Analysing the impacts of ICT on knowledge work productivity

Using ICT to leverage the productivity of knowledge-intensive service work

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Structured Abstract

Purpose – Knowledge work and knowledge-intensive services represent a challenging context for productivity improvement. In this paper, we examine how information and communication technology (ICT) can be utilized as a means to improve productivity in such a context. In addition, the measurement of productivity improvement is examined.

Design/methodology/approach – A case study is conducted in a medium-sized European teleoperator that provides ICT services for the consumer and enterprise markets. The case study examines the actual productivity impacts produced by a new ICT service.

Findings – The results show that ICT can be used to eliminate non-value-adding tasks or make them more efficient, thus giving time for knowledge workers' most important tasks. ICT can also result in improving employee welfare through decreasing dissatisfaction towards ICT systems and through transforming the content of work by deleting unimportant activities. Third, none of the potential ICT-based productivity benefits are automatic but instead depend on how the ICT service in question is implemented and utilized in the given context.

Originality/value – This paper provides new understanding about the potential of ICT in improving the productivity of knowledge-intensive services. In addition, it contributes to the measurement of productivity from the perspective of a customer organization utilizing an ICT service.

Practical implications – This paper presents a pragmatic case study on how to identify and measure the productivity impacts of ICT in the context of knowledge-intensive service work. This may serve as a benchmark for a company planning to carry out a similar initiative.

Keywords – knowledge work, ICT, measurement, productivity, service.

Paper type – Academic Research Paper

1 Introduction

Knowledge work and knowledge-intensive services represent typical job types and organizations in post-industrial countries. 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 labour-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. Thus, companies are eager to purchase various ICT services in order to improve the productivity of their knowledge workers. The potential productivity impacts of ICT can relate to both the service output experienced by a customer (e.g., satisfaction, outcome and value) and to the inputs (e.g., time, effort, emotional energy and cost) provided by that customer (Parasuraman, 2002; Johnston and Jones, 2004). Customer's experience in utilizing ICT in the service context is essential as the customers themselves have vital roles to play in creating service outcomes (Bitner et al., 1997).

It is not self-evident that a given ICT service will lead to positive 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).

In this paper, we examine how ICT can be utilized to improve productivity in the context of knowledge-intensive services. The purpose is also to identify and measure various productivity impacts of ICT. To reach these objectives the phenomenon is first examined conceptually through a review of earlier literature. 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 productivity impacts of ICT are approached through a performance measurement process that takes into account both tangible and intangible impact elements (Vuolle, 2011). Both qualitative and quantitative data is utilized.

The paper contributes to improved understanding on the potential of ICT in improving the productivity of knowledge-intensive services. In addition, it provides new insights on how to measure the productivity impacts in this particular context. The impacts of ICT on customer productivity have been challenging 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-intensive services (i.e., knowledge work) it is difficult to measure even the status of productivity. Thus, measuring the impacts of ICT is considerably more challenging in this context. This paper illustrates through the case study how this can be done.

2 Theoretical background

2.1 Productivity in knowledge-intensive services

Two specific aspects need to be taken into account when addressing productivity issues in knowledge-intensive services: the nature of the work can be characterized as *knowledge work* and the outputs produced as *services*. Both aspects affect how productivity is defined and how it can be measured (Grönroos and Ojasalo, 2004; Okkonen, 2004).

Knowledge work is a challenging and peculiar setting from managerial perspective (Drucker, 1999). In the literature various characterizations and classifications for knowledge-intensive organizations have been proposed (e.g., Käpylä et al., 2011; Miles et al., 1995; Starbuck, 1992; 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 well-known productivity formula, output divided by input, applies in the context of knowledge-intensive services. 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). As this paper is interested in the impacts ICT services can have on improving the productivity of a knowledge-intensive organization, a particular focus area is the customer perspective – i.e. the customer organization using the ICT service.

Edvardsson et al. (2005) suggest that service can be seen as a perspective on value creation where the focus is on value in use in the eyes of the customer. Sampson and Froehle (2006) argue that the presence of customer inputs (customer self-inputs: physical presence or mind, tangible belongings, or customer-provided information) is a necessary and sufficient condition to define a production process as a service process. Services research also provides perspectives related to the nature of services (e.g., quality aspects, intangibility) (Grönroos, 2007; Lovelock, 1983) and defines the concepts of service productivity and customer productivity (Grönroos and Ojasalo, 2004; Johnston and Jones, 2004; Parasuraman, 2002; Anitsal and Schuman, 2007) for understanding the impacts from the customers' point of view.

In the service context, productivity is seen broadly including also quality and customer perspectives. Bitner et al. (1997) see the customer as productive resource, as contributor to quality, satisfaction and value, and as competitor to the service organization. Depending on the customer's role in the service process (e.g., self-service vs. passive recipient of the service), the service provider's inputs and customer's own participation have varying influence on the service process and productivity (Grönroos and Ojasalo, 2004).

Customer productivity refers to the ratio of the service output experienced by a customer to the inputs provided by that customer as a participant in service production (Parasuraman, 2002). Customer outputs include satisfaction, experience, outcome and value, whereas customer inputs include, for example, time, effort, cost, emotional energy and the degree and quality of customer labor (Parasuraman, 2002; Johnston and Jones, 2004; Anitsal and Schumann, 2007). According to Anitsal and Schumann (2007), output for customer includes customer savings (in terms of effort and time) and quality of the service, and finally, overall outcome is the customer's perception of their own productivity. Service providers can offer improved services by understanding the relationships between customer productivity and its components (Anitsal and Schumann, 2007).

Service experience can be seen as an output component of customer productivity (e.g., Johnston and Jones, 2004). According to Bitner et al. (1997), a service experience is the outcome of

interactions between organizations, related systems/processes, service employees and customers. According to Sandström et al. (2008), service experience is the sum total of the functional and emotional outcome dimensions of any kind of service. In addition to service experience, *user experience* is an important factor when studying technology-based services. It refers to a person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service (ISO 9241-210, 2010).

According to Vargo and Lusch (2004), services should be evaluated in relation to the value customer gains from using the service. For Sandström et al. (2008), *value in use* is the evaluation of the service experience, i.e. the individual judgment of the sum total of all the functional and emotional experience outcomes.

2.2 ICT-based productivity improvement of knowledge-intensive services

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 et al., 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. 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 1.

Table 1. 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 et al., 2009; Akkirman and Harris, 2005; Sigala, 2003; Bearudreau, 2009
Better access for information • Real time information • Sharing knowledge	Shin, 1999; Flanagan and Marsh, 2000; Ahuja et al., 2009; Gressgård, 2011
Enhanced information quality • Less errors • Better decisions	Suwardy et al., 2003; Erne, 2010; Aghazadeh and Seyedian, 2004
Employee welfare • ICT does not increase work welfare and motivation, but may decrease it if usability is poor	Motivation: Kaplan and Aronoff, 1996; Kinnie and Arthurs, 1996; Hosie and Sevastos, 2009; Appelbaum et al., 2005 Usability: Cardinali, 1994; Turkyilmaz et al., 2011

The list of potential benefits presented in Table 1 is not exhaustive as there are many specific work tasks which may benefit from ICT. However, the most typical benefits are covered. They are shortly discussed below.

First, time is a scarce resource for knowledge workers and ICT can help save time (while it should be noticed that ICT also consumes knowledge workers' time). Automation of routine tasks and easier communication with colleagues using ICT are good examples of ICT solutions which enable knowledge workers to use their time more efficiently. Second, access to information has an impact on knowledge workers' productivity as it is a key input as well as output of their activities. ICT allows knowledge workers to get better access to information. It may also have an effect on information quality which, in turn, has an impact on the quality of output produced. The third important aspect affecting knowledge workers' performance is welfare and work motivation. Without those it is impossible to achieve good results. If a knowledge worker is not satisfied with the ICT solutions in use it is likely to lead to increased frustration and decreased welfare and motivation.

The 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.

2.3 The challenge of measuring the impacts of service usage

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).

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., 2000; 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 performance 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 performance in addition to a specific service, it may be difficult to determine which factors cause alteration in the performance level.

In this paper, performance 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). Performance impacts of IT are also referred with the concept of *IT business value* (Tallon et al., 2000; Melville et al., 2004; Basole, 2007). 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" (Melville et al., 2004). 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.

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).

2.4 Summary of the theoretical section

The continuously developing field of ICT seems to be a highly potential source for productivity improvements in knowledge-intensive service work. There is also a fair amount of prior studies examining the benefits of ICT. 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 situation. Furthermore, measurement of the productivity impacts of ICT services has proven to be a challenge in practice. Therefore, there is still a need for further analytical insights on the productivity impacts of ICT on the productivity of knowledge work.

It is considered here that a thorough understanding of the customer organization's operations is needed as a starting point in order to understand which benefits may be achieved from the usage of certain ICT service. Based on this, it is possible to tailor measurement instruments to capture those impacts. Next, a case study exploring this proposition is described.

3 Empirical examination

3.1 Description of 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. 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.

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 service.

The next step in the research process was 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 (discussed in the theoretical section), was used as basis for designing the survey questions.

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 2. 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 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.

3.2 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 minutes per one usage scenario.

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 thirty 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). The results concerning time savings are presented in Table 2.

Table 2. Time saved by using the new service (mean values per one person).

Mean time saving per one usage time	**Mean number of times benefiting from the service in one week**	**Calculated time saving for one week (objective)**	**Estimated time saving for one week (subjective)**
3 min	6.5 times	19.5 min (= 3 min * 6.5)	30 min

While Table 2 describes 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 (4290 hours, i.e. 536 eight-hour work days). This estimated time saving could even be turned into cost savings by using, for example, a 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 we also asked the respondents how they use the time that has been saved. The responses are shown in Figure 1. Almost fifty per cent of the respondents state that, as a result, they work more. The second most popular choice was the ability to improve the quality of the respondent's work (35 percent of respondents). Out of all

respondents fourteen 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.

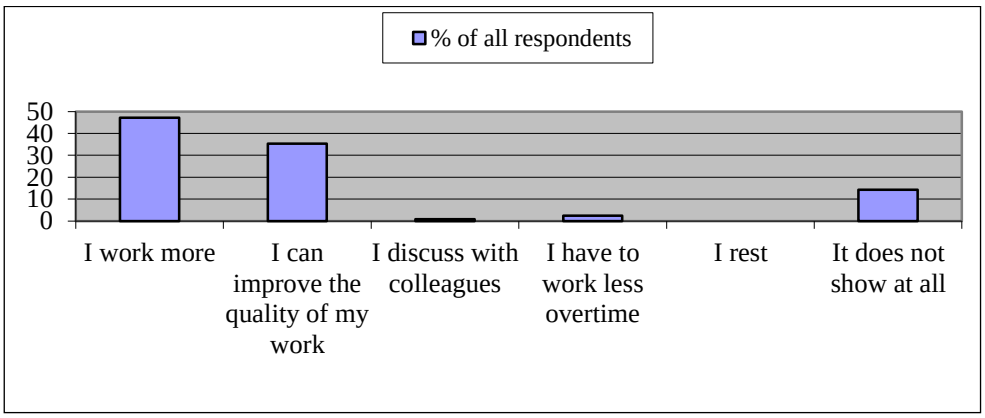

Figure 1. Utilization of the time saved.

Based on the results reported in Figure 1 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 1 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 2. 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.

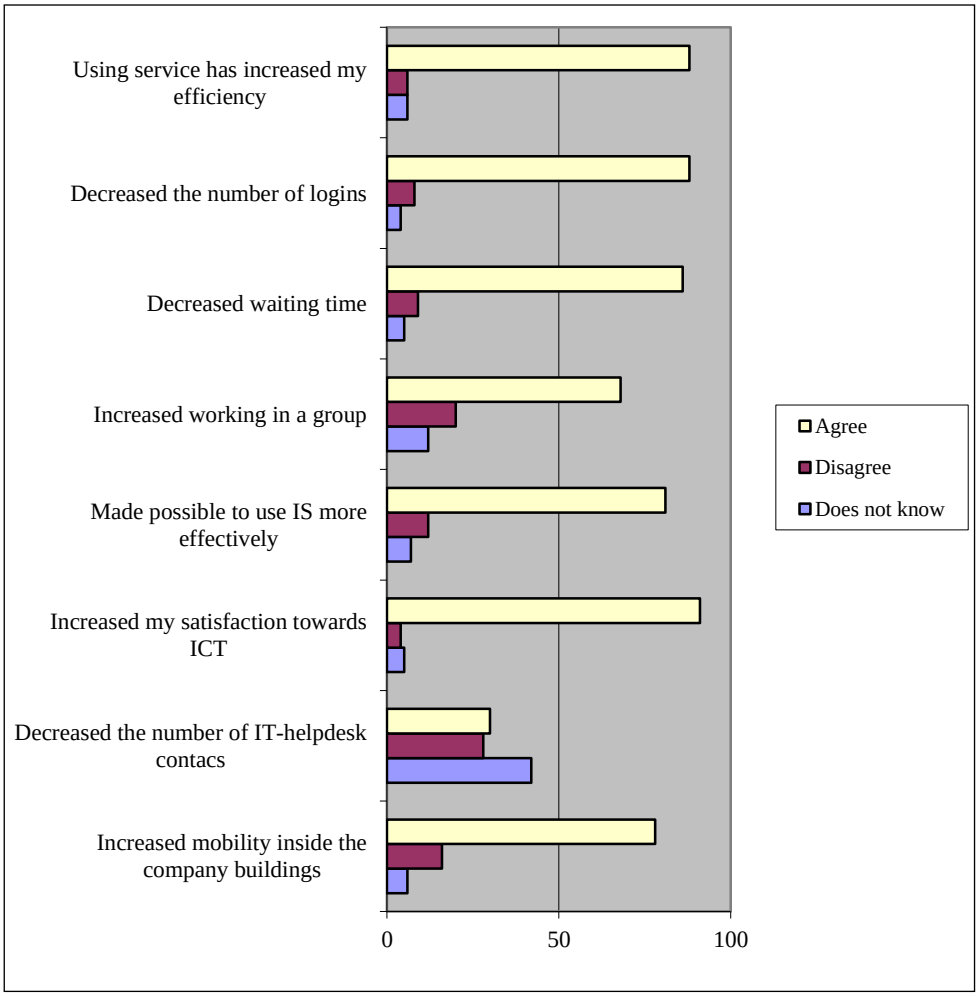

Figure 2. Experienced benefits of the new service.

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. Thus, this issue deserves further analysis.

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 we 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.

Finally, 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. An explanation of 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 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.

4 Conclusions and discussion

The literature research identified a list of knowledge work productivity drivers (or "bottlenecks") which can potentially be affected using ICT services. ICT may help knowledge workers to skip unnecessary work tasks, to accomplish tasks faster, to obtain information easier, to improve the quality of information processed and to support employee welfare (through decreasing dissatisfaction with poorly functioning solutions). A key benefit that ICT offers to knowledge workers is time saving, so that they can spend more time for value creating activities.

The case study conducted at TeliaSonera showed that the ICT service in question was intended for producing similar benefits to those discussed above. 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. When the issue is examined from the service perspective it can be claimed that the new service creates productivity impacts for the

customers 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.

Based on the case study, supported by previous literature, it is proposed here that the use of ICT can facilitate productivity impacts on knowledge work in the following ways:

1. ICT can be used to eliminate non-value-adding tasks or make them more efficient, thus giving time for the most important tasks.
2. ICT can result in improving employee welfare through decreasing dissatisfaction towards ICT systems and through transforming the content of work by deleting unimportant activities.
3. None of the potential ICT-based productivity benefits are automatic. The key issue is analyzing the work practices and locating the potential for productivity improvement. Then, it is possible to identify ICT solutions suitable for the particular issue in question. Furthermore, 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.

Another key perspective in the paper was the measurement of the impacts of the ICT service on the productivity of a knowledge-intensive organization using the service. The extant literature reports thoroughly the variety of problems associated in such measurements (e.g., capturing qualitative and intangible phenomena, taking into account time lags and so on). The process applied in this study consisted of the following key steps. First, the expected benefits (factors to be measured) were identified. Second, measures – both subjective and objective – were designed to best capture the key impact elements. Third, the interpretation of the measurement result 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).

In the case study, the use of both subjective and objective measures worked quite well. Objective measurement suits well in capturing concrete issues such as time saving. Similarly, subjective measurement is suitable for capturing complex and qualitative phenomena such as perceptions towards the usability of an ICT system. The measurement results seemed useful and accurate enough for the purposes of the case study: they demonstrated the key benefits and also pointed out some areas for improvement. Furthermore, the measurement process carried out was very pragmatic and efficient (i.e., it did not take a lot of effort from managers or employees).

To summarize the measurement perspective, contrary to the view presented in the 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.

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