2009) includes options for deduction, induction and abduction. They start with the observation that one or other type is rarely picked alone and continue that it is often advantageous to use the options in combination, although one approach is more dominant than the others (Saunders et al., 2009). This thesis includes a few separate studies with different types of approaches, which makes it difficult to define the approach precisely for the thesis as a whole. The separate studies all start with the existing theory, which makes the thesis mainly deductive. All the studies also include more or less iterative processes, which indicates the abductive and inductive approaches. This kind of adjustable approach to theory is very typical for business and management research (Suddaby, 2006; Saunders et al., 2009).

Regarding the pragmatic philosophical approach, several **research methods** are applied in this thesis. It is common for pragmatic philosophy that the researcher combines both quantitative and qualitative research methods to explore perceptions (Saunders et al., 2009). Mixed-methods research has many strengths compared to mono-method studies (Molina-Azorin, 2012). The most important point for this thesis is that it makes the data richer and increases validity through triangulation. In mixed-methods research, quantitative and qualitative research does not have to be balanced, either can be prioritized depending on the purpose of the research project (Creswell & Clark, 2011). The methods used in this thesis include mainly quantitative methods (survey and objective measures), but also include some qualitative components (interviews and subjective measures).

The purpose of the thesis is to find an answer to two main questions: *how can knowledge work performance be measured in the NewWoW context? and what kind of analytical*

managerial construct can help measure the organisation's current work practices and the impacts of NewWoW initiatives? As referred to in the previous sections, the thesis applies mixed methods based on the pragmatic research philosophy and a primarily deductive approach. The study has two main **research strategies** to provide answers to the research questions. The first research question is answered using the case study and the second is answered using the constructive research approach.

Regarding the first research question, this thesis finds an answer using case studies. According to Yin (2014), a case study is an in-depth analysis of a phenomenon within its real-life setting. The case study approach is often used when it is not clear which part is the phenomenon being studied and which part is the context within which it is being studied (Yin, 2014). The purpose of the case study is to form rich, empirical descriptions and to develop a theory by generating insights from intensive and in-depth research into the study of a phenomenon. It is very typical for a case study to use both quantitative and qualitative methods to achieve rich insight, which makes it common for the mixed-method approach (Saunders et al., 2009). Yin (2014) presents four types of case study strategies based on two dimensions: single case – multiple case and holistic case – embedded case. This thesis uses multiple small cases to create and test measurement approaches. The base for the case studies is formed on previous literature with additional information from the interviews. Then the theories were tested in practice and eventually the results were analysed and the conclusions formed.

For the second research question, this thesis finds an answer using constructive research. According to Kasanen et al. (1993), the constructive research approach can be used to create a managerial construct to solve a practical problem. There are seven phases in the constructive research approach: 1) find a practically relevant problem, which also has research potential, 2) examine the potential for long-term research co-operation with the target organisation, 3) obtain a general and comprehensive understanding of the topic, 4) innovate and construct a theoretically grounded solution idea, 5) implement the solution and test whether it works in practice, 6) examine the scope of the solution's applicability, and 7) show the theoretical connections and the research contribution of the solution (Kasanen et al., 1993; Labro and Tuomela, 2003). Constructive research is usually evaluated and validated using a market test (Kasanen et al., 1993; Labro and Tuomela, 2003) and here it is also validated using statistical validation methods.

In both research strategies, **the time horizon** is mainly cross-sectional, although there are also some longitudinal components in the form of before-after situations

in measurement. With regard to **the techniques and procedures**, the data collection and data analysis are described in the following section.

3.1.2 Research methods for data collection and analysis

Section 3.1.1 explained that there are two main research strategies in this thesis, the case study and constructive research approach. In addition to the main research strategies, there are also two supporting research activities, the interview and survey. The knowledge from interviews was utilized in the background of the constructive research approach. The SmartWoW (Smart Ways of Working) survey was a result of constructive research and was then applied to the other organisations for additional data to validate the construct statistically. This section describes more precisely where and how the data was collected and its relation to the research articles (see Figure 3.1.2).

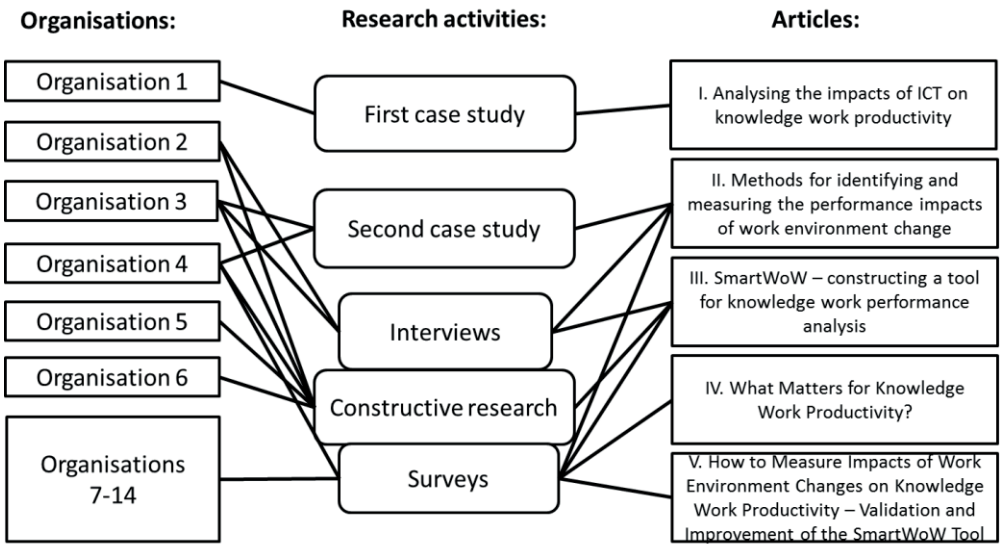


Figure 3.1.2 Summary of the research activities and links to research articles.

The first case study was conducted in TeliaSonera (currently Telia, Organisation 1), a medium-sized European mobile network operator. The company provides ICT services for the consumer and enterprise markets. The ICT service under focus in this case was in pilot testing in the network operator's own offices, i.e. the subject of

the study was TeliaSonera and its knowledge workers as well as the new ICT service as a tool for improving the company's own productivity. The ICT service makes it possible for the personnel to move around the office and remain connected to the company's private network. It also keeps the network connection alive when switching between wireless and wired networks. As a NewWoW initiative, this was very small and focused compared to the second case study, but it gave a more detailed opportunity to learn about the measurement process in the NewWoW context. The process of designing the impact measurement was based on the three-stage model by Vuolle (2011), consisting of the phases of analysing the measurement context, identifying the impact factors and designing suitable measures to capture the impacts. Thus, the case study began by meeting representatives of the company and examining the written material about the service. The next step in the measurement process was to identify the impact factors. This was done through a group interview, which aimed at deepening the researchers' understanding of the service and its impacts in order to design the survey questions. The participants, five persons, represented different managerial levels and departments of the company.

The group interview generated the idea of measuring the time saved objectively by measuring how much less time it takes for a person to use the new service compared to the old way of doing the same operation. Five people performed and timed the tasks related to leaving their own office (i.e., closing programs and logging out) and starting up programs and connections again in a meeting room with both the new and the old procedure. The respondents of the survey were also asked to evaluate subjectively how much time they saved with the new service. Furthermore, they were asked how often they utilized the service. The questionnaire was aimed at examining how the new service affected the productivity of employees using the service. The questionnaire consisted of two parts. The first section identified how much time could be saved with the new service and how the saved time would be used. The second part consisted of eight scaled questions related to the impacts of the service and one open question was also included. The web questionnaire was sent to 330 respondents. In the end a total of 128 responses were received, which corresponds to a 39 percent response ratio.

The second case study was a longitudinal case study of a work environment change project carried out in two companies. The first organisation was Rapal (Organisation 3), which is a medium-sized company operating in the field of the built environment and the second was Senaatti-kiinteistöt (in English Senate Properties, Organisation 4), which is a work environment partner of the Finnish government. 60 employees from Rapal were involved in this research and 250 employees from

Senaatti-kiinteistöt. The goal for both organisations was to develop their own facilities and ways of working to learn and to be able to consult their customers. The aim was to capture the multidimensional performance impacts of the NewWoW initiative by measuring the chosen performance indicators before and after the changes. Both NewWoW initiatives had similar principles of changing the work to activity-based. It started with facilities and required many changes in virtual and social environments. In constructing the measurement system, the basic principles of balanced performance measurement were followed by three main phases: the design of performance measures, the implementation of performance measures, and the use of performance measures (Bourne et al., 2000; Kaplan & Norton, 1996; Neely et al., 2000).

In Rapal, four key indicators were chosen based on the goals of the project (see also Ruostela et al., 2015). The measures were objective measures which the organisation had also used before, e.g. occupancy costs, space usage efficiency and environmental impacts. The organisation also used a survey to gather the workers' experiences about the new way of working. In Senaatti-kiinteistöt the measurement process was more detailed. Firstly, key objectives were identified and then performance measures for each objective were designed in four half-day iterative workshops utilizing the knowledge work performance framework. Participants included two researchers as facilitators and a group of 5–8 representatives from various departments within the company. As a result of the workshops, several objective measures were found from the organisation's existing measures e.g. the same as the first organisation used and, in addition, the average meeting time, papers printed and amount of sick leave. The SmartWoW survey was also used to measure the success of the change. In both organisations, managers wanted to have objective results which guided the finding of objective measures but this turned out to be very difficult. It was not possible to create new measures with the current resources and it was very challenging to obtain data from the existing information systems.

The aim of **the interviews** was to understand and analyse the potential to improve knowledge work productivity through new work environments and work practices. This helped to identify the main elements of knowledge work performance to be covered by the measurement methods. In total, 18 knowledge workers in various roles were interviewed from two organisations. All interviews were semi-structured face-to-face interviews. The interviews were recorded with a digital voice recorder and transcribed for further analysis. The transcribed interviews were analysed qualitatively in order to identify important themes. The purpose was to examine the usefulness of interviewing as a subjective method of capturing and

modelling individual knowledge workers' views about productivity potential. The more detailed description and the results of the interviews are presented in Jenna Ruostela's Master of Science thesis (2012) and in Ruostela & Lönnqvist (2013). The role of the interviews in this study is to present one method for measuring the success of a workplace initiative (article 2). The interviews were also utilized as background information in the constructive research approach along with previous literature to form a structure for the knowledge work performance framework and SmartWoW survey.

The SmartWoW survey was developed using **the constructive research approach** (Kasanen et al., 1993; Labro & Tuomela, 2003). Research methods for constructing this new SmartWoW tool included a literature review, interviews (see above "interviews") as well as pilot tests in four case organisations. The literature review was carried out using Scopus and Google Scholar to search the relevant literature in the context of knowledge work performance and new ways of working. In addition to reviewing the literature, we carried out an interview study in two of the case organisations (2 and 3). The literature review and interviews helped to identify the main elements of knowledge work to be covered by the measurement tool. The measurement tool was constructed by five researchers in several iterative workshops. The construct was tested by asking feedback from five other colleagues and from four pilot organisation representatives. After the tool was constructed, it was pilot tested in the four organisations (organisations 2, 3, 5, 6). After testing the SmartWoW tool in practice, we conducted interviews with each organisation's representatives to collect feedback on the solution's applicability and their willingness to continue using it.

The SmartWoW survey results were utilized in four papers. The first data set from four organisations was used in papers 1 and 3 and the second data set was used in papers 4 and 5. In both data sets, the research data was collected using an online survey for the organisations' own use and for scientific purposes. The survey consisted of 49 (45 in first data set), 5-point Likert-scale variables (disagree-agree), divided between the six dimensions of the conceptual model. The SmartWoW survey was developed using the constructive research approach (paper 3) with originally 45 variables, which was improved and validated to 49 variables (paper 4) based on feedback and statistical analysis. Almost all of the organisations were planning work environment changes, so they needed an overview of how their employees experienced their work environments, individual work practices, well-being and productivity. The organisations also planned to use their own results to measure the impacts of the upcoming changes. The participants were informed that

the data would be used for scientific purposes as well. A questionnaire was sent to the participants by email, and they typically had about two weeks' time to respond. All the respondents were carrying out traditional office work with IT tools of the same kind (laptops and smart phones).

The first data set was collected from four private organisations which operate in the facility management sector and are interested in knowledge work redesign as a tool for improving their operations, but also from the perspective of developing new services for their customers. The organisations ranged in size from small to large, but only a small group of knowledge workers from the large organisations participated. The number of personnel varied from 33 to 80 and the responses from 22 to 35 with response rates from 33% to 65%. The respondents were mainly consultants or experts, but there were also managers and assistants among them.

The second data set was collected from nine organisations with 998 respondents. The response rates varied from 33% to 89%. The respondents were mainly from public organisations or public corporations (formerly public organisations), but there were also respondents from one private organisation. The private organisation respondents were all consultants in the IT sector. The public corporation respondents were experts, managers and assistants in the fields of facility management, IT and health. Public organisations respondents were employees from one ministry and from four civil service departments.

3.2 Research publications

3.2.1 The link between the research publications and the research questions

As presented in section 3.1, the research activities and the research articles are linked together in several ways. A summary of all the articles is presented in Table 3.2.1 and the authors' contribution is specified.

Table 3.2.1 Summary of the articles.

Article	I. Analysing the impacts of ICT on knowledge work productivity	II. Methods for identifying and measuring the performance impacts of work environment changes	III. SmartWoW – Constructing a tool for knowledge work performance analysis	IV. What Matters for Knowledge Work Productivity?	V. How to Measure Impacts of Work Environment Changes on Knowledge Work Productivity – Validation and Improvement of the SmartWoW Tool
Authors	Palvalin, M., Lönnqvist, A., Vuolle, M.	Palvalin, M., Vuolle, M.	Palvalin, M., Vuolle, M., Jääskeläinen, A., Laihonen, H., Lönnqvist, A.	Palvalin, M.	Palvalin, M.
Contri-bution	Collecting and analyzing majority of empirical data, 1/3 reporting	Collecting and analyzing empirical data for 2/3 methods, 1/2 reporting	Collecting and analysing empirical data, 1/5 constructing tool, 1/5 reporting	Full	Full
Journal	Journal of Knowledge Management, 17(4) 545-557.	Journal of Corporate Real Estate, 18(3) 164-179.	Int. J. of Productivity and Performance Management, 64(4) 479-498.	Employee relations, 41(1) 209-227.	Measuring Business Excellence, 21(2) 175-190.
Main topic	NewWoW intervention case specific measurement process	Three measurement methods for NewWoW intervention	Constructing SmartWoW tool	SmartWoW framework validation	SmartWoW tool improvement and statistical validation

Section 3.1. described the link between the research activities and the research articles. This section continues the chain from research articles to research questions. The link between the research articles and the research questions is presented in Figure 3.2.1. Research articles I-IV provide answers research question 1. In articles III and IV, the theoretical framework for knowledge work performance measurement in the NewWoW context is created and tested. Articles I and II are studies that test and develop how the performance can be measured in different-sized NewWoW initiatives. Research articles III-V provide answers to research question 2. The constructed tool for measuring knowledge work performance is described in article III. Based on the feedback after the construction of the tool, it was further developed and the improved version of the tool is presented in paper V. The SmartWoW tool is validated using a market test in article III and using statistical methods in articles IV and V.

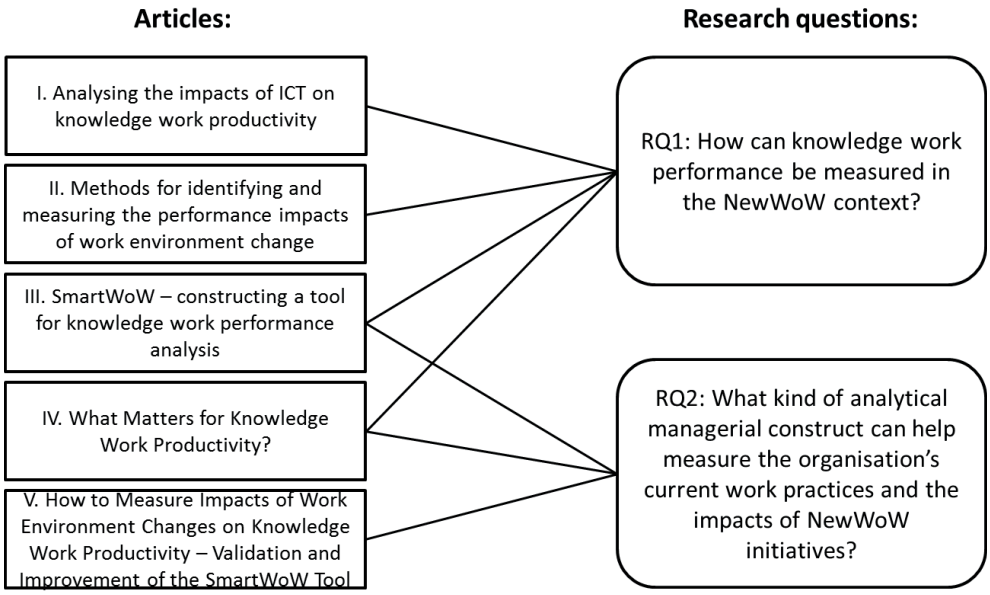


Figure 3.2.1 Link between the research articles and research questions.

The research design was presented in section 3, which summarized all the research activities used in the research articles. Section 3.2 presented how the research articles were related to the research questions of this thesis. In the following section, 3.2.2, the summaries of the research publications are presented. Section 4 presents the empirical results of this thesis, combining the results of the research articles and

forming answers to the research questions. The section is divided in such a way that 4.1 answers research question 1 and section 4.2 answers research question 2.

3.2.2 Summaries of the research publications

Article I: Analysing the impacts of ICT on knowledge work productivity

The potential of information and communication technology (ICT) in improving knowledge work productivity is well-documented in the existing literature. However, prior research fails to provide a means for analysing whether the potential can be realized in a specific organisational context. Thus, this paper aims to focus on the context-specific analysis of the impacts of ICT services on knowledge work. This paper uses a literature review and a case study conducted in a medium-sized European telecommunications company. The case study examines the measurement process for capturing the knowledge work productivity impacts produced by a new ICT service used by the company. ICT can be used to eliminate non-value-adding tasks or to make them more efficient. ICT can also improve employee welfare, for example, through transforming the content of work by eliminating unimportant activities. The empirical study showed that, contrary to the view presented in the prior literature, it did not seem so difficult to measure the impacts of ICT on knowledge work productivity. A key point in the measurement is the identification of case-specific impact factors by examining the characteristics of the ICT service and the organisational setting. The results of the paper will be useful for managers studying the impacts of ICT investments in their organisations. This paper contributes to the prior literature on ICT and knowledge work productivity by explaining how the impacts of ICT can be analysed in a given empirical context. The specific novelty value of the study lies in the new knowledge concerning identification of impact factors.

Article II: Methods for identifying and measuring the performance impacts of work environment changes

New working practices and work environments present the potential to improve both the productivity and the well-being of knowledge workers, and more extensively, the performance of organisations and the wider society. The flexibility offered by ICT has influenced changes in the physical environment where activity-

based offices are becoming the standard. Research offers some evidence on the impacts of work environment changes, but studies examining methods that could be useful in capturing the overall impacts and how to measure them are lacking. The purpose of this paper is to introduce and evaluate methods for analysing the impacts of work environment changes. This paper concludes five years of research and includes data from several organisations. The paper presents and empirically demonstrates the application of three complementary ways to analyse the impacts of knowledge work redesign. The methods include: 1) an interview framework for modelling the potential of NewWoW; 2) a questionnaire tool for measuring subjective knowledge work performance in the NewWoW context; and 3) multidimensional performance measurement for measuring the performance impacts at the organisational level. This paper presents a framework for identifying the productivity potential and measuring the impacts of work environment changes. The paper introduces empirical examples of three different methods for analysing the impacts of NewWoW and discusses the usefulness and challenges of the methods. The results also support the idea of a measurement process and confirm that it suits the NewWoW context. The three methods explored in this study can be used in organisations for planning and measuring work environment changes. The paper presents a comprehensive approach to the work environment which could help managers to identify and improve the critical points of knowledge work. Changes in the work environment are major for knowledge workers, but it is still unclear whether their effects on performance are negative or positive. The value of this paper is that it applies traditional measurement methods to new ways of working contexts, and analyses how these could be used in research and management.

Article III: SmartWoW – Constructing a tool for knowledge work performance analysis

NewWoW refers to a novel approach for improving the performance of knowledge work. The idea is to seek innovative solutions concerning facilities, information technology tools and work practices in order to be able to "work smarter, not harder". In order to develop work practices towards the NewWoW mode, there is a need for an analytical management tool that would help measure the the organisation's current work practices and demonstrate the impacts of development initiatives. This paper introduces such a tool. The constructive research approach was chosen to guide the development of the SmartWoW tool. The tool was designed on the basis of previous knowledge work performance literature as well as on

interviews in two knowledge-intensive organisations. The usefulness of the tool was verified by applying it in four organisations. SmartWoW is a compact questionnaire tool for analysing and measuring knowledge work at the individual level. The questionnaire consists of four areas: work environment, personal work practices, well-being at work and productivity. As SmartWoW is a standardized tool its results are comparable between organisations. SmartWoW was designed as a pragmatic managerial tool. It is thought that it may be valuable as a research instrument as well but the current limited amount of collected data does not yet facilitate determination of its usefulness from that perspective. This paper makes a contribution to the existing literature on knowledge work measurement and management by introducing an analytical tool which takes into account the NewWoW perspective.

Article IV: What Matters for Knowledge Work Productivity?

Knowledge work productivity is a well-studied topic in the existing literature, but it has focused mainly on two issues. There are many theoretical models lacking empirical research or very specific research regarding how something affects productivity. The purpose of this paper is to collect empirical data and to test the conceptual model of knowledge work productivity in practice. The paper also provides information on how different dimensions of knowledge work productivity have an impact. Through the survey method, data were collected from 998 knowledge workers from Finland. Then, confirmatory factor analysis was conducted to confirm the knowledge work productivity dimensions of the conceptual model. Later, regression analysis was used to analyse the impacts of knowledge factors on productivity. This paper increases the understanding of what matters for knowledge work productivity, with statistical analysis. The conceptual model of knowledge work productivity consists of two major elements: the knowledge worker and the work environment. The study results showed that the knowledge worker has the biggest impact on productivity through his or her well-being and work practices, and the social environment was also found to be a significant driver. The results could not confirm or refute the role of the physical or virtual environment in knowledge work productivity. The practical value of the study lies in the analysis results. The information generated about the factors impacting productivity can be used to improve knowledge work productivity. In addition, the limited resources available for organisational development will have the greatest return if they are used to increase intangible assets, i.e. management and work practices. While it is well known that many factors are essential for knowledge work productivity, relatively few

studies have examined it from as many dimensions as in this study, and at the same time. This study adds value to the literature by providing information on which factors have the greatest influence on productivity.

Article V: How to Measure Impacts of Work Environment Changes on Knowledge Work Productivity – Validation and Improvement of the SmartWoW Tool

Measuring knowledge work performance is a challenge for most organisations. SmartWoW is proving to be a useful tool for performance measurement, and several organisations are using it to make changes in the work environment. As organisations become more interested in its uses, studies with more accurate results are necessary. The purpose of this paper is to validate and improve the use of the SmartWoW tool. The SmartWoW tool was used in nine organisations, formulating the research data. Convergent validity, divergent validity and reliability were tested with SPSS and AMOS. Both exploratory and confirmatory factor analyses were applied. The SmartWoW tool structure was found to be valid. It follows the structure described in previous literature, with slight changes in two dimensions. Four variables were added to increase tool consistency, and their wording was harmonized. SmartWoW is useful for evaluating an organisation's current work environment and practices, as well as for measuring the effects of work environment changes. This study's results also suggest that SmartWoW would be useful for research by, for example, evaluating how dimensions affect each other. This study provides a better understanding of the unique features and uses of SmartWoW. The findings not only validate the tool's structure through statistical analysis, but also improve it and offer a broader scope of its uses.

4 RESULTS & DISCUSSION

4.1 Results of RQ1: How can knowledge work performance be measured in the NewWoW context?

The purpose of research question 1 was to find out how the performance measurement process works in the new ways of working context and what kinds of special characteristics need to be taken into account. Previous literature has examined the performance measurement process in general and the contribution of this study was to test how those principles would work in the NewWoW context. The measurement process was presented by Bourne et al. (2000) and modified for the NewWoW context by Laihonen et al., (2012) (see section 2.1). The measurement process was used and tested in three papers (I-III) and the results are presented here and summarized at the end of the section. In the next sections each phase of the measurement process is elucidated.

4.1.1 Purpose of measurement

The NewWoW is strongly related to change as something needs to change in order to be called 'new'. This means that the purpose of measurement is twofold; the first of which is to measure the impacts of the changes. Measuring the impacts of changes also contains two sub-dimensions.

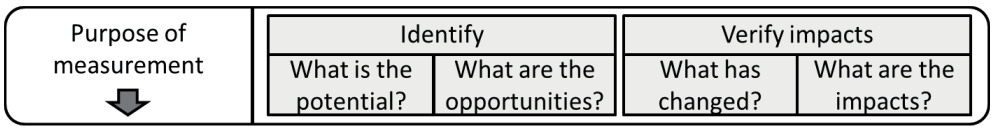


Figure 4.1.1 First phase: Purpose of measurement.

The first purpose includes verification of the change, for example in the NewWoW context the change might have been made in order to increase communication between workers by increasing the number of informal meeting places. The number

of informal meeting places might be higher than before, but are people using all of them or are they communicating more than before? These are good questions when measuring whether something has really changed. Another purpose includes the impact of the changes to ways of working. After it has been verified that there really is more communication, it can be measured whether the change has had any impact, for example on productivity or the well-being of the workers.

The second measurement purpose actually occurs before the first, but it is not as common in practice, which is why it is listed here as the second. Another purpose of measurement is to identify what should be changed to increase the productivity or well-being of the workers. Identification of the changeable factors in the NewWoW context also contains sub-dimensions. The first sub-dimension is identification of what in the organisation or worker inputs and process could be and should be changed to increase the outputs. With limited resources, it is very important to focus development on factors that have the biggest impact on productivity, i.e. where the biggest potential lies. For example in the NewWoW context, people might think the facilities are poor as there is a lot of noise, but what actually should be changed - the facilities or the work practices? Another option for identifying what should be changed is comparing or benchmarking other organisations or units inside the organisation. The measurement results might look good inside the organisation if the workers do not know that there is something better. Benchmarking inside and outside the organisation might reveal shortcomings in the organisational environment or great opportunities to copy.

4.1.2 Identification and choosing measurable objects

Identifying and choosing measurable objects is the next step after the purpose of the measurement has been defined. This is the phase of the measurement process that is mostly impacted by the context. Understanding well all the dimensions related to the NewWoW changes is a good starting point for successful measurement. The theoretical framework for knowledge work performance, which works as the basis for measurement, is presented at the end of section 2 (Figure 2.2.2). This phase of the measurement process is also divided into two different ways of measuring, both of which use the framework.

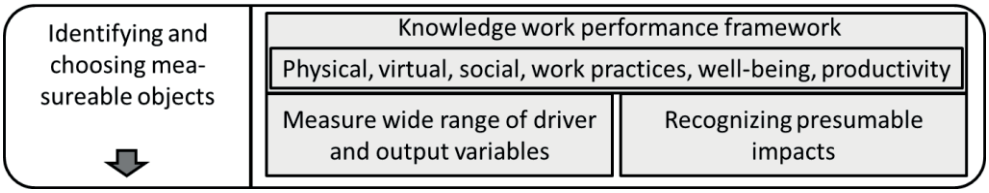


Figure 4.1.2 Second phase: Identifying and choosing measurable objects.

The first method for identifying and choosing measurable objects is 'brute force', where the idea is basically to measure everything. Measuring a wide range of drivers and output variables in the framework makes sure that as little as possible is missed. Of course there might also be a lot of unimportant information depending on the size of the changes. This measuring everything approach may seem a pointless way of measuring, but in fact it is not, for three major reasons: 1) a major NewWoW change has an impact on all the dimensions of the framework so it is natural that all the dimensions are also measured; 2) when all the dimensions are measured it is possible to recognize which things have really changed; and 3) to be able to identify what should be changed, it is important to get a good overview of the current ways of working. This framework has been used in two empirical studies, one using existing objective organisation performance measurement, and one creating a large survey including all the important areas of NewWoW change. In both cases, the approach seemed to work well although the existing measures were quite limited.

The second method for identifying and choosing measurable objects is more sophisticated as only specific measures are used. However, to make sure that all the presumably important areas are included, the framework can be used as a base for the identification process. Then other methodologies can be used to specify what the actual measurable objects are. These methods can include interviews, surveys and available written material. This kind of approach is necessary and especially suitable in smaller NewWoW changes as one of the empirical studies determined. The generic impacts identified as a result of the literature review served as a useful basis for identifying possible benefits. In addition, obtaining a thorough understanding of the context – i.e. the characteristics of the ICT service and the organisational setting in which the service is used – was essential for identifying the key benefits to be expected. Written material, informal discussions as well as a group interview session were used to identify the impact factors. This procedure seemed to work quite well in this case: the fact that the open-ended question concerning the impacts did not reveal any new factors in addition to those specifically asked about using the structured questions suggests that nothing really important was omitted.

4.1.3 Planning the actual measurement and selecting measures

The third step in the measurement process is selecting and creating the measures. Depending on the previous steps there are two options: utilizing existing organisation measures or creating customized measures. In many cases it is wise to combine these, as there are pros and cons for both of them. Utilizing existing measures has the advantage of previous data over a longer period of time and the disadvantage that the measure might not provide the required information directly. While creating customized measures have the opposite advantages and disadvantages, it also requires a lot of resources. The following paragraphs describe how these general guidelines for selecting measures have been applied in empirical studies in the NewWoW context. A total of three measurement approaches are presented; the first example is for a smaller NewWoW change and the others are focused more on larger changes. The first and second are customized measures while the third utilizes both existing and customized measures.

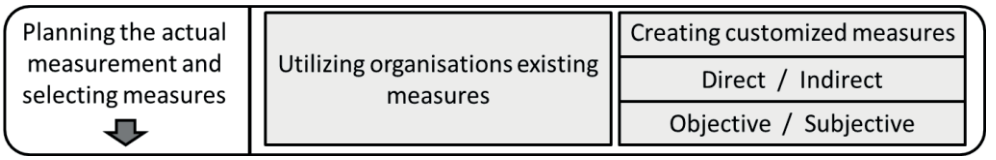


Figure 4.1.3 Third phase: Planning the actual measurement and selecting measures.

Case-specific measures were used in a small NewWoW change where an ICT service was implemented and the focus of interest was to point out the impacts (Paper I). The purpose was to find out how much of the knowledge workers' time it would save and what kind of impacts the time savings would have. The measurement was made by creating an objective measure of how much time the ICT service would save and subjective data was added to understand how the saved time was used. Objective measurement seemed to be very suitable for capturing concrete issues such as time saving whereas subjective measurement captured complex and qualitative phenomena such as perceptions regarding the usability of the ICT system. Interpretation of the measurement results was done by linking both objective and subjective results into an overall assessment, as both types of data contribute to building up the whole story. As an interesting note, the time saved was measured using both objective and subjective measures and the results were very close to each other. The measurement results seemed useful and accurate enough for the purposes

of the organisation: they demonstrated the key benefits and also pointed out some areas for improvement.

Subjective measurement like surveys is considered a valuable tool for practical measurement despite its limitations (Paper III). Surveys are popular in many areas because of their flexibility and straightforwardness. These were the main drivers why a survey was considered as one of the first methods during the process of considering how to measure knowledge work productivity in the NewWoW context. As previously highlighted, NewWoW changes usually include changes in several areas of working and all those areas can be included in the survey. One purpose of NewWoW changes is to increase well-being at work for knowledge workers and a subjective measure has a clear advantage for measuring this. On this basis, the survey-based SmartWoW tool was created to fulfil both purposes of measurement. The SmartWoW tool has proven to be such a practical technique for measuring major NewWoW changes that it has become popular in the Finnish public sector. The tool is presented in more detail in section 4.2 as one of the results of research question 2.

Multidimensional measurement is naturally a valid approach for measurement in the NewWoW context as it includes several dimensions (Paper II). Measures are selected from each of the areas of the theoretical framework (Figure 2.2.2). Multidimensional measurement focuses more on measuring the performance impacts at the organisational level. In multidimensional measurement, both objective and subjective measures can be used to make the measurement richer. These empirical cases included using the organisation's existing objective measures with customized subjective measures in the form of a survey. The existing measures focused more on the physical environment dimension as the main focus in NewWoW change was on the physical environment, but there were also other measures. The other measures were chosen with the two criteria that were available according to the focus of the change. The challenge in multidimensional measurement is that it requires significant resources to gather all the information. As researchers, we would have liked to gather information about the same issues using both subjective and objective measures, but this proved to be difficult. The main difficulty was that the objective information was not available, and when it was, it was still difficult to gather from the organisation's information systems. Some similarities could be seen in both objective and subjective results, e.g. the subjective feeling that meeting practices had improved and the average length of the meeting in the booking system, but this needs more empirical evidence to be confirmed.

4.1.4 Collecting data, analysing results and utilizing the results in decision-making

The final steps of the measurement process, namely collecting data, analysing results and utilizing the results in decision-making are combined as there are no recognized differences in the NewWoW context (Figure 4.1.4.). In fact, previous literature has reported several measurement challenges and only a few solutions to those challenges. The purpose of this section is to consider how the presented measurement solutions can respond to measurement challenges.

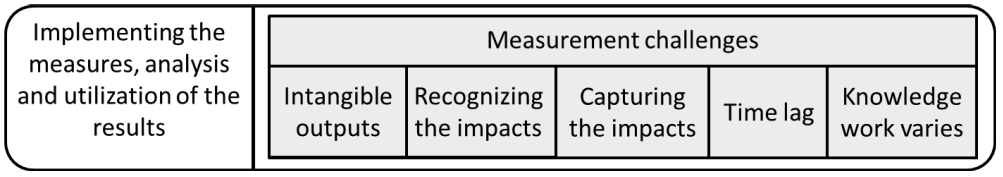


Figure 4.1.4 Final phases: Collecting data, analysing results and utilizing the results on decision-making.

Section 2.1 presents the common measurement challenges in organisational change initiatives found in the literature. The first challenge is the qualitative and intangible nature of knowledge work outputs. This is a major challenge for measurement and the reason why it is lacking in many organisations. It is possible to create customized measures to capture knowledge work outputs, but it requires resources. As reported in the previous literature, subjective measures are an efficient way of capturing the impacts of workplace initiatives. The second challenge is to make sure which factors are actually affected in a workplace initiative. As a solution to this challenge, the knowledge work performance framework (Figure 2.2.2) is presented to ensure that all the important dimensions are considered. It can be used as a basis for a survey or interview to map potential impacts before the actual measurement. The third challenge is how to make sure that the impact is a result of the current change, not something else that is happening at the same time. Measuring a wide range of variables from different dimensions of the knowledge work performance framework also enables it to capture unplanned or other changes in the organisation. It decreases the possibility that the impacts are not caused by the current workplace initiative. The fourth challenge is the time lag between the change and realization of impacts. The latter is a twofold challenge as some changes in working opportunities can be seen and measured immediately. However, the actual impacts can be measured only

after the employees have adapted to the new ways of working. For example, productivity may decrease immediately after the change and increase later when the employees have learned to work in the new environment. The fifth challenge is that the impacts may vary depending on the organisational level and the working role. Measuring the impacts from all the organisational levels and working roles can be a challenge, as it typically requires a lot of resources. Subjective measures like surveys are an inexpensive way to collect measurement information from different levels and working roles as it can be sent to all the employees with a set of appropriate background variables.

4.1.5 Summary of the results of research question 1

As a conclusion for research question 1, the study suggests that the general performance measurement development process is suitable for the NewWoW context, with some adjustments.

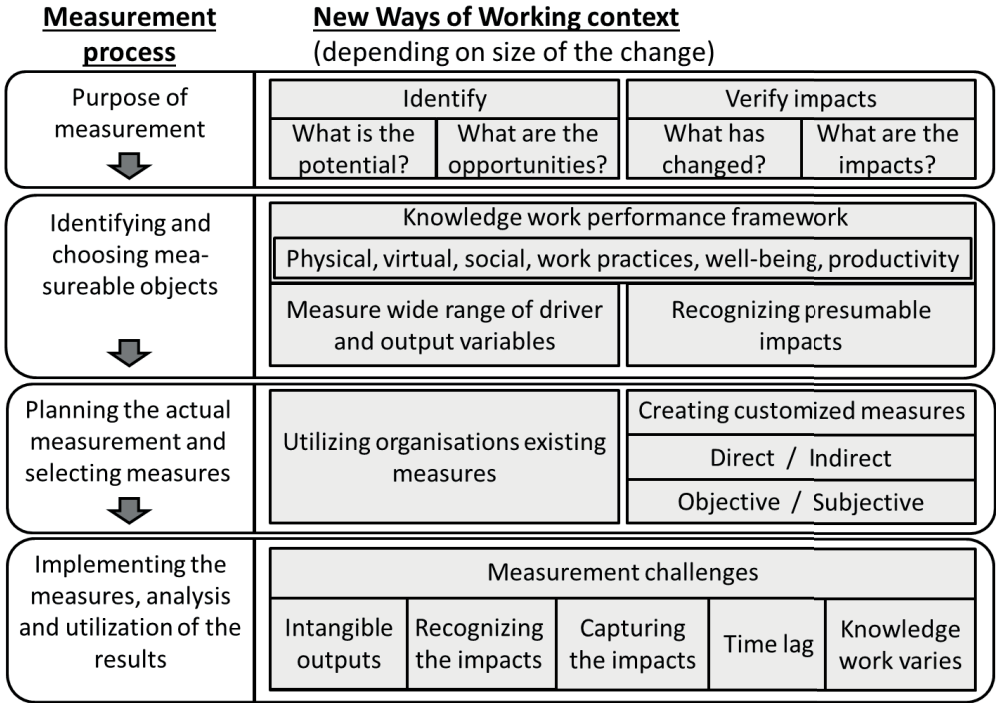


Figure 4.1.5 Knowledge work performance measurement process for the NewWoW context.

The thesis presents and tests a knowledge work performance framework, which is essential for understanding the context and thus successful measurement. Figure 1 summarizes the results of RQ 1 in the form of the measurement process with additions for the NewWoW context. Figure 4.1.5 is built as a practical tool for researchers and practitioners interested in measuring NewWoW initiatives.

It is worth stressing that the measurement is highly dependent on the scale of the changes and the available resources. The size of the change can vary from a very minor technical upgrade to a very extensive change through the whole working process. Naturally, the size of the change is a major factor when selecting the appropriate level for the measurement. In minor changes, the measurement can be minimal, but in major changes, good measurement is the key to successful change. Objective measures are preferable, but typically subjective measures are the most realistic option and they also have many advantages with respect to common measurement challenges. Specifically, the novelty value of the study lies in the new knowledge concerning the identification of the impact factors. After the identification of the impact factors, the measurement process itself is fairly straightforward.

4.2 Results of RQ2: What kind of analytical managerial construct can help measure the organisation's current work practices and the impacts of NewWoW initiatives?

Resulting from research question 2, the SmartWoW tool was constructed (Papers III and V). The purpose of RQ2 was to find a practical and inexpensive tool for managers to support the planning and measuring of NewWoW initiatives. The tool is survey-based and is presented below. It has been validated in several ways and the results of the validation tests are presented after the tool.

4.2.1 Introducing the SmartWoW tool

The purpose and the starting point for SmartWoW tool were to find a practical and inexpensive way to measure NewWoW changes. The tool was required to fulfil two purposes; identification of what could be changed in order to increase productivity and measurement of the changes resulting from NewWoW initiatives. Previous studies suggested the survey as the most appropriate method to fulfil all the

requirements as it is easy to use, inexpensive and provides quantitative data. It could also be sent to all the employees, so they could be part of the planning of a NewWoW change. In addition, they know best what enhances or hinders their productivity. The construction of the SmartWoW tool is described in paper III and it is updated in paper V, based on the feedback and validation results.

The SmartWoW tool was created using the constructive research approach (Paper III). After the original version (Paper III) the SmartWoW tool has been improved based on feedback and statistical validation (presented in Paper V). The basis for the SmartWoW tool is the knowledge work performance measurement framework, presented in section 2.2.3 (Figure 2.2.2). The idea behind the SmartWoW tool is that all the dimensions of the theoretical framework are included in the items. The SmartWoW tool consists of 52 items, where 4 are open-ended and 48 use the five-point Likert scale, ranging from 1 (disagree) to 5 (agree). All the dimensions of the SmartWoW construct are presented below, divided into organisational and individual sections. The theoretical background behind the items is summarized briefly first and then the items are listed in two tables.

The work environment is divided into three dimensions, according to Bosch-Sijtsema et al. (2009) and Vartiainen (2007): the physical environment, the virtual environment and the social environment. The physical environment includes organisation facilities and work spaces and should support work by offering the best facilities for different tasks, for instance, collaboration and concentration (e.g. Heerwagen et al., 2004; Halpern, 2005). It is important to have enough spaces for meetings and informal discussion that can be used based on activity (Maarleveld et al., 2009). The virtual environment includes the computers, smart phones and software that a knowledge worker needs to be able to work efficiently (Vartiainen & Hyrkkänen, 2010). Technology plays a major role in increasing knowledge workers' mobility and flexibility; it allows them to be connected with customers and co-workers from distant locations (O'Neil, 2010). The social environment includes everything from the management to the organisational atmosphere (Bosch-Sijtsema et al., 2009). An effective knowledge worker needs to have clear goals and the ability to perform the work flexibly in time and space (Drucker, 1999; Origo & Pagini, 2008; Kelly et al., 2011). Organisational transparency, good information flow, clear policies conveyed through meetings, and an innovative climate are also an important part of the social environment (Drucker, 1999; Wännström et al., 2009).

Table 4.2.1 SmartWoW items for work environment dimensions.

Physical environment
There is a space available for tasks that require concentration and peace at our workplace when needed
There are enough rooms at my workplace for formal and informal meetings
The facilities at my workplace enable spontaneous interaction between workers
The ergonomic arrangements of the work stations at my workplace are in order
There are generally no disruptive factors in my work environment (like sounds or movements)
There is a place in which I can discuss or talk on the phone about matters which I do not want others to hear
The facilities at my workplace are conducive to efficient working
Virtual environment
The usability of the main software for doing my work tasks is good
I can access the information I need wherever I am
Workers can see other workers' electronic calendar
Workers can communicate with instant messaging tools (e.g. Lync, Skype)
My workplace has sufficient equipment for virtual negotiations
My workplace has electronic teamwork tools (e.g. Google docs, Trello, Yammer)
There are appropriate mobile devices available at my workplace (e.g. laptop, iPhone, tablet)
Social environment
I am able to work in the ways and at the times which suit me best
Telework is a generally accepted practice at my workplace
Operations at my workplace are transparent (e.g. decision-making and information flow)
Information flows well among the people important for my work
The meeting practices at my workplace are efficient
Our workplace has clear guidelines regarding the use of IT and communication tools
I have clear goals set for my work
My work is assessed in terms of results achieved, not only hours worked
My work tasks constitute a reasonable whole
New ways of working are actively explored and experimented at my workplace

There are also three individual level dimensions in the SmartWoW concept. While the work environment defines the framework for working, individual work practices show whether the worker takes advantage of the framework provided (Ruostela & Lönnqvist, 2013; Koopmans et al., 2013). Quiet spaces and virtual negotiation is not a benefit unless the worker utilizes them to support the work. Work outcomes are affected by individual work practices, which include self-management, setting personal goals, prioritizing important tasks and planning (Claessens et al., 2004; Kearns and Gardiner, 2007).

Table 4.2.2 SmartWoW items for knowledge worker dimensions.

Individual work practices
I use technology (e.g. videoconferencing or instant messaging) to reduce the need for unnecessary travelling
I utilize mobile technology in work situations where I have to wait around (e.g. working on the laptop or phone on the train)
I try to manage my workload by prioritizing important tasks
I do things that demand concentration in a quiet place (e.g. in a quiet room or at home)
I prepare in advance for meetings and negotiations
I take care of my well-being during the working day (e.g. by changing my work position or the place I work in)
I follow the communication channels at my workplace
If necessary I close down disruptive software in order to concentrate on important work tasks
I regularly plan my working day in advance
I actively seek out and test better tools and ways of working
Well-being at work
I enjoy my work
I am enthusiastic about my job
I find my work meaningful and it has a clear purpose
My work performance is appreciated at my workplace
My work and leisure time are in balance
The atmosphere at my workplace is pleasant
Conflict situations at my workplace can be resolved quickly
Productivity
I achieve satisfactory results in relation to my goals
I can take care of my work tasks fluently
I can use my working time for matters which are appropriate for the goals
I have sufficient skills to accomplish my tasks efficiently
I can fulfil clients' expectations
The results of my work are of high quality
The group(s) of which I am a member work efficiently as an entity

Well-being at work includes all the topics that are typically measured in work satisfaction surveys, but in a compact form. Job satisfaction, work engagement, appreciation, work-life balance and atmosphere are all important for the knowledge worker's well-being (Bakker & Demerouti, 2008). Well-being at work has a dual role in this model: it operates as a result of work environment drivers (e.g. Kelly et al., 2011; Halpern, 2005), but at the same time, it is itself a driver for productivity (e.g. Wright & Cropanzano, 2000; Schaufeli & Salanova, 2007). The sixth dimension, productivity, is the only complete result dimension in this model. Work efficiency and effectiveness, achieving goals, customer satisfaction and quality of work are important indicators for knowledge worker productivity (e.g. Ramirez & Nembhard,

2004; Koopmans et al., 2011). In addition, the SmartWoW tool also includes several background variables and four open-ended questions, which are presented in Palvalin et al. (2015).

4.2.2 SmartWoW tool validation

SmartWoW validation was made using market test and statistical methods. The market test is a typical method for validation in the constructive research approach. The market test was used for the first time in 2015 when the SmartWoW tool was first published (paper III) and it has since been updated using current information. The statistical validation carried out is described in papers IV and V.

In constructive research, the model under development is usually validated using the so-called **market test**. According to Kasanen et al. (1993), there are three types of market tests: weak, semi-strong and strong. The construct passes the weak market test when a high level manager in an organisation is willing to use it in decision making. The semi-strong market test requires that the construct is used throughout the organisation and the strong market test is passed when there is evidence for economic benefits from using the construct and it is used systematically in several organisations. (Lukka, 2000; Kasanen et al., 1993) According to Labro and Tuomela (2003), the semi-strong and strong market tests cannot be passed in a short time-frame and, thus, when SmartWoW was originally published, only the weak market test could be passed.

The SmartWoW tool was first used by four pilot organisations and comments and feedback were requested after the process. When analysing the observations from pilot organisations it appeared that the measurement tool was versatile. It fulfils key comparative tasks of performance management. Organisation 6 (Figure 3.1.2) regarded the tool as a useful component of a performance measurement system where it can be monitored annually with updated objectives and action plans. Organisation 2 highlighted the benefits in measuring the impacts of change interventions. In practice, this means measurement before and after change interventions. Organisations 3 and 5 felt that the value of such a tool is especially linked to the possibility to utilize it in comparison analysis. When the 'maturity' of working practices is captured in several work environments and units it is possible to utilize the data in comparisons and learn from other organisations. Furthermore, it was mentioned that the measurement results act as a trigger for discussion on knowledge work performance and its drivers. To summarize, the pilot organisations

found SmartWoW useful and are willing to use it again. Some were also interested in using it with their own clients. Therefore, it can be stated that the tool fulfils the criteria of the weak market test.

After the original article on constructing the SmartWoW tool was published, one of the project partner organisations wanted to use SmartWoW after their own major work environment change. The organisation was very satisfied with the results and the practicality of the tool. The purpose of the organisation is to provide consultation and develop the work environments of their customers and they were interested in using SmartWoW with their clients. Currently they have used the tool in 40 organisations and there are more to come. SmartWoW is used before and after the changes to identify what should be changed to gain the best value and also to measure and point out the impacts of the changes. Some of the organisations have even used SmartWoW subsequently and implemented it as part of their work development process. This clearly fulfils the criteria of the semi-strong market test as it is used throughout the organisations. It probably also fulfils the criteria of the strong market test. It is definitely used systematically in several organisations, but there is no clear evidence of economic benefits. However, there are a couple of indicators that it has economic benefits; the first is that it is implemented as part of the development process as pointed out above. The second is the assumption that, if the tool is used to identify what should be changed and after the changes productivity is found to have improved, there are also most likely improvements in revenue.

Another typical step in construct development is **statistical validation** (Paper V). The purpose of this is to prove that the tool is able to measure what it is supposed to and, more specifically, that the different dimensions do not measure the same factors. Such validations are called convergent and divergent validity (Hair et al., 2006). Reliability is used to measure the internal consistency of the dimensions and illustrate the organisation's current state (Bland and Altman, 1997). These approaches to construct validation and reliability are presented in more detail below. The validation process was made using data from 998 respondents in 1 private and 8 public sector organisations in Finland.

Convergent validity refers to the degree of positive relationships among the components that make up the construct. If the construct has convergent validity, then there should be a strong correlation between the components (Narver and Slater, 1990). Convergent validity can be determined in different ways, according to Ahire et al. (1996). The two extremes employ completely different instruments to determine convergent validity, or each item in the same instrument is viewed as a

different approach in defining convergent validity. Hair et al. (2006) take a more practical approach to convergent validity. According to them, convergent validity is a condition that concerns what items are needed in a construct to fully represent the dimension in question. Hair et al. (2006) suggest that factor loadings, composite reliability (CR) and average variance extracted (AVE) should be used to assess convergent validity. According to Fornell and Larcker (1981), construct convergent validity requires CR to be greater than AVE and AVE to be at least 0.50.

The discriminant validity of a construct is the difference between the items that are not theoretically similar (Sureshchandar et al., 2002). Different components in a construct are needed to measure different factors, and this can be tested by using maximum shared variance (MSV), average shared variance (ASV) and average variance extracted (AVE). According to Chau (1997), the average variance extracted reflects the amount of variance that is captured by the construct, in relation to the amount of variance due to measurement error. Discriminant validity is achieved when the square root of AVE is greater than its correlations with other constructs (Fornell and Larcker, 1981). According to Hair et al. (2006), differentiation of items is achieved when MSV and ASV are less than AVE.

Reliability is the measure of consistency of the construct, meaning that the instrument is capable of producing consistent results when the survey is used in two homogenous groups of respondents. Internal consistency can be used to evaluate the consistency of the responses for each item in the instrument. Bland and Altman (1997) suggest that Cronbach's alpha analysis be used for the construct reliability test. Cronbach's alpha is the same as CR and, according to Bland and Altman (1997), an alpha value over 0.8 is considered good for social science research.

Convergent validity, discriminant validity and reliability were tested using both explorative (EFA) and confirmatory (CFA) factor analyses. According to EFA and CFA, the requirements of convergent validity, discriminant validity and reliability were achieved and the SmartWoW tool can be classified valid and reliable. The results of the factor analyses prove that the items in the dimensions are related, but there is a difference between the dimensions in SmartWoW.

The validity of SmartWoW and the theoretical framework (Figure 2.2.2, section 2.2.3) was also tested using regression analysis (Paper IV). Regression analysis can be used to verify the direction and the strength of the relation. Regression analysis was based on the factors found in CFA and the results suggest that the social environment, individual work practices and well-being at work have a strong positive connection with productivity. The connections between the physical and virtual environments with productivity were also positive, although weak and not

statistically significant. However, these results indicate that the theoretical framework can be confirmed with empirical data.

4.2.3 Summary of the results of research question 2

As a conclusion for research question 2, the SmartWoW tool has proved to be an efficient and accurate tool for measuring NewWoW and knowledge work performance to assess workplace changes. It has been easy to use and 40 organisations have chosen to use it for two measurement purposes, identifying what should be changed and measuring the impacts of changes. The tool has proven to have high practical value, which is one dimension of validity and it fulfils all the common statistical validation criteria. While statistical validation does not validate all the items in the tool, it validates the dimensions and the framework behind it. The framework is the most important part of the tool while some of the variables are initially replaceable, depending on the current interests.

5 CONCLUSIONS

5.1 Contribution of the study

The results of the study are the responses to the two research questions based on the theoretical framework and empirical studies. The thesis responds to the first research question by reviewing the previous literature of the knowledge work performance measurement process and empirically testing it in the new context. As a response to the second research question, this study introduces the SmartWoW tool, which is a practical survey-based metric for identifying needs and measuring changes in NewWoW. The key part for both of the results is the framework for knowledge work performance, which covers all the dimensions of the NewWoW context and thus defines what should be measured.

The contribution of this thesis is that it fills the gap of how to measure knowledge work performance in the NewWoW context and workplace initiatives in general. General performance measurement is well known in the literature, but the knowledge work and NewWoW contexts are not as common. Laihonen et al. (2012) have made a literature review on how to measure the productivity impacts of New Ways of Working, but the paper lacks empirical evidence. They suggest the measurement process be used in the NewWoW context and one of the contributions of this study is to test the process in practice. In addition to empirical evidence, this thesis improves the suggested measurement process in the first three phases. In the first phase, Laihonen et al. (2012) focused on measuring impacts of the changes, but it is equally important to identify what kind of opportunities and potential there is for different changes. For the second phase of the measurement process, this study contains a more structured knowledge work performance framework (Figure 2.2.2) to be used in identifying and selecting measurable objects. This also introduces an option to measure 'everything' related to the NewWoW context as the changes could be major and even in minor changes it might be otherwise difficult to prove what caused an improvement in productivity. The knowledge work performance framework can also be used in background when defining specific metrics to capture the impacts of the NewWoW initiative. For the third phase of the measurement process, the contribution is to have an option to use existing measures alongside

customized measures. This is not new in general measurement, but it is now also added to the NewWoW context with some empirical evidence. Previous literature (e.g. Mettänen, 2005; Helo et al., 2009; Bosch-Sijtsema et al., 2009; Laihonen et al., 2012) has presented various measurement challenges and fewer solutions to the challenges. The results of this study are also evaluated on how they can respond to the challenges.

Another contribution of this thesis is that it presents and validates a practical tool for identifying and measuring changes from NewWoW initiatives. There have been a few previous attempts to construct this kind of tool, e.g. De Been & Beijer (2014) and Koopmans et al. (2012), but this is the first balanced and validated tool covering all the dimensions of NewWoW and is based on the knowledge work performance framework (Figure 2.2.2). While the tool has a high practical value, it is also of value to researchers. In this research area, it is one of the first tools that can gather information for several fields of science (facilities management, ICT, management, work practices, well-being at work, productivity). This opens up several options for future studies e.g. comparing the relation and significance of different aspects to productivity.

The knowledge work performance framework lies behind both of the main contributions. While it is a combination of previous studies (e.g. Drucker, 1999; Duffy, 1999; Maarleveld et al., 2009; Bosch-Sijtsema et al., 2011; Ramirez & Nembhard, 2004; Koopmans et al., 2011), it has value as an addition to previous frameworks. The contribution is that it collects previous studies from the fields of knowledge work and productivity and merges them with the NewWoW context into a simple upper level structure. The framework is also tested with empirical data regression analysis. Underneath the dimensions there are several fields of science, e.g. facilities management, information technology, management, etc. which are related to knowledge work productivity. Part of the value of the presented framework is that does not specifically focus on any of those fields of science, like for example the previous NewWoW-related frameworks (e.g. De Been & Beijer, 2014; Maarleveld et al., 2009; Riratanaphong & van der Voordt 2015) which is aimed at facilities management. It also covers more of the performance drivers than most of the frameworks (e.g. Ramirez & Nembhard, 2004; Koopmans et al., 2011) and more results and outcomes than some of the frameworks (e.g. Duffy, 1999; Bosch-Sijtsema et al., 2011). The framework brings understanding and management practices one step closer to the ideas of Davenport et al. (1996) and Drucker (1999), who suggest that the work and work environment should be managed as a whole.

NewWoW itself is a very narrow academic discussion, but it is related to many research areas. The contribution of this thesis should also be considered in the related fields. For example the results of this study present one approach to counter the typical measurement challenges in the performance measurement debate. This study contributes additionally to the fields of knowledge work and performance measurement. As far as performance measurement is concerned, the contribution is that the measurement development process also works in the NewWoW context with an appropriate theoretical framework. The main contribution to the debate on knowledge work is the knowledge work performance framework. It adds a combined and updated version of previous understanding to the discussion. The typical discussion in the area of knowledge work is usually reductionist while this framework is closer to the complex nature of working where everything influences everything. The framework and use of measurement in decision-making are both minor contributions to the discussion of knowledge management.

The basic idea behind the thesis is the same as the one that Taylor had a long time ago, improving the productivity of employees. As Drucker (1999) pointed out, the means and tools are still quite different in knowledge work today. The framework and whole NewWoW approach is about making sure that the environment supports the individual knowledge worker as well as possible. The knowledge workers themselves know best how the work should be done and the motivation of the worker has a great influence on productivity (Drucker, 1999). The contribution of this thesis is hopefully a small step in that direction.

5.2 Managerial implications

Like pragmatic studies in general, this study offers clear managerial implications, which are easy to adopt in daily management. The first implication is increased understanding of how knowledge work performance is formed and how it was used in this study as a basis for measurement. Also, the performance measurement process in the NewWoW context, which is a result of research question 1, is a good starting point for practitioners planning the measurement of a workplace initiative. It is a step-by-step guide to the process and what should be taken care of in each step. It gives options and examples of how performance measurement can be carried out, depending on the size of the workplace initiative and the available resources.

The second result in this study, which has a clear practical value for managers, is the SmartWoW tool. There has been interest in it since 2012, which is continuing.

The SmartWoW tool is a very easy way to obtain measurement information about a NewWoW change. It offers a wide variety of variables which managers can use for planning and evaluating the changes. The survey is also a good way to obtain information from all the employees. It gives them the chance to participate in planning the change. It is also a good way to initiate discussion inside the organisation on how the employees would like to do their work. The SmartWoW tool can also be used for benchmarking, which helps organisations to recognize their own strengths and weaknesses. The third managerial implication is that the data collected by the SmartWoW tool can be later used in research to analyse for example the most important factors affecting knowledge work productivity. Alternatively, it can be used to analyse how productivity changes depending on what type of office is in use. These managerial implications do not derive directly from this study, but they are related and will have a large impact later on all knowledge workers.

The fourth implication is the theoretical framework for knowledge work performance (Figure 2.2.2). While the framework is theoretical, it was also tested using empirical data. The framework gives a good overview of what the performance drivers are and how productivity can be improved. This study offers valuable information about where managers should focus their investments to experience the biggest improvements in productivity. According to the results, managers should keep focusing on making sure that their knowledge workers are satisfied with their working conditions and are able to manage themselves, as these seem to have the strongest relation with productivity. As for the NewWoW context, the focus is typically on the physical environment when it should be placed more on management and individual work practices.

5.3 Evaluation of the study

The purpose of the study was to define the performance measurement process in the NewWoW context and to find practical measurement solutions. The study consisted of several steps which together formed the answers to the research questions. In every study, it is important to critically evaluate the process and the results of the study. The research was executed during the period 2012-2017 in two large research projects and a few smaller ones, which supported well the themes of this thesis. The projects allowed rigorous focus on the theoretical background of the performance measurement and the NewWoW context. They also offered good opportunities for empirical data, as there were many different types of measurement

cases. After the research projects ended, funding from the Finnish Work Environment Fund made it possible to analyse the previously collected data and publish the journal articles. In the beginning, it is important to highlight the fact that the study was made in Finland and the results seem to work in this cultural context, but might not be applicable everywhere. More studies are needed in other cultures to be able to generalize the results. The research process went mainly as planned and there were no significant problems. However, there were many small details that could have gone better. For example, while the first part of SmartWoW was developed with private organisations, the second part focused more than we intended on public organisations. There is probably no major difference between public and private organisations, but this remains unknown. The study also leans heavily on subjective measurement as there were difficulties finding objective measures from those available in the organisations and, if they had some data, it was difficult to retrieve from their systems. The interest towards analytics and measures has increased every year, so probably future studies will also have better chances to obtain more objective data. With the available resources the study process was successful although the writing of this thesis took more time than expected.

This study has two essential results, the performance measurement process and adjustments for the NewWoW context and the SmartWoW tool. The general performance measurement process is well known and has proven useful in many areas. The purpose of this study was to find out what has to be taken into account when the process is applied in the NewWoW context and how it can be applied. The study succeeded in finding out and testing how the performance measurement process works in practice. However, the measurement process with adjustments for NewWoW was not finalized in its current form until this thesis was written. While it should work, it is still unknown for example how someone else could use it for measuring their workplace initiative. Utilizing it also requires some previous knowledge on performance measurement, as there are no very specific instructions for example on how to create measures.

The SmartWoW tool is the other essential result of the study. It is not by any means perfect and has some limitations, but it has also a clear value for organisations as it has been used in dozens of organisations and has fulfilled the criteria of the most common validity and reliability tests. Although the variables of the SmartWoW tool were designed to be updated from time to time, there are some variables that require reconsideration as the validation tests suggested (updates require also re-validation). This is mainly due to the limitation in the knowledge work performance framework, which does not describe the dimensions as mentioned. The tool also has

a limited amount of variables due to the practicality of the tool. It can be argued why one factor is included and not another, but some of the variables were removed to keep the SmartWoW tool short. In practice, organisations have been able to add or remove some variables depending on their specific needs. The SmartWoW tool would also benefit from additional validation and development based on other and bigger data sets.

One important part of the study was the knowledge work performance framework, which covers all the critical dimensions of NewWoW and enables effective performance measurement. The framework started as a theoretical framework based on previous studies and evolved a couple of times during the research process before achieving its current form. At a higher level, it covers all the critical dimensions for knowledge work performance and has been validated using factor and regression analyses. The limitation of the framework is that it is based on the literature of knowledge work, new ways of working and performance management. Research areas such as work psychology, human resources management, facilities management and information systems are touched upon, but not deeply explored. The other limitation and avenue for future studies is that it does not describe the dimensions in as well-structured a way as the higher level. The study also succeeds in finding solutions to the common measurement challenges raised in previous studies. However, the solutions presented are more like examples of how it could evolve in this context, but have not been studied in depth or validated. Another question to be evaluated is the sorting of the variables, especially dividing the variables between the social environment and well-being at work, as the two latter include variables which could go be included in either one. As a conclusion of the evaluation of the study, the research publications included in this thesis support both research questions well and were published in respected journals from different fields. The papers are balanced and cover all the areas of this thesis. The thesis itself is a concise and consistent summary of the research publications.

5.4 Avenues for further research

In terms of future research, this thesis opens up many possibilities to overcome the limitations of this study and to advance from developing performance measurement to actually studying the results of the research data. One avenue for future research is to continue testing and developing measures in the knowledge work performance and NewWoW contexts. This study offers some examples, but more studies are

needed to confirm the results of this study and especially to increase the actual measurement in these areas. Increased interest towards analytics in many organisations will most likely offer a fertile ground for future studies. Subjective performance measurement seems to solve many of the measurement challenges found in previous studies and is recommended in the previous literature as a good way for measuring knowledge work performance. However, more studies are required to explore the relation of subjective and objective productivity in particular, because subjective productivity cannot be quantified or compared between persons. Another opportunity is developing the knowledge work performance framework. Currently, the framework can answer the question at a higher level, but not below the dimensions level. One opportunity for future research is to continue developing the theoretical framework to find the structure below the dimensions.

The SmartWoW tool offers two paths for future studies. The first is to continue improving and validating the tool. The SmartWoW tool was designed to be updated occasionally to match current needs. The theoretical background should be good as it stands, but specific variables might need updates. The current variables of SmartWoW were updated in 2015 and some of the examples might soon become outdated. Also, it would be beneficial to reconsider all the variables in the light of current knowledge and a stronger theoretical background. Reworking the variables will also have a positive outcome on the validity of the tool in the form of stronger factor loadings. Another high priority avenue for future research would be comparing SmartWoW with objective measures, for example, what is the relation between subjectively and objectively measured productivity. The validity of the SmartWoW tool could also be improved in the future by collecting more data from different types of organisations, especially from the private sector. In addition, data from different countries would be beneficial in the future, as cultural differences will certainly have an effect, starting from how employees respond to surveys.

Another path for the future use of SmartWoW is to start using it as a research tool. It offers several interesting approaches, starting with analysing the impacts of NewWoW changes on knowledge work performance, whether it is good to have an activity-based office or finding out how different productivity drivers impact on knowledge work productivity. The information could then be used in decision-making to focus development initiatives on those which have the highest impact. It can also be used for example to identify the most important characteristics and ways of working of the productive knowledge worker. The avenues for future research are numerous and, while there is a lot of existing data it is a tempting option to continue with this.

6 REFERENCES

Aaltonen, I., Ala-Kotila, P., Järnström, H., Laarni, J., Määttä, H., Nykänen, E., Schembri, I., Lönnqvist, A., Ruostela, J., Laihonen, H., Jääskeläinen, A., Oyue, J., Nagy, G. (2012), "State-of-the-Art Report on Knowledge work, VTT Technology 17, Espoo.

Adcroft, A., Willis, R., Hurst, J. (2008), "A new model for managing change: the holistic view", The Journal of Business Strategy, Vol. 29, No.1, pp. 40-45.

Ahire, S.L., Golhar, D.Y., Waller, M.A. (1996), "Development and validation of TQM implementation constructs", Decision Science, Vol. 27 No. 1, pp. 23-56.

Alvesson, M. (2001), "Knowledge work: Ambiguity, image and identity", Human relations, Vol. 54, No. 7, pp. 863-886.

Amir, A., Ahmad, N., Mohamad, M. (2010), "An investigation on PMS attributes in service organisations in Malaysia", International Journal of Productivity and Performance Management, Vol. 59, No. 8, pp. 734–756.

Antikainen, R., Lappalainen, S., Lönnqvist, A., Maksimainen, K., Reijula, K., Uusi-Rauva, E. (2008), "Exploring the relationship between indoor air and productivity", SJWEH Supplements, No. 4, pp. 79–82.

Antikainen, R., Lönnqvist, A. (2005), "Knowledge worker productivity assessment", Proceedings of the 3rd Conference on Performance Measurement and Management, Nice, France, September 2005.

Appel-Meulenbroek, R., Groenen, P., Janssen, I. (2011), "An end-user's perspective on activity-based office concepts", Journal of Corporate Real Estate, Vol. 13, No. 2, pp. 122-135.

Appel-Meulenbroek, R., Kemperman, A., Kleijn, M., Hendriks, E. (2015). To use or not to use; which type of property should you choose? Predicting the use of activity based offices. Journal of Property Investment & Finance, 33 (4), 320-336.

Bailey, S. (2011), "Measuring the impacts of records management – Data and discussion from the UK higher education sector", Records Management Journal, Vol. 21, No. 2, pp. 46–68.

Bakker, A.B. (2011), "An evidence-based model of work engagement", Current Directions in Psychological Science, Vol. 20, No. 4, pp. 265-269.

Bakker, A.B., Demerouti, E. (2008), "Towards a model of work engagement", Career Development International, Vol. 13, No. 3, pp. 209-223.

Barbosa, D.H., Musetti, M.A. (2011), "The use of performance measurement system in logistics change process", International Journal of Productivity and Performance Management, Vol. 60, No. 4, pp. 339-59.

Beauregard, T.A., Henry, L.C. (2009), "Making the link between work-life balance practices and organizational performance", Human Resource Management Review, Vol. 19, No. 1, pp. 9-22.

Bland, J.M., Altman, D.G. (1997), "Statistics notes: Cronbach's alpha", BMJ, No. 314, pp. 572.

Blok, M., Groenesteijn, L., van den Berg, C., Vink, P. (2011), "New ways of working: A proposed framework and literature review", M. M. Robertson (Ed.), Ergonomics and health aspects, Heidelberg: Springer-Verlag. HCII 2011, LNCS 6779, pp. 3-12.

Bosch-Sijtsema, P., Ruohomäki, V. and Vartiainen, M. (2009), "Knowledge work productivity in distributed teams", Journal of Knowledge Management, Vol. 13, No. 6, pp. 533-546.

Bosch-Sijtsema, P., Fruchter, R., Vartiainen, M., Ruohomäki, V. (2011) "A framework to analyze knowledge work in distributed teams", Group and Organization Management, Vol. 36, No. 3, pp. 275-307.

Bourne, M., Mills, J., Wilcox, M., Neely, A., Platts, K. (2000), "Designing, implementing and updating performance measurement systems", International Journal of Operations & Production Management, Vol. 20, No. 7, pp. 754-771.

Brynjolfsson, E. (1993), "The Productivity Paradox of Information technology: Review and Assessment", Communications of the ACM, Vol. 36, No. 12.

Campbell, J. (1990), "Modeling the performance prediction problem in industrial and organizational psychology", in M. D. Dunnette & L. M. Hough (Eds.), Handbook of Industrial and Organizational Psychology (pp. 687-732). Palo Alto, CA: Consulting Psychologists Press, Inc.

Chau, P. (1997), "Reexamining a model for evaluating information center success using a structural equation modeling approach", Decision Sciences, Vol. 28 No. 2, pp. 309-34.

Claessens, B.J., Van Eerde, W., Rutte, C.G., Roe, R.A. (2004), "Planning behavior and perceived control of time at work", Journal of Organizational Behavior, Vol. 25, No. 8, pp. 937-950.

Coppola, A. (1991) "Measuring the quality of knowledge work", Quality and Reliability Engineering International, Vol. 7, No. 5, pp. 411-416.

Craig, C., Harris, R., (1973), "Total productivity measurement at the firm level", Sloan Management Review, Vol. 14, No. 3, pp. 13.

Creswell, J., Clark, P. (2011), Designing and conducting mixed methods research, Sage publications.

Dahooie, J., Afrazeh, A., Hosseini, S. (2011), "An activity-based framework for quantification of knowledge work", Journal of Knowledge Management, Vol. 15, No. 3, pp. 422 – 444.

Dallner, A, Elo, A-L., Gambrele, F., Hottinen, V., Knardahl, S., Linstrom, K., Skogstad, A., Orhede, E. (2000), "Validation of the General Nordic Questionnaire for Psychological and Social Factors at Work", Nordic Council of Ministers Copenhagen, DK. Nord 2000:12.

Davenport, T. (2005), "Thinking for a Living: How to Get Better Performance and Results from Knowledge Workers", Harvard Business School Press, Boston, MA.

Davenport, T. (2008), "Improving Knowledge Worker Performance" in Pantaleo, D. and Pal, N. (eds.) From Strategy to Execution: Turing Accelerated Global Change into Opportunity, Springer Berlin Heidelberg, pp. 215–235.

Davenport, T., Jarvenpaa, S., Beers, M. (1996), "Improving knowledge work processes", MIT Sloan Management Review, Vol. 37, No. 4, pp. 53.

Davenport, T., Prusak, L. (2000), "Working knowledge", Boston, MA: Harvard Business School Press.

Davenport, T., Thomas, R. and Cantrell, S. (2002), "The mysterious art and science of knowledge-worker performance", MIT Sloan Management Review, Vol. 44 No. 1, pp. 23-9.

Davern, M.J., Kauffman, R.J. (2000), "Discovering potential and realizing value from information technology investments", Journal of Management Information Systems, Vol. 16, No. 4, pp. 121-143.

De Been, I., & Beijer, M. (2014). The influence of office type on satisfaction and perceived productivity support. Journal of Facilities Management, Vol. 12, No. 2, pp. 142-157.

De Paoli, D., Arge, K., & Blakstad, S. H. (2013) "Creating business value with open space flexible offices", Journal of Corporate Real Estate, Vol. 15, No. 3/4, pp. 181-193.

Deakins, E., Dillon, S. (2005), "Local government consultant performance measures: an empirical study", International Journal of Public Sector Management, Vol. 18, No. 6, pp. 546 – 562.

Devaraj, S. and Kohli, R. (2003), "Performance impacts of information technology: Is actual usage the missing link?", Management Science, Vol. 49 No. 3, pp.273-289.

Dove, R. (1998), The knowledge worker, Automotive Manufacturing and Production, Vol. 110, pp. 26-28.

Drucker, P. (1959), "The Landmarks of Tomorrow: A Report on the New" Post-Modern." World. Harper Colophon Books, New York.

Drucker, P.F. (1991), "The new productivity challenge", Harvard Business Review, Vol. 69 No. 6, pp. 69-79.

Drucker, P.F. (1999), "Knowledge-Worker Productivity: The Biggest Challenge", California Management Review, Vol. 41, No. 2, pp. 79-94.

Duffy, F. (1999) "Mind the gap", Journal of Corporate Real Estate, Vol. 1, No. 4, pp. 377-387.

Elsayed-Elkhouly, S., Lazarus, H., Forsythe, V. (1997), "Why is a third of your time wasted in meetings?", Journal of Management Development, Vol. 16, No. 9, pp. 672-676.

Erne, R. (2011) "What is productivity in knowledge work?: A cross-industrial view", Journal of Universal Computer Science, Vol. 17, No. 10, pp. 1367-1389.

Fitzgerald, G. (1998), "Evaluating information systems projects: a multidimensional approach", Journal of Information Technology, Vol. 13, pp.15-27.

Folan, P., Browne, J. (2005), A review of performance measurement: Towards performance management, Computers in industry, Vol. 56, No. 7, pp. 663-680.

Fornell, C., Larcker, D.F. (1981), "Structural equation models with unobservable variables and measurement error: Algebra and statistics", Journal of Marketing Research, Vol. 18, pp. 382-388

Garrett, R.K., Danziger, J.N. (2007), "IM= Interruption management? Instant messaging and disruption in the workplace", Journal of Computer-Mediated Communication, Vol. 13, No. 1, pp. 23-42.

Gorgievski, M.J., van der Voordt, T.J.M., van Herpen, S.G.A., van Akkeren, S. (2010), "After the fire - New ways of working in an academic setting", Facilities, Vol. 28 No. 3/4, pp. 206-224.

Greene, C., Myerson, J. (2011), "Space for thought: designing for knowledge workers", Facilities, Vol. 29, No. 1/2, pp. 19-30.

Griffin, R.W., Moorhead, G. (2011), "Organizational behavior", Cengage Learning.

Groen, B., van de Belt, M., Wilderom, C. (2012), "Enabling performance measurement in a small professional service firm", International Journal of Productivity and Performance Management, Vol. 61, No. 8, pp. 839-862.
Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C. (2006) "Multivariate Data Analysis", Upper Saddle River, NJ, Prentice Hall.
Halford, A. (2005), Hybrid Workspace: Re-Spatialisation of Work, Organization and Management, New Technology, Work and Employment, Vol. 20, No. 1, pp. 19-33.
Halpern, D.F. (2005), "How time-flexible work policies can reduce stress, improve health, and save money", Stress and Health, Vol. 21, No. 3, pp. 157-168.
Hammer, M., Champy, J. (1993), "REENGINEERING THE CORPORATION: A MANIFESTO FOR BUSINESS REVOLUTION.", Harper Business, New York.
Haner, U-E., Kelter, J., Bauer, W., Rief, S. 2009. "Increasing Information Worker Productivity through Information Work Infrastructure", Proceeding EHAWC '09 Proceedings of the International Conference on Ergonomics and Health Aspects of Work with Computers: Held as Part of HCI International 2009, pp. 39-48.
Den Hartog, D.N., Boselie, P., Paauwe, J. (2004), "Performance management: A model and research agenda", Applied psychology, Vol. 53, No. 4, pp. 556-569.
Haynes, B.P. (2007), "The impact of the behavioural environment on office productivity", Journal of Facilities Management, Vol. 5, No. 3, pp. 158 – 171.
Heerwagen, J.H., Kampschroer, K., Powell, K.M., Loftness, V. (2004), "Collaborative knowledge work environments", Building Research & Information, Vol. 32, No. 6, pp. 510-528.
Helo, P., Takala, J., Phusavat, K. (2009) "Productivity measurement for knowledge work in research and development", International Journal of Productivity and Quality Management, Vol. 4, No. 1, pp. 39-54.
Hernández-López, A., Colomo-Palacios, R., Soto-Acosta, P., Lumberas, C.C. (2015) "Productivity measurement in software engineering: A study of the inputs and the outputs", International Journal of Information Technologies and Systems Approach, Vol. 8, No. 1, pp. 46-68.
Hertel, G., Geister, S. Konradt, U. (2005), "Managing virtual teams: a review of current empirical research", Human Resource Management Review, Vol. 15, pp. 69-95.
Holtshouse, D. (2010), "Knowledge work 2010: thinking ahead about knowledge work", On the horizon, Vol.18, No. 3, pp. 193-203.
Hopp, W., Iravani, S., Liu, F. (2009), "Managing white-collar work: an operations-oriented survey", Production and operations management, Vol. 18, No. 1, pp. 1-32.
Huselid, M. A. (1995), "The impact of human resource management practices on turnover, productivity, and corporate financial performance", Academy of management journal, Vol. 38, No. 3, pp. 635-672.
Irani, Z., Love, P.E.D. (2002), "Developing a frame of reference for ex-ante IT/IS investment evaluation", European Journal of Information Systems, Vol. 11 No.1, pp.74-82.
Jacks, T., Palvia, P., Schilhavy, R., Wang, L. (2011), "A framework for the impact of IT on organizational performance", Business Process Management Journal, Vol. 17, No. 5, pp. 846-870.
Jackson, D. (1991) "A computerized system for measuring knowledge work", Computers and Industrial Engineering, Vol. 21, No. 1-4, pp. 607-611.

Jett, Q.R., George, J.M. (2003), "Work interrupted: A closer look at the role of interruptions in organizational life", Academy of Management Review, Vol. 28, No. 3, pp. 494-507.
Jones, E.C., Chung, C.A. (2006) "A methodology for measuring engineering knowledge worker productivity", EMJ - Engineering Management Journal, Vol. 18, No. 1, pp. 32-38.
Jones, D.C., Kalmi, P., Kauhanen, A. (2011), "Firm and employee effects of an enterprise information system: Micro-econometric evidence", International Journal of Production Economics, Vol. 130, pp.159-168.
Judge, T., Thoresen, C., Bono, J., Patton, G. (2001), "The job satisfaction–job performance relationship: A qualitative and quantitative review", Psychological bulletin, Vol. 127, No. 3, pp. 376.
Jääskeläinen, A. (2010) "Productivity measurement and management in large public service organizations", Tampere University of Technology, Publication; Vuosikerta 927, Tampere: Tampere University of Technology.
Jääskeläinen, A., Laihonen, H. (2013), "Overcoming the Specific Performance Measurement Challenges of Knowledge-intensive Organizations", International Journal of Productivity and Performance Management, Vol. 62, No. 4, pp. 350 - 363.
Jääskeläinen, A., Lönnqvist, A. (2010), "Knowledge Work Productivity Measurement: Case Study in a Municipal Administration", Proceedings of 16th World Productivity Congress and European Productivity Conference, Belek-Antalya, Turkey, 02-05 November, 2010.
Kaplan, R., Norton, D. (1996), The balanced scorecard: translating strategy into action, Harvard Business Press.
Kasanen, E., Lukka, K., Siitonen, A. (1993), "The constructive approach in management accounting research", Journal of Management Accounting Research, Vol. 5, No. 1, pp. 243-64.
Kattenbach, R., Demerouti, E., Nachreiner, F. (2010), "Flexible working times: effects on employees' exhaustion, work-nonwork conflict and job performance", Career Development International, Vol. 15, No. 3, pp. 279-295.
Kaydos W. (1999), "Operational Performance Measurement: Increasing Total Productivity", St. Lucie Press, Florida.
Kearns, H., Gardiner, M. (2007), "Is it time well spent? The relationship between time management behaviours, perceived effectiveness and work-related morale and distress in a university context", High Education Research & Development, Vol. 26, No. 2, pp. 235-247.
Kelemen, M., Rumens, N. (2008), An introduction to critical management research, Sage.
Kelloway, E. K., Barling, J. (2000), "Knowledge work as organizational behavior", International Journal of Management Reviews, Vol. 2, No. 3, pp. 287–304.
Kelly, E.L., Moen, P., Tranby, E. (2011), "Changing Workplaces to Reduce Work-Family Conflict Schedule Control in a White-Collar Organization", American Sociological Review, Vol. 76, No. 2, pp. 265-290.
Koopmans, L., Bernaards, C., Hildebrandt, V., Schaufeli, W., de Vet Henrica, C., van der Beek, A. (2011), "Conceptual frameworks of individual work performance: a systematic review", Journal of Occupational and Environmental Medicine, Vol. 53, No. 8, pp. 856-866.
Koopmans, L., Bernaards, C., Hildebrandt, V., van Buuren, S., van der Beek, A., de Vet, H. (2012), "Development of an individual work performance questionnaire",

International Journal of Productivity and Performance Management, Vol. 62, No. 1, pp. 6-28.
Koroma, J., Hyrkkänen, U., & Vartiainen, M. (2014). Looking for people, places and connections: hindrances when working in multiple locations: a review. New Technology, Work and Employment, Vol. 29, No. 2, pp. 139-159.
Kotter, J.P. (1996), "Leading change", Harvard business press.
Kujansivu P. and Oksanen, L. (2010), "White-collar worker productivity: challenges in Finland", International Journal of Services Technology and Management, Vol. 14 No. 4, pp.391-405.
Kujansivu, P., Lönnqvist, A. (2009), "Measuring the Impacts of an IC Development Service: the Case of the Pietari Business Campus", Electronic Journal of Knowledge Management, Vol. 7, No. 4, pp. 469–480.
Labro, E., Tuomela, T-S. (2003), "On bringing more action into management accounting research: process considerations based on two constructive case studies", European Accounting Review, Vol. 12, No. 3, pp. 409-42.
Laihonen, H., Jääskeläinen, A., Lönnqvist, A., Ruostela, J. (2012), "Measuring the productivity impacts of new ways of working", Journal of Facilities Management, Vol. 10, No. 2, pp. 102-113.
Loughney, D., Claus, B., Johnson, S. (2011) "To measure is to know: An approach to CADD performance metrics", Drug Discovery Today, Vol. 16, No. 13-14, pp. 548-554.
Lukka, K. (2000), "The key issues of applying the constructive approach to field research", Management Expertise for the New Millenium: In Commemoralion of the 50th Anniversary of the Turku School of Economics and Business Administration. Publications of Turku School of Economics and Administration, Series A-1:2000, pp. 113-141.
Lynch, W., Riedel, J. (2001), Measuring Employee Productivity: A guide to self assessment tools", William M. Mercer & Institute for Health and Productivity Management.
Lönnqvist, A. (2004), Measurement of Intangible Success Factors: Case Studies on the Design, Implementation and Use of Measures, Tampere, Tampere University of Technology, Publication 475.
Maarleveld, M., Volker, L., Van Der Voordt, T. (2009), "Measuring employee satisfaction in new offices–the WODI toolkit", Journal of Facilities Management, vol. 7, no. 3, pp. 181-197.
Margaryan, A., Milligan, C., Littlejohn, A. (2011), "Validation of Davenport's classification structure of knowledge-intensive processes", Journal of Knowledge Management, Vol. 15, No. 4, pp. 568-581.
Mehta, R., Zhu, R.J., Cheema, A. (2012), "Is Noise Always Bad? Exploring the Effects of Ambient Noise on Creative Cognition", Journal of Consumer Research, Vol. 39, No. 4, pp. 784-799.
Mettänen, P. (2005) "Design and implementation of a performance measurement system for a research organization", Production Planning and Control, Vol. 16, No. 2, pp. 178-188.
Miles, I. (2005), "Knowledge Intensive Business Services: Prospects and Policies", Foresight, Vol. 7, No. 6, pp. 39-63.
Miller, D. B., (1978), "How to Improve the Performance and Productivity of the Knowledge Worker", Organizational Dynamics, Vol. 5, No. 3, pp. 62–80.

Misterek, S.D.A., Dooley, K.J., Anderson, J.C. (1992), "Productivity as a Performance Measure", International Journal of Operations & Production Management, Vol. 12 No. 1, pp.29-45.
Molina-Azorin, J. (2012), Mixed methods research in strategic management: Impact and applications, Organizational Research Methods, Vol. 15, No. 1, pp. 33-56.
Najafi, A., Afrazeh, A., Ghomi, S. (2011) "Providing an integrated method for measuring and predicting productivity of knowledge workers on the basis of time-series techniques: A case study of Parskhodro company", Information Sciences and Technology, Vol. 26, No. 2, pp. 301-334.
Najafi, A. (2013) "Using penalty function method for measuring productivity in the knowledge workers clusters", World Applied Sciences Journal, Vol. 24, No. 1, pp. 96-102.
Narver, J., Slater, S. (1990), "The effect of a market orientation on business profitability", Journal of Marketing, Vol. 54, pp. 20-35.
Neely, A., Gregory, M., Platts, K. (1995), "Performance measurement system design: a literature review and research agenda", International Journal of Operations and Production Management, Vol. 15, No. 4, pp. 80-116.
Neely, A., Mills, J., Platts, K., Richards, H., Gregory, M., Bourne, M., Kennerley, M. (2000), "Performance Measurement System Design: Developing and Testing a Process-Based Approach", International Journal of Operations & Production Management, Vol. 20, No. 10, pp. 1119-1145.
Nickols, F. (2000), "'What is' in the world of work and working: some implications of the shift to knowledge work", Butterworth-Heinemann Yearbook of Knowledge Management, pp. 1-7.
Nonaka, I. (2008), "The knowledge-creating company", Harvard Business Review Press.
O'Neill, M.J. (2010), "A model of environmental control and effective work", Facilities, Vol. 28, No. 3/4, pp. 118-136.
Okkonen, J. (2004a), "The Use of Performance Measurement in Knowledge Work Context". Tampere University of Technology, Tampere, Finland.
Okkonen, J. (2004b), "How virtuality affects knowledge work: points on performance and knowledge management", International journal of networking and virtual organisations, Vol. 2, No. 2, pp. 153-161.
Origo, F., Pagani, L. (2008), "Workplace flexibility and job satisfaction: some evidence from Europe", International Journal of Manpower, Vol. 29, No. 6, pp. 539-566.
Pande, P.S., Neuman, R.P., Cavanagh, R.R. (2000), "The six sigma way: How GE, Motorola, and other top companies are honing their performance", McGraw-Hill, New York.
Paradi, J., Smith, S., Schaffnit-Chatterjee, C. (2002) "Knowledge worker performance analysis using DEA: An application to engineering design teams at Bell Canada", IEEE Transactions on Engineering Management, Vol. 49, No. 2, pp. 161-172.
Parasuraman, A., (2002), "Service quality and productivity: a synergistic perspective", Managing Service Quality, Vol. 12, No. 1, pp. 6-9.
Perlow, L. A., & Kelly, E. L. (2014). "Toward a model of work redesign for better work and better life", Work and Occupations, Vol. 41, No. 1, pp.111-134.
Peters, P., Poutsma, E., Van der Heijden, B. I., Bakker, A. B., & Bruijn, T. D. (2014). Enjoying New Ways to Work: An HRM-Process Approach to Study Flow. Human resource management, 53(2), 271-290.

Pyöriä, P. (2005), "The concept of knowledge work revisited", Journal of Knowledge Management, Vol. 9 No. 3, pp. 116-127.
Ramirez, Y.W., Nembhard, D.A. (2004), "Measuring knowledge worker productivity. A taxonomy", Journal of Intellectual Capital Vol. 5, No. 4, pp. 602-628.
Ramirez, Y.W., Steudel, H.J. (2008), "Measuring knowledge work: the knowledge work quantification framework", Journal of Intellectual Capital, Vol. 9, No. 4, pp. 564-584.
Rampersad, H., Hussain, S. (2014), "Personal balanced scorecard". In Authentic Governance (pp. 29-38). Springer International Publishing.
Riratanaphong, C., & van der Voordt, T. (2015). Measuring the added value of workplace change: performance measurement in theory and practice. Facilities, Vol. 33, No. 11/12, pp. 773-792.
Rosen, E. (1993), Improving Public Sector Productivity – Concepts and Practice, Sage, Newbury Park, California.
Ruostela, J. (2012). Improving knowledge work productivity through new ways of working, Master of Science Thesis, Tampere.
Ruostela, J., Lönnqvist, A. (2013), "Exploring More Productive Ways of Working", World Academy of Science, Engineering and Technology, International Science Index 73, Vol. 7, No. 1, pp. 611-615.
Ruostela, J., Lönnqvist, A., Palvalin, M., Vuolle, M., Patjas, M., Raij, A.-L. (2015), "New Ways of Working'as a tool for improving the performance of a knowledge-intensive company", Knowledge management research & practice, Vol., 13, No. 4, pp. 382-390.
Sahay, B. S., (2005), "Multi-Factor Productivity Measurement Model for Service Organization", International Journal of Productivity and Performance Measurement, Vol. 54 No. 1, pp.7–22.
Saunders, M., Lewis, P., Thornhill, A. (2009), Research methods for business students, Pearson education.
Schaufeli, W., Salanova, M. (2007), "Work engagement", Managing social and ethical issues in organizations, pp. 135-177.
Schaufeli, W.B., Bakker, A.B. & Salanova, M. (2006), "The measurement of work engagement with a short questionnaire", Educational and psychological Measurement, Vol. 66, No. 4, pp. 701-716.
Schroeder, R., Anderson, J., Scudder, G. (1985) "MEASUREMENT OF WHITE COLLAR PRODUCTIVITY.", International Journal of Operations & Production Management, Vol. 5, No. 2, pp. 25-34.
Simons, R. (2000), Performance Measurement & Control Systems for Implementing Strategy, Prentice Hall, New Jersey.
Sink, D. (1985), Productivity Management: Planning, Measurement and Evaluation, Control and Improvement, John Wiley & Sons, New York.
Sitlington, H., Marshall, V. (2011), Do downsizing decisions affect organizational knowledge and performance?, Management Decision, Vol. 49, No. 1, pp. 116-29.
Soliman, F., Spooner, K. (2000), "Strategies for implementing knowledge management: role of human resources management", Journal of knowledge management, Vol. 4, No. 4, pp. 337-345.
Stevenson, W.J., Hojati, M. (2007), "Operations management (Vol. 8)", Boston: McGraw-Hill/Irwin.
Suddaby, R. (2006), From the editors: What grounded theory is not, Academy of Management Journal, Vol. 49, No. 4.

Sureshchandar, G.S., Rajendran, C. Anantharaman, R.N. (2002), "Determinants of customer-perceived service quality: a confirmatory factor analysis approach", Journal of Service Marketing, Vol. 16, No. 1, pp. 9-34.

Syed, J. (1998), "An adaptive framework for knowledge work", Journal of Knowledge Management, Vol. 2, No. 2, pp. 59-69.

Takala, J., Suwansaranyu, U., Phusavat, K. (2006), "A proposed white-collar workforce performance measurement framework", Industrial Management & Data Systems, Vol. 106, No. 5, pp. 644-662.

Tangen, S. (2005), "Demystifying productivity and performance", International Journal of Productivity and Performance Management, Vol. 54, No. 1, pp. 34-46.

Taskinen, T., Smeds, R. (1999), "Measuring change project management in manufacturing", International Journal of Operations & Production Management, Vol. 19, No. 11, pp. 1168-87.

Thompson, P., Warhurst, C., Callaghan, G. (2001), "Ignorant theory and knowledgeable workers: interrogating the connections between knowledge, skills and services", Journal of Management Studies, Vol. 38, No. 7, pp. 923-943.

Torkzadeh, G., Doll, W.J. (1999), "The development of a tool for measuring the perceived impact of information technology on work", Omega, The International Journal of Management Science, Vol. 27, pp.327-339.

Uusi-Rauva, E. (1996), Ohjauksen tunnusluvut ja suoritusten mittaus, Tampereen teknillinen korkeakoulu, Tampere. (in Finnish)

van der Voordt, T.J.M. (2004). "Productivity and employee satisfaction in flexible workplaces", Journal of Corporate Real Estate, Vol. 6, No. 2, pp. 133-148.

Van Meel, J. (2011), "The origins of new ways of working - Office concepts in the 1970s", Facilities, Vol. 29, No. 9/10, pp. 357-367.

Vartiainen, M. (2007), "Analysis of Multilocational and Mobile Knowledge Workers' Work Spaces", Lecture Notes in Computer Science, Vol. 4562, No. 1, pp. 194-203.

Vartiainen, M., Hyrkkänen, U. (2010), "Changing requirements and mental workload factors in mobile multi-locational work", New Technology, Work and Employment, Vol. 25, No. 2, pp. 117-135.

Vischer, J. (2005), "Space Meets Status: Designing Workplace Performance", Routledge, New York, NY.

Viswesvaran, C., Ones, D. (2000), "Perspectives on models of job performance", International Journal of Selection and Assessment, Vol. 8, No. 4, pp. 216-226.

Womack, J.P., Jones, D.T., Roos, D. (1990), "Machine that changed the world", Simon and Schuster.

Wright, T. A., Cropanzano, R. (2000), "Psychological well-being and job satisfaction as predictors of job performance", Journal of occupational health psychology, Vol. 5, No. 1, pp. 84.

Vuolle, M. (2010), "Productivity impacts of mobile office service", International Journal of Services Technology and Management, Vol. 14, No. 4, pp. 326–342.

Vuolle, M., (2011), Measuring Performance Impacts of Mobile Business Services from the Customer Perspective, Tampere University of Technology, Publication 1013, Tampere.

Wännström, I., Peterson, U., Åsberg, M., Nygren, Å., Gustavsson, J.P. (2009), "Psychometric properties of scales in the General Nordic Questionnaire for Psychological and Social Factors at Work (QPSNordic): Confirmatory factor analysis and prediction of

certified long-term sickness absence", Scandinavian Journal of Psychology, Vol. 50, No. 3, pp. 231-244.
Yin, R. (2009), Case study research: Design and methods (applied social research methods), Sage, London and Singapore

PUBLICATIONS

Palvalin, M., Lönnqvist, A., & Vuolle, M. (2013), Analysing the impacts of ICT on knowledge work productivity, Journal of Knowledge Management, Vol. 17, No. 4, pp. 545-557.

Palvalin, M. & Vuolle, M. (2016), Methods for identifying and measuring the performance impacts of work environment changes, Journal of Corporate Real Estate, Vol. 18, No. 3, pp. 164-179.

Palvalin, M., Vuolle, M., Jääskeläinen, A., Laihonen, H., & Lönnqvist, A. (2015), SmartWoW – constructing a tool for knowledge work performance analysis, International Journal of Productivity and Performance Management, Vol. 64, No. 4, pp. 479-498.

Palvalin, M. (2019), What matters for knowledge work productivity?, Employee Relations, Vol. 41, No. 1, pp. 209-227.

Palvalin, M. (2017), How to measure impacts of work environment changes on knowledge work productivity – validation and improvement of the SmartWoW tool, Measuring Business Excellence, Vol. 21, No. 2, pp. 175-190.

PUBLICATION I

Analysing the Impacts of ICT on Knowledge Work Productivity

Miikka Palvalin, Antti Lönnqvist, Maiju Vuolle

Journal of Knowledge Management, 17(4) 454-557

Analysing the impacts of ICT on knowledge work productivity

Miikka Palvalin, Antti Lönnqvist and Maiju Vuolle



Miikka Palvalin, Antti Lönnqvist and Maiju Vuolle are based at the Department of Information Management and Logistics, Tampere University of Technology, Tampere, Finland.

Abstract

Purpose – *The potential of information and communication technology (ICT) in improving knowledge work productivity is well-documented in the existing literature. However, prior research fails to provide means for analyzing whether the potential can be realized in a specific organizational context. Thus, this paper aims to focus on the context-specific analysis of the impacts of ICT services on knowledge work.*

Design/methodology/approach – *This paper uses a literature review and a case study conducted in a medium-sized European teleoperator company. The case study examines the measurement process for capturing the knowledge work productivity impacts produced by a new ICT service used by the company.*

Findings – *ICT can be used to eliminate non-value-adding tasks or to make them more efficient. ICT can also improve employee welfare, for example, through transforming the content of work by deleting unimportant activities. The empirical study showed that, contrary to the view presented in the prior literature, it does not seem that difficult to measure the impacts of ICT on knowledge work productivity. A key point in the measurement is identification of case-specific impact factors by examining the characteristics of the ICT service and the organisational setting.*

Practical implications – *The results of the paper will be useful for managers studying the impacts of ICT investments in their organizations.*

Originality/value – *This paper contributes to the prior literature on ICT and knowledge work productivity by explaining how the impacts of ICT can be analysed in a given empirical context. The specific novelty value of the study lies in the new knowledge concerning the identification of the impact factors.*

Keywords *Knowledge work, ICT, Measurement, Productivity, Service, Knowledge management, Communication technologies, Europe*

Paper type *Research paper*

1. Introduction

While the significance of knowledge work has been continuously increasing it still represents a particularly challenging context from productivity improvement point-of-view (see e.g. Drucker, 1999; Haas and Hansen, 2007; Bosch-Sijtsema *et al.*, 2009). A key challenge is that many of the knowledge workers' tasks are labor-intensive, i.e. knowledge workers are required to use their personal work time to think, communicate, read and carry out other knowledge-related tasks. As the daily work time is limited the allocation of knowledge workers' time to important versus non-value-adding activities is critical from productivity perspective. Thus, there is a need to explore ways to reduce the time knowledge workers use for unnecessary tasks in order to maximize their productive activities.

Information and communication technology (ICT) provides potential means for improving knowledge work productivity, for example, through helping knowledge workers perform certain routine (i.e. non-value-adding) tasks faster and through supporting knowledge sharing among professionals (Ahuja and Shankar, 2009; Norton, 1995; Rodríguez Casal *et al.*, 2005; Sigala, 2003). Thus, companies are eager to purchase various ICT services in order to improve the productivity of their knowledge workers.

Received 20 March 2013
Accepted: 28 March 2013

It is not self-evident that a given ICT service will lead to the expected productivity impacts. In fact, the large sum of money spent on ICT projects in general and the high degree of uncertainty associated with the adoption of new technology (benefits, risks, and costs) implies that the measurement of such projects should assume great importance (Irani and Love, 2002; Gunasekaran *et al.*, 2006). ICT investments have often been based on beliefs in the benefits rather than on any sound attempts to measure such benefits (Fitzgerald, 1998). The lack of understanding of the holistic implications of adopting new technology may lead decision-makers to invest in unproductive technology and at the same time to refuse to implement a technology that could be beneficial to their long-term competitiveness (Irani and Love, 2002; Gunasekaran *et al.*, 2006).

There is a fair amount of prior studies examining the benefits of ICT on knowledge work productivity as well as those examining the related measurement issues (a review of relevant literature is provided in the following section). This prior research provides a generic understanding on the topic. However, within the vast scope of different ICT products and services available it is difficult to identify which ones would be most beneficial in a specific knowledge work context. Furthermore, measuring the productivity impacts of ICT services has proven to be a challenge in practice (e.g. due to the time lags before the impacts are achieved and the problems of identifying non-financial and intangible benefits). Therefore, there is still a need for further analytical insights on the impacts of ICT on the productivity of knowledge work.

In this paper, the authors focus on the context-specific analysis of the impacts of ICT services on knowledge work. In particular, the authors pose the following two research questions concerning the measurement of impacts:

RQ1. How to identify – in a particular knowledge work context – the factors that can be impacted by the ICT service?

RQ2. How to obtain information about the expected impacts in practice?

In order to reach these objectives the phenomenon is first examined conceptually through a review of earlier literature. This section is divided into two parts in line with the research questions. Then, an empirical case study is carried out. The case study is conducted in TeliaSonera, which is a medium-sized European teleoperator that provides ICT services for the consumer and enterprise markets. The ICT service examined in this study aims at improving work processes and local mobility for office workers. Within the case study the productivity impacts of ICT are approached through a performance measurement process that takes into account both tangible and intangible impact elements (Vuolle, 2011).

This study makes a contribution to the prior literature on ICT and knowledge work productivity by explaining and illustrating with the case study how the impacts of ICT can be analyzed in a given empirical context. Thus, the novelty value of the paper lies in the operationalization of the impact analysis. The results of the paper will be useful for managers studying the impacts of ICT investments in their organizations and for scholars conducting further empirical studies on the impacts of ICT on knowledge work productivity.

2. Theoretical background

2.1 Potential of ICT in knowledge work productivity improvement

Knowledge work is a challenging and peculiar setting from managerial perspective (Drucker, 1999). In the literature various characterizations and classifications for knowledge work and knowledge-intensive organizations have been proposed (e.g. Käpylä *et al.*, 2011; Miles *et al.*, 1995; Starbuck, 1992; Pyöriä, 2005; Von Nordenflycht, 2010). Knowledge work and knowledge-intensive organizations are characterized by, e.g. highly skilled and autonomous personnel, ambiguous work processes and intangible outputs (Pyöriä, 2005).

The specific theme of knowledge work productivity has gained a fair amount of attention in the literature (Drucker, 1999; Okkonen, 2004; Haas and Hansen, 2007; Bosch-Sijtsema *et al.*, 2009). The well-known productivity formula, output divided by input, also applies in the

context of knowledge work. However, it is quite problematic to operationalize the formula in a context in which the outputs are intangible services (with varying quality) and the key inputs consist of the skills and knowledge of the experts performing the work (Laihonen *et al.*, 2012).

There are numerous ways to improve knowledge work productivity. One might even claim that the purpose of the whole knowledge management discipline is knowledge work productivity improvement: the practices related to, for example, knowledge sharing, organizational learning and competence development are all aimed at improving the efficiency and effectiveness of knowledge-based activities within an organization. Simply put, knowledge work productivity is a result of ''doing things right'' (i.e. performing routine activities as efficiently as possible) and ''doing the right things'' (i.e. focusing on the most value-adding activities). For example, ICT tools can help perform routine activities (e.g. information processing and communication) efficiently. On the other hand, various knowledge management practices are available for improving the performance of the more creative, non-routine activities (e.g. Bettiol *et al.*, 2012).

The development of ICT has changed knowledge work significantly in recent decades. Technology allows many operations to be automated (Norton, 1995; Flanagan and Marsh, 2000). At best, automation takes care of many routine tasks and thus people have additional time for the more demanding tasks. Technology has also improved access to information (Shin, 1999; Flanagan and Marsh, 2000; Ahuja and Shankar, 2009) and communication has become easier due to, e.g. mobile phones and video conference calls. Furthermore, the increased use of ICT has improved the quality of information (Suwardy *et al.*, 2003). However, the development of technology has not had only positive consequences. ICT is associated with a lot of dissatisfaction (Karr-Wisniewski and Lu, 2010). A poorly functioning or difficult to use systems cause frustration and inefficiency for many people (Kaplan and Aronoff, 1996; Kinnie and Arthurs, 1996). For this reason, more and more attention is used to improve the usability of the systems. ICT is also a key source of information flood (in the form of emails, social media messages, news items etc.) facing knowledge workers daily. Having information is important but too much information leads to inefficiency (e.g. the need to search for the right information) and may create stress for knowledge workers.

In knowledge work context there are specific issues acting as ''bottle necks'' from productivity perspective (e.g. knowledge worker's time used in various activities). The potential ICT-based benefits for knowledge work productivity improvement discussed in the extant literature are summarized in Table I.

The list of potential benefits presented in Table I is not exhaustive as there are many specific work tasks which may benefit from ICT. However, the most typical benefits are covered. The

Table I ICT as means to improve productivity in knowledge work context

ICT-based benefits for knowledge work productivity	*References*
Skipping work tasks Automation Travelling	Norton (1995); Flanagan and Marsh (2000); Rodríguez Casal *et al.* (2005)
Performing tasks faster Searching information Real time communication	Ahuja and Shankar (2009); Akkirman and Harris (2005); Sigala (2003); Beaudreau (2009)
Better access for information Real time information Sharing knowledge	Shin (1999); Flanagan and Marsh (2000); Ahuja and Shankar (2009); Gressgård (2011)
Enhanced information quality Less errors Better decisions	Suwardy *et al.* (2003); Erne (2010); Aghazadeh and Seyedian (2004)
Employee welfare	Motivation: Kaplan and Aronoff (1996); Kinnie and Arthurs (1996); Hosie and Sevastos (2009); Appelbaum *et al.* (2005)
ICT does not increase work welfare and motivation, but may decrease it if usability is poor	Usability: Cardinali (1994); Turkyilmaz *et al.* (2011)

potential benefits of ICT remain as assumptions until they can be verified by measurements in practice. Thus, the next section examines the measurement of ICT impacts.

2.2 Measuring the impacts of ICT service

There are many reasons for measuring the impacts of ICT – in knowledge work context and more generally. Analysis of benefits is one part of the overall information technology/information systems (IT/IS) evaluation process (Fitzgerald, 1998). IT/IS investments are usually measured in order to compare between different projects, rank projects in terms of organizational priorities, justify investment requests by management, control expenditure, benefits, risk, development and implementation of projects, provide a framework that facilitates organizational learning, and facilitate mechanisms to decide whether to fund, postpone or reject investment requests (Irani and Love, 2002). A key motivation for measurement is also the fact that none of the potential ICT-based productivity benefits come automatically. For example, the utilization of the ICT service is an essential precondition for the benefits. Even if the direct benefits, such as time saving, are achieved the actual productivity impacts still depend on the way the time-used is spent. Therefore, it is important to be able to analyze whether the expected benefits are realized or not.

The main difficulty in evaluating IT projects has been the identification and measurement of benefits, and particularly intangible and other non-financial benefits and thus, they are often neglected (Seddon *et al.*, 2002; Irani, 2002; Gunasekaran *et al.*, 2006). For a technology to positively affect performance it must be utilized and it must be appropriate for the task (Goodhue, 2007) and more broadly for the organizational context in which it is used.

Typical measurement challenge of productivity impacts includes the timing of realization as there is often a time lag before the impacts are achieved (Davern and Kauffman, 2000; Love and Irani, 2004): some of the impacts may occur immediately, shortly or only after long period of time, for example, due to learning. The impact may also be negative right after the investment (e.g. Jones *et al.*, 2011). In addition, some may not achieve any observable impacts (e.g. Devaraj and Kohli, 2003). Overall, the more detailed the level of analysis, the better chance to detect the impact, if any, of a given technology. For example, Torkzadeh and Doll (1999) argue that the success of IT can be measured through its impact on work at individual user level. As there are several aspects that may influence productivity in addition to a specific ICT service, it may be difficult to determine which factors cause alteration in the productivity level.

In this paper, productivity impacts refer to both tangible and intangible benefits and changes in relation to performance that are achieved after some specific intervention such as deployment of new technology in companies (Vuolle, 2011). ''IT business value'' (Tallon *et al.*, 2000; Melville *et al.*, 2004; Basole, 2007) is another term which is used in the literature for the same purpose. Melville *et al.* (2004) define IT business value as ''the organizational performance impacts of information technology at both the intermediate process level and the organization-wide level, and comprising both efficiency impacts and competitive impacts''. The business value of ICT is defined as an overarching measure of different types of benefits to the organization, which combines strategic benefits, informational benefits, transactional benefits and enterprise transformation benefits (Basole, 2007). These definitions both point out the fact that various levels need to be taken into account when analyzing the impacts. In their model of IT business value, Melville *et al.* (2004) divide performance into business process performance and organizational performance. Business process performance refers to operational efficiency of specific business processes, measures of which include customer service, flexibility, information sharing, and inventory management. Organizational performance refers to overall firm performance, including productivity, efficiency, profitability, market value, competitive advantage, etc.

Some authors have presented process-oriented models for measuring the impacts of ICT (or similar change initiatives) for knowledge work. Laihonen *et al.* (2012) introduced a process for measuring the impacts of change in the context new work practices (including new ICT solutions). The process includes the following steps: defining the measurement task in question, identifying the factors to be measured, planning the actual measurement and

choosing metrics to be used, implementation of the measures and, finally, analysing and reporting of measurement results. Vuolle (2011) has developed a three-stage model for measuring the impacts of mobile ICT services. The process starts by analyzing the measurement context. Then, the impact factors to be measured are identified. Finally, suitable measures are designed to capture the impacts. As a process model, the framework by Vuolle seems to suit well the purposes of this paper. However, Vuolle's work is focused on mobile ICT services and thus does not offer a lot concerning the identification of the impacts on knowledge work.

In general, business performance can be measured many ways with objective and subjective measures either directly or indirectly and they may focus on financial and non-financial, tangible and intangible factors (e.g. Kaydos, 1999; Simons, 2000; Lönnqvist, 2004). The problem with the traditional productivity measures (i.e. total and partial productivity measures) is that they do not take into account changes in the quality of the inputs or outputs (Misterek *et al.*, 1992). In addition, they are related to service provider's productivity and do not capture the customer perspective which is important in service context. In service business, quality and productivity cannot be dealt separately (Sahay, 2005). For example, in knowledge and service work, inputs and outputs are usually intangible and the quality may vary a lot. In these cases, subjective measurement is a possible method to collect the needed information about the level of or problems in productivity or performance (see, e.g. Antikainen *et al.*, 2008; Kujansivu and Oksanen, 2010; Torkzadeh and Doll, 1999). Subjective measures are based on personnel's subjective assessments and data is usually collected using surveys or interviews (Lynch and Riedel, 2001).

To summarize, the impacts of ICT are generally difficult to measure due to, e.g. the time lags before the impacts are achieved and the identification of non-financial and intangible benefits. In the case of knowledge work it is difficult to measure even the status of productivity (Laihonen *et al.*, 2012). Thus, measuring the impacts of ICT is considerably more challenging in this context. The empirical section illustrates how this can be done.

3. Empirical examination

3.1 Introduction to the empirical research setting

The case study was conducted in TeliaSonera, a medium-sized European teleoperator. The company provides ICT services for the consumer and enterprise markets. The ICT service in focus in this paper is now in pilot testing in the teleoperator's own office, i.e. the subject of the study is TeliaSonera and its knowledge workers as well as the new ICT service as a tool for improving the company's own productivity. The ICT service makes it possible for the personnel to move around the office and remain connected to the company's private network. It also keeps the network connection alive when switching between wireless and wired networks.

The new service will most likely save significant amount of time because knowledge workers do not have to shut down and start up that many programs anymore when they switch locations, e.g. between meeting rooms and their own work station. It is also expected to improve employees' satisfaction (or decrease dissatisfaction) regarding the usability of the IT systems. These factors, in turn, are expected to lead to improved productivity. However, at the starting phase of this research these benefits were only assumptions: the company had no measured evidence about the impacts of the service. This evidence would be particularly useful later on when the service will be marketed to external customers. Therefore, the management of the organization considered it important to measure the impacts of the service.

The rest of empirical section is structured as follows. First, the next subsection explains both the process for identifying the ICT impacts (*RQ1*) and the procedures for measuring them (*RQ1*). After that, the measurement results are presented. An analysis section ends the empirical part by addressing the lessons learned concerning the two research questions:

how to identify the factors that can be impacted by the ICT service; and how to obtain information about the expected impacts in practice?

3.2 The process of measuring the impacts

The process of designing the impact measurement was based on the three-stage model by Vuolle (2011), consisting of the phases of analyzing the measurement context, identifying the impact factors and designing suitable measures to capture the impacts. Thus, the case study began by learning about the service and how it is assumed to change the work carried out in the organization. This was done by meeting the representatives of the company and examining the written material about the service. Based on these it was soon decided that the main measurement approach would be a questionnaire survey, supplemented by interviews. The aim was to get data representing a large group of employees in order to ensure the reliability of the results and to see how different people perceive the benefits of the ICT service.

The next step in the measurement process was to identify the impact factors. This was done through a group interview, which aimed at deepening researchers' understanding of the service and its impacts in order to design the survey questions. The participants, five persons, represented different managerial levels and departments of the company. All of them had used the new service as well as the prior one, so they had personal experience of the benefits. The group interview, which was taped and transcribed, resulted in a list of assumed benefits. This list, combined with issues raised in the previous literature (Table I), was used as basis for designing the survey questions.

The third step in the measurement process was to design the practical measurements. As mentioned, one of the concrete benefits of the new service is the time saving related to shutting down and starting up programs when moving a laptop from a work station to a meeting room. The group interview produced the idea of measuring this time saved objectively by measuring how much less time it takes for a person to use the new service compared to the old way for doing the same operation. Measuring the time saved was done in two ways. First, five people performed and timed the tasks related to leaving their own office (i.e. closing programs and logging out) and starting up programs and connections again in a meeting room with both the new and the old procedure. Second, the respondents of the survey were also asked to subjectively evaluate how much they save time with the new service. Furthermore, they were asked how often they utilize the service. Combining this information makes it possible to calculate the total time savings.

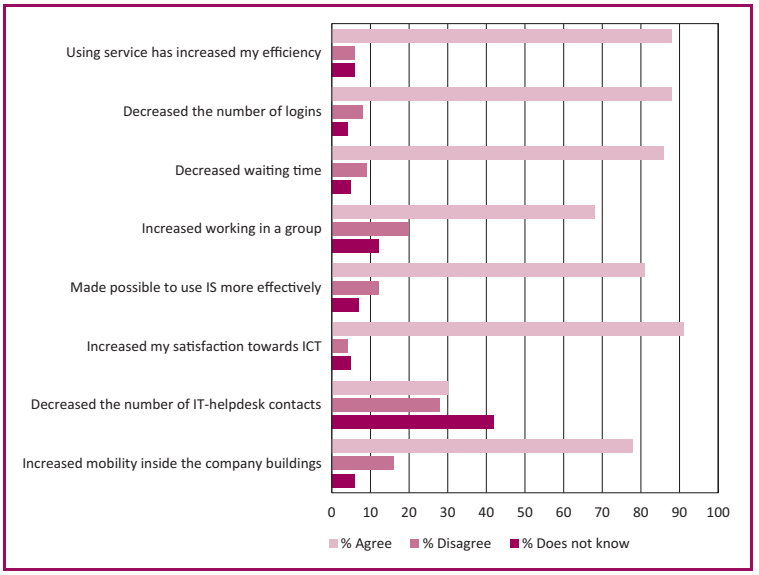
The questionnaire was aimed at examining how the new service affects the productivity of employees using the service. The questionnaire consists of two parts. The first section identifies how much time can be saved with the new service and how the saved time will be used. The second part consists of eight scale questions related to the impacts of the service. The scale used is a six-point 'agree-disagree' scale. The questions, which were identified based on prior literature and the group interview, are listed in the results section, in Figure 1. One open question was also included: ''What are the most important advantages and disadvantages resulting from the new service?'' The open question was included especially for capturing the disadvantages as the structured questions focused on the expected benefits only.

The web questionnaire was sent to 330 respondents. The respondents had one week to return it. One reminder message was sent before the deadline. In the end a total of 128 responses were received, which corresponds to 39 percent response ratio.

3.3 Measurement results

How much time is saved?. The key benefit the new service is expected to produce is time saving. Time saving was first approached by taking the time for utilizing the old and the new system and calculating the difference. The mean time saving for five test users was 3.0 (ranging from two to four) minutes per one usage scenario.

Figure 1 Experienced benefits of the new service



In the questionnaire the respondents were asked to check from their calendar how many times a week they have such meetings in which they benefit from the new service (they were asked to select a typical work week with no holidays or other unusual activities). Responses varied between zero to twenty times a week with an average of 6.5 times a week. Combining the mean time saving of three minutes (per time of using) with the average number of times used per week (6.5) results in an average time saving of 19.5 minutes for one person in a week.

The survey respondents were also asked to subjectively estimate how much time they will save in a week due to the new service. Estimates varied between zero to four hours, with a median of 30 minutes in a week. These subjective evaluations seem to be roughly in line with the results of the objective calculations presented above (supporting the reliability of the measurement).

While the last two paragraphs describe the mean values of time savings at individual level it is also possible to estimate the time saving at organizational level. For example, using the mean weekly time saving (19.5 minutes per week) and multiplying that with the number working weeks in a year (e.g. 40 weeks) results in the annual time saving of one person (780 minutes, i.e. 13 hours). Furthermore, if this time is multiplied by the number of employees using the service (e.g. 330 – the amount selected for the questionnaire study) it is possible to evaluate the potential time saving at organizational level (4,290 hours, i.e. 536 eight-hour work days). This estimated time saving could even be turned into cost savings by using, for example, the mean salary cost as multiplier.

The time saving and the potential cost saving discussed above are impressive. However, there are no automatic cost savings as the personnel are working on a monthly salary. The benefits are dependent on what the personnel does with the time saved. This is discussed next.

How the time saved is utilized?. As time saving was an expected benefit of the new service the authors also asked the respondents how they use the time that has been saved. The responses are shown in Figure 2. Almost 50 percent of the respondents state that, as a result, they work more. The second most popular choice was the ability to improve the quality

Figure 2 Utilization of the time saved

of the respondent's work (35 percent of respondents). Out of all respondents 14 percent said that the time saved does not show at all. However, most of them used did not utilize the service or utilized it seldom.

Based on the results reported in Figure 2 it could be concluded that the impacts of the new service in question seem to have benefited mainly the company (through better quality and increased time used for working). The respondents do not seem to be using the extra time for improving their own welfare, for example, by resting more or by decreasing overtime work. However, it should be noted that the respondents had to choose only one alternative from the list. This is likely to explain to some extent why the performance-related alternatives dominate the welfare-related ones. It seems likely that actually the extra time is used for several of the alternatives listed. Thus, the results presented in Figure 2 should be interpreted only as a rough description of the impacts. Next, the perceived impacts are examined in more detail.

What kind of impacts has the new service produced?. The questionnaire included eight questions on how respondents perceive the impacts of the new service on their work. The results are presented in Figure 1. The list of potential benefits was used as a basis for designing the questions. Thus, it was expected that the respondents would verify whether these benefits do actually occur.

It seems that seven out of the eight potential benefits have been observed by a clear majority of respondents. Increased satisfaction towards ICT, decreased waiting time and increased efficiency are among the benefits that are most often reported. However, contrary to what was expected, IT helpdesk contacts have increased. It was expected that the service would have decreased the number of contacts to IT-helpdesk because it is more automatic than the old system. The company representatives assumed that a possible explanation for the surprising increase in the number of contacts to IT-helpdesk might be that the service is still new and the users might not have gotten used to it yet.

The impacts were also asked about using an open question, which resulted in 51 responses. These data are used below to provide more in-depth understanding of the expected benefits.

Most of the respondents considered that the new service has generally increased their efficiency:

> Work has become more flexible and time saving can be easily observed.

Almost all respondents also agreed that the new service has decreased waiting times and the number of logins:

> Biggest benefit is that I can keep my laptop and all software open when I move from my desk to the meeting room. It does not only affect me, but also every other person in a meeting room.

Based on this study the authors cannot say how much time the new service saves indirectly from other persons in the same meeting room, but that is in any case an important issue to consider.

Most of the respondents agreed that the new service has increased group working. However, this question also got some negative comments:

> When it is easier to get online in a meeting people read their emails more during it and do not focus on the topic at hand making the meetings last longer.

This seems to be the flipside of the responses saying that the new service has made it possible to use information systems more effectively.

As mentioned the respondents report being more satisfied with ICT in general. Many respondents commented that the service is great and they like it very much. One respondent even stated that:

> It has made totally new ways of working possible in certain situations.

Despite the positive overall response there were some negative comments also. A few respondents mentioned that the new service does not work always as fine as it should. It was assumed that, partly as a result of the new service, the company's wireless network is now more crowded than it used to be.

The open-ended question did not result in any totally new benefits or disadvantages resulting from the use of the new service. All comments were related to the main themes covered by the structured questions.

3.4 Discussion

The ICT service examined at TeliaSonera was intended for producing similar benefits to those identified in the previous literature (e.g. Ahuja and Shankar, 2009; Norton, 1995; Rodríguez Casal *et al.*, 2005; Sigala, 2003). It turned out that many of the expected benefits were also obtained. The new service examined seems to have increased the efficiency of performing certain tasks which requires the knowledge workers to move their laptops within the facility. This has given time for more valuable tasks. Thus, it can be claimed that the new service creates productivity impacts for the organization using the service. Furthermore, from employee perspective the new service seems to have increased satisfaction towards ICT. While employee welfare is important as such it is also an issue that can be assumed to have at least an indirect impact on productivity as well (e.g. Ipsen and Jensen, 2012; Patterson *et al.*, 2005).

The key aspect in the empirical study was the operationalization of the measurement of the impacts of ICT on knowledge work. The first part of the process was the identification of the expected benefits (*RQ1*). The generic benefits identified as a result of the literature review (Table I) served as a useful basis for identifying possible benefits. In addition, obtaining a thorough understanding of the context – i.e. the characteristics of the ICT service and the organizational setting in which the service is used – was essential for identifying the key benefits to be expected. Written material, informal discussions as well as a group interview session were used to identify the impact factors. This procedure seemed to work quite well in the case of TeliaSonera: the fact that the open ended question concerning the impacts did not reveal any new factors in addition to those specifically asked using the structured questions suggests that nothing really important was left out.

Along with the identification of the impact factors to be measured the detailed procedures for capturing information about the factors were planned (*RQ2*). The extant literature reports thoroughly the variety of problems associated in such measurements but also provides some models for designing the measures. The procedures applied in this study consisted of both subjective and objective measurements which were designed to best capture the key impact elements. In this particular context, it was possible to objectively calculate the time saved. On the other hand, the more qualitative benefits were assessed using a subjective approach.

The interpretation of the measurement results was done by linking both objective and subjective results into an overall assessment as both types of data contribute by bringing their own parts for building the whole story. The measurement results seemed useful and

accurate enough for the purposes of the organization: they demonstrated the key benefits and also pointed out some areas for improvement. Furthermore, the measurement process carried out was pragmatic and efficient (i.e. it did not take a lot of effort from managers or employees).

The observations concerning *RQ2* reflect prior findings quite well. For example, Vuolle (2011) has applied a similar case-specifically tailored set of subjective and objective measures. Thus, the novelty value of this study does not lie so much in the (technical) information collection procedures but more in the identification of the factors to be measured.

4. Conclusions

ICT is a potential source of knowledge work productivity improvement. ICT can be used to eliminate non-value-adding tasks or make them more efficient, thus giving time for the most important tasks. In addition, taking into use new ICT services, which function better than existing ones, can result in improving employee welfare through decreasing dissatisfaction towards ICT systems and through transforming the content of work by deleting unimportant activities. Therefore, ICT clearly has potential as means to transform knowledge work processes. However, this potential must be realized by context-specific applications. In order to learn whether the benefits are realized in a particular case there is a need for measurement solutions.

The starting point of this study was the lack of knowledge on how to assess – in a given empirical context – the impacts of ICT on knowledge work. The empirical study showed that contrary to the view presented in the prior literature it does not seem that difficult to measure the impacts of ICT on knowledge work productivity. Of course, it is always a question of the level of how precise (valid and reliable) information is required. Nevertheless, practically useful measurement of impacts does not necessary have to be difficult or costly.

The case study demonstrated how the impact factors can be identified and how the measurements can be conducted in a given context. Objective measurement seemed to suit well in capturing concrete issues such as time saving while subjective measurement capture complex and qualitative phenomena such as perceptions towards the usability of an ICT system. Naturally, the detailed solutions only apply in this case but a similar procedure will likely be useful in the context of other ICT services and other knowledge work organizations also.

To conclude, this paper contributes to the prior literature on ICT and knowledge work productivity by explaining how the impacts of ICT can be analysed in a given empirical context. Specifically, the novelty value of the study lies in the new knowledge concerning the identification of the impact factors. The list of generic impact factors, summarized based on prior literature (Table I), acts as a basis for identifying the impacts in a specific context. The identification of case-specific impact factors by examining the characteristics of the ICT service and the organizational setting was illustrated in detail with the case study. After the identification of the impact factors, the measurement process itself was fairly straightforward.

The results of the paper open up new research avenues for scholars conducting further empirical studies on the impacts of ICT on knowledge work productivity. For example, more detailed empirical studies concerning which kinds of ICT solutions work in a given type of knowledge work context, and which do not, and why they work or do not work, are some of the possible research questions for the future. The results – and the detailed case description – may also be useful as a benchmark for managers studying the impacts of ICT investments in their organizations. Considering the implications from the perspective of knowledge management research more widely, the measurement practices proposed in this paper might be adapted to many other research settings in which the impacts of a knowledge management initiative are to be determined. Providing measured evidence of the impacts of any new managerial approach or tool is likely to enhance its managerial credibility.

References

Aghazadeh, S-M. and Seyedian, M. (2004), ''The high-performance work system: is it worth using?'', *Team Performance Management*, Vol. 10 Nos 3/4, pp. 60-64.

Ahuja, V. and Shankar, J. (2009), ''Benefits of collaborative ICT adoption for building project management'', *Construction Innovation: Information, Process, Management*, Vol. 9 No. 3, pp. 323-340.

Akkirman, A. and Harris, D. (2005), ''Organizational communication satisfaction in the virtual workplace'', *Journal of Management Development*, Vol. 24 No. 5, pp. 397-409.

Antikainen, R., Lappalainen, S., Lönnqvist, A., Maksimainen, K., Reijula, K. and Uusi-Rauva, E. (2008), ''Exploring the relationship between indoor air and productivity'', *SJWEH Supplements*, Vol. 4, pp. 79-82.

Appelbaum, S., Adam, J., Javeri, N., Lessard, M., Lion, J-P., Simard, M. and Sorbo, S. (2005), ''A case study analysis of the impact of satisfaction and organizational citizenship on productivity'', *Management Research News*, Vol. 28 No. 5, pp. 1-26.

Basole, R.C. (2007), ''Strategic planning for enterprise mobility: a readiness-centric approach'', *Proceedings of the 2007 Americas Conference in Information Systems*, Vol. 2007.

Beaudreau, B.C. (2009), ''The dynamo and the computer: an engineering perspective on the modern productivity paradox'', *International Journal of Productivity and Performance Management*, Vol. 59 No. 1, pp. 7-17.

Bettiol, M., Di Maria, E. and Grandinetti, R. (2012), ''Codification and creativity: knowledge management strategies in KIBS'', *Journal of Knowledge Management*, Vol. 16 No. 4, pp. 550-562.

Bosch-Sijtsema, P.M., Ruohomäki, V. and Vartiainen, M. (2009), ''Knowledge work productivity in distributed teams'', *Journal of Knowledge Management*, Vol. 13 No. 6, pp. 533-546.

Cardinali, R. (1994), ''Productivity improvements through the use of graphic user interfaces'', *Industrial Management & Data Systems*, Vol. 94 No. 4, pp. 3-7.

Davern, M.J. and Kauffman, R.J. (2000), ''Discovering potential and realizing value from information technology investments'', *Journal of Management Information Systems*, Vol. 16 No. 4, pp. 121-143.

Devaraj, S. and Kohli, R. (2003), ''Performance impacts of information technology: is actual usage the missing link?'', *Management Science*, Vol. 49 No. 3, pp. 273-289.

Drucker, P.F. (1999), ''Knowledge-worker productivity: the biggest challenge'', *California Management Review*, Vol. 41 No. 2, pp. 79-94.

Erne, R. (2010), ''Does knowledge worker productivity really matter?'', *Proceedings of I-KNOW 2010 (10th International Conference on Knowledge Management and Knowledge Technologies), Austria.*

Fitzgerald, G. (1998), ''Evaluating information systems projects: a multidimensional approach'', *Journal of Information Technology,* Vol. 13 No. 1, pp. 15-27.

Flanagan, R. and Marsh, L. (2000), ''Measuring the costs and benefits of information technology in construction'', *Engineering, Construction and Architectural Management*, Vol. 7 No. 4, pp. 423-435.

Goodhue, D.L. (2007), ''Comment on Benbasat and Barki's 'Quo Vadis TAM' article'', *Journal of the Association for Information Systems*, Vol. 8 No. 4, pp. 219-222.

Gressgård, L.J. (2011), ''Virtual team collaboration and innovation in organizations'', *Development and Learning in Organizations*, Vol. 25 No. 4.

Gunasekaran, A., Ngai, E.W.T. and McGaghey, R.E. (2006), ''Information technology and systems justification: a review for research and applications'', *European Journal of Operational Research*, Vol. 173 No. 3, pp. 957-983.

Haas, M.R. and Hansen, M.T. (2007), ''Different knowledge, different benefits: towards a productivity perspective on knowledge sharing organizations'', *Strategic Management Journal*, Vol. 28 No. 1, pp. 1133-1153.

Hosie, P.J. and Sevastos, P. (2009), ''Does the 'happy-productive worker' thesis apply to managers?'', *International Journal of Workplace Health Management*, Vol. 2 No. 2, pp. 131-160.

Ipsen, C. and Jensen, P.L. (2012), ''Organizational options for preventing work-related stress in knowledge work'', *International Journal of Industrial Ergonomics*, Vol. 42 No. 4, pp. 325-334.

Irani, Z. (2002), ''Information systems evaluation: navigating through the problem domain'', *Information and Management*, Vol. 40 No. 1, pp. 11-24.

Irani, Z. and Love, P.E.D. (2002), ''Developing a frame of reference for ex-ante IT/IS investment evaluation'', *European Journal of Information Systems*, Vol. 11 No. 1, pp. 74-82.

Jones, D.C., Kalmi, P. and Kauhanen, A. (2011), ''Firm and employee effects of an enterprise information system: micro-econometric evidence'', *International Journal of Production Economics*, Vol. 130 No. 2, pp. 159-168.

Kaplan, A. and Aronoff, S. (1996), ''Productivity paradox: work settings for knowledge work'', *Facilities*, Vol. 14 Nos 3/4, pp. 6-14.

Käpylä, J., Laihonen, H., Lönnqvist, A. and Carlucci, D. (2011), ''Knowledge-intensity as an organisational characteristic'', *Knowledge Management Research and Practice*, Vol. 9, pp. 315-326.

Karr-Wisniewski, P. and Lu, Y. (2010), ''When more is too much: operationalizing technology overload and exploring its impact on knowledge worker productivity'', *Computers in Human Behavior*, Vol. 26 No. 5, pp. 1061-1072.

Kaydos, W. (1999), *Operational Performance Measurement: Increasing Total Productivity*, St Lucie Press, Delray Beach, FL.

Kinnie, N. and Arthurs, A. (1996), ''Personnel specialists' advanced use of information technology Evidence and explanations'', *Personnel Review*, Vol. 25 No. 3, pp. 3-19.

Kujansivu, P. and Oksanen, L. (2010), ''White-collar worker productivity: challenges in Finland'', *International Journal of Services Technology and Management*, Vol. 14 No. 4, pp. 391-405.

Laihonen, H., Jääskeläinen, A., Lönnqvist, A. and Ruostela, J. (2012), ''Measuring the impacts of new ways of working'', *Journal of Facilities Management*, Vol. 10 No. 2, pp. 102-113.

Lönnqvist, A. (2004), *Measurement of Intangible Success Factors: Case Studies on the Design, Implementation and Use of Measures*, Tampere University of Technology, Tampere.

Love, P.E.D. and Irani, Z. (2004), ''An exploratory study of information technology evaluation and benefits management practices of SMEs in the construction industry'', *Information and Management*, Vol. 42 No. 1, pp. 227-242.

Lynch, W. and Riedel, J. (2001), *Measuring Employee Productivity: A Guide to Self-assessment Tools*, William M. Mercer and Institute for Health and Productivity Management, Glen Allen, VA.

Melville, N., Kraemer, K. and Gurbaxani, V. (2004), ''Review: information technology and organizational performance: an integrative model of IT business value'', *MIS Quarterly*, Vol. 28 No. 2, pp. 283-322.

Miles, I., Kastrinos, N., Flanagan, K., Bilderbeek, R., den Hertog, P., Huntink, W. and Bouman, M. (1995), *Knowledge-intensive Business Services: Users, Carriers and Sources of Innovation*, EIMS Publication No.15, European Innovation Monitoring System (EIMS), Luxembourg.

Misterek, S.D.A., Dooley, K.J. and Anderson, J.C. (1992), ''Productivity as a performance measure'', *International Journal of Operations & Production Management*, Vol. 12 No. 1, pp. 29-45.

Norton, D. (1995), ''Managing benefits from information technology'', *Information Management and Computer Security*, Vol. 3 No. 5, pp. 29-35.

Okkonen, J. (2004), *The Use of Performance Measurement in Knowledge Work Context*, Tampere University of Technology, Tampere.

Patterson, M.G., West, M.A., Shackleton, V.J., Dawson, J.F., Lawthom, R., Maitlis, S., Robinson, D.L. and Wallace, A.M. (2005), ''Validating the organizational climate measure: links to managerial practices, productivity and innovation'', *Journal of Organizational Behavior*, Vol. 26 No. 4, pp. 379-408.

Pyöriä, P. (2005), ''The concept of knowledge work revisited'', *Journal of Knowledge Management*, Vol. 9 No. 3, pp. 116-127.

Rodríguez Casal, C., Van Wunnik, C., Delgado Sancho, L., Burgelman, J.C. and Desruelle, P. (2005), ''How will ICTs affect our environment in 2020'', *Foresight*, Vol. 7 No. 1, pp. 77-87.

Sahay, B.S. (2005), ''Multi-factor productivity measurement model for service organization'', *International Journal of Productivity and Performance Measurement*, Vol. 54 No. 1, pp. 7-22.

Seddon, P.B., Graeser, V. and Willcocks, L.P. (2002), ''Measuring organizational IS effectiveness: an overview and update of senior management perspectives'', *The DATA BASE for Advances in Information Systems*, Vol. 33 No. 2, pp. 11-28.

Shin, N. (1999), ''Does information technology improve coordination? An empirical analysis'', *Logistics Information Management*, Vol. 12 Nos 1/2, pp. 138-144.

Sigala, M. (2003), ''The information and communication technologies productivity impact on the UK hotel sector'', *International Journal of Operations & Production Management*, Vol. 23 No. 10, pp. 1224-1245.

Simons, R. (2000), *Performance Measurement and Control Systems for Implementing Strategy*, Prentice Hall, Englewood Cliffs, NJ.

Starbuck, W.H. (1992), ''Learning by knowledge-intensive firms'', *Journal of Management Studies*, Vol. 29 No. 6, pp. 713-740.

Suwardy, T., Ratnatunga, J., Sohal, A. and Speight, G. (2003), ''IT projects: evaluation, outcomes and impediments'', *Benchmarking: An International Journal*, Vol. 10 No. 4, pp. 325-342.

Tallon, P.P., Kraemer, K.L. and Gurbaxani, V. (2000), ''Executives perceptions of the business value of information technology: a process-oriented approach'', *Journal of Management Information Systems*, Vol. 16 No. 4, pp. 145-173.

Torkzadeh, G. and Doll, W.J. (1999), ''The development of a tool for measuring the perceived impact of information technology on work'', *Omega, The International Journal of Management Science*, Vol. 27 No. 7, pp. 327-339.

Turkyilmaz, A., Akman, G., Ozkan, C. and Pastuszak, Z. (2011), ''Empirical study of public sector employee loyalty and satisfaction'', *Industrial Management & Data Systems*, Vol. 111 No. 5, pp. 675-696.

Von Nordenflycht, A. (2010), ''What is a professional service firm? Toward a theory and taxonomy of knowledge-intensive firms'', *Academy of Management Review*, Vol. 35 No. 1, pp. 155-174.

Vuolle, M. (2011), *Measuring Performance Impacts of Mobile Business Services from the Customer Perspective*, Publication 1013, Tampere University of Technology, Tampere.

About the authors

Miikka Palvalin is a Researcher at the Department of Information Management and Logistics at Tampere University of Technology, Finland. He is a member of the Performance Management Team research group. Palvalin received his MSc. (Eng.) in Information and Knowledge Management from Tampere University of Technology in 2011. He is currently working in two projects dealing with knowledge work productivity improvement. Miikka Palvalin is the corresponding author and can be contacted at: miikka.palvalin@tut.fi

Antti Lönnqvist is Professor at the Department of Information Management and Logistics, Tampere University of Technology, Finland. He also holds the position of Adjunct Professor at Aalto University, School of Science and Technology. He has over a decade of research experience dealing with the measurement and management of intellectual capital and business performance. Currently, service activities are a focal area of his research.

Maiju Vuolle is a Postdoctoral Researcher at the Department of Information Management and Logistics, Tampere University of Technology, Finland. She received her Doctor of Science (Technology) degree from Tampere University of Technology in 2012. Her research interests focus on mobile and other technology-based services, productivity and performance measurement.

PUBLICATION II

Methods for Identifying and Measuring the Performance impacts of Work Environment Changes

Miikka Palvalin, Maiju Vuolle

Journal of Corporate Real Estate, 18(3) 164-179

Received 1 November 2015
Revised 26 January 2016
1 April 2016
Accepted 5 April 2016

Methods for identifying and measuring the performance impacts of work environment changes

Miikka Palvalin and Maiju Vuolle
Department of Business Information and Logistics, Tampere University of Technology, Tampere, Finland

Abstract

Purpose – The purpose of this paper is to introduce and evaluate methods for analysing the impacts of work environment changes. New working practices and work environments present the potential to improve both the productivity and the wellbeing of knowledge workers, and more widely, the performance of organisations and the wider society. The flexibility offered by information and communication technology has influenced changes in the physical environment where activity-based offices are becoming the standard. Research offers some evidence on the impacts of work environment changes, but studies examining methods that could be useful in capturing the overall impacts and how to measure them are lacking.

Design/methodology/approach – This paper concludes research of the last five years and includes data from several organisations. The paper presents and empirically demonstrates the application of three complementary ways to analyse the impacts of knowledge work redesigns. The methods include: interview framework for modelling the potential of new ways of working (NWoW); questionnaire tool for measuring the subjective knowledge work performance in the NWoW context; and multidimensional performance measurement for measuring the performance impacts at the organisational level.

Findings – This paper presents a framework for identifying the productivity potential and measuring the impacts of work environment changes. The paper introduces the empirical examples of three different methods for analysing the impacts of NWoW and discusses the usefulness and challenges of the methods. The results also support the idea of a measurement process and confirm that it suits NWoW context.

Practical implications – The three methods explored in this study can be used in organisations for planning and measuring work environment changes. The paper presents a comprehensive approach to work environment which could help managers to identify and improve the critical points of knowledge work.

Originality/value – Changes in the work environment are huge for knowledge workers, but it is still unclear whether their effects on performance are negative or positive. The value of this paper is that it applies traditional measurement methods to NWoW contexts, and analyses how these could be used in research and management.

Keywords Measurement, Performance, Productivity, Work environment, Knowledge work, Work practices

Paper type Research paper

Journal of Corporate Real Estate
Vol. 18 No. 3, 2016
pp. 164-179

1463-001X
DOI 10.1108/JCRE-11-2015-0035

1. Introduction

The knowledge-intensive nature of work and the continuously developing possibilities provided by information and communication technology create new ways of working

(NWoW). An emerging bundle of flexible and mobile work practices have recently been introduced in the literature (Bosch-Sijtsema *et al.*, 2009; Gorgievski *et al.*, 2010; Peters *et al.*, 2014; Van der Voordt, 2004a). The main idea is to provide more flexibility and autonomy and allow workers to decide when, where and how their work gets done. Thus, workers can choose the most suitable place and tools based on the task at hand. For example, conventional offices are turning into activity-based workplaces to support both concentration and collaboration (Appel-Meulenbroek *et al.*, 2015a; De Paoli *et al.*, 2013; Halford, 2005), and some of the tasks can be done at multiple locations, such as the home, coffee shops and hubs (Koroma *et al.*, 2014). Some aspects of e-mail interactions have moved to instant messaging and social collaboration tools, and meetings are being held via videoconferencing tools to minimise travelling. Moreover, flexible work policies and trust-based managerial principles have been introduced to support autonomy, progress and the work-life balance (Perlow and Kelly, 2014; Peters *et al.*, 2014).

Redesigning knowledge work practices and the work environment presents the potential to improve both the productivity and the wellbeing of knowledge workers, and more widely, the business performance of knowledge-intensive organisations and also the wider society. These kinds of changes may have implications, for example, on employee motivation or, from the real estate and facility management perspectives, to office space requirements and workplace services. However, measuring knowledge work performance and the impacts of work environment changes is challenging (Davenport, 2008; Laihonen *et al.*, 2012; Ramirez and Nembhard, 2004). Only a few specific studies exist concerning the measurement of impacts of work environment or work practice changes on knowledge work and organisational performance (Riratanaphong and van der Voordt, 2015). A study by Laihonen *et al.* (2012) specifically explored the measurement of impacts of NWoW and developed some conceptual measurement solutions. Nevertheless, empirical experience on applying these measurements in practice is lacking. The purpose of this study is to fill this gap with practical solutions.

Work environment changes, work practice initiatives and the organisational contexts in which they are implemented vary. Thus, there may be many kinds of related measurement tasks as well. This suggests that there will not be a "one size fits all" type of measurement solution available. Instead, various measurement tools are likely to be needed for different purposes. Therefore, it is useful to study this topic in different contexts. The aim of this paper is to present and empirically demonstrate the application of three complementary ways to analyse the impacts, and to identify the potential of new work environments and more flexible and mobile work practices. Different measurement approaches may be needed due to various organisational contexts and management needs. For example, analysing the productivity potential (ex-ante) is a different management and measurement task compared to evaluating the impacts of a change project (ex-post). Therefore, it is important to have an empirical understanding about the application and usefulness of different measurement approaches in different managerial contexts. This study answers two research questions:

RQ1. How can the productivity potential and goals for work environment changes be identified?

RQ2. How can the impacts of work environment changes on knowledge work be analysed?

2. Measurement approaches for analysing the work environment change process

2.1 The impact of NWoW

New ways of working demonstrate great potential for improving the business performance of knowledge-intensive organisations (Blok *et al.*, 2012; Ruostela *et al.*, 2015). The performance of knowledge-intensive companies is highly dependent on their ability to provide value to customers through the knowledge and competence possessed by their workers. Various contextual factors may either enable or prevent the successful activities within companies. These contextual factors include the utilisation or adoption of various physical locations, virtual collaborative and mobile tools, as well as various social and organisational practices (Bosch-Sijtsema *et al.*, 2009; Ruostela and Lönnqvist, 2013). In addition, the individual's way of working can be seen as an important performance driver. If workers are not willing to change their habits or attitudes, fancy offices, tools and policies will not make any improvements. Therefore, to understand the bottlenecks and the potential to improve knowledge work productivity, current ways of working should be analysed, including the underlying attitudes, culture and practices. Then, the objectives and targets for change can be set.

Knowledge work redesign can have many positive impacts on a firm's performance and competitiveness at various levels (De Paoli *et al.*, 2013; Gibson, 2003; Ruostela *et al.*, 2015; van der Voordt, 2004b). NWoW can have an impact on employees' wellbeing, work motivation, work-life fit and productivity (Peters *et al.*, 2014; van der Voordt, 2004a, 2004b; van Meel, 2011). Work processes can be improved through better planning and eliminating low value work, whereas flexibility, predictability and control improve wellbeing in work and life (Perlow and Kelly, 2014). For example, when work is more flexible in terms of time or location, it can be possible to work at home and save commuting time (Harrison, 2002). Working from home also reduces travel costs and, at the same time, takes into account the sustainability aspect by reducing the carbon footprint caused by commuting (Hassanain, 2006). With different kinds of space usage (e.g. hot desking), it is possible to use the organisation's resources and especially space more efficiently and reduce occupancy costs (van der Voordt, 2004b). According to Bradley (2002) and van der Voordt (2004a), these NWoW may also improve the modern and innovative image of the company from the customers' perspective, and also seem to be more attractive to future employees.

Table I summarises the above paragraphs and presents the framework for this study. Knowledge work is analysed from the perspectives of performance drivers and results and outcome. Drivers are divided into organisational level drivers, which are the physical, virtual and social environments, and the personal level driver, which is the individual's work practices. Results and outcomes can also be divided into organisational and personal level impacts, such as productivity, wellbeing at work and customer satisfaction.

2.2 Measurement challenges and proposed solutions

Measuring the impacts of NWoW and related work environment changes on knowledge work has various challenges. The challenges emanate from the varying content of knowledge work (Davenport, 2008; Greene and Myerson, 2011), the qualitative and intangible nature of knowledge work outputs (Davenport, 2008; Drucker, 1999; Ramirez and Nembhard, 2004) and the difficulty of capturing the impacts on customers (Deakins

Perspective	Level	Dimension	References
Performance drivers	Organisation	Physical environment	Bosch-Sijtsema *et al.* (2009), Gorgievski *et al.* (2010)
		Virtual environment	Bosch-Sijtsema *et al.* (2009), Harrison (2002), Vartiainen and Hyrkänen (2010)
		Social environment	Bosch-Sijtsema *et al.* (2009), Vartiainen (2007)
	Knowledge worker	Work practices	Ruostela and Lönnqvist (2013), Koopmans *et al.* (2013)
Results and outcomes	Organisation	Performance	De Paoli *et al.* (2013), Gibson (2003)
		Customer value	Ramirez and Nembhard (2004)
		Sustainability	Hassanain (2006), Ruostela *et al.* (2015)
	Knowledge worker	Wellbeing at work	Bakker and Demerouti (2008), Perlow and Kelly (2014)
		Productivity	Peters *et al.*, 2014, van der Voordt (2004a)

Table I. Framework for identifying productivity potential and measuring impacts of work environment changes

and Dillon, 2005). Due to the characteristics of knowledge work, the so-called traditional productivity measures (quantitative outputs/quantitative inputs) do not usually fit the requirements of the measurement context. However, certain alternative measurement approaches exist that are better suited. For example, subjective measurements have been considered a potential way to capture the multidimensional and intangible aspects of knowledge work productivity (Deakins and Dillon, 2005; Drucker, 1999; Ramirez and Nembhard, 2004), as well as measuring employee satisfaction and productivity related to different work environments (e.g. Appel-Meulenbroek *et al.* 2015b; De Been and Beijer, 2014; Maarleveld *et al.*, 2009). Another potential approach is the use of a multidimensional performance measurement system to capture various aspects of performance and work environment changes using both objective and subjective indicators (Jääskeläinen and Lönnqvist, 2010; Riratanaphong and van der Voordt, 2015; Takala *et al.*, 2006).

Typical measurement challenges related to measuring the impacts of organisational change initiatives include the following (Laihonen *et al.*, 2012) identifying which factors

are actually impacted (Bailey, 2011) taking into account the fact that impacts may vary depending on the working role (Antikainen *et al.*, 2008) and the organisational level in question (Vuolle, 2010) distinguishing the impact resulting from the change in question in comparison to other factors affecting productivity simultaneously (Kujansivu and Lönnqvist, 2009) and dealing with the time lag between the change and the realisation of the impacts (Davern and Kauffman, 2000). There does not appear to be any generic solution to measure different kinds of organisational impacts. Instead, impacts must be measured on a case-specific basis that allows for examining changes – for example, a before and after comparison.

Based on Bourne *et al.* (2000); Laihonen *et al.* (2012) proposed a process model for measuring the impacts of workplace initiatives. This process consists of the following steps:

- defining the measurement task in question (i.e. what is the purpose of the measurement?);
- identifying the factors to be measured;
- planning the actual measurement and choosing the metrics to be used;
- implementing the measures (the execution of which is based on the choices made during the previous steps); and
- analysing and reporting the measurement results.

As pragmatic measurement solutions, Laihonen *et al.* (2012) propose, for example, a survey for measuring employees' experienced productivity, interviews, observations and objective indicators. The proposed model and the measures seem to have potential, but their value in this context is still unclear. Thus, the empirical part of the paper uses these as a starting point to search for practical ways to measure workplace initiatives.

3. Research methods and data collection

This paper is based on five years of research projects on knowledge work redesign, including NWoW and work environment changes. The research projects were carried out in Finland during 2011-2015 and included four organisations. All companies operate in the facility management sector and are interested in knowledge work redesign as a tool for improving their operations, but also as a perspective for developing new services for their customers.

The research can be characterised as action research consisting of a set of three independent studies for developing measurement methods (Table II). Action research is a pragmatic approach that aims to solve current practical problems while learning from outcomes and expanding scientific knowledge and theory (Baskerville and Myers, 2004; Coughlan and Coghlan, 2002). Action researchers are external helpers who act as facilitators of the change and reflection within an organisation and simultaneously study the process (Baskerville and Myers, 2004; Coughlan and Coghlan, 2002). Therefore, action research can be viewed as a dual cycle process that includes both problem-solving and research interests, differentiating it from pure consultancy (McKay and Marshall, 2001). The companies were at different stages concerning their workplace initiatives, and this had implications on their measurement information needs and on our access to the measurement data. Two of the case organisations had implemented a major workplace initiative including the office layout, tools and

Focus of the study	Measurement approach	Research methods
Identifying and modelling the potential of work environment changes for improving knowledge work productivity	Knowledge work performance framework for identifying factors to be improved and measured	Thematic interview study within two companies ($N = 18$)
Developing and testing measurement tools for analysing the level and impacts of the work environment and work practices on knowledge work performance	Subjective measurement tool for quantifying employee experience on the impact of new ways of working on wellbeing and productivity	Constructive research with pilot tests in four organisations ($N = 527$)
Developing measurement frameworks and metrics for measuring the performance of a knowledge-intensive company through work environment changes	Balanced business performance measurement, subjective and objective measures	Four interviews for identifying the potential impacts. Four iterative measurement development workshops in one company. Analysis of exiting performance metrics in another company

Table II. The studies and measurement approaches examined

practices. Other companies were planning their workplace initiatives or experimenting with smaller-scale pilot solutions.

The aim of the first study was to understand and analyse the potential to improve knowledge work productivity through new work environments and work practices. This helped to identify the main elements of knowledge work performance to be covered by the measurement methods. In total, 18 knowledge workers in various roles were interviewed. All interviews were semi-structured face-to-face interviews. The interviews were recorded with a digital voice recorder and transcribed for further analysis. The transcribed interviews were analysed qualitatively to identify important themes. The purpose was to examine the usefulness of interviewing as a subjective method of capturing and modelling individual knowledge workers' views about productivity potential.

The second study was conducted using the constructive research approach to create a managerial construction to solve a practical problem (Kasanen *et al.*, 1993; Labro and Tuomela, 2003). Based on the literature and interviews conducted in the first study, a SmartWoW tool was developed and tested to measure the key elements of knowledge work performance, work environments and flexible work practices. This study covered all of the case companies. After testing the SmartWoW tool in practice, we conducted interviews in each organisation to collect feedback for the solution's applicability.

The third study was a longitudinal case study of a work environment change project carried out in two companies. The aim was to capture the multidimensional performance impacts of an NWoW initiative by measuring the chosen performance indicators before and after the changes. In one of the companies, four key indicators were chosen based on the goals of the project. In the other company, four half-day

iterative workshops were organised to develop the measurement framework and key metrics. In constructing the measurement system, we followed the basic principles of balanced performance measurement with three main phases: the design of performance measures, the implementation of performance measures and the use of performance measures (Bourne *et al.*, 2000; Kaplan and Norton, 1996; Neely *et al.*, 2000). First, key objectives were identified and then performance measures for each objective were designed. After that, the measures were implemented, used and reflected upon. Participants included two facilitators and a group of five to eight representatives from the various departments within the company. This kind of a facilitated workshop process has proven useful not only in finding useful indicators, but also for committing the key actors to the outcomes of the design process.

The experiences from the three measurement approaches are discussed in the sections below. Each approach is discussed from four perspectives:

(1) What is the measurement method like?

(2) For which management purposes is the method suitable?

(3) How was the measurement method applied?

(4) What were the lessons learned?

4. Results: introducing and analysing three methods for measuring work environment changes

4.1 Interview framework for modelling productivity potential

Interviewing is a potential approach for capturing the intangible and subjective aspects related to the working environment and work practices (Ramirez and Nembhard, 2004). Interviews are not typically considered a measurement, but the process actually fulfils the measurement role as it provides information about the current state in the organisation. In two case companies, it was necessary to obtain an in-depth understanding about individual knowledge workers' productivity and how work environment changes could impact it. Interviewing personnel was chosen as a method for capturing these issues.

The purpose of the interviews was to identify factors related to the work environment and work practices that could be improved. By doing this, the goal of the interviews was to identify the potential for workplace changes to improve knowledge work productivity. In this sense, interviewing works as a kind of *ex-ante* measurement – as a tool for identifying and assessing the potential of workplace initiative. In two companies, nine knowledge workers were interviewed (i.e. 18 in total). Respondents were chosen so that they represented three different working profiles (e.g. fixed, flexible and mobile workers). The interview questions were based on the first version of the Table I framework, which focused on two key knowledge work productivity drivers:

(1) the impacts of physical, virtual and social work environments on productivity; and

(2) the impacts of mobile and flexible work practices on productivity.

Both positive and negative impacts were investigated, as well as the ways productivity could be improved.

The interviews provided information on both the actual perceived productivity impacts as well as the productivity potential for further development. Combining

different work environments and work practices in the analysis provided a more comprehensive and systematic view on knowledge work productivity. For example, in one of the companies, the factors with the highest potential for improving knowledge work productivity included:

- more effective use of space (e.g. more team spaces and policies for using the work environment properly);
- promoting creativity (e.g. by providing employees with creative spaces); and
- enhancing flexibility (e.g. by focusing more on results and promoting flexibility).

It is important to highlight that these development areas are only relevant for this company and that different issues are probably considered relevant for other companies.

The organisations' representatives felt that the interviews gave them good insights into the individuals' views on the impacts and improvement potential of the work environment and practices. One of the organisations reported that they had read the results carefully and used the information for their work environment change plans. Typical features of the interview method seemed particularly applicable in this context. For example, the strengths of interviewing include sensitivity to context (i.e. ability to discover issues that are relevant to the company in question), wide coverage of different aspects of the ways of working and the ability to capture subjective and qualitative phenomena. Some of the downsides of this approach are those related to subjective measurement techniques in general: interviewing takes resources (both skills and time), and the interpretation of the results always leaves room for criticism. It may also be difficult to examine the improvement of work practices over time.

4.2 Questionnaire for subjective knowledge work performance measurement

Questionnaires are typically used as a method for measuring the experiences of employees and customers. The Smart Ways of Working (SmartWoW) questionnaire was constructed to measure knowledge work performance, and it covers four components from the Table I framework related to knowledge work performance. SmartWoW analyses:

(1) the contextual factors – physical (seven statements), virtual (seven) and social work environment (ten);

(2) personal ways of working (ten) as drivers of knowledge work performance;

(3) the experienced wellbeing (eight); and

(4) productivity (seven) of personnel as key work outcomes.

Multiple-choice statements are scored using a 5-point Likert scale from 1 = "Disagree" to 5 = "Agree". In addition, one open-ended question is asked concerning ideas for improvement in relation to each of the four main dimensions of the tool. Examples of the statements include the following:

- There is a space for informal interaction at our workplace when needed (physical).
- Workers have access to information regardless of location (virtual).
- Knowledge flows adequately between the key persons at our workplace (social).

- I often telework for carrying out tasks that require uninterrupted concentration (personal).
- I find my work meaningful and having a clear purpose (wellbeing).
- My job mainly includes tasks in which I am able to exploit my knowledge and skills efficiently (productivity).

SmartWoW is a multi-use tool as it serves management in three ways. First, it can be used to identify areas to be developed (ex-ante). Second, when used ex-ante and ex-post as an NWoW initiative, it can be used to determine impacts. Third, with a fixed set of statements, it produces comparable information about different companies, thus providing an opportunity for benchmarking and learning. SmartWoW is very light and takes only 10-15 minutes to answer, which is important for busy knowledge workers. It also works as a communication tool for employees and challenges them to re-think their own work practices.

Since the creation of SmartWoW, one of the organisations has applied it to some of their processes, and 14 organisations and 1,840 knowledge workers have responded to it. Its popularity and systematic use indicate that the tool is valid for practitioners (Kasanen *et al.*, 1993). It is most often used to identify necessary work environment changes before the change is implemented. Open-ended questions have proved to be valuable for identifying specific needs and problems. Example results show how the method can be used in practice. In one case, employees felt that the effectiveness of meeting practices was low (average 2.59) and facilities were not effective (average 3.62). Work environment changes focused especially on these two factors, and in the ex-post measurement, both were significantly improved; meeting practices (from 2.59 to > 2.96) and effectiveness of facilities (from 3.62 to > 3.91).

SmartWoW has proved to be an effective tool for evaluating the maturity or intelligence of the ways of working and how the current practices affect wellbeing and productivity. Based on the interviews, representatives felt that "SmartWoW is good for recognising the problems" and "comparisons to other companies is the most valuable information produced by SmartWoW". SmartWoW limitation is its specific work environment and work practice questions, which could become "outdated" as organisations develop. Thus, adjustments to the questions might be required. The benefit of the after results is that they could be used to identify new targets for development.

4.3 Multidimensional performance measurement of the impacts of work environment changes

The two methods introduced above focus on the work environment and practices from the individual knowledge worker's perspective. Moreover, both approaches are subjective. As one of the aims of workplace initiatives is to create business performance impacts, measuring financial and other company-level phenomena is also necessary. A potential approach for carrying this out is to use a multidimensional performance measurement system, consisting of a set of indicators that are relevant to the objectives of the workplace initiative in question.

In two of the case companies, a multidimensional performance measurement system was developed to capture whether the goals of the work environment and work practice changes would be reached. The choice of measures was based on the goals of the project.

For example, some of the key objectives and related performance measures are presented in Table III. One of these companies had more dimensions as their measurement system measures all of the dimensions in the Table I framework, such as the length of the meetings and the amount of Microsoft Lync hours.

There are two options for choosing measures. The first is to develop new measures based on the goals of the project. However, developing the measures and gathering the new data may be very labour intensive. The second option is to use existing measures. In this method, it is important to recognise the impacts of work environment changes and which measures those impacts affect. The advantage of this approach is that current and previous data are already collected. Although in our experience with these cases, it can be surprisingly laborious to gather all the data from the organisation's various IT systems. Another benefit of the second method is that it could be used even if the changes are already made because the beforehand data exist.

In both of the case studies, measurements were carried out before and after the change project to capture the changes. In addition to the objective indicators, personnel's views of the impacts of the changes were examined using a questionnaire survey. In the first case study, three months after the change was completed, the personnel evaluated how the new setting supports their work compared to the previous one. Different aspects, such as operations, flexibility and sustainability, were taken into account in the evaluation process. In the second case study, SmartWoW tool was used 1 month and 12 months after the change.

The measurement results (Table III) clearly show improvement in many of the target areas. No doubt, setting clear measurable targets and designing indicators to measure them helped focus the development activities. In addition, the quantitative results appeared to be credible evidence of the value of the NWoW thinking, which is an important issue for a company providing facility management services to its customers.

In many ways, the multidimensional measurement system – used before, during and after the change initiative – seems like a very functional approach to measure the impacts of work environment changes. Nevertheless, some downsides can be associated with this approach as well. First, the measurement system focused only on a few concrete elements of business performance (such as space utilisation efficiency), and the impacts of the initiative on knowledge work productivity remained somewhat unclear, although the subjective personnel assessment provided a rough view of it. Second, the measurement system must be tailored according to the needs of the change project. This requires some resources.

5. Strengths and weaknesses of each method

The first purpose of this paper was to determine how to identify the productivity potential and goals for work environment change. Previous literature suggests that it is useful to classify all measures into well-defined categories to measure performance. Section 2.1 presented the framework, which includes all categories that may have an impact on work environment changes. This framework was an important starting point for all these methods, as it ensures that everything is taken account. During the studies, three methods were tested and their applicability was evaluated by the case organisations' representatives and the researchers. To identify productivity potential and recognise the most critically needed work environment changes, two methods arose – interviews and survey questionnaire. A multidimensional measurement could

Table III.
Example measures and results

Measure	Organisation 1		Organisation 2	
	Before	After	Before	After
Space usage efficiency (NIA)	26 m^2/person	13 m^2/person	22.6 m^2/person	14.9 m^2/person
Occupancy costs (including the rent, repair cost, security, cleaning and electricity)	€7,025/person	€3,570/person	€4,650/person	€3,438/person
Environmental impact	2,650 kg CO_2/person	1,850 kg CO_2/person	690 kg CO_2/person	592 kg CO_2/person

trigger the process; for example, if the number of unoccupied desks is high, but the reason for this cannot be explained. In the NWoW context, the interview and survey methods seemed to give identical results in identifying areas in need of improvement. The survey method has one major advantage over interviews, as it also offers information about the impacts of the change.

The second purpose of this paper was to examine how to analyse and measure the impacts of work environment changes. The typical approach for measuring impacts is to use objective measures, but the previous literature mentioned in Section 2.2 suggests that subjective measures also work fine, and it might be beneficial to use both methods together. From the three methods of this study, we used surveys and multidimensional measurements to measure impacts of work environment changes. The organisation that used both methods felt that the survey gave good results and would be easy to use by any organisation. They were so satisfied that they utilised the SmartWoW tool for some of their customers work environment change processes. This organisation felt that they also needed objective measures because some people at the customer organisation trusted measurable numbers more than subjective evaluations. The weakness of multidimensional measurement is that it requires significant resources to gather all the information. As researchers, we would have liked to gather information about the same things using both subjective and objective measures, but this presented difficulties. The main difficulty was that the objective information was not available, and when it was, it was still difficult to gather from all of the organisations' information systems. Some similarities could be seen in both results within the same organisation, e.g. subjective feeling that meeting practices have improved and the average length of the meeting in the booking system, but this needs more empirical evidence to be confirmed.

Table IV concludes the case organisations and the researchers' experiences about the strengths and weaknesses of the three methods of this study. It shows that the general characteristics of interview, survey and objective measurements exist also in the context of NWoW. The reason why those methods work well in this context lies in the theoretical framework (Table I), which is in the background of all the methods. This ensures that the measurement is comprehensive and that every dimension of knowledge work is observed.

6. Conclusions

This paper has introduced empirical examples of three different methods used to analyse the impacts of NWoW and discussed the usefulness and challenges of the methods. The methods are based on the framework that includes all the important areas of work environment changes. The methods include:

(1) interview framework for modelling the potential of NWoW;

(2) questionnaire tool for measuring the subjective knowledge work performance in the NWoW context; and

(3) multidimensional performance measurement for measuring the performance impacts at the organisational level.

These methods can be used independently, but they also complete each other, depending on the measurement task at hand. For example, interviews and questionnaires can be used before planning the NWoW initiative to analyse the current practices and level of productivity and to set targets for the NWoW project. These targets can then be used

Method	Interview	Questionnaire	Multidimensional performance measurement
Strengths	Ability to discuss sensitive topics Wide coverage of different aspects Can be used to recognise which factors are impacted Workers are the experts to evaluate how the changes would impact	Covers all dimensions of framework which may reveal if something else is changing at the same time Covers all the organisational levels Generalised results Can be easily re-used	Can cover all the dimensions of the framework Gives objective information Continuous measurement reveals the impacts during the time
Weaknesses	Takes resources (skills and time) Interpretation of results Difficult to examine the improvement over time Difficult to define sample Hard to find less obvious needs	Employees may respond as they think they should Subjective evaluation might be biased Survey structure needs occasional updates as the ways of working change	Requires information which measures should be used Focuses only on a few elements of the framework due to available data limitations Initiative on knowledge work productivity may remain unclear Tailoring needs resources Hard to confirm which are the right measures

Table IV.
Conclusion of the strengths and weaknesses of the methods

when designing measures for a multidimensional performance framework. Moreover, the scores from the SmartWoW tool can be used as one subjective measure in the performance framework. After the NWoW initiative, the impacts can be captured by conducting the SmartWoW survey again 6 and 12 months after the changes, and collecting the objective measurement data at the same time.

Measuring the impacts should be seen as a process, and the measurements should be integrated into the NWoW project from the beginning, to set the baseline and determine whether the targets have been achieved. By utilising both subjective and objective measures as well as short-term and long-term evaluations, it is possible to capture the overall impacts from the intervention.

References

Antikainen, R., Lappalainen, S., Lönnqvist, A., Maksimainen, K., Reijula, K. and Uusi-Rauva, E. (2008), "Exploring the relationship between indoor air and productivity", *SJWEH Supplements*, pp. 79-82.

Appel-Meulenbroek, R., Kemperman, A., Kleijn, M. and Hendriks, E. (2015a), "To use or not to use; which type of property should you choose? Predicting the use of activity based offices", *Journal of Property Investment & Finance*, Vol. 33 No. 4, pp. 320-336.

Appel-Meulenbroek, R., Kemperman, A., van Susante, P. and Hoendervanger, J.G. (2015b), "Differences in employee satisfaction in new versus traditional work environments", *14th EuroFM Research Symposium*.

Bailey, S. (2011), "Measuring the impacts of records management – data and discussion from the UK higher education sector", *Records Management Journal*, Vol. 21 No. 2, pp. 46-68.

Bakker, A.B. and Demerouti, E. (2008), "Towards a model of work engagement", *Career Development International*, Vol. 13 No. 3, pp. 209-223.

Baskerville, R. and Myers, M.D. (2004), "Special issue on action research in information systems: making IS research relevant to practice – foreword", *MIS Quarterly*, Vol. 28 No. 3, pp. 329-335.

Blok, M., Groenesteijn, L., Schelvis, R. and Vink, P. (2012), "New ways of working: does flexibility in time and location of work change work behavior and affect business outcomes?", *Work: A Journal of Prevention, Assessment and Rehabilitation*, Vol. 41 No. 1, pp. 5075-5080.

Bosch-Sijtsema, P.M., Ruohomäki, V. and Vartiainen, M. (2009), "Knowledge work productivity in distributed teams", *Journal of Knowledge Management*, Vol. 13 No. 6, pp. 533-546.

Bourne, M., Mills, J., Wilcox, M., Neely, A. and Platts, K. (2000), "Designing, implementing and updating performance measurement systems", *International Journal of Operations & Production Management*, Vol. 20 No. 7, pp. 754-771.

Bradley, S. (2002), "What's working? Briefing and evaluating workplace performance improvement", *Journal of Corporate Real Estate*, Vol. 4 No. 2, pp. 150-159.

Coughlan, P. and Coghlan, D. (2002), "Action research for operations management", *International Journal of Operations & Production Management*, Vol. 22 No. 2, pp. 220-240.

Davenport, T.H. (2008), "Improving knowledge worker performance", *From Strategy to Execution: Turing Accelerated Global Change into Opportunity*, Springer Berlin Heidelberg, pp. 215-235.

Davern, M.J. and Kauffman, R.J. (2000), "Discovering potential and realizing value from information technology investments", *Journal of Management Information Systems*, Vol. 16 No. 4, pp. 121-143.

De Been, I. and Beijer, M. (2014), "The influence of office type on satisfaction and perceived productivity support", *Journal of Facilities Management*, Vol. 12 No. 2, pp. 142-157.

De Paoli, D., Arge, K. and Blakstad, S.H. (2013), "Creating business value with open space flexible offices", *Journal of Corporate Real Estate*, Vol. 15 Nos 3/4, pp. 181-193.

Deakins, E. and Dillon, S. (2005), "Local government consultant performance measures: an empirical study", *International Journal of Public Sector Management*, Vol. 18 No. 6, pp. 546-562.

Drucker, P.F. (1999), "Knowledge-worker productivity: the biggest challenge", *California Management Review*, Vol. 41 No. 2, pp. 79-94.

Gibson, V. (2003), "Flexible working needs flexible space? – towards an alternative workplace strategy", *Journal of Property Investment & Finance* Vol. 21 No. 1, pp. 12-22.

Gorgievski, M.J., van der Voordt, T.J.M., van Herpen, S.G.A. and van Akkeren, S. (2010), "After the fire – new ways of working in an academic setting", *Facilities*, Vol. 28 Nos 3/4, pp. 206-224.

Greene, C. and Myerson, J. (2011), "Space for thought: designing for knowledge workers", *Facilities*, Vol. 29 No. 1, pp. 19-30.

Harrison, A. (2002), "Accommodating the new economy: the SANE space environment model", *Journal of Corporate Real Estate*, Vol. 4 No. 3, pp. 248-265.

Hassanain, M. (2006), "Factors affecting the development of flexible workplace facilities", *Journal of Corporate Real Estate*, Vol. 8 No. 4, pp. 213-220.

Jääskeläinen, A. and Lönnqvist, A. (2010), "Knowledge work productivity measurement: case study in a municipal administration", *Proceedings of 16th World Productivity Congress and European Productivity Conference, Belek, 2-5 November*.

Kaplan, R.S. and Norton, D.P. (1996), *The Balanced Scorecard. Translating Strategy into Action*, Harvard Business School Press, Boston, MA.

Kasanen, E., Lukka, K. and Siitonen, A. (1993), "The constructive approach in management accounting research", *Journal of Management Accounting Research*, Vol. 5 No. 1, pp. 243-264.

Koopmans, L., Bernaards, C., Hildebrandt, V., van Buuren, S., van der Beek, A. and de Vet, H. (2013), "Development of an individual work performance questionnaire", *International Journal of Productivity and Performance Management*, Vol. 62 No. 1, pp. 6-28.

Koroma, J., Hyrkkänen, U. and Vartiainen, M. (2014), "Looking for people, places and connections: hindrances when working in multiple locations: a review", *New Technology, Work and Employment*, Vol. 29 No. 2, pp. 139-159.

Kujansivu, P. and Lönnqvist, A. (2009), "Measuring the impacts of an IC development service: the case of the Pietari business campus", *Electronic Journal of Knowledge Management*, Vol. 7 No. 4, pp. 469-480.

Labro, E. and Tuomela, T.-S. (2003), "On bringing more action into management accounting research: process considerations based on two constructive case studies", *European Accounting Review*, Vol. 12 No. 3, pp. 409-442.

Laihonen, H., Jääskeläinen, A., Lönnqvist, A. and Ruostela, J. (2012), "Measuring the impacts of new ways of working", *Journal of Facilities Management*, Vol. 10 No. 2, pp. 102-113.

McKay, J. and Marshall, P. (2001), "The dual imperatives of action research", *Information Technology & People*, Vol. 14 No. 1, pp. 46-59.

Maarleveld, M., Volker, L. and Van Der Voordt, T.J. (2009), "Measuring employee satisfaction in new offices-the WODI toolkit", *Journal of Facilities Management*, Vol. 7 No. 3, pp. 181-197.

Neely, A., Mills, J., Platts, K., Richards, H., Gregory, M., Bourne, M. and Kennerley, M. (2000), "Performance measurement system design: developing and testing a process-based approach", *International Journal of Operations & Production Management*, Vol. 20 No. 10, pp. 1119-1145.

Perlow, L.A. and Kelly, E.L. (2014), "Toward a model of work redesign for better work and better life", *Work and Occupations*, Vol. 41 No. 1, pp. 111-134.

Peters, P., Poutsma, E., Van der Heijden, B.I., Bakker, A.B. and Bruijn, T.D. (2014), "Enjoying new ways to work: an HRM-process approach to study flow", *Human Resource Management*, Vol. 53 No. 2, pp. 271-290.

Ramirez, Y.W. and Nembhard, D.A. (2004), "Measuring knowledge worker productivity. A taxonomy", *Journal of Intellectual Capital*, Vol. 5 No. 4, pp. 602-628.

Riratanaphong, C. and van der Voordt, T. (2015), "Measuring the added value of workplace change: performance measurement in theory and practice", *Facilities*, Vol. 33 Nos 11/12, pp. 773-792.

Ruostela, J. and Lönnqvist, A. (2013), "Exploring more productive ways of working", *World Academy of Science, Engineering and Technology, International Science Index 73*, Vol. 7 No. 1, pp. 611-615.

Ruostela, J., Lönnqvist, A., Palvalin, M., Vuolle, M., Patjas, M. and Raij, A.-L. (2015), "'New ways of working' as a tool for improving the performance of a knowledge-intensive company", *Knowledge Management Research & Practice*, Vol. 13 No. 4, pp. 382-390.

Takala, J., Suwansaranyu, U. and Phusavat, K. (2006), "A proposed white-collar workforce performance measurement framework", *Industrial Management & Data Systems*, Vol. 106 No. 5, pp. 644-662.

van der Voordt, T.J.M. (2004a), "Productivity and employee satisfaction in flexible workplaces", *Journal of Corporate Real Estate*, Vol. 6 No. 2, pp. 133-148.

van der Voordt, T.J.M. (2004b), "Costs and benefits of flexible workspaces: work in progress in The Netherlands", *Facilities*, Vol. 22 No. 9, pp. 240-246.

van Meel, J. (2011), "The origins of new ways of working – office concepts in the 1970s", *Facilities*, Vol. 29 Nos 9/10, pp. 357-367.

Vartiainen, M. (2007), "Analysis of multilocational and mobile knowledge workers' work spaces", *Lecture Notes in Computer Science*, Vol. 4562 No. 1, pp. 194-203.

Vartiainen, M. and Hyrkkänen, U. (2010), "Changing requirements and mental workload factors in mobile multi-locational work", *New Technology, Work and Employment*, Vol. 25 No. 2, pp. 117-135.

Vuolle, M. (2010), "Productivity impacts of mobile office service", *International Journal of Services Technology and Management*, Vol. 14 No. 4, pp. 326-342.

Further reading

Bentley, K. and Yoong, P. (2000), "Knowledge work and telework: an exploratory study", *Internet Research*, Vol. 10 No. 4, pp. 346-356.

Kelloway, E.K. and Barling, J. (2000), "Knowledge work as organizational behavior", *International Journal of Management Reviews*, Vol. 2 No. 3, pp. 287-304.

Lönnqvist, A. (2004), *Measurement of Intangible Success Factors: Case Studies on the Design, Implementation and Use of Measures*, Tampere University of Technology, Tampere.

Corresponding author

Miikka Palvalin can be contacted at: miikka.palvalin@tut.fi

PUBLICATION III

SmartWoW – Constructing a Tool for Knowledge Work Performance Analysis

Miikka Palvalin, Maiju Vuolle, Aki Jääskeläinen, Harri Laihonen, Antti Lönnqvist

International Journal of Productivity and Performance Management, 64(4) 479-498

SmartWoW – constructing a tool for knowledge work performance analysis

Miikka Palvalin, Maiju Vuolle, Aki Jääskeläinen, Harri Laihonen and Antti Lönnqvist
Department of Business Information and Logistics, Tampere University of Technology, Tampere, Finland

Received 28 June 2013
Revised 5 March 2014
Accepted 11 June 2014

Abstract

Purpose – New Ways of Working (NewWoW) refers to a novel approach for improving the performance of knowledge work. The purpose of this paper is to seek innovative solutions concerning facilities, information technology tools and work practices in order to be able to "work smarter, not harder." In order to develop work practices toward the NewWoW mode there is a need for an analytical management tool that would help assess the status of the organization's current work practices and demonstrate the impacts of development initiatives. This paper introduces such a tool.

Design/methodology/approach – Constructive research approach was chosen to guide the development of the Smart ways of working (SmartWoW) tool. The tool was designed on the basis of previous knowledge work performance literature as well as on interviews in two knowledge-intensive organizations. The usefulness of the tool was verified by applying it in four organizations.

Findings – SmartWoW is a compact questionnaire tool for analyzing and measuring knowledge work at the individual level. The questionnaire consists of four areas: work environment, personal work practices, well-being at work and productivity. As SmartWoW is a standardized tool its results are comparable between organizations.

Research limitations/implications – SmartWoW was designed a pragmatic managerial tool. It is considered possible that it can be valuable as a research instrument as well but the current limited amount of collected data does not yet facilitate determining its usefulness from that perspective.

Originality/value – This paper makes a contribution to the existing literature on knowledge work measurement and management by introducing an analytical tool which takes into account the NewWoW perspective.

Keywords Performance, Knowledge workers, Productivity, Measurement, Knowledge work, New Ways of Working

Paper type Research paper

1. Introduction

The performance of an individual knowledge worker drives the success of knowledge-intensive organizations (Alvesson, 1993; Blackler, 1995; Miles, 2005; Groen *et al.*, 2012). Therefore, the improvement of knowledge work performance is a key challenge of modern economy (Drucker, 1999). New Ways of Working (NewWoW) refers to a novel approach to overcome this challenge.

The concept of NewWoW deals with the application of non-traditional and flexible work practices and locations for carrying out knowledge work (Van der Voordt, 2004; Gorgievski *et al.*, 2010). The utilization of ICT is typical for NewWoW practices. For example, Gorgievski *et al.* (2010) describe "New Ways of Working" as a possibility to work when and where people prefer to work using fast and mobile IT-facilities. They also depict offices becoming networks of activity-related non-assigned "hot" desks and people using additional external workplaces at home, at the client, in a restaurant, etc. The concept arises from the needs of modern companies to provide

International Journal of Productivity and Performance Management
Vol. 64 No. 4, 2015
pp. 479-498

1741-0401
DOI 10.1108/IJPPM-06-2013-0122

flexible work arrangements and more cost efficient and creative office environments in order to support competitiveness and employee productivity without decreasing job satisfaction (e.g. Van der Voordt, 2004; Beauregard and Henry, 2009; Kattenbach *et al.*, 2010). NewWoW is used to refer to such concepts as telework, mobile work, desk sharing, paperless offices, video conferencing and flexible or alternative workplaces and practices (Van der Voordt, 2004; Van Meel, 2011). NewWoW idea consists of applying novel practices and open-minded testing of different options rather than doing things as before without questioning the suitability of existing practices. The whole idea is to work smarter, not harder (Bontis, 2011). In this paper, we construct a framework for measuring the "smartness" of work practices that are expected to lead to improving knowledge work productivity and the welfare of knowledge workers.

Measurement information on knowledge work performance is needed both in daily managerial activities and in demonstrating the impacts of development initiatives, such as NewWoW. It is suggested in this context that the purpose of measurement should be oriented toward facilitating the employees' performance instead of formal control (Amir *et al.*, 2010; Groen *et al.*, 2012). While the nature of knowledge work and the means to improve its performance (Davenport, 2008; Miller, 1977) have been studied a lot, there are fewer studies on knowledge work performance measurement (Takala *et al.*, 2006). In the literature, there are some measurement models for knowledge work (Ramirez and Nembhard, 2004; Laihonen *et al.*, 2012; Takala *et al.*, 2006) and some case-specific measurement processes for NewWoW interventions (Ruostela *et al.*, 2012; Palvalin *et al.*, 2013). However, there are no prior managerial tools for analyzing the status (or maturity) of NewWoW practices and the related level of productivity and employee welfare. Thus, this paper and the tool introduced clearly have both academic and managerial novelty value.

In order to develop an organization's ways of working toward the NewWoW mode, there is a need for an analytical tool that would help assess the status of the organization's current work practices (i.e. the extent of novelty of work practices in use) and their effectiveness in terms of productivity and employee welfare. This tool would be useful in analyzing the status of work practices, guiding development practices toward the NewWoW mode and capturing the impacts of NewWoW interventions. The objective of this paper is to introduce such a tool.

This paper presents a new tool – Smart Ways of Working (SmartWoW) – for knowledge work performance analysis and improvement. The tool is particularly tailored for measuring the NewWoW mode of operations. SmartWoW is a questionnaire-based self-reporting tool as opposed to, for example, objective measures, peer evaluations or managerial ratings (see, e.g. Ramirez and Nembhard, 2004; Koopmans *et al.*, 2013; Laihonen *et al.*, 2012). Subjective measurement tools, while having their limitations, have been considered useful in knowledge work context (Koopmans *et al.*, 2013). This paper reports the construction process of the new tool. From a research methodology perspective, this study follows the phases of the constructive research approach (Kasanen *et al.*, 1993; Labro and Tuomela, 2003), which is well-suited for studies aiming to develop new managerial tools. This includes, for example, the literature-based justification of the elements of the measurement model and the empirical testing of the tool in four case organizations.

This paper is organized as following. In the next section there is a methodology which describes shortly the steps of constructive research approach and co-operating organizations. After that, there is a literature about the topic of measuring performance in knowledge work context. Sections 4 and 5 present the results and discussion of the

study. These sections follow the steps of constructive research approach which is typical format to report constructive research. At the end we have concluding remarks to summary the paper.

2. Methodology

This research was conducted using the constructive research approach. According to Kasanen *et al.* (1993), constructive research approach can be used to create a managerial construction to solve a practical problem. There are seven phases in the constructive research approach: first, find a practically relevant problem, which also has research potential; second, examine the potential for long-term research co-operation with the target organization; third, obtain a general and comprehensive understanding of the topic; fourth, innovate and construct a theoretically grounded solution idea; fifth, implement the solution and test whether it works in practice; sixth, examine the scope of the solution's applicability; and seventh, show the theoretical connections and the research contribution of the solution (Kasanen *et al.*, 1993; Labro and Tuomela, 2003).

Research methods for constructing this new SmartWoW tool include literature review, interviews as well as pilot tests in four case organizations. In addition to reviewing literature, we carried out an interview study in two of the case organizations (2 and 4). Altogether 18 knowledge workers were interviewed in order to understand how various aspects of work environment and work practices affect the productivity and well-being of employees. This helped to identify the main elements of knowledge work to be covered by the measurement tool. After testing the SmartWoW tool in practice, we conducted interviews in each organization to collect feedback for the solution's applicability.

Organization 1 is a small 33 person company which aims to guide other companies to develop their business. Its mission is to increase regional well-being while working in collaboration with the business world, public sector and universities.

Organization 2 has more than 400 employees of with 75 were selected as the target group for the pilot tests in this study. All the participants are working in consulting services. Energy efficiency and building services design are the core competences of the organization.

Organization 3 is a large real estate and business facility company employing thousands of people. An 80 person side office participated in this study. While the company's main operations include fairly basic facility services all the respondents were white-collar workers.

Organization 4 is a medium-sized company operating in the field of built environment. It offers expert services to assist in decision making which is sustainable from the viewpoints of economy, environment and workplace well-being. Totally, 60 employees were involved in this research.

3. Literature review: measuring performance of a knowledge worker in a "smart" context

The context of knowledge work was introduced 1959 by Drucker when he used it as a term to separate knowledge work from manual work. Drucker proposed that knowledge worker is a person who works primarily with information or is a person who develops and uses knowledge at workplace (Drucker, 1959). Since then, knowledge work is defined in many ways, but there is no standardized definition for it (Dahooie *et al.*, 2011; Kelloway and Barling, 2000). The problem with defining knowledge work is

that knowledge has some role in every work (Dahooie *et al.*, 2011). In this research we use Drucker's (1959) definition, but add that "knowledge worker's work is not usually dependent on location or time." This addition is used to outline, e.g. the work of doctors and teachers which is high-knowledge-intensive work, but has a special nature.

Instead of labeling all workplace and work practice changes as "new," we elaborate the concept of NewWoW and rename it as "Smart Ways of Working". The important notion is to work smarter, not harder (Bontis, 2011). This wording emphasizes the importance of renewing work practices in smart ways – not just focussing on whether the initiative is new or even innovative but that it works in practice in a given context in order to improve productivity without having more stress and frustration. SmartWoW attempts to change the organizational culture in a way that the knowledge workers can decide about the ways they work: work practices, schedules and workplaces can be controlled by employees.

Existing literature recommends balanced performance measurement frameworks as a solution for measuring performance of knowledge-intensive organizations. For example, the framework of Ramirez and Nembhard (2004) focusses on productivity dimensions and provides several aspects to be considered in measurement: quantity, costs, profitability, timeliness, autonomy, efficiency and many others are recognized as the drivers of knowledge work productivity. Authors note that different subsets of these dimensions are typically used in measurement. Takala *et al.* (2006), propose a structured framework for measuring white-collar performance. Their framework approaches the performance of strategic work from four aspects: results, process, behavior and physiology. In routine work only results are measured. The problem with the balanced performance frameworks is that they do not provide any measurement solutions (how to measure); they only support in recognizing measurement objects (what to measure).

In addition to the above-mentioned organizational approach to the issue, Jääskeläinen and Laihonen (2013) recognize two specific components that should be carefully considered in the performance measurement of knowledge-intensive organizations: performance of a knowledge worker and customer-perceived performance. Both perspectives represent essential success factors (Alvesson, 1993; Groen *et al.*, 2012) of knowledge-intensive organizations and also provide specific measurement challenges. Knowledge worker perspective represents the most relevant aspect for tackling the objective of this research. It calls for specific evaluation instruments capturing the individual nature of knowledge work.

Subjective evaluation methods are widely supported in measuring knowledge worker performance at the individual level. It has been argued that these flexible methods capture the unique and changing nature of knowledge work, and provide the possibility to comprehensively capture the relevant intangible aspects of knowledge worker performance (Jääskeläinen and Laihonen, 2013). There are specific subjective measurement tools for knowledge work performance (Clements-Croome and Kaluarachchi, 2000; Kemppilä and Lönnqvist, 2003; Janz *et al.*, 2007) but they are characterized with complex and theoretical constructs which are difficult to apply as practical managerial tools.

Similar measurement solutions are provided by the human resources management literature. Tools and practices like behaviorally anchored rating scales, competence frameworks and 360° feedback evaluations are often used for supporting performance appraisal (Fisher, 2005; Mann *et al.*, 2012; Koopmans *et al.*, 2013). The same tools are also used for evaluating employees' competencies and creating

a basis for remuneration, promotion or termination and to identify training needs (Dulewicz and Fletcher, 1992). The challenge in these methods is that they often concentrate on individual performance but are only implicitly linked to organizational performance (Jääskeläinen and Laihonen, 2013). Most of the existing subjective measurement tools are also suitable for measuring the change in performance of knowledge work as an output variable but they have limited ability to provide explanations about the reasons for performance changes. One reason for this is that performance is approached from the perspective of task performance. However, contextual factors such as facilities, technological equipment, personal relationships or working atmosphere (Ferris *et al.*, 2009; Kahya, 2008; Koopmans *et al.*, 2013) are often the triggers of performance improvements.

Although the measurement of organizational change is a common setting in academic studies, the literature on performance measurement and management has paid little attention on the examination of change processes (Barbosa and Musetti, 2011). There are surveys tailored to specific change contexts but less tools proving managerially relevant and comparable information from different organizational environments posing changes. This particular setting brings along with specific measurement challenges (Laihonen *et al.*, 2012) such as the identification of aspects impacted by the change. The key question is whether the identified impacts are the result of studied change or some other random factors. There is a need to measure both the change itself and its impacts (Adcroft *et al.*, 2008; Taskinen and Smeds, 1999). This means that there is a need to obtain information not only from outputs or outcomes but also the actual work processes and practices (Laihonen *et al.*, 2012; Okkonen, 2004), i.e. performance drivers.

It appears that the current literature on knowledge worker performance evaluation has not kept up with the modern work environment reflecting NewWoW. NewWoW seems to be a highly potential approach for improving both productivity and employee welfare in knowledge work context. However, the theme is still quite new and there is a lack of empirical evidence on the effectiveness of NewWoW practices. There is also a lack of practical tools for analyzing and managing performance from the NewWoW perspective. In the extant literature, there are some examples of studies in which the impacts of NewWoW have been examined related to specific interventions, for example, changes in physical office environment (Gorgievski *et al.*, 2010; Haynes, 2007; Maarleveld *et al.*, 2009), impacts of information and communication technologies (Jacks *et al.*, 2011; Palvalin *et al.*, 2013) or flexible workplace policies and shifts in organizational culture (Halpern, 2005; Kelly *et al.*, 2011). While these studies provide valuable understanding of knowledge work performance and related measurement practices they usually focus only on a certain performance driver and its impact on either productivity or employee welfare. Instead, the key point of NewWoW thinking is the evaluation of the functioning of work practices as a whole in the given context. Thus, a need for a new kind of measurement tool clearly exists.

There are some previous attempts to develop subjective measurement tools for analyzing performance in general. For example, Koopmans *et al.* (2013) created a generic three-dimensional individual work performance questionnaire (IWPQ) for measuring task performance, contextual performance and counterproductive work behavior in occupational sectors. They define individual work performance as "behaviors or actions that are relevant to the goals of the organization, and under control of the individual." The IWPQ focusses on measuring employee behaviors instead of the effectiveness of these behaviors. However, we see that both

perspectives – behaviors and outcomes – should be included when analyzing knowledge work. In addition to these, work environment plays a crucial role in supporting knowledge workers, including physical, virtual and social-organizational environments (Bosch-Sijtsema *et al.*, 2009). These contextual factors are also integrated into our construct of knowledge work performance.

4. Constructing the SmartWoW tool

4.1 Starting point

The SmartWoW tool was constructed through seven phases of constructive approach as was described in Section 2. First, the relevance of the problem, that is, the need for a new kind of knowledge work performance measurement tool has been explained in the first and third sections of the paper. In addition to what has been already mentioned, this study was motivated by the practical needs raised by an ongoing research project dealing with the measurement of the impacts of companies' NewWoW initiatives. During the project it became evident that there is a need for an easy to use standard tool which can be used to carry out before-after comparisons or to compare companies with each other. Second, ongoing research collaboration with a group of knowledge-intensive business organizations gave a starting point to this research. Four case organizations were selected for this research. They all experienced a need to find a novel tool for measuring the performance of knowledge work.

Third, the authors preunderstanding of the theme is based on several years of experience on the topic of measuring and managing the performance of knowledge-intensive organizations. In addition, for the past three years they have been involved in a research project in which the NewWoW approach as a mean to develop knowledge work performance has been examined. Thus, the background knowledge of the topic was strong already in the beginning of the project. Understanding of the theme was further strengthened by reviewing the latest literature (discussed in Section 3).

As a result of the previous steps, we suggest that the following three factors are important when analyzing the performance of knowledge work (in the NewWoW environment): contextual factors, actual work processes and practices as well as results and outcomes of work (Figure 1). When taking all these factors into account, it is possible to have a comprehensive view on performance and to identify the reasons behind good or poor performance. Moreover, by evaluating both the performance drivers and outcomes, it is possible to detect the impacts of NewWoW initiatives and to identify, for example, which of the practices or tools improve performance.

4.2 "Innovate and construct a theoretically grounded solution idea"

The initial idea was to develop a general subjective measure for knowledge work productivity and include productivity drivers in it. The authors had previous experience in applying subjective productivity measures in several companies. In addition, the interviews carried out in the two companies suggested that a subjective approach would be useful in capturing the subtle, individual experiences related to knowledge work

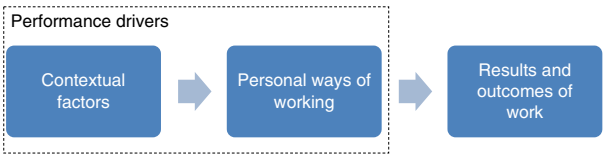


Figure 1.
Three components of knowledge work performance

practices. The perspective of employee well-being was also integrated in order to better cover the NewWoW thinking – to aim at both productivity and well-being.

Then, relevant existing literature and questionnaires were analyzed in order to validate the construct and generate items for the tool (e.g. Maarleveld *et al.*, 2009; Koopmans *et al.*, 2013; Wännström *et al.*, 2009; Schaufeli *et al.*, 2006; Vuolle *et al.*, 2008). This creative questionnaire design process included several researcher workshops and two commentary rounds, one with the authors' colleagues and one with collaborative companies. Several revisions to different aspects of the tool were made during these iterative rounds in order to reach a solution that met every party's expectations. Figure 2 presents the four key components of the tool. Compared to Figure 1, "results and outcomes" have been divided into "well-being" and "productivity."

The questionnaire is presented in Appendix. The first two parts of the SmartWoW tool analyze the contextual factors and personal ways of working that are both seen as important drivers of knowledge work performance. The rest of the SmartWoW tool measures the results and outcomes of knowledge work in terms of well-being and productivity. All of the statements are positively phrased and they are scored using a five-point Likert scale from 1 = "disagree" to 5 = "agree." In addition, at the end of each dimension there is one open-ended question.

Contextual factors include physical location, virtual and social workplaces as well as organizational context (e.g. Bosch-Sijtsema *et al.*, 2009; Vartiainen, 2007). The physical workplace should be supportive to tasks needing both concentration and collaboration in order to stay productive and creative (e.g. Halpern, 2005; Heerwagen *et al.*, 2004; Maarleveld *et al.*, 2009; Gorgievski *et al.*, 2010). Statements related to physical workplace measures the functionality, ability to concentrate and ergonomics of the workplace. For example, whether there are enough spaces for official and informal meetings and whether space can be used based on activity and orientation (Maarleveld *et al.*, 2009). A high level of noise and interruption distracts workers and, thus, workers should be able to work concentrated when needed to be productive (Jett and George, 2003; Haynes, 2007; Mehta *et al.*, 2012)

Technology plays a significant role in providing employees control over how, where and when they conduct their work (O'Neill, 2010). Statements related to virtual workplace measures whether organization provides proper tools for accessing real-time information and for efficient communication and collaboration. These tools also help knowledge workers to increase their awareness and creating a sense of belonging in a community which are especially important issues for remote and mobile workers and virtual teams (Vartiainen and Hyrkkänen, 2010). Virtual workspace includes, for

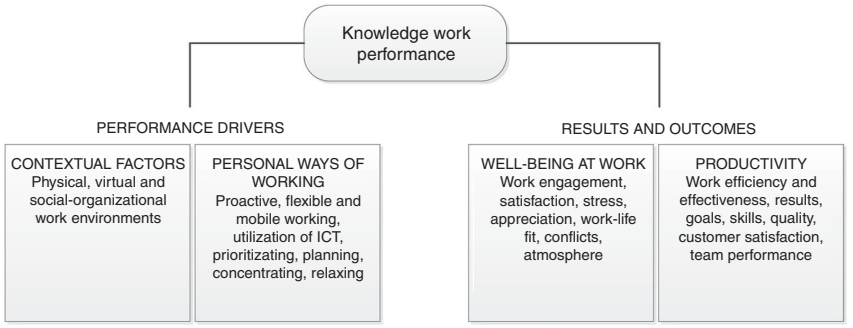


Figure 2.
The key components of the SmartWoW tool

example, ICT tools and platforms, video conferencing, shared calendars and documents and other collaborative groupware, instant messages, mobile tools and social network services (e.g. Vartiainen and Hyrkkänen, 2010; Holtshouse, 2010). All these tools have a possibility to impact knowledge workers productivity through time savings and increased information (Palvalin *et al.*, 2013). Some might be worried out that employees are spending too much time using all modern tools at work but it has been noted that employees use, for example, instant messaging in ways that help them to manage interruption, such as quickly obtaining task-relevant information and negotiating conversational availability (Garrett and Danziger, 2007).

Social workplace measures whether knowledge workers are supported or allowed to have autonomy and utilize NewWoW in terms of attitudes, common routines and policies as well as organizational habits. Social environment refers to cognitive constructs, thoughts, beliefs and mental states that employees share (see, e.g. Vartiainen, 2007). Organizational context includes, for example, culture, strategy, policy and rewards (Bosch-Sijtsema *et al.*, 2009). In order to improve engagement and performance of people and organizations, it is important to provide choice about where, when and how to work (O'Neill, 2010) and have support from colleagues and supervisors (Bakker and Demerouti, 2008). Statements related to social and organizational context include policies and attitudes for flexible, mobile and remote working, clear goal setting, transparency, as well as common routines and policies for efficient meetings and communication, which all have an impact on productivity (e.g. Drucker, 1999; Origo and Pagani 2008; Ramirez and Steudel, 2008). In addition, it is suggested that work should be evaluated more in terms of results achieved instead of only measuring working hours (Kelly *et al.*, 2011). Moreover, innovative climate is the key for utilizing smarter culture as it encourages workers to think of ways to improve things at their workplace (Wännström *et al.*, 2009).

Whereas contextual factors define the overall atmosphere and support for conducting knowledge work in new ways, personal ways of working measures if the workers are willing or motivated to utilize such practices (Ruostela and Lönnqvist, 2013; Koopmans *et al.*, 2013). Individual work practices and behaviors include ways to have control over schedule, workload and interruptions whether it means that a worker prefers to come to the office during office hours or to work flexibly at home or at the office or in various other places utilizing ICT. Workers can control, for example, the timing of their work and the location where they work, which affects their commuting time and total time away from home (Kelly *et al.*, 2011). Mobile services can be used for accomplishing tasks that need a rapid reaction or response, improving situation awareness and utilizing idle time for working while on the move (Vuolle, 2010). Planning behavior, including goal setting, prioritizing and, for example, preparing for meetings, help workers to focus on results and control their time and workload (Kearns and Gardiner 2007; Claessens *et al.*, 2004). Interruptions can be managed, for example, by working remotely when needing concentration (or boosting creativity). It is also suggested that the effect of e-mail interruption could be reduced, for example, by changing the settings and modes of using the e-mail software (Jackson *et al.*, 2003; Garrett and Danziger, 2007).

Well-being at work is measured through overall job satisfaction, work engagement, stress, appreciation, work-life balance, conflicts and atmosphere. The welfare of knowledge workers is a highly important driver for a high-performing organization because engaged workers are known to be more creative and open to new information and they tend to be productive (Bakker and Demerouti, 2008; Bakker, 2011). In addition,

flexible work practices can reduce stress and work-family conflicts, improve health, work-non-work fit and well-being (Greenhaus and Powell, 2006; Beauregard and Henry, 2009; Halpern, 2005; Kelly *et al.*, 2011). The importance of social climate of the workplace is also acknowledged in literature (Wännström *et al.*, 2009). There is a lot of existing research on the measurement of well-being and employee satisfaction. Thus, for the purposes of the SmartWoW we used selected questions from established and tested personnel welfare surveys QPSNordic (Dallner *et al.*, 2000; Wännström *et al.*, 2009) and UWES (Schaufeli and Bakker, 2003; Schaufeli *et al.*, 2006).

Productivity is measured by statements related to work efficiency and effectiveness, achieving results, goals, utilizing skills, quality of work, customer satisfaction and team performance (e.g. Ramirez and Nembhard, 2004; Ramirez and Steudel, 2008; Wännström *et al.*, 2009). These are all typical issues related to productivity, reflecting internal efficiency of the worker and the effectiveness of the outcomes from the customer perspective (Palvalin *et al.*, 2013). Instead of just asking about productivity directly, we considered it more useful to focus on the more detailed components or related factors to indicate about the status of productivity.

5. Testing the smartwow tool

5.1 "Implement the solution and test whether it works in practice"

SmartWoW was tested in three stages and some adjustments to it were made in between. First, the tool was tested by authors' fellow researchers. The result of this test was that while the tool seemed to work quite well as a whole some of the questions were unclear in terms of formatting and some relevant issues seemed to be missing (e.g. related to work engagement). Thus, some modifications were made. Second, SmartWoW was tested in the first external organization (pilot test No. 1). The feedback from the respondents was positive and no changes were required. However, the reporting of the results pointed out a few problems. For example, work environment and individual work practices sections had questions which were not giving any relevant information or seemed to be in the wrong place. Based on these experiences the tool was slightly modified again. Third, SmartWoW was implemented in the three other companies (pilot tests Nos 2-4) for testing on how it works in practice. Table I summarizes the pilot tests showing their sample size, the number of respondents, response rate and results.

Table I also presents Cronbach' α's in different dimensions of SmartWoW. All α's are fairly over 0.5 which is the minimum requirement and each area except for virtual workplace exceed the limit of 0.7, which is usually considered a good level. High internal consistency enables examining questions in selected groups.

Figure 3 shows an example of presenting an overview of the results of SmartWoW, which was send to the organization managers. The percentages are calculated by valuating the answers from 1 disagree to 5 agree and then calculating the average. The mean value was then compared to the maximum value 5 to get percentages. As SmartWoW is a standardized tool, the results are comparable. Thus, it is possible to compare the results between internal departments, between companies, over time (e.g. before and after a work place development project) or between industries or professions. In the pilot test we compared organizations 2, 3 and 4 to each other. The results indicated clear differences between the companies. This was very helpful in understanding how a certain company performs in relation to others, that is, to determine whether a certain measurement result is actually good or bad.

Table I.
Summary of the pilot tests

	Organization 1		Organization 2		Organization 3		Organization 4		
Sample size	33		75		80		60		
n	22		28		26		35		
Response rate (%)	67		37		33		58		
Dimension (number of factors)	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Cronbach's α
1. Physical workplace (5)	3.41	1.34	3.60	1.26	3.24	1.42	3.81	1.21	0.77
2. Virtual workplace (6)			3.67	1.28	3.42	1.34	4.27	0.91	0.69
3. Social-organizational workplace (9)			3.49	1.10	3.23	1.31	4.04	0.99	0.86
4. Personal work practices (10)	3.42	1.18	3.26	1.27	3.59	1.26	3.52	1.34	0.73
5. Well-being at work (8)	3.38	1.07	3.90	0.84	3.58	1.16	4.31	0.83	0.88
6. Productivity (7)	3.40	0.92	3.89	0.85	3.96	0.93	4.16	0.69	0.84

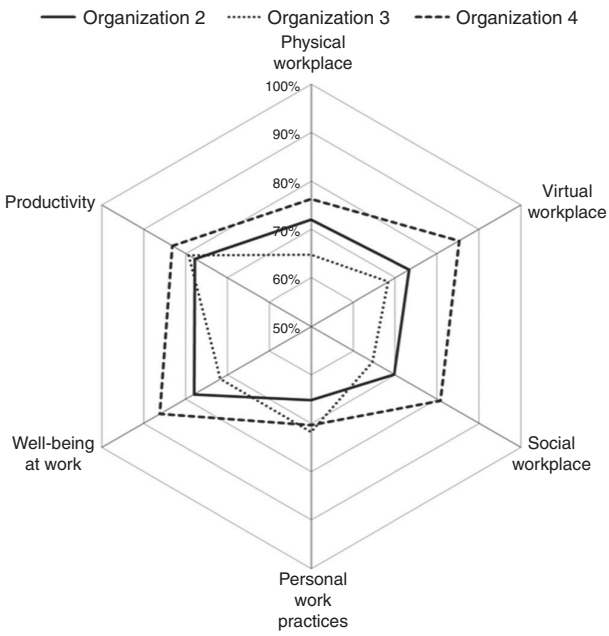


Figure 3.
An illustration of the comparison of SmartWoW results

As mentioned, open-ended questions are also a key part of SmartWoW. Some examples of real responses for the question "How could your productivity be improved?" are listed below:

- "Every worker should have clear personal goals, which are strictly related to the results. At the moment I am working with several units, but there are moments when I do not know my goals."
- "Less bureaucracy. Focus more to the actual doing, not discussing how every small detail should be done."
- "More working as a team. Increased level of communication, e.g. weekly meetings."

As the examples show, the open-ended questions provide more insight on the Likert scale questions. In addition, they are more development focussed, providing means to improve the problematic areas.

5.2 "Examine the scope of the solution's applicability"

In constructive research, the model being developed is usually validated by using the so-called market test. According to Kasanen *et al.* (1993), there are three types of market tests: weak, semi-strong and strong. The construct passes the weak market test when a high-level manager in an organization is willing to use it in decision making. The semi-strong market test requires that the construct is used throughout the organization. The strong market test is passed when there is evidence for economic benefits from using the construct and it is used systematically in several organizations (Lukka, 2000; Kasanen *et al.*, 1993). According to Labro and Tuomela (2003), the semi-strong and strong market tests cannot be passed in short time and, thus, those are not applicable in this case. Below, we report the feedback from the pilot organizations concerning SmartWoW.

Organization 1 felt that they needed this kind of tool to measure their human resources, work well-being and productivity. They were interested in using SmartWoW again in order to get more information on how well-being and productivity have changed during the year. They also implement SmartWoW results as a part of their performance measurement system.

Organization 2 is going to continue their physical workplace change project and the results of SmartWoW are going to be used in decision making. They felt that SmartWoW is good for recognizing the problems but at the same time felt that it should also provide some solutions. Respondents in organization 2 felt that SmartWoW works very well and it has good usability.

Organization 3 had very positive feeling about SmartWoW. The first good signal was that the results were forwarded immediately to the company managers because the contact person felt that the information was relevant and important. Company representatives were very pleased about that there finally is a standardized tool for measuring productivity and work well-being. They felt that this is extremely important for getting comparable data. Comparison to other companies and comparison to previous results were regarded as the most valuable information produced by SmartWoW. Organization 3 is planning to do some changes in its work environment in the near future and they were interested in using the SmartWoW again after the changes in order to evaluate their impacts. They were also interested in using SmartWoW with their clients to identify the need for changes.

Organization 4 also had a positive feeling about SmartWoW and they felt that their organization is suitable for this kind of tool due to advanced ways of working. They were a little bit disappointed because the term "tool" referred to the questionnaire. Organization 4 was interested in knowing how to improve performance and they valued open-ended questions highly. They were also interested in knowing what they could learn from the other organizations' results. Organization 4 felt that SmartWoW has potential to be used with their clients.

When analyzing the observations from pilot organizations it appears that the measurement tool is versatile. It fulfills three key comparative task of performance management (Matta, 1989). Organization 1 regarded the tool as a useful component of a performance measurement system where it can be monitored annually with updated objectives and action plans ("goal analysis"). Organization 2 highlighted the benefits in measuring the impacts of change interventions ("trend analysis"). In practice, this means measurement before and after change interventions. Organizations 3 and 4 felt that the value of such a tool links especially to the possibility to utilize it in comparison analysis. When the "maturity" of working practices is captured in several work environments and units it is possible to utilize the data in comparisons and learn from other organizations. Furthermore, it was mentioned that the measurement results act as a trigger for discussion around knowledge work performance and its drivers.

To summarize, the pilot organizations found SmartWoW useful and are willing to use it again. Some were also interested in using it with their own clients. Therefore, it can be stated that the tool fulfills the criteria of the weak market test. At the moment, we only applied SmartWoW in four organizations. Thus, it is not possible to claim that it would be universally applicable or useful in all knowledge work environments. However, it is a compact and generic tool and, thus, it should be useful in many different contexts.

5.3 "Show the theoretical connections and the research contribution of the solution"

The theoretical basis of SmartWoW has been discussed thoroughly in previous sections. It is connected to the ongoing discussion on knowledge work performance improvement,

with a fresh twist related to the NewWoW thinking. More specifically, the tool seems promising as a research instrument in exploring the relationships between the components of the tool. It can act as a platform for the analysis of performance benefits from changing work practices and work environment. Currently available surveys have yet rarely incorporated modern, flexible or alternative workplaces and practices. Furthermore, the survey tool can be applied in studying the balance between sometimes competing objectives of productivity and work well-being. However, more data is needed in order to explore these further research possibilities.

6. Concluding remarks

Knowledge work performance management is not an easy task and there is a need for pragmatic tools to support the managerial work. The new SmartWoW measurement tool constructed in this study has demonstrated potential as a part of a managerial toolbox of knowledge-intensive organizations. The experience gained from applying SmartWoW is so far positive and promising. The tool fulfills rather well the objectives defined at the beginning of this study. It supports in analyzing the status and novelty of knowledge work practices and facilitates an open-minded search for NewWoW. Furthermore, when SmartWoW is used before and after change interventions it is useful in capturing the impacts of NewWoW initiatives.

Knowledge work performance is a phenomenon that is difficult to approach. It has an immaterial, qualitative and changing nature. Earlier research highlights the need to understand the drivers of performance in order to measure and manage knowledge work performance. The framework underlying the SmartWoW tool is a novel addition to existing literature, categorizing the knowledge work performance drivers from the perspective of modern work practices. There are several avenues for further research applying and refining the survey tool itself.

Further research could go deeper in the different forms of knowledge work in order to better understand the varying nature of different contexts. The experiences of this study indicate that SmartWoW is applicable specifically in non-standard and mobile knowledge work but less so in fixed office work. The tool was specifically addressed to the needs of practitioners. From the academic perspective, validity and reliability requires more testing with wider data sets and consideration of modifications to the survey structure. This paper did not attempt to identify rigor causalities between the identified perspectives of knowledge work which is one obvious direction of further research. Such research would benefit from objective-dependent variables for productivity. In order to fulfill the criterion of practicality, the survey structure was compromised in length. There is probably a need to reconsider the different analysis levels such as the individual, the team, the unit and the whole organization. Furthermore, more detailed questions regarding social context, especially in terms of attitudes and culture, could improve the validity of the survey.

References

Adcroft, A., Willis, R. and Hurst, J. (2008), "A new model for managing change: the holistic view", *The Journal of Business Strategy*, Vol. 29 No. 1, pp. 40-45.

Alvesson, M. (1993), "Organizations as rhetoric: knowledge-intensive companies and the struggle with ambiguity", *Journal of Management Studie*, Vol. 30 No. 6, pp. 997-1015.

Amir, A., Ahmad, N. and Mohamad, M. (2010), "An investigation on PMS attributes in service organisations in Malaysia", *International Journal of Productivity and Performance Management*, Vol. 59 No. 8, pp. 734-756.

Bakker, A.B. (2011), "An evidence-based model of work engagement", *Current Directions in Psychological Science*, Vol. 20 No. 4, pp. 265-269.

Bakker, A.B. and Demerouti, E. (2008), "Towards a model of work engagement", *Career Development International*, Vol. 13 No. 3, pp. 209-223.

Barbosa, D.H. and Musetti, M.A. (2011), "The use of performance measurement system in logistics change process", *International Journal of Productivity and Performance Management*, Vol. 60 No. 4, pp. 339-359.

Beauregard, T.A. and Henry, L.C. (2009), "Making the link between work-life balance practices and organizational performance", *Human Resource Management Review*, Vol. 19 No. 1, pp. 9-22.

Blackler, F. (1995), "Knowledge, knowledge work and organizations: an overview and interpretation", *Organization Studies*, Vol. 16 No. 6, pp. 1021-1046.

Bosch-Sijtsema, P.M., Ruohomäki, V. and Vartiainen, M. (2009), "Knowledge work productivity in distributed teams", *Journal of Knowledge Management*, Vol. 13 No. 6, pp. 533-546.

Bontis, N. (2011), "Information bombardment", *Rising Above the Digital Onslaught*, Institute for Intellectual Capital Research, Hamilton.

Claessens, B.J., Van Eerde, W., Rutte, C.G. and Roe, R.A. (2004), "Planning behavior and perceived control of time at work", *Journal of Organizational Behavior*, Vol. 25 No. 8, pp. 937-950.

Clements-Croome, D. and Kaluarachchi, Y. (2000), "Assessment and measurement of productivity", in Clements-Croome, D. (Ed.), *Creating the Productive Workplace*, E & FN Spon, Suffolk, pp. 129-151.

Dahooie, J., Afrazeh, A. and Hosseini, S. (2011), "An activity-based framework for quantification of knowledge work", *Journal of Knowledge Management*, Vol. 15 No. 3, pp. 422-444.

Dallner, A., Elo, A.-L., Gambrele, F., Hottinen, V., Knardahl, S., Linstrom, K., Skogstad, A. and Orhede, E. (2000), "Validation of the general Nordic questionnaire for psychological and social factors at work", No. Nord 2000:12, Nordic Council of Ministers Copenhagen, Copenhagen.

Davenport, T.H. (2008), "Improving knowledge worker performance", in Pantaleo, D. and Pal, N. (Eds), *From Strategy to Execution: Turing Accelerated Global Change into Opportunity*, Springer, Berlin Heidelberg, pp. 215-235.

Drucker, P. (1959), "The landmarks of tomorrow: a report on the new post-modern world", Haper Colophon Books, New York, NY.

Drucker, P.F. (1999), "Knowledge-worker productivity: the biggest challenge", *California Management Review*, Vol. 41 No. 2, pp. 79-94.

Dulewicz, V. and Fletcher, C. (1992), "The context and dynamics of performance appraisal", in Harriot, P. (Ed.), *Assessment and Selection in Organizations. Methods and Practice for Recruitment and Appraisal*, 3rd ed., John Wiley & Sons, New York, NY, pp. 1-680.

Ferris, G.R., Witt, L.A. and Hochwarter, W.A. (2009), "Interaction of social skill and general mental ability on job performance and salary", *Journal of Applied Psychology*, Vol. 86 No. 6, pp. 1075-1082.

Fisher, C. (2005), "Performance management and performing management", in Leopold, J., Harris, L. and Watson, T. (Eds), *The Strategic Managing of Human Resources*, Prentice Hall, Edinburgh.

Garrett, R.K. and Danziger, J.N. (2007), "IM=interruption management? Instant messaging and disruption in the workplace", *Journal of Computer-Mediated Communication*, Vol. 13 No. 1, pp. 23-42.

Gorgievski, M.J., van der Voordt, T.J.M., van Herpen, S.G.A. and van Akkeren, S. (2010), "After the fire – new ways of working in an academic setting", *Facilities*, Vol. 28 Nos 3/4, pp. 206-24.

Greenhaus, J.H. and Powell, G.N. (2006), "When work and family are allies: a theory of work-family enrichment", *Academy of Management Review*, Vol. 31 No. 1, pp. 72-92.

Groen, B., van de Belt, M. and Wilderom, C. (2012), "Enabling performance measurement in a small professional service firm", *International Journal of Productivity and Performance Management*, Vol. 61 No. 8, pp. 839-862.

Halpern, D.F. (2005), "How time-flexible work policies can reduce stress, improve health, and save money", *Stress and Health*, Vol. 21 No. 3, pp. 157-168.

Haynes, B.P. (2007), "The impact of the behavioural environment on office productivity", *Journal of Facilities Management*, Vol. 5 No. 3, pp. 158-171.

Heerwagen, J.H., Kampschroer, K., Powell, K.M. and Loftness, V. (2004), "Collaborative knowledge work environments", *Building Research & Information*, Vol. 32 No. 6, pp. 510-528.

Holtshouse, D. (2010), "Knowledge work 2010: thinking ahead about knowledge work", *On the Horizon*, Vol. 18 No. 3, pp. 193-203.

Jackson, T., Dawson, R. and Wilson, D. (2003), "Reducing the effect of email interruptions on employees", *International Journal of Information Management*, Vol. 23 No. 1, pp. 55-65.

Jacks, T., Palvia, P., Schilhavy, R. and Wang, L. (2011), "A framework for the impact of IT on organizational performance", *Business Process Management Journal*, Vol. 17 No. 5, pp. 846-870.

Janz, B.D., Colquitt, J.A. and Noe, R.A. (1997), "Knowledge worker team effectiveness: the role of autonomy, interdependence, team development, and contextual support variables", *Personnel Psychology*, Vol. 50 No. 4, pp. 877-902.

Jett, Q.R. and George, J.M. (2003), "Work interrupted: a closer look at the role of interruptions in organizational life", *Academy of Management Review*, Vol. 28 No. 3, pp. 494-507.

Jääskeläinen, A. and Laihonen, H. (2013), "Overcoming the specific performance measurement challenges of knowledge-intensive organizations", *International Journal of Productivity and Performance Management*, Vol. 62 No. 4, pp. 350-363.

Kahya E. (2008), "The effects of job performance on effectiveness", *International Journal of Industrial Ergonomics*, Vol. 39 No. 1, pp. 96-104.

Kasanen, E., Lukka, K. and Siitonen, A. (1993), "The constructive approach in management accounting research", *Journal of Management Accounting Research*, Vol. 5 No. 1, pp. 243-64.

Kattenbach, R., Demerouti, E. and Nachreiner, F. (2010), "Flexible working times: effects on employees' exhaustion, work-nonwork conflict and job performance", *Career Development International*, Vol. 15 No. 3, pp. 279-295.

Kearns, H. and Gardiner, M. (2007), "Is it time well spent? The relationship between time management behaviours, perceived effectiveness and work-related morale and distress in a university context", *High Education Research & Development*, Vol. 26 No. 2, pp. 235-247.

Kelloway, E.K. and Barling, J. (2000), "Knowledge work as organizational behavior", *International Journal of Management Reviews*, Vol. 2 No. 3, pp. 287-304.

Kelly, E.L., Moen, P. and Tranby, E. (2011), "Changing workplaces to reduce work-family conflict schedule control in a white-collar organization", *American Sociological Review*, Vol. 76 No. 2, pp. 265-290.

Kemppilä, S. and Lönnqvist, A. (2003), "Subjective productivity measurement", *The Journal of American Academy of Business*, Vol. 2 No. 2, pp. 531-537.

Koopmans, L., Bernaards, C., Hildebrandt, V., van Buuren, S., van der Beek, A. and de Vet, H. (2013), "Development of an individual work performance questionnaire", *International Journal of Productivity and Performance Management*, Vol. 62 No. 1, pp. 6-28.

Labro, E. and Tuomela, T.-S. (2003), "On bringing more action into management accounting research: process considerations based on two constructive case studies", *European Accounting Review*, Vol. 12 No. 3, pp. 409-442.

Laihonen, H., Jääskeläinen, A., Lönnqvist, A. and Ruostela, J. (2012), "Measuring the productivity impacts of new ways of working", *Journal of Facilities Management*, Vol. 10 No. 2, pp. 102-113.

Lukka, K. (2000), "The key issues of applying the constructive approach to field research", Series No. A-1:2000, Management Expertise for the New Millenium: In Commemoration of the 50th Anniversary of the Turku School of Economics and Business Administration, Publications of Turku School of Economics and Administration, pp. 113-141.

Maarleveld, M., Volker, L. and Van Der Voordt, T.J.M. (2009), "Measuring employee satisfaction in new offices – the WODI toolkit", *Journal of Facilities Management*, Vol. 7 No. 3, pp. 181-197.

Mann, S., Budworth, M.H. and Ismaila, A. (2012), "Ratings of counterproductive performance: the effect of source and rater behavior", *International Journal of Productivity and Performance Management*, Vol. 61 No. 2, pp. 142-156.

Matta, K. (1989), "A goal-oriented productivity index for manufacturing systems", *International Journal of Operations & Production Management*, Vol. 9 No. 4, pp. 66-76.

Mehta, R., Zhu, R.J. and Cheema, A. (2012), "Is noise always bad? Exploring the effects of ambient noise on creative cognition", *Journal of Consumer Research*, Vol. 39 No. 4, pp. 784-799.

Miles, I. (2005), "Knowledge intensive business services: prospects and policies", *Foresight*, Vol. 7 No. 6, pp. 39-63.

Miller, D.B. (1977), "How to improve the performance and productivity of the knowledge worker", *Organizational Dynamics*, Vol. 5 No. 3, pp. 62-80.

Okkonen, J. (2004), *The Use of Performance Measurement in Knowledge Work Context*, Tampere University of Technology, Tampere.

O'Neill, M.J. (2010), "A model of environmental control and effective work", *Facilities*, Vol. 28 Nos 3/4, pp. 118-136.

Origo, F. and Pagani, L. (2008), "Workplace flexibility and job satisfaction: some evidence from Europe", *International Journal of Manpower*, Vol. 29 No. 6, pp. 539-566.

Palvalin, M., Lönnqvist, A. and Vuolle, M. (2013), "Analysing the impacts of ICT on knowledge work productivity", *Journal of Knowledge Management*, Vol. 17 No. 4, pp. 545-557.

Ramirez, Y.W. and Nembhard, D.A. (2004), "Measuring knowledge worker productivity: a taxonomy", *Journal of Intellectual Capital*, Vol. 5 No. 4, pp. 602-628.

Ramirez, Y.W. and Steudel, H.J. (2008), "Measuring knowledge work: the knowledge work quantification framework", *Journal of Intellectual Capital*, Vol. 9 No. 4, pp. 564-584.

Ruostela, J. and Lönnqvist, A. (2013), "Exploring more productive ways of working", *World Academy of Science, Engineering and Technology, International Science Index 73*, Vol. 7 No. 1, pp. 611-615.

Ruostela, J., Palvalin, M., Lönnqvist, A., Patjas, M. and Ikkala, A.-L. (2014), "New ways of working' as a tool for improving the performance of a knowledge intensive company", *Knowledge Management Research & Practise*, March 10, 2014, doi:10.1057/kmrp.2013.57.

Schaufeli, W.B. and Bakker, A.B. (2003), "UWES – utrecht work engagement scale: test manual", unpublished manuscript, Department of Psychology, Utrecht University, Utrecht.

Schaufeli, W.B., Bakker, A.B. and Salanova, M. (2006), "The measurement of work engagement with a short questionnaire", *Educational and psychological Measurement*, Vol. 66 No. 4, pp. 701-716.

Takala, J., Suwansaranyu, U. and Phusavat, K. (2006), "A proposed white-collar workforce performance measurement framework", *Industrial Management & Data Systems*, Vol. 106 No. 5, pp. 644-662.

Taskinen, T. and Smeds, R. (1999), "Measuring change project management in manufacturing", *International Journal of Operations & Production Management*, Vol. 19 No. 11, pp. 1168-1187.

Van der Voordt, T.J.M. (2004), "Productivity and employee satisfaction in flexible workplaces", *Journal of Corporate Real Estate*, Vol. 6 No. 2, pp. 133-148.

van Meel, J. (2011), "The origins of new ways of working – office concepts in the 1970s", *Facilities*, Vol. 29 Nos 9/10, pp. 357-367.

Vartiainen, M. (2007), "Analysis of multilocational and mobile knowledge workers' work spaces", *Lecture Notes in Computer Science*, Vols /4562/2007 No. 1, pp. 194-203.

Vartiainen, M. and Hyrkkänen, U. (2010), "Changing requirements and mental workload factors in mobile multi-locational work", *New Technology, Work and Employment*, Vol. 25 No. 2, pp. 117-135.

Vuolle, M. (2010), "Productivity impacts of mobile office service", *International Journal of Services Technology and Management*, Vol. 14 No. 4, pp. 326-342.

Vuolle, M., Tiainen, M., Kallio, T., Vainio, T., Kulju, M. and Wigelius, H. (2008), "Developing a questionnaire for measuring mobile business service experience", *Proceedings of the 10th International Conference on Human Computer Interaction With Mobile Devices and Services*, *ACM*, pp. 53-62.

Wännström, I., Peterson, U., Åsberg, M., Nygren, Å. and Gustavsson, J.P. (2009), "Psychometric properties of scales in the general nordic questionnaire for psychological and social factors at work (QPSNordic): confirmatory factor analysis and prediction of certified long-term sickness absence", *Scandinavian Journal of Psychology*, Vol. 50 No. 3, pp. 231-244.

Appendix. SmartWoW questionnaire

Physical workplace

(1) There is a space available for tasks that require concentration and peace at our workplace when needed

(2) There are enough rooms for official and unofficial meetings at our workplace

(3) There is a space for informal interaction at our workplace when needed

(4) Issues related to ergonomics are properly taken care of at our workplace

(5) The restlessness of the work environment does not significantly interfere with my working

Virtual workplace

(6) The most important information systems are easy to use

(7) Workers have an access to information regardless of my location

(8) Workers have opportunity to see each other's calendar

(9) Workers have possibility to communicate with each other using instant messaging (e.g. Lync, Skype)

(10) Our workplace has equipment that enables having video conferences

(11) Group work software is used in our workplace

Social workplace

(12) Workers have the possibility to work in the most suitable ways and when it is the most convenient

(13) Telework is a generally accepted practice at our workplace

(14) Operations in our workplace are transparent

(15) Knowledge flows adequately between the key persons at our workplace.

(16) Meeting practices are efficient

(17) Our workplace has clear policy how to use IT and communication tools

(18) I have clear personal goals for my work

(19) I am being evaluated according to the results I achieve, not, for example, according to the working hours

(20) New ways of working are actively explored and experimented at our workplace

OPEN-ENDED: What is the best practice in your organization?

Personal work practices

(1) I exploit video conferences to minimize the need for unnecessary traveling

(2) I use mobile services for working in situations where I have idle time (e.g. working in trains by using smart phones or laptops)

(3) I am able to prioritize my tasks in order to manage my workload

(4) I often telework for carrying out tasks that require uninterrupted concentration

(5) I prepare for meetings

(6) I stretch my muscles during the brakes

(7) I follow the organization communication channels

(8) I shut down email and other communication tool to concentrate important work task

(9) I plan my day beforehand

(10) I actively seek for the most suitable work practices and tools

OPEN-ENDED: What are your personal best practices for smarter and more productive working?

Well-being at work

(1) I enjoy my work

(2) I am enthusiastic about my job

(3) I find my work meaningful and having a clear purpose

(4) My work does not cause stress

(5) My work performance is appreciated at the workplace

(6) My work and leisure time are in balance with each other

(7) The atmosphere at my workplace is pleasant

(8) Our work community is able to solve conflicts quickly

OPEN-ENDED: How could your well-being at work be improved?

Productivity

(1) I achieve satisfactory results in relation to my goals

(2) I am usually able to carry out my work tasks efficiently (smoothly, without problems)

(3) I am able to use the majority of my working time for conducting relevant tasks related to my goals

(4) My job mainly includes tasks in which I am able to exploit my knowledge and skills efficiently

(5) I am able to meet customers' expectations

(6) The quality of my work outputs is high

(7) The work group I work in works efficiently as a whole

OPEN-ENDED: How could your productivity be improved?

Background

Gender (male/female)
Age (< 30, 31-40, 41-50, > 50)
Experience in current (< 1 year, 1-5 years, > 5 years)
Profession (manager, expert, supportive)
Working place % (office, home, other company, vehicle, public place)

About the authors

Miikka Palvalin is a Researcher and a Doctoral Student in the Department of Business Information Management and Logistics at the Tampere University of Technology, Finland. He is a member of the Performance Management Team research group. Palvalin received his MSc (Tech.) in Information and Knowledge Management from the Tampere University of Technology in 2011. He is currently working in two projects dealing with knowledge work productivity improvement. Miikka Palvalin is the corresponding author and can be contacted at: miikka.palvalin@tut.fi

Dr Maiju Vuolle is a Postdoctoral Researcher at the Department of Business Information Management and Logistics, Tampere University of Technology, Finland. She received her Doctor of Science (Technology) Degree from the Tampere University of Technology in 2012. Her research interests focus on mobile and other technology-based services, productivity and performance measurement.

Dr Aki Jääskeläinen works as a Research Fellow on the Performance Management Team at the Tampere University of Technology, Finland. His research interests focus on performance measurement and management especially in service operations. He has participated in many development projects related to performance management in Finnish organizations.

Professor Harri Laihonen works as a Research Fellow in the Institute of Business Information Management and Logistics at the Tampere University of Technology. In his Doctoral Thesis, Dr Laihonen studied knowledge flows in health system management. Recently his research has focussed on the management of knowledge flows and intellectual capital in knowledge-intensive services.

Dr Antti Lönnqvist is a Professor at the Department of Business Information Management and Logistics, Tampere University of Technology, Finland. He also holds the position of Adjunct Professor at the Aalto University, School of Science and Technology. He has over a decade of research experience dealing with the measurement and management of intellectual capital and business performance. Currently, service activities are a focal area of his research.

PUBLICATION IV

What Matters for Knowledge Work Productivity?

Miikka Palvalin

Employee Relations, 41(1) 209-227

What matters for knowledge work productivity?

Miikka Palvalin
Laboratory of Industrial and Information Management, Tampereen Teknillinen yliopisto, Tampere, Finland

Received 20 April 2017
Revised 13 March 2018
29 May 2018
Accepted 31 May 2018

Abstract

Purpose – Knowledge work productivity is a well-studied topic in the existing literature, but it has focussed mainly on two things. First, there are many theoretical models lacking empirical research, and second, there is a very specific research regarding how something impacts productivity. The purpose of this paper is to collect empirical data and test the conceptual model of knowledge work productivity in practice. The paper also provides information on how different drivers of knowledge work productivity have an impact on productivity.

Design/methodology/approach – Through the survey method, data were collected from 998 knowledge workers from Finland. Then, confirmatory factor analysis was conducted to confirm the knowledge work productivity dimensions of the conceptual model. Later, regression analysis was used to analyse the impacts of knowledge factors on productivity.

Findings – This paper increases the understanding of what matters for knowledge work productivity, with statistical analysis. The conceptual model of knowledge work productivity consists of two major elements: the knowledge worker and the work environment. The study results showed that the knowledge worker has the biggest impact on productivity through his or her well-being and work practices. The social environment was also found to be a significant driver. The results could not confirm or refute the role of the physical or virtual environment in knowledge work productivity.

Practical implications – The practical value of the study lies in the analysis results. The information generated about the factors impacting productivity can be used to improve knowledge work productivity. In addition, the limited resources available for organisational development will have the greatest return if they are used to increase intangible assets, i.e., management and work practices.

Originality/value – While it is well known that many factors are essential for knowledge work productivity, relatively few studies have examined it from as many dimensions at the same time as this study. This study adds value to the literature by providing information on which factors have the greatest influence on productivity.

Keywords Measurement, Performance management, Work environment, Productivity, Knowledge work

Paper type Research paper

1. Introduction

Since the days of Frederick Taylor, organisations have tried to increase their workers' productivity by identifying work tasks and optimising work processes. After the majority of the work has moved towards knowledge work, the productivity of knowledge work has also raised interest. While knowledge work productivity is a young topic, it has been researched both directly and indirectly for several decades (Pyöriä, 2005). It has been studied in conjunction with the topics of white-collar work and office work, with the term "knowledge work" being established only recently (Dahooie *et al.*, 2011). Drucker (1999) highlighted the importance of knowledge work productivity by announcing that it could be one of the biggest challenges of the twenty-first century. Whether he was right or wrong remains to be seen, but at least it has been of interest to many researchers (see, e.g. Thomas and Baron, 1994; Pyöriä, 2005; Koopmans *et al.*, 2013). In addition to the research topic of knowledge work productivity, "productivity" is a common dependent variable in many research areas, for example, in facility management (e.g. Van der Voordt, 2004), work psychology (e.g. Judge *et al.*, 2001) and knowledge management (e.g. McCampbell *et al.*, 1999).

The current discussion on knowledge work productivity is twofold. First, several theoretical models on the phenomenon (see, e.g. Syed, 1998; Davenport *et al.*, 2002; Bosch-Sijtsema *et al.*, 2009) have little to no empirical evidence, and second, a countless

Employee Relations
Vol. 41 No. 1, 2019
pp. 209-227

0142-5455
DOI 10.1108/ER-04-2017-0091

number of empirical studies have very focussed drivers (see e.g. Kearns and Gardiner, 2007; O'Neill, 2010; Palvalin *et al.*, 2013). The literature lacks an empirical examination on how knowledge work productivity drivers affect productivity. Testing the theoretical model in practice would take the discussion one step forward. It would also provide evidence for the discussion on which knowledge work productivity drivers are the most important. For example, Davenport *et al.* (2002) requested this kind of research, as they recognised that three work environmental drivers for knowledge work productivity—the workplace, technology and management—are closely related and should thus be measured and managed together. Drucker (1999) was not as specific but emphasised the importance of understanding knowledge work productivity as a unit.

Understanding knowledge work productivity and its drivers in a more comprehensive way has become a fairly topical issue due to the concept of new ways of working (NewWoW). The concept of NewWoW was created in the field of facility management as the opposite of traditional work practices (Van der Voordt, 2004). Since then, it has evolved to consist of work in information technology, work in management and personal work practices as well (Van Meel, 2011; Ruostela *et al.*, 2015). The idea behind NewWoW is to increase productivity without decreasing job satisfaction (Van der Voordt, 2004). This can be achieved by increasing the autonomy and flexibility of knowledge workers so that they are able to find the best ways of working for themselves (Van der Voordt, 2004; Aaltonen *et al.*, 2012). In western cultures, such as Finland and the Netherlands, an increasing number of organisations are starting NewWoW changes by implementing activity-based offices, acquiring portable ICT tools for all employees and improving organisation policies to support the NewWoW (Appel-Meulenbroek *et al.*, 2011; Ruostela *et al.*, 2015).

The purpose of this paper is to answer the following research question:

RQ1. What matters for knowledge work productivity?

The study approached the problem by building a conceptual model of knowledge work productivity drivers and testing it in practice. The empirical examination included surveying knowledge workers in nine organisations, with a total of 998 respondents. The results were then obtained using regression analysis (RA). The contribution of this study is the conceptual model and the results of the analysis, which show how the dimensions highlighted in the conceptual model impact knowledge work productivity. The results are valuable for managers looking for a competitive advantage, as they can see how the different drivers impact knowledge work productivity and thus focus their time on the right things.

The paper is organised according to the following structure. Previous literature is reviewed and the theoretical background is presented in Section 2. This is followed by the conceptual model and hypotheses, which are built in Section 3. Section 4 describes the methods used, including a more detailed description of the sample. In Section 5, the results of the study are presented, and they are discussed in Section 6. At the end of the paper, there is a short conclusion on the study's contribution.

2. Theoretical background

2.1 Knowledge work

The term "knowledge work" was introduced by Drucker (1959). It was created to describe the work of workers who use intangible resources as their primary assets. It was also created to distinguish knowledge workers from manual workers. The line between knowledge workers and manual workers is still quite unclear, and some jobs include elements of both (Drucker, 1999). After Drucker, many scholars have created their own definitions of knowledge work, without a good consensus on what it actually is (Dahooie *et al.*, 2011; Kelloway and Barling, 2000). Davenport and Prusak (2000), for example, defined knowledge

workers as those who create knowledge or those who use knowledge as their primary resources in work. Nickols (2000) also gave a nice and simple suggestion: knowledge work does not involve converting materials from one form to another but rather converting knowledge from one form to another. Thompson *et al.* (2001) provided a wider definition. According to them, a knowledge worker is a person who has access to, learns and is qualified to practice formal, abstract and complex knowledge. The terms "office work" and "white-collar work" are also often used when talking about knowledge work (Okkonen, 2004). White-collar work was especially a very popular research topic in the late 1980s and early 1990s. While office work, white-collar work and knowledge work can be the same in many cases, the former two are more restricted than the latter is (Okkonen, 2004).

As stated before, knowledge work can be defined in many ways. This is mainly because knowledge work consists of a wide variety of different work professions (Dahooie *et al.*, 2011). For a better understanding, researchers have started to categorise different types of knowledge work. A commonly used classification was created by Davenport (2005), where knowledge work is divided into four types (transaction, integration, collaboration and expert) based on the degree of expertise and the level of coordination involved. Haner *et al.* (2009) also created a classification for different kinds of knowledge workers. According to Haner *et al.* (2009), three distinctive characteristics of knowledge work exist: complexity, autonomy and newness. Using those, they found a very similar classification to that of Davenport (2005). Margaryan *et al.* (2011) tested Davenport's (2005) classification and argued that "expert" is only a distinct type of knowledge work. The other classes could not be found as being clear in practice. Common for all knowledge workers is that the work contains concentration and collaboration, with the distribution between the two potentially varying a lot (Alvesson, 2001). Even if it is not clear what knowledge work is and how it should be classified, it is possible to recognise some attributes of knowledge work (Dahooie *et al.*, 2011). According to the classifications above and to Pyöriä (2005), knowledge work is unpredictable and needs innovativeness. Collaboration also seems to be important, but at the same time, a balance in concentration is needed (Greene and Myerson, 2011).

Like the definitions and categories above show, the concept of knowledge work is very difficult to define. The difficulty comes from two things: first, near all work requires some amount of knowledge, and second, knowledge work includes many different types of work profiles. Warhurst and Thompson (2006) have recognised the problem in the concept and challenge the discussion to be more specific. They suggest that in addition to mapping the content of knowledge at work, the context also needs to be mapped. In this study, knowledge work is limited to work traditionally made in offices by experts, managers and assistants. Experts include positions such as specialist, inspector, civil servant, developer, consultant and coordinator. Managers include positions such as project manager, team manager and department manager. Assistants include positions such as financial secretary, office secretary and human resources secretary.

2.2 Knowledge work productivity

The origin of productivity is related to industrial manufacturing and agriculture (Tangen, 2005). It is usually defined as the ratio of the outputs and resources (Craig and Harris, 1973). This definition of productivity is very close to the concept of efficiency, but it is different from it in that the quality of the outcomes is also important in productivity (Drucker, 1991; Parasuraman, 2002). Another concept closely related to productivity is performance (e.g. Koopmans *et al.*, 2011). According to Tangen (2005), a difference exists between the concepts, where performance can be seen as an umbrella term for all of the concepts that involve examining the success of organisations. For example, Kaplan and Norton's (1996) balanced-scorecard performance includes the dimensions of internal processes and customers but also finance, organisational learning and growth. In this study, productivity

is defined as the ratio of outputs and inputs, where the quality of the output is important as well. Productivity drivers are things that matter in the process where inputs are used to create outputs (Davenport *et al.*, 1996).

Knowledge work productivity is defined above as productivity in general, but the knowledge work context provides some challenges (Davenport *et al.*, 2002). The intangible nature of knowledge work is the biggest reason why the context of productivity cannot be applied directly from manufacturing. The definition of productivity is similar, but in knowledge work, the challenges start when the inputs and outputs have to be measured (Bosch-Sijtsema *et al.*, 2009). While inputs and outputs are tangible and easier to measure in manufacturing, for example, in weight or in pieces, both resources and outcomes could be intangible in knowledge work (e.g. Ramirez and Nembhard, 2004; Antikainen and Lönnqvist, 2005). Due to this, knowledge work productivity has proved to be a challenging context, and many researchers have tried to solve the problem (Ramirez and Nembhard, 2004; Laihonen *et al.*, 2012; Koopmans *et al.*, 2011). Different approaches presented—for example, those of Ramirez and Nembhard (2004) and Koopmans *et al.* (2011)—show that productivity needs to be divided into smaller pieces.

Koopmans *et al.* (2011) completed a broad literature review about individual work performance, where they also included many knowledge work productivity articles. As a conclusion, they created an individual work performance framework. In the framework, they divided performance into four categories: task performance, contextual performance, adaptive performance and counterproductive work behaviour. Task performance includes things such as completing job tasks, the quantity and quality of the work, job skills, etc., related directly to the output. Contextual performance consists of cooperation, effective communication, proactivity and enthusiasm, all of which are a part of the work environment. Adaptive performance consists of generating new ideas, being flexible and being open minded—everything needed to develop and increase productivity. Counterproductive work behaviour includes off-task behaviour, doing tasks incorrectly and everything else that may decrease productivity or even harm the organisation.

Drucker (1999) divided knowledge work productivity into two pieces: "doing right things and doing things right". The second, "doing things right", focusses on the use of resources and the work process. It means that everything should be done in the best way possible and with minimal resources. The four dimensions that Koopmans *et al.* (2011) presented are all a part of this. The first, "doing right things", is related to the other side of productivity, the outputs. An output needs to be valuable to the customer. It does not matter how efficient the organisation is; if the value of the output is zero, the productivity is zero. On the other hand, if the organisation is making profit, it is most likely "doing the right thing", and productivity development can focus more on "doing things right". Public organisations can focus on "doing things right" as they are doing duties provided by the government. Bosch-Sijtsema *et al.* (2009) emphasised that knowledge work productivity is not standard. It may differ largely depending on the task, on contextual factors and on the knowledge worker's individual capabilities.

Measuring knowledge work productivity has also been of interest to researchers and practitioners for a long time. Ramirez and Nembhard (2004) completed a literature review about knowledge work productivity and found more than 20 methodological approaches to measuring productivity in knowledge work. Common themes in these productivity measures are, for example, work efficiency, quality of work, results and achieving goals. In most methods, productivity is not measured directly; rather, it is split into parts of productivity, for example, efficiency or quality (Blok *et al.*, 2011). This type of splitting reflects the existing knowledge work productivity challenges (Davenport and Prusak, 2000). In many cases, it is easier to understand and evaluate the parts of productivity than productivity itself.

2.3 Knowledge work productivity drivers

At the "expert" level of knowledge work, everything is intangible, the resources and the outputs (Davenport, 2005). This means that the only input or "resource" is the knowledge worker himself or herself. Knowledge workers' resources have been studied in the field of organisational psychology, and Campbell (1990) presented one of the common approaches (Viswesvaran and Ones, 2000). Campbell (1990) suggested that knowledge worker resources are a combination of three components: declarative knowledge, procedural knowledge and skill, and motivation. Declarative knowledge is knowing the facts, principles and objectives. Procedural knowledge and skill refer to knowing how to do something. Motivation reflects the persistence and intensity of the effort. Palvalin *et al.* (2013) examined the same issue in the field of knowledge work but from the productivity drivers' perspective. They ended up with almost a similar list, consisting of information, knowledge and skills, well-being at work and time. The first two are identical, but well-being at work is a bit of a wider term that also includes motivation. As a fourth driver, they considered time, the working time that each worker gives to the employer and the time that is used to produce certain outputs. If the knowledge worker has all of the resources above, producing the outputs involves concentrating on the task and performing it, but this is not reality. In current organisations, knowledge work is rarely done alone due to the size of the outputs or the skills required to produce these outputs. Information is also usually scattered among the employees and interest groups.

Syed (1998) presented a model of how the knowledge worker works and interacts with other knowledge workers. The model suggests that physical resources such as facilities and plants; procedural resources, such as processes and management systems; and intellectual resources, such as technologies and culture, drive productivity. Davenport *et al.* (2002) developed a similar model, but their focus was on work environment. According to them, knowledge work productivity is determined by three major factors: management and organisation, information technology and workplace design. Bosch-Sijtsema *et al.* (2009) agreed that these three are the main components of knowledge work productivity. Hopp *et al.* (2009) examined the problem from the individual, team and organisation levels but ended up with similar results.

Vartiainen (2007) agreed with the other researchers on the importance of the work environment but pointed out that the knowledge workers' "mental space" also has an impact. Ruostela and Lönnqvist (2013) additionally highlighted that knowledge workers' individual work practices also have a major impact on knowledge work productivity. For example, places designed for concentration are useless if the knowledge worker is not using it. According to Drucker (1999), well-being and work practices have the biggest impact on knowledge worker productivity.

The three dimensions of work environment, work practices and their impact on knowledge work productivity have been studied separately in previous literature. Examples can be found in the next section, which forms a hypothesis and conceptual model based on previous literature. It should be noted that most of the drivers mentioned above and the examples below focus on Drucker's "doing-things-right" side of productivity. The assumption in this study is also that the organisation is "doing right things" and that the productivity is improved if the time required for the process is decreased, for example, by optimising the productivity drivers.

3. Conceptual model and hypotheses

The physical environment consists of an organisation's office and all of the spaces in it, for example, rooms for working, negotiation and coffee breaks. It also includes the desks, chairs and other pieces of furniture. In an effective physical environment, knowledge workers are able to concentrate on their tasks (Maarleveld *et al.*, 2009). Interruptions distract knowledge

workers' concentration more or less, so the level of interruptions should be low when their tasks require concentration (Jett and George, 2003). Interruptions could be caused directly by their colleagues' asking them questions, but a high level of noise or someone who is moving in a knowledge worker's field of vision could also be distracting (Mehta *et al.*, 2012; Haynes, 2007). Knowledge work sometimes requires concentration on the task and involves a lot of collaboration with co-workers (Heerwagen *et al.*, 2004). Information and knowledge should flow from one person to another. Official and unofficial meetings are typical in almost every type of knowledge work and require suitable spaces to avoid interrupting other people (Vischer, 2005). Between concentration and collaboration on tasks, a lot of spontaneous interaction takes place among workers, which is good for creativity, satisfaction and productivity (Hertel *et al.*, 2005; Heerwagen *et al.*, 2004):

H1. Physical environment is positively related to knowledge work productivity.

An organisation's virtual environment consists of information and communications technology and everything related. Productivity improvements from information technology come mainly from the automation of work tasks and from making information more accessible (Jacks *et al.*, 2011; Palvalin *et al.*, 2013). The basic requirement for a productive virtual environment is the use of appropriate tools depending on what kind of knowledge work is in question, and the usability of information technology and software should not cause dissatisfaction (Brynjolfsson, 1993). With current technology, a level 3 basic requirement would be that the worker could access the needed information despite his or her location, so he or she could use, for example, travelling time to effectively get work done (Vuolle, 2010). All of this increases the knowledge workers' ability to control how, where and when they work (O'Neill, 2010). Communication and collaboration tools become more important as the work being performed is less dependent on location (Vartiainen and Hyrkkänen, 2010). Instant messaging tools enable workers to have quick access to colleagues' knowledge and, when used correctly, may also help with managing interruptions (Garrett and Danziger, 2007). In addition, instant messaging and virtual negotiation tools can reduce travelling and hence save time (Holtshouse, 2010). The virtual environment also includes electronic teamwork tools that allow document editing simultaneously for all of the team members, for example:

H2. Virtual environment is positively related to knowledge work productivity.

The social environment covers everything related to human relations in the work environment. There are two main aspects of the social environment; the first is management, for example, the relationship between the knowledge worker and the supervisor (Drucker, 1999). The second is the atmosphere in the organisation, for example, the relationships among colleagues, culture and work practices (Vartiainen, 2007; Bosch-Sijtsema *et al.*, 2009). The following management practices are suggested to have a positive relationship with productivity. Knowledge worker work tasks should constitute a reasonable whole, and the goals for the work should be clear (Drucker, 1999; Ramirez and Steudel, 2008). Knowledge workers need high levels of autonomy (Drucker, 1999) and should be able to choose methods and times that best suit them (O'Neill, 2010; Origo and Pagani, 2008; Kelly *et al.*, 2011). Organisation work practices, for example, meeting practices, information technology and communication guidelines and innovative climate, may all help knowledge workers to save time and be productive (e.g. Elsayed-Elkhouly *et al.*, 1997; Wännström *et al.*, 2009). A good atmosphere consists of open and transparent decision-making and communication, supportive feedback and quick interference in conflict situations (Wännström *et al.*, 2009; Dallner *et al.*, 2000):

H3. Social environment is positively related to knowledge work productivity.

In knowledge work, the knowledge worker has the biggest impact on productivity (Drucker, 1999). An organisation can offer people opportunities to work productively, but the productivity level is ultimately dependent on knowledge workers' own work practices, for example, if the opportunities are utilised (Ruostela and Lönnqvist, 2013; Koopmans *et al.*, 2013). Weak flow of information, inefficient meetings and interruptions are all typical complaints in organisations, but knowledge workers are able to influence these with their own actions and activity. Another dimension in individual work practices is self-management (Drucker, 1999). An organisation should be giving knowledge workers goals, but it is the knowledge workers' own responsibility to achieve them and to choose how to do it. Planning and prioritising are important in the world where available time is limited (Kearns and Gardiner, 2007; Claessens *et al.*, 2004). Knowledge workers' responsibility over their own work includes the development of their own work practices as well, for example, trying to seek out and test better tools and ways of working (Drucker, 1999):

H4. Individual work practices are positively related to knowledge work productivity.

Personal well-being and well-being at work are widely researched topics (Judge *et al.*, 2001). The most common part of well-being at work is job satisfaction. The link between job satisfaction and work performance has been pursued for almost as long as manufacturing has existed (Judge *et al.*, 2001). At present, researchers are quite unanimous in asserting that the link exists, but the exact magnitude is not clear (Judge *et al.*, 2001). A recent topic in the conversation on well-being at work is work engagement (Schaufeli *et al.*, 2006). Knowledge workers who find their work meaningful and are enthusiastic about their jobs are known to work harder, be more creative and be more productive (Bakker and Demerouti, 2008, Bakker, 2011) (Figure 1):

H5. Well-being at work is positively related to knowledge work productivity.

4. Methods

Research was carried out in Finland in 2015 with nine organisations and 998 respondents. The respondents were mainly from public organisations or public corporations (formerly public organisations), but there were also respondents from one private organisation.

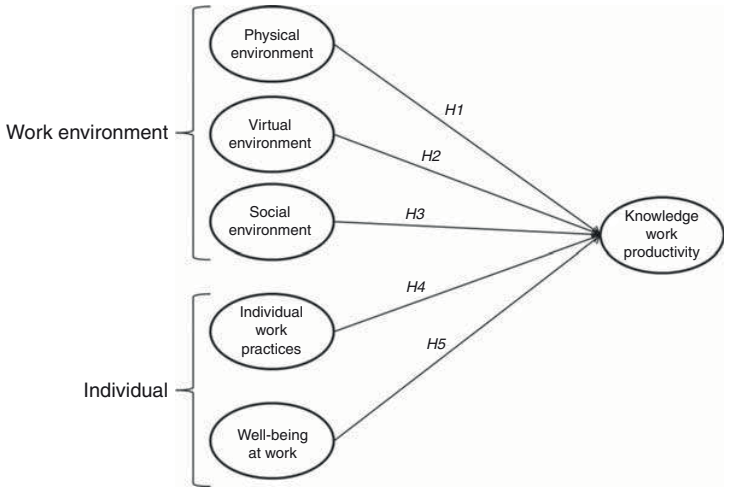


Figure 1.
Conceptual model

Private organisation respondents were all consultants in the IT sector. Public corporation respondents were experts (e.g. developers, consultants, researchers), managers (e.g. project, team, department) and assistants in the fields of facilities, IT and health. Public organisations respondents were ministry employees from one ministry and from four civil service departments. All the respondents were doing traditional office work with IT tools of the same kind (laptops and smart phones). Private organisation respondents were a small minority in this study, which disabled the opportunity to compare results.

The research data were collected using an online survey for the organisations' own use and for scientific purposes. The survey consisted of 49, five-point Likert-scale variables (disagree–agree), divided between the six dimensions of the conceptual model. The variables were chosen based on previous literature and are presented in Table AI. Almost all of the organisations were planning work environment changes, so they needed overviews on how their employees were experiencing their work environments, individual work practices, well-being and productivity. The organisations also planned to use their own results to measure the impacts of the upcoming changes. The participants were informed of that the data would be used for scientific purposes as well. A questionnaire was sent to the participants by e-mail, and they typically had about two weeks' time to respond. The response rates varied from 33 to 89 per cent (Table I).

The analysis included two primary methods: confirmatory factor analysis (CFA) was used to confirm the hypothesised dimension structure in the conceptual model, and RA was then conducted to point out if the hypotheses were supported or not. CFA included several iterations,

	n	%
Sex		
Female	602	60.3
Male	384	38.5
Missing	12	1.2
Age		
< 35	150	15.0
35–44	241	24.1
45–54	332	33.3
> 54	265	26.6
Missing	10	1.0
Work space		
Personal room	369	37.0
2-person room	147	14.7
3–6 person room	94	9.4
Open-plan office	205	20.5
Multiuse office	179	17.9
Missing	4	0.4
Respondents by organisation		
Public organisation 1	139	13.9
Public organisation 2	38	3.8
Public organisation 3	28	2.8
Public organisation 4	101	10.1
Public organisation 5	82	8.2
Public corporation 1	165	16.5
Public corporation 2	232	23.2
Public corporation 3	183	18.3
Private organisation 1	30	3.0

Table I.
Respondents

and the results are presented in Section 5.2. On the basis of CFA, new variables were computed in SPSS for each of the dimensions. In the computation, average values were calculated from each respondent's responses in a certain dimension.

To be able to use CFA with the ML estimation method and RA, the data need to fulfil certain criteria (West *et al.*, 1995). "The sample size needs to be over 200 respondents", which is easily achieved with 998 responses. Also, "observed variables need to be continuous", according to Lubke and Muthen (2004). Likert-scale variables can be used in CFA if other assumptions are met. RA was conducted using average variables that are continuous. In addition, the "distribution of the observed variables should be multivariate normal"; West *et al.* (1995) continued that skewness should be less than 2 and kurtosis less than 7, which both were met (see Table AI). In RA, the independent variables cannot be multicollinear, which was achieved, as the variance inflation factor (VIF) was below 2.5 (see Table IV). As these assumptions were met, CFA was conducted using AMOS 20.0 and RA using SPSS 23.

5. Results

5.1 Data screening

Analysis started with data screening; first, respondents with missing values higher than 10 per cent, for example, more than five, were deleted (in total, seven respondents). Second, unengaged responses, for example, responses with no variance, were deleted (in total, one respondent). CFA with AMOS requires that there are no missing values; due to this, all of the missing values were replaced with the median value. Variables and basic information are described in Table AI.

5.2 CFA results

The results of CFA indicated that the variables loaded into six factors as expected in the conceptual model. CFA included several iterations, and the final version of the factor structure is presented in Figure A1. In total, 12 variables were dropped during the process, as they did not load into any factor more than the threshold of 0.5. The model fit of the final CFA structure is presented in Table II.

5.3 RA results

Table III reports scale reliabilities, means, standard deviations and correlations among productivity, physical environment, virtual environment, social environment, individual work practices and well-being at work. All correlations are significant at the 0.01 level, which reflects the expected relationships.

	Reliability coefficients				Correlations					
	CR	AVE	MSV	ASV	PE	VE	SE	IWP	WB	P
PE	0.852	0.539	0.291	0.171	0.734*					
VE	0.808	0.678	0.464	0.228	0.539	0.824*				
SE	0.962	0.927	0.533	0.352	0.538	0.681	0.963*			
IWP	0.928	0.866	0.244	0.169	0.290	0.348	0.439	0.931*		
WB	0.909	0.768	0.533	0.255	0.332	0.380	0.730	0.451	0.877*	
P	0.862	0.559	0.285	0.203	0.288	0.348	0.531	0.494	0.534	0.724*

Notes: CR, composite reliability; MSV, maximum shared squared variance; ASV, average shared squared variance; AVE, average variance extracted; χ^2/df, χ^2 per degrees of freedom; RMSEA, root-mean-square error of approximation; SRMR, standardised root-mean-square residual; CFI, comparative fit index; NFI, normed fit index; TLI, Tucker–Lewis index. χ^2/df = 3.512; RMSEA = 0.050; SRMR = 0.0494; CFI = 0.908; NFI = 0.877; TLI = 0.898. *The square root of a given factor's AVE

Table II.
Reliability coefficients, correlations among factors and model fit

The results of linear RA are presented in Table IV, including standardised coefficients and related *p*-values. Table IV's adjusted R^2 value of 0.303 means that these variables can explain 30.3 per cent of productivity.

5.4 Findings

H1—not supported. As the results of RA in Table IV show, the relationship between the physical environment and productivity is positive (standardised $\beta = 0.014$), but it is not significant, so the hypothesis is not supported.

H2—not supported. Like physical environment, virtual environment has a positive relationship with productivity as well ($\beta = 0.24$), but it is not significant, so the hypothesis is not supported.

H3—supported. Social environment has a positive ($\beta = 0.189$) and significant relationship with productivity.

H4—supported. As the results of RA show, the relationship between individual work practices and productivity is positive ($\beta = 0.214$) and significant, so the hypothesis is supported.

H5—supported. Well-being at work and productivity have the highest significant positive ($\beta = 0.226$) relationship among the dimensions, and thus, the hypothesis is supported.

Figure 2 summarises the results of the study by combining the created conceptual model with the results of RA. It shows that the knowledge worker has the greatest influence on knowledge work productivity. Employee well-being has the highest positive relation with productivity, followed by individual work practices; the third most important factor is the social environment. The relation of the physical environment and the virtual environment could not be confirmed.

6. Discussion

The purpose of this research was to answer the following question:

RQ1. What matters for knowledge work productivity?

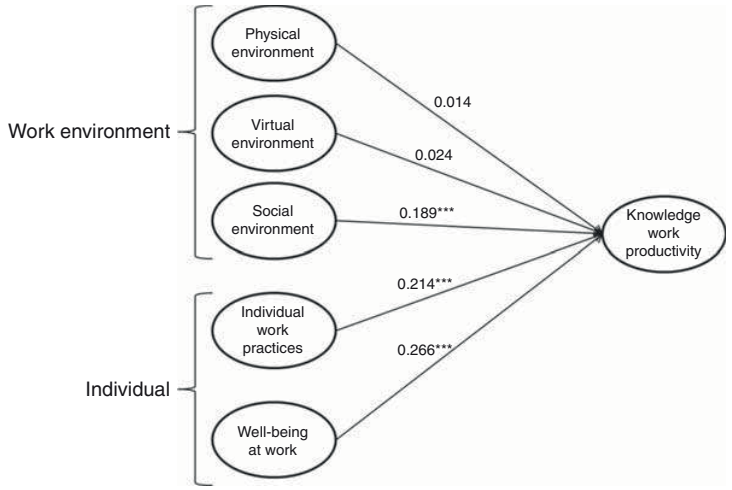
	α	Mean	SD	P	PE	VE	SE	IWP	WB
(P) Productivity	0.86	3.97	0.67						
(PE) Physical environment	0.85	3.52	1.10	0.236**					
(VE) Virtual environment	0.73	3.80	0.74	0.252**	0.413**				
(SE) Social environment	0.90	3.45	0.77	0.451**	0.469**	0.505**			
(IWP) Individual work practices	0.71	3.82	0.60	0.391**	0.230**	0.233**	0.338**		
(WB) Well-being at work	0.88	4.07	0.86	0.482**	0.281**	0.290**	0.643**	0.390**	

Note: **Correlation is significant at the 0.01 level (two-tailed)

Table III. Scale reliabilities, means, standard deviations and correlations (Pearson, two-tailed)

Dimension	Standardised β	*t*-value	Significance	Collinearity statistics (tolerance/VIF)
Physical environment	0.014	0.445	0.656	0.734/1.363
Virtual environment	0.024	0.768	0.442	0.700/1.428
Social environment	0.189	4.719	0.000	0.438/2.283
Individual work practices	0.214	7.355	0.000	0.823/1.216
Well-being at work	0.266	7.451	0.000	0.549/1.820
Constant		11.324	0.000	
F	87.551		0.000	
Adjusted R^2	0.303			

Table IV. Regression analysis



Note: ***Significance = 0.001

Figure 2.
The main effects of work environment and individual factors on knowledge work productivity

Based on previous literature, a conceptual model was created, and the question was sharpened to: what is the relation between the physical, virtual and social environments, individual work practices and well-being at work to knowledge work productivity? According to the RA well-being at work has the biggest impact on knowledge work productivity, followed by individual work practices and the social environment. Surprisingly, this study could not express the impact of physical and virtual environment on knowledge work productivity as hypothesised.

Previous literature on knowledge work productivity has included several theoretical models about the phenomenon itself (e.g. Syed, 1998; Davenport *et al.*, 2002; Bosch-Sijtsema *et al.*, 2009), without any empirical evidence. There has been a clear lack of studies testing the theoretical models in practice. The value of this study is that it examines knowledge work productivity from a wide perspective using a large amount of empirical data. The study confirms, using factor analysis, that the six dimensions of the theoretical model can be found in the data. The whole conceptual model can be confirmed only partially based on the results of RA, but it is still one step further from the current literature.

A common understanding in the current literature (e.g. Davenport *et al.*, 2002; Bosch-Sijtsema *et al.*, 2009) is that the physical (*H1*) and virtual (*H2*) environments would also have an impact on productivity. This study could not confirm it, but does not counter it either. Inconsistency might be caused by a bias in population, or it might have something to do with measuring variables in physical and virtual dimensions. It is also possible that a positive relationship does not really exist. The last one is hardly the right answer, as the physical and virtual environments most likely have an impact on productivity, as many previous studies have pointed out. This can also be excluded by the following extreme example: if the temperature of the office is 35-plus degrees Celsius one morning and the organisation's information systems are not working, the physical and virtual environments must have an impact on productivity. One answer to the question of why no positive relationship exists is that it could be more likely that the physical environment and virtual environment are hygiene factors. These are not important for knowledge work productivity as long as they work or are at a sufficient level, but when they fall below that, they become important.

In addition to theoretical models, previous literature on knowledge work productivity includes countless empirical studies with only one dimension (e.g. ICT or work practices) of independent variables (e.g. Kearns and Gardiner, 2007; O'Neill, 2010; Palvalin *et al.*, 2013). Those studies offer very important information about the certain driver of productivity but cannot answer the question of how important it is compared to other drivers. This study investigates the five dimensions of knowledge work productivity drivers, which allows for comparison among the drivers. This is one of the first attempts to evaluate the significance of different drivers. The results of RA show that differences exist among the dimensions and that some drivers are more important to knowledge work productivity than others.

For the practitioners, this study offers valuable information on where they should focus their investments on in order to experience the biggest improvements in productivity. According to the results, managers should keep focussing on making sure that their knowledge workers are satisfied with their working circumstances and are able to manage themselves. Focus should also be placed on the managers' management skills and the organisation's work practices. In the NewWoW context, the focus is typically placed on activity-based offices and on other physical environment improvements when it should be placed more on management and individual work practices. The physical environment requires changes from time to time, and it might be a good place to start, as it is something that is concrete, but according to the results, the biggest focus should be placed on other dimensions.

A limitation of this study is the sample, as it was collected mainly from public organisations with certain levels of maturity. Public organisations in Finland are known to be more traditional than private organisations are. Another limitation of this study is the data collection tool, which included questions depending on NewWoW practices, for example, activity-based offices, but only a small number of the respondents worked in such an office. Data were also collected in one survey, which never is optimal with dependent variables and independent variables, but it was the only available option for obtaining the data.

The next step for future research is to continue working with the theme and trying to find out why the physical or virtual environment did not have a significant positive relationship with knowledge work productivity. Could it be that they are more like hygiene factors, and if so, what are the limit values for when they start to matter? More research is also needed to confirm the results of this study and to see if any differences with data exist in other types of organisations or countries.

7. Conclusions

Previous literature pointed to the need for understanding knowledge work productivity drivers and their impact on productivity more comprehensively. The problem has arisen lately due to an increasing interest in the NewWoW concept, which includes changes in the physical, virtual and social environments and focusses on improving productivity and well-being. This paper was one of the first attempts to evaluate the importance of different knowledge work productivity drivers in the same study. The results of this study suggest that individual knowledge workers' well-being at work has the biggest influence on their productivity. Individual work practices and organisation management have an impact on productivity as well. This study could not confirm the role of the physical environment and the virtual environment in knowledge work productivity.

From a managerial perspective, this paper offers a good model for better understanding work-environment-change projects and highlights the importance of individual knowledge workers. The work environment is the focus of many organisational changes, but it is still the knowledge worker who is—or is not—using the opportunities in the work environment.

The study continues the discussion that Drucker, Davenport and others have started to increase the understanding of knowledge work productivity more comprehensively. This study has pointed out which drivers have the most impact on knowledge work productivity.

Hopefully this information reaches practitioners so that they can start to focus more on the most important drivers and allocate their limited resources effectively. In the end, it looks as though big productivity improvements can be achieved without big investments by focussing on good management and knowledge workers' self-management skills.

References

Aaltonen, I., Ala-Kotila, P., Järnström, H., Laarni, J., Määttä, H., Nykänen, E., Schembri, I., Lönnqvist, A., Ruostela, J., Laihonen, H., Jääskeläinen, A., Oyue, J. and Nagy, G. (2012), "State-of-the-art report on knowledge work", VTT Technology No. 17, Espoo.

Alvesson, M. (2001), "Knowledge work: ambiguity, image and identity", *Human Relations*, Vol. 54 No. 7, pp. 863-886.

Antikainen, R. and Lönnqvist, A. (2005), "Knowledge worker productivity assessment", *Proceedings of the 3rd Conference on Performance Measurement and Management*, *Nice*, September.

Appel-Meulenbroek, R., Groenen, P. and Janssen, I. (2011), "An end-user's perspective on activity-based office concepts", *Journal of Corporate Real Estate*, Vol. 13 No. 2, pp. 122-135.

Bakker, A.B. (2011), "An evidence-based model of work engagement", *Current Directions in Psychological Science*, Vol. 20 No. 4, pp. 265-269.

Bakker, A.B. and Demerouti, E. (2008), "Towards a model of work engagement", *Career Development International*, Vol. 13 No. 3, pp. 209-223.

Blok, M., Groenesteijn, L., van den Berg, C. and Vink, P. (2011), "New ways of working: a proposed framework and literature review", in Robertson, M.M. (Ed.), *Ergonomics and Health Aspects*, Springer-Verlag, Heidelberg, HCII, LNCS 6779, pp. 3-12.

Bosch-Sijtsema, P., Ruohomäki, V. and Vartiainen, M. (2009), "Knowledge work productivity in distributed teams", *Journal of Knowledge Management*, Vol. 13 No. 6, pp. 533-546.

Brynjolfsson, E. (1993), "The productivity paradox of information technology: review and assessment", *Communications of the ACM*, Vol. 36 No. 12, pp. 66-77.

Campbell, J. (1990), "Modeling the performance prediction problem in industrial and organizational psychology", in Dunnette, M.D. and Hough, L.M. (Eds), *Handbook of Industrial and Organizational Psychology*, Consulting Psychologists Press, Inc., Palo Alto, CA, pp. 687-732.

Claessens, B.J., Van Eerde, W., Rutte, C.G. and Roe, R.A. (2004), "Planning behavior and perceived control of time at work", *Journal of Organizational Behavior*, Vol. 25 No. 8, pp. 937-950.

Craig, C. and Harris, R. (1973), "Total productivity measurement at the firm level", *Sloan Management Review*, Vol. 14 No. 3, pp. 13-27.

Dahooie, J., Afrazeh, A. and Hosseini, S. (2011), "An activity-based framework for quantification of knowledge work", *Journal of Knowledge Management*, Vol. 15 No. 3, pp. 422-444.

Dallner, A., Elo, A.-L., Gambrele, F., Hottinen, V., Knardahl, S., Linstrom, K., Skogstad, A. and Orhede, E. (2000), *Validation of the General Nordic Questionnaire for Psychological and Social Factors at Work*, Nordic Council of Ministers, Nord, Copenhagen.

Davenport, T. (2005), *Thinking for a Living: How to Get Better Performance and Results from Knowledge Workers*, Harvard Business School Press, Boston, MA.

Davenport, T. and Prusak, L. (2000), *Working knowledge*, Harvard Business School Press, Boston, MA.

Davenport, T., Jarvenpaa, S. and Beers, M. (1996), "Improving knowledge work processes", *MIT Sloan Management Review*, Vol. 37 No. 4, pp. 53-66.

Davenport, T., Thomas, R. and Cantrell, S. (2002), "The mysterious art and science of knowledge-worker performance", *MIT Sloan Management Review*, Vol. 44 No. 1, pp. 23-29.

Drucker, P. (1959), *The Landmarks of Tomorrow: A Report on the New "Post-Modern"*, World, Harper Colophon Books, New York, NY.

Drucker, P.F. (1991), "The new productivity challenge", *Harvard Business Review*, Vol. 69 No. 6, pp. 69-79.

Drucker, P.F. (1999), "Knowledge-worker productivity: the biggest challenge", *California Management Review*, Vol. 41 No. 2, pp. 79-94.

Elsayed-Elkhouly, S., Lazarus, H. and Forsythe, V. (1997), "Why is a third of your time wasted in meetings?", *Journal of Management Development*, Vol. 16 No. 9, pp. 672-676.

Garrett, R.K. and Danziger, J.N. (2007), "IM = Interruption management? Instant messaging and disruption in the workplace", *Journal of Computer-Mediated Communication*, Vol. 13 No. 1, pp. 23-42.

Greene, C. and Myerson, J. (2011), "Space for thought: designing for knowledge workers", *Facilities*, Vol. 29 Nos 1/2, pp. 19-30.

Haner, U.-E., Kelter, J., Bauer, W. and Rief, S. (2009), "Increasing information worker productivity through information work infrastructure", *Proceeding EHAWC'09 Proceedings of the International Conference on Ergonomics and Health Aspects of Work with Computers: Held as part of HCI International*, pp. 39-48.

Haynes, B.P. (2007), "The impact of the behavioural environment on office productivity", *Journal of Facilities Management*, Vol. 5 No. 3, pp. 158-171.

Heerwagen, J.H., Kampschroer, K., Powell, K.M. and Loftness, V. (2004), "Collaborative knowledge work environments", *Building Research & Information*, Vol. 32 No. 6, pp. 510-528.

Hertel, G., Geister, S. and Konradt, U. (2005), "Managing virtual teams: a review of current empirical research", *Human Resource Management Review*, Vol. 15 No. 1, pp. 69-95.

Holtshouse, D. (2010), "Knowledge work 2020: thinking ahead about knowledge work", *On the Horizon*, Vol. 18 No. 3, pp. 193-203.

Hopp, W., Iravani, S. and Liu, F. (2009), "Managing white-collar work: an operations-oriented survey", *Production and Operations Management*, Vol. 18 No. 1, pp. 1-32.

Jacks, T., Palvia, P., Schilhavy, R. and Wang, L. (2011), "A framework for the impact of IT on organizational performance", *Business Process Management Journal*, Vol. 17 No. 5, pp. 846-870.

Jett, Q.R. and George, J.M. (2003), "Work interrupted: a closer look at the role of interruptions in organizational life", *Academy of Management Review*, Vol. 28 No. 3, pp. 494-507.

Judge, T., Thoresen, C., Bono, J. and Patton, G. (2001), "The job satisfaction–job performance relationship: a qualitative and quantitative review", *Psychological Bulletin*, Vol. 127 No. 3, p. 376.

Kaplan, R. and Norton, D. (1996), *The Balanced Scorecard. Translating Strategy into Action*, Harvard Business School Press, Boston, MA.

Kearns, H. and Gardiner, M. (2007), "Is it time well spent? The relationship between time management behaviours, perceived effectiveness and work-related morale and distress in a university context", *High Education Research & Development*, Vol. 26 No. 2, pp. 235-247.

Kelloway, E.K. and Barling, J. (2000), "Knowledge work as organizational behavior", *International Journal of Management Reviews*, Vol. 2 No. 3, pp. 287-304.

Kelly, E.L., Moen, P. and Tranby, E. (2011), "Changing workplaces to reduce work–family conflict schedule control in a white-collar organization", *American Sociological Review*, Vol. 76 No. 2, pp. 265-290.

Koopmans, L., Bernaards, C., Hildebrandt, V., Schaufeli, W., de Vet Henrica, C. and van der Beek, A. (2011), "Conceptual frameworks of individual work performance: a systematic review", *Journal of Occupational and Environmental Medicine*, Vol. 53 No. 8, pp. 856-866.

Koopmans, L., Bernaards, C., Hildebrandt, V., van Buuren, S., van der Beek, A. and de Vet, H. (2013), "Development of an individual work performance questionnaire", *International Journal of Productivity and Performance Management*, Vol. 62 No. 1, pp. 6-28.

Laihonen, H., Jääskeläinen, A., Lönnqvist, A. and Ruostela, J. (2012), "Measuring the productivity impacts of new ways of working", *Journal of Facilities Management*, Vol. 10 No. 2, pp. 102-113.

Lubke, G. and Muthen, B. (2004), "Applying multigroup confirmatory factor models for continuous outcomes to Likert scale data complicates meaningful group comparisons", *Structural Equation Modeling*, Vol. 11 No. 4, pp. 514-534.

McCampbell, A., Moorhead, L. and Howard, S. (1999), "Knowledge management: the new challenge for the 21st century", *Journal of Knowledge Management*, Vol. 3 No. 3, pp. 172-179.

Maarleveld, M., Volker, L. and Van Der Voordt, T. (2009), "Measuring employee satisfaction in new offices—the WODI toolkit", *Journal of Facilities Management*, Vol. 7 No. 3, pp. 181-197.

Margaryan, A., Milligan, C. and Littlejohn, A. (2011), "Validation of Davenport's classification structure of knowledge-intensive processes", *Journal of Knowledge Management*, Vol. 15 No. 4, pp. 568-581.

Mehta, R., Zhu, R.J. and Cheema, A. (2012), "Is noise always bad? Exploring the effects of ambient noise on creative cognition", *Journal of Consumer Research*, Vol. 39 No. 4, pp. 784-799.

Nickols, F. (2000), "'What is' in the world of work and working: some implications of the shift to knowledge work", in Cortada, J.W. and Woods, J.A. (Eds), *The Knowledge Management Yearbook 2000-2001*, Butterworth Heinemann, Woburn, MA, pp. 3-11.

O'Neill, M.J. (2010), "A model of environmental control and effective work", *Facilities*, Vol. 28 Nos 3/4, pp. 118-136.

Okkonen, J. (2004), *The Use of Performance Measurement in Knowledge Work Context*, Tampere University of Technology, Tampere.

Origo, F. and Pagani, L. (2008), "Workplace flexibility and job satisfaction: some evidence from Europe", *International Journal of Manpower*, Vol. 29 No. 6, pp. 539-566.

Palvalin, M., Lönnqvist, A. and Vuolle, M. (2013), "Analysing the impacts of ICT on knowledge work productivity", *Journal of Knowledge Management*, Vol. 17 No. 4, pp. 545-557.

Parasuraman, A. (2002), "Service quality and productivity: a synergistic perspective", *Managing Service Quality*, Vol. 12 No. 1, pp. 6-9.

Pyöriä, P. (2005), "The concept of knowledge work revisited", *Journal of Knowledge Management*, Vol. 9 No. 3, pp. 116-127.

Ramirez, Y.W. and Nembhard, D.A. (2004), "Measuring knowledge worker productivity: a taxonomy", *Journal of Intellectual Capital*, Vol. 5 No. 4, pp. 602-628.

Ramirez, Y.W. and Steudel, H.J. (2008), "Measuring knowledge work: the knowledge work quantification framework", *Journal of Intellectual Capital*, Vol. 9 No. 4, pp. 564-584.

Ruostela, J. and Lönnqvist, A. (2013), "Exploring more productive ways of working", *World Academy of Science, Engineering and Technology, International*, Vol. 7 No. 1, pp. 611-615.

Ruostela, J., Lönnqvist, A., Palvalin, M., Vuolle, M., Patjas, M. and Raij, A.-L. (2015), "'New ways of working' as a tool for improving the performance of a knowledge-intensive company", *Knowledge Management Research & Practice*, Vol. 13 No. 4, pp. 382-390.

Schaufeli, W.B., Bakker, A.B. and Salanova, M. (2006), "The measurement of work engagement with a short questionnaire", *Educational and Psychological Measurement*, Vol. 66 No. 4, pp. 701-716.

Syed, J. (1998), "An adaptive framework for knowledge work", *Journal of Knowledge Management*, Vol. 2 No. 2, pp. 59-69.

Tangen, S. (2005), "Demystifying productivity and performance", *International Journal of Productivity and Performance Management*, Vol. 54 No. 1, pp. 34-46.

Thomas, B. and Baron, J. (1994), *Evaluating Knowledge Worker Productivity: Literature Review*, No. USACERL-IR-FF-94/27, Construction Engineering Research Lab (ARMY), Champaign, IL.

Thompson, P., Warhurst, C. and Callaghan, G. (2001), "Ignorant theory and knowledgeable workers: interrogating the connections between knowledge, skills and services", *Journal of Management Studies*, Vol. 38 No. 7, pp. 923-943.

Van der Voordt, T. (2004), "Productivity and employee satisfaction in flexible workplaces", *Journal of Corporate Real Estate*, Vol. 6 No. 2, pp. 133-148.

Van Meel, J. (2011), "The origins of new ways of working—office concepts in the 1970s", *Facilities*, Vol. 29 Nos 9/10, pp. 357-367.

Vartiainen, M. (2007), "Analysis of multilocational and mobile knowledge workers' work spaces", *Lecture Notes in Computer Science*, Vol. 4562 No. 1, pp. 194-203.

Vartiainen, M. and Hyrkkänen, U. (2010), "Changing requirements and mental workload factors in mobile multi-locational work", *New Technology, Work and Employment*, Vol. 25 No. 2, pp. 117-135.

Vischer, J. (2005), *Space Meets Status: Designing Workplace Performance*, Routledge, New York, NY.

Viswesvaran, C. and Ones, D. (2000), "Perspectives on models of job performance", *International Journal of Selection and Assessment*, Vol. 8 No. 4, pp. 216-226.

Vuolle, M. (2010), "Productivity impacts of mobile office service", *International Journal of Services Technology and Management*, Vol. 14 No. 4, pp. 326-342.

Wännström, I., Peterson, U., Åsberg, M., Nygren, Å. and Gustavsson, J.P. (2009), "Psychometric properties of scales in the General Nordic Questionnaire for psychological and social factors at work (QPSNordic): confirmatory factor analysis and prediction of certified long-term sickness absence", *Scandinavian Journal of Psychology*, Vol. 50 No. 3, pp. 231-244.

Warhurst, C. and Thompson, P. (2006), "Mapping knowledge in work: proxies or practices?", *Work, Employment and Society*, Vol. 20 No. 4, pp. 787-800.

West, S.G., Finch, J.F. and Curran, P.J. (1995), "Structural equation models with non-normal variables: problems and remedies", in Hoyle, R.H. (Ed.), *Structural Equation Modeling: Concepts, Issues, and Applications*, Sage Publications, London, pp. 56-75.

Further reading

Davenport, T. (2008), "Improving knowledge worker performance", in Pantaleo, D. and Pal, N. (Eds), *From Strategy to Execution: Turing Accelerated Global Change into Opportunity*, Springer, Berlin and Heidelberg, pp. 215-235.

Appendix 1

Code	Key variable	Mean	SD	Skewness	Kurtosis
1PE	There is a space available for tasks that require concentration and peace at our workplace when needed	3.82	1.44	−0.89	−0.70
2PE	There are enough rooms at my workplace for formal and informal meetings	3.32	1.44	−0.29	−1.35
3PE	The facilities at my workplace enable spontaneous interaction between workers	3.79	1.20	−0.78	−0.43
4PE	The ergonomic arrangements of the work stations at my workplace are in order	3.74	1.20	−0.78	−0.43
5PE	There are generally no disruptive factors in my work environment (like sounds or movements)	2.99	1.40	0.02	−1.37
6PE	There is a place in which I can discuss or talk on the phone about matters which I do not want others to hear	3.73	1.43	−0.77	−0.87
7PE	The facilities at my workplace are conducive to efficient working	3.72	1.25	−0.74	−0.53
8VE	The usability of the main software for doing my work tasks is good	3.78	1.07	−0.83	−0.06
9VE	I can access the information I need wherever I am	3.62	1.18	−0.68	−0.52
10VE	Workers can see other workers' electronic calendar	4.23	0.98	−1.39	1.56
11VE	Workers can communicate with instant messaging tools (e.g. Lync, Skype)	4.31	1.04	−1.65	2.10
12VE	My workplace has sufficient equipment for virtual negotiations	3.63	1.21	−0.54	−0.74
13VE	My workplace has electronic teamwork tools (e.g. Google Docs, Trello, Yammer)	3.47	1.22	−0.41	−0.73
14VE	There are appropriate mobile devices available at my workplace (e.g. laptop, iPhone, tablet)	4.02	1.13	−1.20	0.68
15SE	I am able to work in the ways and at the times which suit me best	3.65	1.18	−0.70	−0.47
16SE	Telework is a generally accepted practice at my workplace	3.72	1.26	−0.70	−0.66
17SE	Operations at my workplace are open (e.g. decision-making and information flow)	3.23	1.16	−0.32	−0.85
18SE	Information flows well among the people important for my work	3.39	1.12	−0.46	−0.71
19SE	The meeting practices at my workplace are efficient	2.88	1.11	0.05	−0.87
20SE	Our workplace has clear guidelines regarding the use of IT and communication tools	3.25	1.08	−0.26	−0.64
21SE	I have clear goals set for my work	3.75	1.11	−0.82	−0.01
22SE	My work is assessed in terms of results achieved, not only hours worked	3.72	1.12	−0.77	−0.10
23SE	My work tasks constitute a reasonable whole	3.82	1.09	−0.87	0.09
24SE	New ways of working are actively explored and experimented at my workplace	3.08	1.15	−0.14	−0.76
1IWP	I use technology (e.g. videoconferencing or instant messaging) to reduce the need to for unnecessary travelling	3.83	1.15	−0.95	0.15
2IWP	I utilise mobile technology in work situations where I have to wait about (e.g. working on the laptop or phone in the train)	3.56	1.42	−0.64	−0.93
3IWP	I try to manage my workload by prioritising important tasks	4.32	0.73	−1.15	1.99
4IWP	I do things that demand concentration in a quiet place (e.g. in the quiet room or at home)	3.50	1.36	−0.51	−1.01
5IWP	I prepare in advance for meetings and negotiations	4.06	0.84	−0.98	1.16
6IWP	I take care of my well-being during the working day (e.g. by changing my work position or the place I work in)	3.67	1.10	−0.59	−0.44
7IWP	I follow the communication channels at my workplace	4.08	0.85	−0.93	0.93
8IWP	If necessary I close down disruptive software in order to concentrate on important work task	3.42	1.20	−0.34	−0.91

(*continued*)

Table AI.
Variables, means, standard deviations, skewness and kurtosis

Code	Key variable	Mean	SD	Skewness	Kurtosis
9IWP	I regularly plan my working day in advance	3.32	1.11	−0.40	−0.67
10IWP	I actively seek out and test better tools and ways of working	3.50	1.01	−0.38	−0.37
1WB	I enjoy my work	3.98	0.99	−1.14	1.15
2WB	I am enthusiastic about my job	4.05	0.96	−1.04	0.78
3WB	I find my work meaningful and it has a clear purpose	4.19	0.92	−1.33	1.78
4WB	My work does not cause continuous stress	3.14	1.21	−0.12	−1.06
5WB	My work performance is appreciated at my workplace	3.57	1.07	−0.62	−0.18
6WB	My work and leisure time are in balance	3.69	1.09	−0.58	−0.53
7WB	The atmosphere at my workplace is pleasant	3.80	1.02	−0.85	0.38
8WB	Conflict situations at my workplace can be resolved quickly	3.24	1.11	−0.30	−0.56
1P	I achieve satisfactory results in relation to my goals	4.09	0.81	−0.90	0.95
2P	I can take care of my work tasks fluently	4.04	0.83	−0.91	1.00
3P	I can use my working time for matters which are right for the goals	3.62	0.99	−0.61	−0.07
4P	I have sufficient skills to accomplish my tasks efficiently	4.26	0.77	−1.19	2.06
5P	I can fulfil clients' expectations	4.01	0.79	−0.78	1.00
6P	The results of my work are of high quality	4.11	0.72	−0.52	0.20
7P	The group(s) of which I am a member work efficiently as an entity	3.53	1.00	−0.56	−0.15

Table AI.

Appendix 2

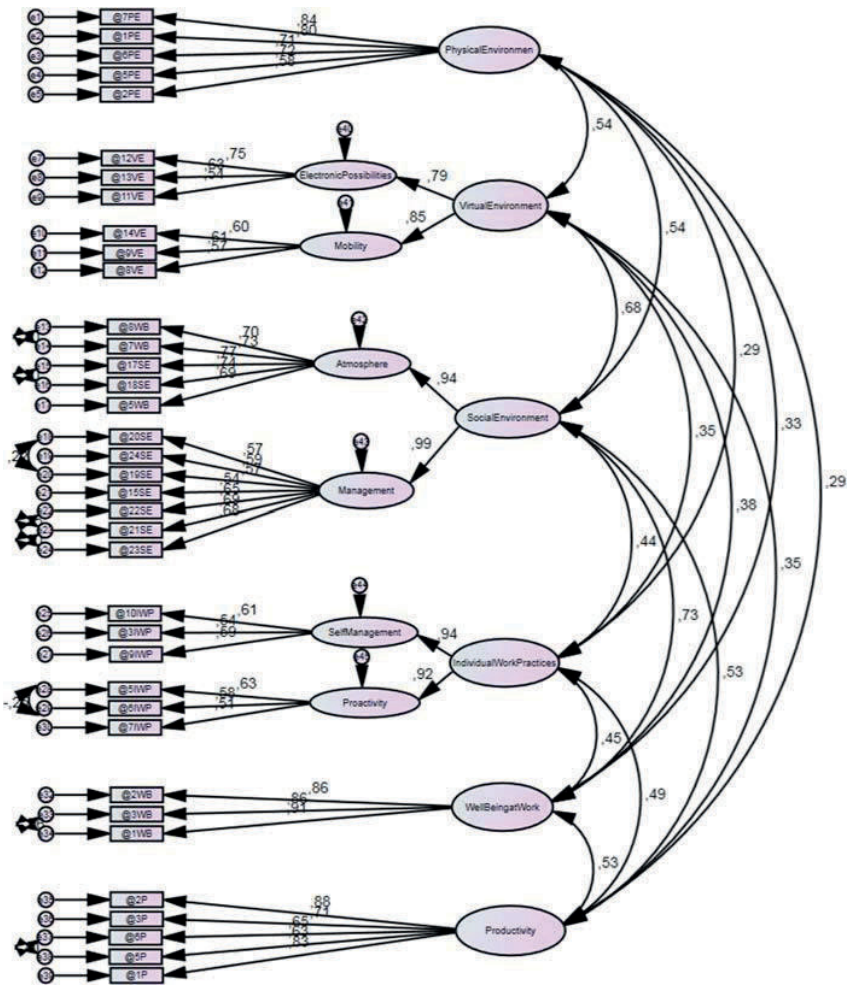


Figure A1.
CFA model

Corresponding author
Miikka Palvalin can be contacted at: miikka.palvalin@tut.fi

PUBLICATION V

How to Measure Impacts of Work Environment Changes on Knowledge Work Productivity – Validation and Improvement of SmartWoW Tool

Miikka Palvalin

Measuring Business Excellence, 21(2) 175-190

How to measure impacts of work environment changes on knowledge work productivity – validation and improvement of the SmartWoW tool

Miikka Palvalin

Summary

Purpose – *Measuring productivity in changing environment is a challenging task for most of the organizations. However, it is very important for managers to measure how the changes in work environment impact on knowledge work productivity. SmartWoW is proving to be a useful tool for this type of productivity measurement, and organizations are using it to make changes in the work environment. As organizations become more interested in its uses, studies with more accurate results are needed. The purpose of this paper is to validate and improve the use of the SmartWoW tool.*

Design/methodology/approach – *The SmartWoW tool was used in nine organizations, which formulates the research data. Convergent validity, divergent validity and reliability are tested with SPSS and AMOS. Both exploratory and confirmatory factor analyses are applied.*

Findings – *The SmartWoW tool structure was found to be valid. It follows the structure described in previous literature, with slight changes in two dimensions. Four variables were added to increase tool consistency, and their wording was harmonized.*

Practical implications – *SmartWoW is useful for evaluating an organization's current work environment and practices, as well as for measuring the effects of work environment changes. This study's results also suggest SmartWoW would be useful for research by, for example, evaluating how dimensions affect each other.*

Originality/value – *This study provides a better understanding of the unique features and uses of SmartWoW. The findings not only validate through statistical analysis the tool's structure but also improve it and offer a broader scope of its uses.*

Keywords *Validation, Productivity, Measurement, Knowledge work, Work environment, SmartWoW*

Paper type *Research paper*

Miikka Palvalin is Researcher at the Department of Information Management and Logistics, Tampere University of Technology, Tampere, Finland.

1. Introduction

Increasing competition and a constant need to increase productivity are concerns for organizations, government and media. Recently, knowledge work productivity has improved by using the New Ways of Working (NewWoW) concept and changing work environments (Gorgievski *et al.*, 2010; Van Meel, 2011). The idea involves giving the knowledge worker more responsibility for how work is done, whereas management focuses on results; thus, the knowledge worker has more autonomy and flexibility to choose how, when and where the results are created (Van der Voordt, 2004; Van Meel, 2011). This solution is fairly topical, as the level of information and communications technology has reached certain heights in many organizations. Flexible working requires that all workers have mobile tools that easily facilitate access to their organization's information systems regardless of location (Ruostela *et al.*, 2014; Van der Voordt, 2004). Use of

Received 2 May 2016
Revised 10 February 2017
16 March 2017
Accepted 16 March 2017

NewWoW could make massive changes in organizations, covering the entire work environment (physical spaces, technology and management practices). Organizations are willing to start these changes, as they get direct benefits in decreased occupancy costs (Ruostela *et al.*, 2014) and, at least in theory, more satisfied and productive workers (Kattenbach *et al.*, 2010). Assessing the last, however, is still somewhat unclear because the measurement of the effects of work environment changes against knowledge work productivity is challenging (Drucker, 1999; Laihonen *et al.*, 2012).

Drucker (1999) has even announced that knowledge worker productivity is the biggest challenge for the modern work life. Other researchers have also discovered that the productivity of an individual knowledge worker is the most important factor for good organizational performance (Miles, 2005; Groen *et al.*, 2012). Thus, knowledge work productivity is one essential element of work performance, including also the elements of work environment and personal work practices and well-being (Bosch-Sijtsema *et al.*, 2009; Ruostela and Lönnqvist, 2013; Palvalin *et al.*, 2015). To manage this important resource, it must first be accurately measured (Drucker, 1999). Knowledge work productivity measurement is not a very well-studied topic in the literature (Takala *et al.*, 2006), but some models exist (Ramirez and Nembhard, 2004; Laihonen *et al.*, 2012; Takala *et al.*, 2006). Most of the existing measures are based on knowledge worker subjective evaluations which, while having limitations, have proved to be useful in the knowledge work context because of various intangible aspects which are difficult to measure otherwise (Jääskeläinen and Laihonen, 2013; Koopmans *et al.*, 2013; Palvalin *et al.*, 2013). Palvalin *et al.* (2015) have presented one solution for this challenge: the SmartWoW tool seems to be a promising method for measuring knowledge work performance within a changing work environment. Construct is introduced in Section 2.1 and more precisely in Palvalin *et al.* (2015). The purpose of this study is to test the tool and to improve it. SmartWoW was easily accepted in organizations planning work environment changes, and, currently, nine organizations have used it to measure the current state of knowledge work performance and assess the potential areas for change. Most of the organizations have already committed to use SmartWoW again within a year after they have made changes in work environment and practices.

Palvalin *et al.* (2015) have already found that the tool has practical value, and current interest seems to confirm that. The study conducted by Palvalin *et al.* (2015) is limited in a couple of ways. First, the sample is quite small, and, second, the construct is not statistically validated. To address these limitations, this study intends to gather a larger sample and statistically validate the SmartWoW tool. Validation is important for two reasons. First, it confirms the sound structure of the tool; second, validation reveals if the tool measures what it is supposed to measure. Validation also enables improvements to the tool based on the results. After validation, it is also possible to create sum variables based on the construct categories, which will increase the scientific and practical value of the tool. Finally, validation opens up possibilities for the use of SmartWoW in future research with different types of data analyses.

This paper is organized in the following structure: Previous literature and the SmartWoW tool are presented in Section 2. Section 3 describes the methods, including a more detailed description of the sample. Section 4 presents the results of the study, which are then discussed in Section 5. The paper closes with a short conclusion about the study's contribution to this field of knowledge.

2. Theoretical background

2.1 SmartWoW construct

The SmartWoW tool (Palvalin *et al.*, 2015) consists of 53 items, where 4 are open-ended and 49 use the five-point Likert scale (Appendix 1), ranging from 1 (disagree) to 5 (agree). The SmartWoW tool covers six dimensions of knowledge work performance divided into drivers

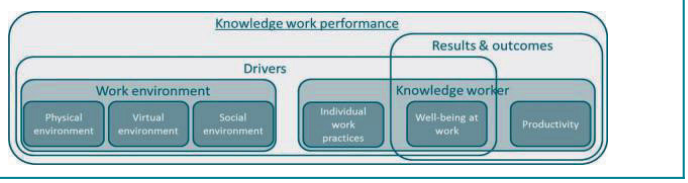
and results and outcomes (Figure 1). On the other hand, the construct can be also divided into the knowledge worker itself who is doing the work and the work environment where the work is done. According to Palvalin *et al.* (2015), the purpose was to keep tool as light as possible that respondents would be more willing to respond so all the dimensions have only seven to ten items. The following briefly explains the construct.

Work environment is divided into three dimensions, according to Bosch-Sijtsema *et al.* (2009) and Vartiainen (2007): the physical environment, the virtual environment and the social environment. *Physical environment* includes organization facilities and work spaces and should support work by offering the best facilities for different tasks, for instance, collaboration and concentration (Heerwagen *et al.*, 2004; Halpern, 2005). It is important to have enough spaces for meetings and informal discussion that can be used based on activity (Maarleveld *et al.*, 2009). *Virtual environment* includes computers, smartphones and software that a knowledge worker needs to be able to work efficiently (Vartiainen and Hyrkkänen, 2010). Technology plays a major role in increasing knowledge workers' mobility and flexibility; it allows them to be connected with customers and co-workers from distant locations (O'Neill, 2010). *Social environment* includes everything from the management to organization atmosphere (Bosch-Sijtsema *et al.*, 2009). An effective knowledge worker needs to have clear goals and the ability to perform the work flexibly in time and space (Drucker, 1999; Origo and Pagani, 2008; Kelly *et al.*, 2011). Organization transparency, good information flow, clear policies conveyed through meetings and an innovative climate are also an important part of the social environment (Drucker, 1999; Wännström *et al.*, 2009).

While the work environment defines the frame for working, the fourth dimension, *individual work practices*, shows whether the worker takes advantage of the frame provided (Ruostela and Lönnqvist, 2013; Koopmans *et al.*, 2013). Quiet spaces and virtual negotiation is not a benefit unless the worker utilizes them to support the work. Individual work practices, which include self-management, setting personal goals, prioritizing important tasks and planning, impact work outcomes (Claessens *et al.*, 2004; Kearns and Gardiner, 2007).

The fifth dimension, *well-being at work*, includes all the topics that are typically measured in work satisfaction surveys but in a compact form. Job satisfaction, work engagement, appreciation, work–life balance and atmosphere are all important for the knowledge worker's well-being (Bakker and Demerouti, 2008). Well-being at work has a dual role in this model: it operates as a result of work environment drivers (Kelly *et al.*, 2011; Halpern, 2005), but, at the same time, it is itself a driver for productivity (Wright and Cropanzano, 2000; Schaufeli *et al.*, 2006). The sixth dimension, *productivity*, is the only complete result dimension in this model. It includes items from two dimensions of productivity, quantity and quality; for example, work efficiency and effectiveness, achieving goals, customer satisfaction and quality of work are important indicators for knowledge worker productivity (Ramirez and Nembhard, 2004; Ramirez and Steudel, 2008; Palvalin *et al.*, 2013). Figure 1 summarizes the theoretical framework for knowledge work performance, presented by Palvalin *et al.* (2015).

Figure 1 SmartWoW framework for knowledge work performance



2.2 Statistical validation, starting point for improvement

A typical step for construct development is statistical validation. The purpose of this is to prove that the tool is able to measure what it is supposed to and, more specifically, that the different dimensions do not measure the same things. Such validations are called convergent and divergent validity (Hair *et al.*, 2006). Reliability is used to measure the internal consistency of the dimensions and illustrate the organization's current state (Bland and Altman, 1997). These approaches for construct validation and reliability are presented more precisely below.

Convergent validity refers to the degree of positive relationships among the components that make up the construct. If the construct has convergent validity, then there should be a strong correlation between the components. (Narver and Slater, 1990). Convergent validity can be determined in different ways, according to Ahire *et al.* (1996). The two extremes use completely different instruments to determine convergent validity, or each item in the same instrument is viewed as different approaches in defining convergent validity. Hair *et al.* (2006) has a more practical approach to convergent validity. According to them, convergent validity is a condition that concerns what items are needed in a construct to fully represent the dimension in question. They suggest that factor loadings, composite reliability (CR) and average variance extracted (AVE) should be used to assess convergent validity. According to Fornell and Larcker (1981), construct convergent validity requires CR to be greater than AVE and AVE to be at least 0.50.

Discriminant validity of a construct is the difference between the items that are not theoretically similar (Sureshchandar *et al.*, 2002). Different components in a construct need to measure different things, and this can be tested by using maximum shared variance (MSV), average shared variance (ASV) and AVE. According to Chau (1997), the AVE reflects the amount of variance that is captured by the construct, in relation to the amount of variance because of measurement error. Discriminant validity is achieved when the square root of the AVE is greater than its correlations with other constructs (Fornell and Larcker, 1981). According to Hair *et al.* (2006), differentiation of items is achieved when MSV and ASV are less than AVE.

Reliability is the measure of consistency of the construct, meaning that the instrument is capable of producing consistent results when the survey is used in two homogenous groups of respondents. Internal consistency can be used to evaluate the consistency of the responses for each item in the instrument. Bland and Altman (1997) suggest the Cronbach's alpha analysis be used for the construct reliability test. Cronbach's alpha is the same as CR, and, according to Bland and Altman (1997), the alpha value over 0.8 is considered good for social science research.

3. Methods

3.1 Predevelopment

At the beginning of this study, the SmartWoW tool and the results of the construction of SmartWoW (Palvalin *et al.*, 2015) research paper were analyzed in collaboration with one organization that was interested in using the tool. Palvalin *et al.* (2015) had reported Cronbach's alphas for each dimension and feedback from organization representatives, which are presented in Section 4.1. The results of the predevelopment caused slight changes in the SmartWoW tool, and those are presented in Section 4.1. The rest of the research was conducted using the updated version of the SmartWoW tool.

3.2 Data

The data were collected in Finland in 2015 with nine organizations and 998 participants. Organizations were mainly from public or third sectors, but there were also some departments in private organizations. Data were collected using an online survey for the

organization's own use and for scientific purposes. Almost all of these organizations were planning work environment changes; so, they needed an overview of how their employees were experiencing the work environment and their individual work practices, well-being and productivity. Organizations are also going to use their own results for measuring impacts of the upcoming changes. Participants were informed that the data will also be used for scientific purposes. Questionnaires were sent to participants in e-mails, and they typically had about two weeks' time to respond. Response rates varied from 33 to 89 per cent (Table I).

3.3 Exploratory factor analysis

Exploratory factor analysis (EFA) is a commonly used statistical analysis for exploring factor structure. The construct is based on previous literature; so, it would have been possible to just see how it fits in CFA, but, in this research, EFA was used for the preliminary validation for the factorial structure. Using EFA without any limitations (factors with eigenvalues above 1.0) creates a base structure for the CFA. EFA is not limited by the theory; so, it could reveal if there were some hidden connections between the items (Fabrigar *et al.*, 1999). In EFA, the maximum likelihood (ML) was used with promax rotation in SPSS. Items with factor loadings less than 0.3 are considered dropped from the model. The accuracy of the EFA is evaluated using Kaiser–Meyer–Olkin test and Bartletss's test. EFA has some limitations; for example, items could load on more than one factor, and items might correlate with each other even if it could be theoretically explained (Ahire *et al.*, 1996). These limitations can be negated by using confirmatory factor analysis (CFA).

3.4 Confirmatory factor analysis

CFA is reckoned as the best statistical analysis for testing a hypothesized factor structure (Byrne, 2001; Schumacker and Lomax, 1996). A total of 998 responses were analyzed using AMOS 20.0. Analysis was conducted by using ML estimation method. The ML method makes a couple of assumptions for the data. First, the sample size needs to be at least 200 cases (West *et al.*, 1995). This is easily fulfilled with my 998 respondents. Second, the scale of the observed variables needs to be continuous. Likert scale is not technically considered continuous, but, according to Lubke and Muthen (2004), it can be used in CFA if other assumptions are met. Third, the distribution of the observed variables is a multivariate normal (West *et al.*, 1995). Skewness and kurtosis were used to test normality; according to West *et al.* (1995), univariate skewness should be less than 2 and univariate

Table I Respondents

Code	*n*	*(%)*
Sex		
Female	602	60.3
Male	384	38.5
Missing	12	1.2
Age		
<lt;35	150	15.0
35-44	241	24.1
45-54	332	33.3
>54	265	26.6
Missing	10	1.0
Work space		
Personal room	369	37.0
Two-person room	147	14.7
Three-six person room	94	9.4
Open-plan office	205	20.5
Multiuse office	179	17.9
Missing	4	0.4

kurtosis less than 7. According to Sposito *et al.* (1983), a good rule of thumb for kurtosis is that it should be below 2,200. Skewness and Kurtosis for each variable is listed in Appendix 1 and shows that the above conditions are met. This means that the data are distributed normally; therefore, all the assumptions of ML estimation are fulfilled.

3.5 Construct validity and reliability evaluation

In CFA, the following measures and critical values are considered for establishing validity and reliability. CR, AVE, MSV and ASV. According to Fornell and Larcker (1981), the construct *convergent validity* requires CR to be greater than AVE and AVE to be at least 0.50. For the construct *discriminant validity*, or differentiation of items between, MSV and ASV should be less than AVE (Hair *et al.*, 2006). *Reliability* of the measurement items could be tested using Cronbach's alpha, which is the same as CR. According to Bland and Altman (1997), the alpha value over 0.8 is considered good for social science research.

4. Results

4.1 Predevelopment results

Palvalin *et al.* (2015) results point to a couple of issues in SmartWoW; the Cronbach's alphas were not excellent on each of the dimensions (physical environment 0.77, virtual environment 0.69, social environment 0.86, individual work practices 0.73, well-being at work 0.88 and productivity 0.84). Some of the variables seemed to be too specific and needed generalization to work for different organizations. Some other variables were also quite difficult to understand and/or evaluate. To counter these issues, four new variables were added (6PE, 7PE, 14VE and 23SE), too specific variables were generalized (1IWP, 4IWP, 6IWP and 8IWP) and all the statements were reread, style was harmonized and more examples were added. Based on the results, changes were successful as Cronbach's alphas increased (Table II, CR), and the collaborating organizations' representatives felt that the variables were good, with no negative feedback after the questionnaire was run in their organizations.

4.2 Data screening

Analysis started with data screening. First, respondents with missing values higher than 10 per cent, i.e. more than 5 were deleted (7 respondents). Second, unengaged responses, i.e. responses with no variance were deleted (1 respondent). CFA with AMOS requires that there are no missing values; therefore, because of this, all the missing values were replaced with a median. Variables and basic information is described in Appendix 1.

Table II Reliability coefficients, correlations among factors and model fit

	Reliability coefficients				*Correlations*					
Code	*CR*	*AVE*	*MSV*	*ASV*	*PE*	*VE*	*SE*	*IWP*	*WB*	*P*
PE	0.852	0.539	0.291	0.171	0.734*					
VE	0.808	0.678	0.464	0.228	0.539	0.824*				
SE	0.962	0.927	0.533	0.352	0.538	0.681	0.963*			
IWP	0.928	0.866	0.244	0.169	0.290	0.348	0.439	0.931*		
WB	0.909	0.768	0.533	0.255	0.332	0.380	0.730	0.451	0.877*	
P	0.862	0.559	0.285	0.203	0.288	0.348	0.531	0.494	0.534	0.724*

Notes: *The square root of a given factor's AVE; χ^2/df = 3.512; RMSEA = 0.050; SRMR = 0.0494; CFI = 0.908; NFI = 0.877; TLI = 0.898; CR = composite reliability; MSV = maximum shared squared variance; ASV = average shared squared variance; AVE = average variance extracted; χ^2/df = chi-square per degrees of freedom; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; CFI = comparative fit index; NFI = normed fit index; TLI = Tucker-Lewis index

4.3 Exploratory factor analysis

EFA is tested before CFA to see how factors would naturally construct, and it can be used as a starting point for CFA. During EFA, seven variables (1IWP, 2IWP, 4IWP, 4WB, 6WB, 4P, 7P) were dropped because they did not suit theoretically to any factors and loadings were low. Appendix 2 presents a pattern matrix for EFA. The results were very close to the framework. As a result of EFA, and based on eigenvalue, there are a total of ten factors, which is four more than in the Figure 1 framework, but these four are formed because some framework dimensions were split into two different factors. This is the first important result for EFA and is taken into account in CFA. Three variables (3PE, 10VE, 16SE) did not load into any factor over the limit of 0.3 thresholds. Those were still kept in, as they are important theoretically. These need extra attention in CFA, as they might cause problems in the model fit.

EFA included some exploration with using a fixed number of factors. This revealed that the three variables from well-being at work (5WB, 7WB, 8WB) loaded constantly into the same factor with social environment variables. This makes sense theoretically because those variables are close to social environment variables, which measure organizational atmosphere. This is the second important lesson from EFA that needs to be taken into account in CFA.

4.4 Confirmatory factor analysis

CFA is the main analysis in validation of SmartWoW tool. CFA was used after the EFA, and the results of EFA were a starting point for CFA. The first factor structure was based on the theoretical framework, and it was modified with the results of EFA. CFA processes included several iterations until the acceptable model fit was found. During the CFA, four variables (3PE, 4PE, 10VE, 16SE) were dropped, as they did not load into any factor more than threshold 0.5. The final factor structure is presented in Appendix 3.

As a result, CFA variables loaded into factors, as they were supposed to load, and six factors were found. All six dimension of the Figure 1 framework (physical environment, virtual environment, social environment, individual work practices, well-being at work and productivity) had its own factor. As EFA results indicated, three of the factors were second level, which consists of two, first-level factors. First was virtual environment, which has variables divided into more device centric or electronic possibilities centric variables. Social environment also consists of two first level factors, management and atmosphere. Individual work practice was the third; second-level factor and its first-level factors were proactivity and utilization of electronic possibilities. CFA also confirms that a couple of well-being at work variables loaded more on the social environment atmosphere factor than the well-being at work factor.

Accuracy of CFA is tested with several indicators. Bentler (1990), McDonald *et al*. (1990) and Mulaik *et al*., (1989) have suggested the following values for good model fit:

- χ^2/df, chi-square per degrees of freedom, below 5;
- RMSE, root mean square error of approximation, below 0.08;
- SRMR, standardized root mean square residual, below 0.08;
- CFI, comparative fit index, above 0.90;
- NFI, normed fit index, above 0.90; and
- TLI, Tucker–Lewis index, above 0.90.

The model fit of the final CFA structure is presented in Table II. My model meets these criteria in χ^2/df, RMSE, SRMR and CFI. NFI (0.877) and TLI (0.898) are just below the threshold.

4.5 Validity results

The purpose of the CFA was to measure the construct convergent and divergent validity and reliability requirements. Convergent validity requires that each factor has a CR higher than AVE, which is accomplished and AVE needs to be over 0.5, which it is. The construct is convergent valid. Discriminant validity requires that each factor MSV and ASV are less than AVE, which is easily achieved, and, so, the construct is discriminant valid. Reliability requires that CR is over 0.8 which is easily achieved on every factor except on VE which is barely over the threshold. Construct reliability is achieved. Convergent validity, discriminant validity and reliability requirements are fulfilled in this factor structure.

5. Discussions

5.1 Structure of SmartWoW tool

The purpose of this study was to improve SmartWoW tool by adding the variables based on pilot test feedback and by performing validation and reliability analyses on updated SmartWoW tool. The purpose of the statistical analysis was to confirm the structure of the tool. With regard to convergent and discriminant validity, the SmartWoW tool has shown a structure of six factors as suggested in previous literature. The analyses indicate that items in each factor are related, and there are differences between the factors. This study reasserts the claims of previous literature by recognizing the six dimensions as suggested.

SmartWoW tool was supposed to have six dimensions: physical environment, virtual environment, social environment, individual work practices, well-being at work and productivity. All these were found in CFA. The results were mainly as expected, but one adjustment is needed. The part of well-being at work variables loaded more on social environment factor. This is also theoretically logical; so, it is possible to accept that WB5, WB7 and WB8 are part of the social environment factor. This leaves three variables for well-being at work factor which illustrate the personal work satisfaction and engagement. The amount of variables in this factor is low compared to the others, but loadings and consistency are on good level; so, no changes are required. Three factors, virtual environment, social environment and individual work practice are all divided into two first-level factors. This makes sense as all those dimensions are very diverse and include many variables.

Some variables are not in the final CFA model because they did not load into any factor. Those are listed in Table III, with the discussion about their future in part of the SmartWoW tool.

In conclusion, this research suggests keeping the structure of SmartWoW as it is. There is a statement that a couple variables from well-being at work dimension could be integrated into the social environment, but, on the other hand, those are also very typical variables in well-being at work surveys. Factor structure allows an opportunity to rearrange the order of variables, but this study cannot confirm how it would affect the results, so it is not changed. Usefulness of a couple (10VE, 16SE, 8IWP) of variables stays open, and more data are needed to evaluate their place in the tool. It is suggested that 4WB be dropped, as it did not load into any factor, and it is difficult to evaluate a good result.

5.2 Practical value, limitations and future

The practical value of the SmartWoW is demonstrated in Palvalin *et al.* (2015), and current interest also indicates a practical value. This research affirms its practical value by confirming the structure of SmartWoW and enabling dimension-based analysis using the discovered dimensions. Organization results could be compared to the other organization results in dimension level, which makes information easier to handle.

Table III Items that did not load into any factor and decisions should those still be a part of SmartWoW tool

Variable	*Decision*	*Justification*
3PE: The facilities at my workplace enable spontaneous interaction between workers	Keep	It was the last variable that was dropped from the model and it is important theoretically, so it would have been nice to have it in final CFA
4PE: The ergonomic arrangements of the work stations at my workplace are in order	Keep	Theoretically different than other variables in physical environment. Might still be an important driver for well-being at work and productivity
10VE: Workers can see other workers' electronic calendar	More data needed	This was dropped from the final model, probably due to low variance in responses
16SE: Telework is a generally accepted practice at my workplace	More data needed	Loading was just below the threshold of 0.5, probably because of that, it was not allowed in many of the organizations
1IWP: I use technology (e.g. videoconferencing or instant messaging) to reduce the need to for unnecessary travelling	Keep	Does not belong to theoretical model, but it is interesting for managers to know if employees are utilizing possibilities or not
2IWP: I utilize mobile technology in work situations where I have to wait about (e.g. working on the laptop or phone in the train)	Keep	Does not belong to theoretical model, but it is interesting for managers to know if employees are utilizing possibilities or not
4IWP: I do things that demand concentration in a quiet place (e.g. in the quiet room or at home)	Keep	Does not belong to theoretical model, but it is interesting for managers to know if employees are utilizing possibilities or not
8IWP: If necessary I close down disruptive software in order to concentrate on important work task	More data needed	The nature of the work might not allow this. It is an interesting variable for future research
4WB: My work does not cause continuous stress	Drop	This variable is difficult to evaluate as it is unclear how much stress is good or bad
6WB: My work and leisure time are in balance	Keep	This might be an explanation if well-being or productivity is low, but it is not theoretically close to anything to load into current factors
4P: I have sufficient skills to accomplish my tasks efficiently	Keep	Theoretically important part of productivity, but it does not fit into any factors
7P: The group(s) of which I am a member work efficiently as an entity	Keep	This was not supposed to load anywhere, but it offers an interesting angle to productivity as the results are significantly lower than in the other productivity variables

The limitations of this study arise from data collection. The main part of the data is collected from public or third-sector organizations, which means that there is a possibility that the work environment is biased. These organizations are typically a bit more conservative when it comes to work practices and hierarchy. It can be seen, for example, in the physical environment where more employees have their own room or in the virtual environment, which might not be as exploited as somewhere else. This might cause some low factor loadings. Response rates were very good in every organization, but there is always a possibility that a non-response bias exists.

For future research, this study offers two clear paths. The first is to continue validating this tool by countering the possible biases and testing it with the new data from different types of organizations. The second path is to use it to gather research data and analyze the results from the knowledge workers' points of view. This could contain, for example, analysis of what makes some knowledge workers more productive than others. The third option is to combine these two paths and find out if the framework based on literature works in practice, i.e. whether the work environment, individual work practices and well-being at work impact on productivity.

6. Conclusions

SmartWoW tool is an interesting approach for measuring impacts of work environment changes on knowledge work productivity. It gives information for managers on what the current state of the work environment is, individual work practices, well-being at work and productivity. Previously, there has not been a tool that combines all these dimensions, which is important with major work environment changes. The contribution of this study to this field of inquiry is that it improves the SmartWoW tool by confirming the structure, adding four variables to increase the reliability of the dimensions and dropping one variable as too difficult to understand. The results allow six dimensions to be used as sum variables, which could then be used for comparing the results of two organizations. Hopefully, this tool finds its way into many organizations and work environment change projects because it provides valuable information for managers. Even better, if the data were also available for researchers because there are many interesting methods of analysis from different angles.

References

Ahire, S.L., Golhar, D.Y. and Waller, M.A. (1996), "Development and validation of TQM implementation constructs", *Decision Science*, Vol. 27 No. 1, pp. 23-56.

Bakker, A.B. and Demerouti, E. (2008), "Towards a model of work engagement", *Career Development International*, Vol. 13 No. 3, pp. 209-223.

Bentler, P.M. (1990), "Comparative fit indexes in structural models", *Psychological Bulletin*, No. 107, pp. 238-246.

Bland, J.M. and Altman, D.G. (1997), "Statistics notes: Cronbach's alpha", *BMJ*, No. 314, p. 572.

Bosch-Sijtsema, P.M., Ruohomäki, V. and Vartiainen, M. (2009), "Knowledge work productivity in distributed teams", *Journal of Knowledge Management*, Vol. 13 No. 6, pp. 533-546.

Byrne, B.M. (2001), *Structural Equation Modeling with AMOS: Basic Concepts, Applications and Programming*, Lawrence Erlbaum Associates, Mahwah, NJ.

Chau, P. (1997), "Reexamining a model for evaluating information center success using a structural equation modeling approach", *Decision Sciences*, Vol. 28 No. 2, pp. 309-334.

Claessens, B.J., Van Eerde, W., Rutte, C.G. and Roe, R.A. (2004), "Planning behavior and perceived control of time at work", *Journal of Organizational Behavior*, Vol. 25 No. 8, pp. 937-950.

Drucker, P.F. (1999), "Knowledge-worker productivity: the biggest challenge", *California Management Review*, Vol. 41 No. 2, pp. 79-94.

Fabrigar, L.R., Wegener, D.T., MacCallum, R.C. and Strahan, E.J. (1999), "Evaluating the use of exploratory factor analysis in psychological research", *Psychological Methods*, Vol. 4 No. 3, pp. 272-299.

Fornell, C. and Larcker, D.F. (1981), "Structural equation models with unobservable variables and measurement error: algebra and statistics", *Journal of Marketing Research*, Vol. 18 No. 3, pp. 382-388.

Gorgievski, M.J., van der Voordt, T.J.M., van Herpen, S.G.A. and van Akkeren, S. (2010), "After the fire – new ways of working in an academic setting", *Facilities*, Vol. 28 Nos 3/4, pp. 206-224.

Groen, B., van de Belt, M. and Wilderom, C. (2012), "Enabling performance measurement in a small professional service firm", *International Journal of Productivity and Performance Management*, Vol. 61 No. 8, pp. 839-862.

Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. (2006), *Multivariate Data Analysis*, Prentice Hall, Upper Saddle River, NJ.

Halpern, D.F. (2005), "How time-flexible work policies can reduce stress, improve health, and save money", *Stress and Health*, Vol. 21 No. 3, pp. 157-168.

Heerwagen, J.H., Kampschroer, K., Powell, K.M. and Loftness, V. (2004), "Collaborative knowledge work environments", *Building Research & Information*, Vol. 32 No. 6, pp. 510-528.

Jääskeläinen, A. and Laihonen, H. (2013), "Overcoming the specific performance measurement challenges of knowledge-intensive organizations", *International Journal of Productivity and Performance Management*, Vol. 62 No. 4, pp. 350-363.

Kattenbach, R., Demerouti, E. and Nachreiner, F. (2010), "Flexible working times: effects on employees' exhaustion, work-nonwork conflict and job performance", *Career Development International*, Vol. 15 No. 3, pp. 279-295.

Kearns, H. and Gardiner, M. (2007), "Is it time well spent? The relationship between time management behaviours, perceived effectiveness and work-related morale and distress in a university context", *High Education Research & Development*, Vol. 26 No. 2, pp. 235-247.

Kelly, E.L., Moen, P. and Tranby, E. (2011), "Changing workplaces to reduce work-family conflict schedule control in a white-collar organization", *American Sociological Review*, Vol. 76 No. 2, pp. 265-290.

Koopmans, L., Bernaards, C., Hildebrandt, V., van Buuren, S., van der Beek, A. and de Vet, H. (2013), "Development of an individual work performance questionnaire", *International Journal of Productivity and Performance Management*, Vol. 62 No. 1, pp. 6-28.

Laihonen, H., Jääskeläinen, A., Lönnqvist, A. and Ruostela, J. (2012), "Measuring the productivity impacts of new ways of working", *Journal of Facilities Management*, Vol. 10 No. 2, pp. 102-113.

Lubke, G. and Muthen, B. (2004), "Applying multigroup confirmatory factor models for continuous outcomes to Likert scale data complicates meaningful group comparisons", *Structural Equation Modeling*, Vol. 11 No. 4, pp. 514-534.

Maarleveld, M., Volker, L. and Van Der Voordt, T. (2009), "Measuring employee satisfaction in new offices–the WODI toolkit", *Journal of Facilities Management*, Vol. 7 No. 3, pp. 181-197.

McDonald, R.P. and Marsh, H.W. (1990), "Choosing a multivariate model: noncentrality and goodness of fit", *Psychological Bulletin*, No. 107, pp. 247-255.

Miles, I. (2005), "Knowledge intensive business services: prospects and policies", *Foresight*, Vol. 7 No. 6, pp. 39-63.

Mulaik, S.A., James, L.R., Van Alstine, J., Bennett, N., Lind, S. and Stilwell, C.D. (1989), "Evaluation of goodness-of-fit indices for structural equation models", *Psychological Bulletin*, Vol. 105 No. 3, pp. 430-445.

Narver, J. and Slater, S. (1990), "The effect of a market orientation on business profitability", *Journal of Marketing*, Vol. 54 No. 4, pp. 20-35.

O'Neill, M.J. (2010), "A model of environmental control and effective work", *Facilities*, Vol. 28 Nos 3/4, pp. 118-136.

Origo, F. and Pagani, L. (2008), "Workplace flexibility and job satisfaction: some evidence from Europe", *International Journal of Manpower*, Vol. 29 No. 6, pp. 539-566.

Palvalin, M., Lönnqvist, A. and Vuolle, M. (2013), "Analysing the impacts of ICT on knowledge work productivity", *Journal of Knowledge Management*, Vol. 17 No. 4, pp. 545-557.

Palvalin, M., Vuolle, M., Jääskeläinen, A., Laihonen, H. and Lönnqvist, A. (2015), "SmartWoW – constructing a tool for knowledge work performance analysis", *International Journal of Productivity and Performance Management*, Vol. 64 No. 4, pp. 479-498.

Ramirez, Y.W. and Nembhard, D.A. (2004), "Measuring knowledge worker productivity: a taxonomy", *Journal of Intellectual Capital*, Vol. 5 No. 4, pp. 602-628.

Ramirez, Y.W. and Steudel, H.J. (2008), "Measuring knowledge work: the knowledge work quantification framework", *Journal of Intellectual Capital*, Vol. 9 No. 4, pp. 564-584.

Ruostela, J. and Lönnqvist, A. (2013), "Exploring more productive ways of working", *World Academy of Science, Engineering and Technology, International Science Index 73*, Vol. 7 No. 1, pp. 611-615.

Ruostela, J., Palvalin, M., Lönnqvist, A., Patjas, M. and Ikkala, A.-L. (2014), "'New ways of working' as a tool for improving the performance of a knowledge-intensive company", *Knowledge Management Research & Practise*, advance online publication, March 10, 2014, doi: 10.1057/kmrp.2013.57.

Schaufeli, W.B., Bakker, A.B. and Salanova, M. (2006), "The measurement of work engagement with a short questionnaire: a cross-national study", *Educational and Psychological Measurement*, Vol. 66 No. 4, pp. 701-716.

Schumacker, R.E. and Lomax, R.G. (1996), *A Beginner's Guide to Structural Equation Modeling*, Lawrence Erlbaum Associates, Mahwah, NJ.

Sposito, V.A., Hand, M.L. and Skarpness, B. (1983), "On the efficiency of using the sample kurtosis in selecting optimal Lp-estimators", *Communications in Statistics-Simulation and Computation*, Vol. 12 No. 3, pp. 265-272.

Sureshchandar, G.S., Rajendran, C. and Anantharaman, R.N. (2002), "Determinants of customer-perceived service quality: a confirmatory factor analysis approach", *Journal of Service Marketing*, Vol. 16 No. 1, pp. 9-34.

Takala, J., Suwansaranyu, U. and Phusavat, K. (2006), "A proposed white-collar workforce performance measurement framework", *Industrial Management & Data Systems*, Vol. 106 No. 5, pp. 644-662.

Van der Voordt, T.J.M. (2004), "Productivity and employee satisfaction in flexible workplaces", *Journal of Corporate Real Estate*, Vol. 6 No. 2, pp. 133-148.

van Meel, J. (2011), "The origins of new ways of working – office concepts in the 1970s", *Facilities*, Vol. 29 Nos 9/10, pp. 357-367.

Vartiainen, M. (2007), "Analysis of multilocational and mobile knowledge workers' work spaces", in Harris D. (Eds), *Engineering Psychology and Cognitive Ergonomics. EPCE 2007. Lecture Notes in Computer Science*, Springer, Berlin, Vol. 4562, pp. 194-203.

Vartiainen, M. and Hyrkkänen, U. (2010), "Changing requirements and mental workload factors in mobile multi-locational work", *New Technology, Work and Employment*, Vol. 25 No. 2, pp. 117-135.

Wännström, I., Peterson, U., Åsberg, M., Nygren, Å. and Gustavsson, J.P. (2009), "Psychometric properties of scales in the General Nordic Questionnaire for Psychological and Social Factors at Work (QPSNordic): Confirmatory factor analysis and prediction of certified long-term sickness absence", *Scandinavian Journal of Psychology*, Vol. 50 No. 3, pp. 231-244.

West, S.G., Finch, J.F. and Curran, P.J. (1995), "Structural equation models with non-normal variables: problems and remedies", in Hoyle, R.H. (Ed.), *Structural Equation Modeling: Concepts, Issues, and Applications*, Sage Publications, London, pp. 56-75.

Wright, T.A. and Cropanzano, R. (2000), "Psychological well-being and job satisfaction as predictors of job performance", *Journal of Occupational Health Psychology*, Vol. 5 No. 1, p. 84.

Further reading

Chin, W.W. (1998), "The partial least squares approach for structural equation modeling", in Marcoulides, G.A. (Ed.), *Modern Methods for Business Research*, Lawrence Erlbaum Associates, Mahwah, NJ, pp. 295-336.

Cote, J.A. and Buckley, R. (1987), "Estimating trait, method, and error variance: generalizing across 70 construct validation studies", *Journal of Marketing Research*, No. 24, pp. 315-318.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol. 88 No. 5, p. 879.

Raykov, T. and Widaman, K.F. (1995), "Issues in structural equation modeling research", *Structural Equation Modeling: A Multidisciplinary Journal*, Vol. 2 No. 4, p. 289-318.

Wilcox, J.B. (1994), "Assessing sample representativeness in industrial surveys", *Journal of Business & Industrial Marketing*, Vol. 9 No. 2, pp. 51-61.

Appendix 1

Table AI Variables, means, standard deviations, skewness and kurtosis

Code	*Key variable*	*Mean*	*SD*	*Skewness*	*Kurtosis*
1PE	There is a space available for tasks that require concentration and peace at our workplace when needed	3.82	1.44	−0.89	−0.70
2PE	There are enough rooms at my workplace for formal and informal meetings	3.32	1.44	−0.29	−1.35
3PE	The facilities at my workplace enable spontaneous interaction between workers	3.79	1.20	−0.78	−0.43
4PE	The ergonomic arrangements of the work stations at my workplace are in order	3.74	1.20	−0.78	−0.43
5PE	There are generally no disruptive factors in my work environment (like sounds or movements)	2.99	1.40	0.02	−1.37
6PE	There is a place in which I can discuss or talk on the phone about matters which I do not want others to hear	3.73	1.43	−0.77	−0.87
7PE	The facilities at my workplace are conducive to efficient working	3.72	1.25	−0.74	−0.53
8VE	The usability of the main software for doing my work tasks is good	3.78	1.07	−0.83	−0.06
9VE	I can access the information I need wherever I am	3.62	1.18	−0.68	−0.52
10VE	Workers can see other workers' electronic calendar	4.23	0.98	−1.39	1.56
11VE	Workers can communicate with instant messaging tools (e.g. Lync, Skype)	4.31	1.04	−1.65	2.10
12VE	My workplace has sufficient equipment for virtual negotiations	3.63	1.21	−0.54	−0.74
13VE	My workplace has electronic teamwork tools (e.g. Google docs, Trello, Yammer)	3.47	1.22	−0.41	−0.73
14VE	There are appropriate mobile devices available at my workplace (e.g. laptop, iPhone, tablet)	4.02	1.13	−1.20	0.68
15SE	I am able to work in the ways and at the times which suit me best	3.65	1.18	−0.70	−0.47
16SE	Telework is a generally accepted practice at my workplace	3.72	1.26	−0.70	−0.66
17SE	Operations at my workplace are open (e.g. decision-making and information flow)	3.23	1.16	−0,.32	−0.85
18SE	Information flows well among the people important for my work	3.39	1.12	−0.46	−0.71
19SE	The meeting practices at my workplace are efficient	2.88	1.11	0.05	−0.87
20SE	Our workplace has clear guidelines regarding the use of IT and communication tools	3.25	1.08	−0.26	−0.64
21SE	I have clear goals set for my work	3.75	1.11	−0.82	−0.01
22SE	My work is assessed in terms of results achieved, not only hours worked	3.72	1.12	−0.77	−0.10
23SE	My work tasks constitute a reasonable whole	3.82	1.09	−0.87	0.09
24SE	New ways of working are actively explored and experimented at my workplace	3.08	1.15	−0.14	−0.76
1IWP	I use technology (e.g. videoconferencing or instant messaging) to reduce the need to for unnecessary travelling	3.83	1.15	−0.95	0.15
2IWP	I utilize mobile technology in work situations where I have to wait about (e.g. working on the laptop or phone in the train)	3.56	1.42	−0.64	−0.93

(*continued*)

Table AI

Code	Key variable	Mean	SD	Skewness	Kurtosis
3IWP	I try to manage my workload by prioritizing important tasks	4.32	0.73	−1.15	1.99
4IWP	I do things that demand concentration in a quiet place (e.g. in the quiet room or at home)	3.50	1.36	−0.51	−1.01
5IWP	I prepare in advance for meetings and negotiations	4.06	0.84	−0.98	1.16
6IWP	I take care of my well-being during the working day (e.g. by changing my work position or the place I work in)	3.67	1.10	−0.59	−0.44
7IWP	I follow the communication channels at my workplace	4.08	0.85	−0.93	0.93
8IWP	If necessary I close down disruptive software in order to concentrate on important work task	3.42	1.20	−0.34	−0.91
9IWP	I regularly plan my working day in advance	3.32	1.11	−0.40	−0.67
10IWP	I actively seek out and test better tools and ways of working	3.50	1.01	−0.38	−0.37
1WB	I enjoy my work	3.98	0.99	−1.14	1.15
2WB	I am enthusiastic about my job	4.05	0.96	−1.04	0.78
3WB	I find my work meaningful and it has a clear purpose	4.19	0.92	−1.33	1.78
4WB	My work does not cause continuous stress	3.14	1.21	−0.12	−1.06
5WB	My work performance is appreciated at my workplace	3.57	1.07	−0.62	−0.18
6WB	My work and leisure time are in balance	3.69	1.09	−0.58	−0.53
7WB	The atmosphere at my workplace is pleasant	3.80	1.02	−0.85	0.38
8WB	Conflict situations at my workplace can be resolved quickly	3.24	1.11	−0.30	−0.56
1P	I achieve satisfactory results in relation to my goals	4.09	0.81	−0.90	0.95
2P	I can take care of my work tasks fluently	4.04	0.83	−0.91	1.00
3P	I can use my working time for matters which are right for the goals	3.62	0.99	−0.61	−0.07
4P	I have sufficient skills to accomplish my tasks efficiently	4.26	0.77	−1.19	2.06
5P	I can fulfill clients' expectations	4.01	0.79	−0.78	1.00
6P	The results of my work are of high quality	4.11	0.72	−0.52	0.20
7P	The group(s) of which I am a member work efficiently as an entity	3.53	1.00	−0.56	−0.15

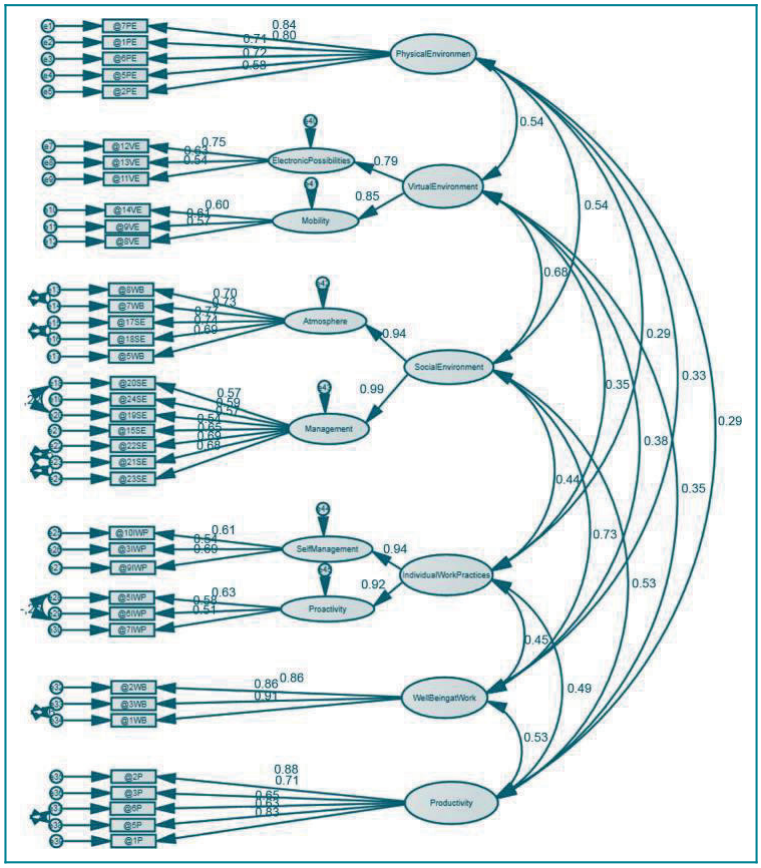
Appendix 2

Table AII EFA pattern matrix

	Factor									
Code	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
8WB	0.888									
7WB	0.851									
17SE	0.769									
18SE	0.677									
19SE	0.612									
24SE	0.409									
5WB	0.404									
7P	0.365									
20SE	0.355									
6P		0.852								
1P		0.796								
5P		0.779								
2P		0.743								
4P		0.630								
3P		0.502								
1PE			0.901							
7PE			0.827							
6PE			0.746							
5PE			0.716							
2PE			0.456		0.340					
4PE			0.383					0.321		
3PE										
10IWP				0.599						
9IWP				0.555						
8IWP				0.484						
5IWP				0.464						
6IWP				0.437						
3IWP				0.377						
7IWP				0.352						
12VE					0.753					
13VE					0.557					
11VE					0.495					
10VE										
2WB						0.944				
3WB						0.701				
1WB						0.627				
4WB							0.779			
6WB							0.736			
8VE								0.528		
9VE								0.476		
14VE					0.370			0.439		
15SE								0.376		
21SE									0.683	
22SE	0.315								0.596	
23SE									0.575	
2IWP										0.516
4IWP										0.408
1IWP										0.395
16SE										

Appendix 3

Figure A1 CFA model



Corresponding author

Miikka Palvalin can be contacted at: miikka.palvalin@tut.fi