What Matters for Knowledge Work Productivity?

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Abstract

Purpose – Knowledge work productivity is a well-studied topic in the existing literature, but it has focused mainly on two things. First, there are many theoretical models lacking empirical research, and second, there is very specific research regarding how something impacts 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 drivers of knowledge work productivity have an impact on productivity.

Method – Through the survey method, data was 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 – 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 – Knowledge work, productivity, measurement, performance, work environment

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 optimizing work processes. After the majority of the work has moved towards knowledge work, the productivity of knowledge work has also raised interest. Whileknowledge 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 21st 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. Syad, 1998; Davenport et al., 2002; Bosch-Sijtseva et al., 2009) have little to no empirical evidence, and second, a countless number of empirical studies have very focused drivers (see e.g. Kearns and Gardiner, 2008; 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 new ways of working (Appel-Meulenbroek et al., 2011; Ruostela et al., 2015).

The purpose of this paper is to answer the following research question: '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. 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 in 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 & 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, 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 those, they found a very similar classification to that of Davenport (2005). Margaryan et al. (2001) 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 & 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 & Thompson (2006) have recognized 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-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 could 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 (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 behavior. 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 behavior includes off-task behavior, 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', focuses 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-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.

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 in 1990 Campbell presented one of the common approaches (Viswesvaranha 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-Sijtseva 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 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 hasve 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-three 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 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 & 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 (Vartaiainen, 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).

H5: *Well-being at work is positively related to knowledge work productivity.*

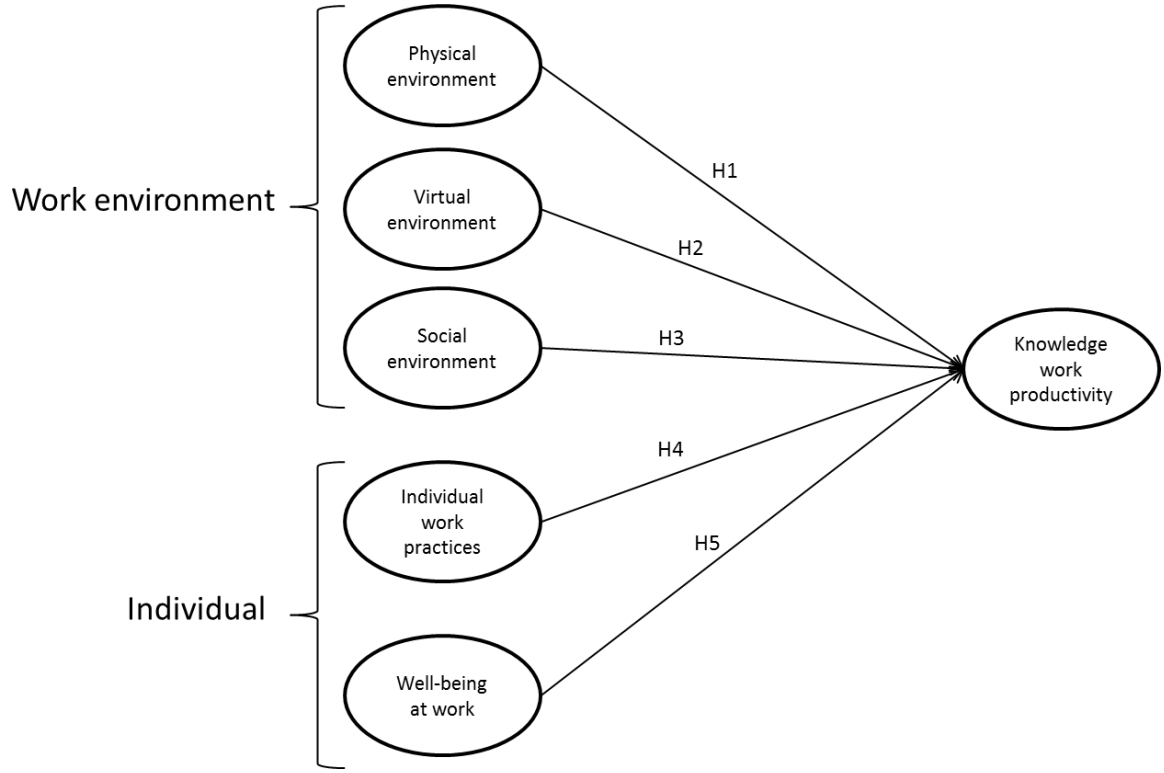

Figure 1. Conceptual model.

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. 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 was collected using an online survey for the organisations' own use and for scientific purposes. The survey consisted of 49, 5-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 Appendix 1. 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 email, and they typically had about two weeks' time to respond. The response rates varied from 33% to 89%.

Table 1. Respondents.

Sex	**n**	**%**
Female	602	60,3
Male	384	38,5
Missing	12	1,2
Age	**n**	**%**
<35	150	15,0
35-44	241	24,1
45-54	332	33,3
>54	265	26,6
Missing	10	1,0
Work space	**n**	**%**
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	**N**	**%**
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

The analysis included two primary methods: Confirmatory factor analysis (CFA) was used to confirm the hypothesised dimension structure in the conceptual model, and regression analysis (RA) was then conducted to point out if the hypotheses were supported or not. CFA included several iterations, and the results are presented in section 5.2. From 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 needs 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 Appendix 1). In RA, the independent variables cannot be multicollinear, which was achieved, as the variance inflation factor (VIF) was below 2,5 (see Table 4). 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%, 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 Appendix 1.

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 Appendix 2. 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 2.

Table 2. Reliability coefficients, correlations among factors and model fit.

	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*

* The square root of a given factor's AVE

x^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; x^2/df, chi-square 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

5.3 Regression analysis results

Table 3 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.

Table 3. Scale reliabilities, means, standard deviations and correlations. (Pearson, two-tailed)

	Alpha	Mean	SD	P	PE	VE	SE	IWP	WB
(P) Productivity	,86	3,97	,67						
(PE) Physical environment	,85	3,52	1,10	,236**					
(VE) Virtual environment	,73	3,80	,74	,252**	,413**				
(SE) Social environment	,90	3,45	,77	,451**	,469**	,505**			
(IWP) Individual work practices	,71	3,82	,60	,391**	,230**	,233**	,338**		
(WB) Well-being at work	,88	4,07	,86	,482**	,281**	,290**	,643**	,390**	

**. Correlation is significant at the 0,01 level (two-tailed).

The results of linear regression analysis are presented in Table 4, including standardised coefficients and related *p*-values. Table 4's adjusted R^2 value of 0,303 means that these variables can explain 30,3 percent of productivity.

Table 4. Regression analysis.

Dimension	**Standardised β**	***t*-value**	**Significance**	**Collinearity statistics (tolerance/VIF)**
Physical environment	,014	,445	,656	,734/1,363
Virtual environment	,024	,768	,442	,700/1,428
Social environment	,189	4,719	,000	,438/2,283
Individual work practices	,214	7,355	,000	,823/1,216
Well-being at work	,266	7,451	,000	,549/1,820
Constant		11,324	,000	
F	87,551		,000	
Adjusted R^2	,303			

5.4 Findings

H1: *Physical environment is positively related to knowledge work productivity* – not supported. As the results of regression analysis in Table 4 show, the relationship between the physical environment and productivity is positive (standardised β = 0,014), but it is not significant, so the hypothesis is not supported.

H2: *Virtual environment is positively related to knowledge work productivity* – not supported. Like physical environment, virtual environment has a positive relationship with productivity as well (β = 0,24), but it is not significant, so the hypothesis is not supported.

H3: *Social environment is positively related to knowledge work productivity* – supported. Social environment has a positive (β = 0,189) and significant relationship with productivity.

H4: *Individual work practices are positively related to knowledge work productivity* – supported. As the results of regression analysis show, the relationship between individual work practices and productivity is positive (β = 0,214) and significant, so the hypothesis is supported.

H5: *Well-being at work is positively related to knowledge work productivity* – supported. Well-being at work and productivity have the highest significant positive (β = 0,226) relationship among the dimensions, and thus, the hypothesis is supported.

Figure 3 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.

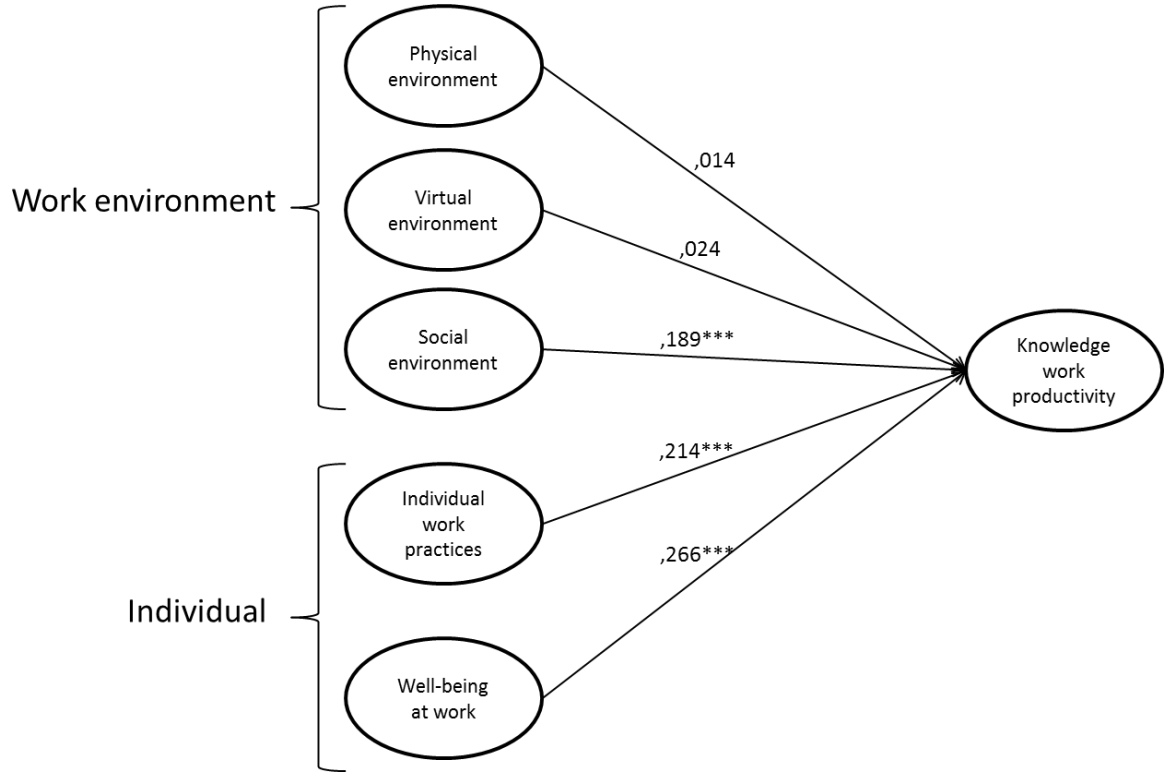

Figure 2. The main effects of work environment and individual factors on knowledge work productivity.

6 Discussion

The purpose of this research was to answer the following question: What matters to 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 regression analysis 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. Syad, 1998; Davenport et al., 2002; Bosch-Sijtseva 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-Sijtseva 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, 2008; 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 regression analysis 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 focusing 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 was 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 increasing interest in the NewWoW concept, which includes changes in the physical, virtual, and social environments and focuses 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 focusing on good management and knowledge workers' self-management skills.

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Appendices

Appendix 1. Variables, means, standard deviations, skewness and kurtosis.

Code	Key variable	Mean	Std.dev	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
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. CFA model.