Increasing Information Worker Productivity through Information Work Infrastructure

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Abstract. Deploying high-quality information work infrastructure leads to higher productivity levels of information workers, findings from empirical research show. Different types of information workers use different sets of technologies and devices. Knowledge workers with a high degree of autonomy depend on mobile and flexible work infrastructure. The OFFICE21® Information Worker's Workplace supports productive information work.

Keywords: information work, knowledge work, productivity, workplace, work infrastructure, technology profile, information and communication technology.

1 Introduction

The number of people working in offices keeps growing. For example, estimates say that some 45% of the working population in Germany work in office type environments where they process information, generate knowledge, or develop innovative products and creative solutions. Yet, it is not fully understood how to measure and increase the productivity of this increasingly valuable personnel. One lever for increasing productivity is to invest and provide better tools and work infrastructure including information and communication technology (ICT).

Investments in information technology lead to significant changes in the competitive environment and can increase the productivity of organizations. McAfee and Brynjolfsson [1] argue that not only the deployment of enterprise information technology (e.g. ERP and CRM systems, Web 2.0 applications etc.) leads to higher levels of productivity but also the usage of these technologies in particular for propagating business processes and innovations within an organization generates competitive difference. According to Vluggen and Bollen, IT investments have become a new competitive necessity [2] that organizations should embrace rather than simply accept.

To increase productivity on the individual level an active adoption and an appropriate integration of new equipment and applications is necessary. As Davenport [3] pointed out "companies load up knowledge workers with desktop and laptop computers, personal digital assistants, cell phones, wireless communicators, e-mail, voice mail, and instant messaging – then leave them to their own device." As a consequence companies should actively seek productivity increases through information

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work systems by providing infrastructure that is appropriate for the type of information work to be performed.

As part of the project OFFICE21® at the Fraunhofer IAO in Stuttgart, Germany, the authors have conducted a series of studies – some conceptual [4], some empirical [5], [6] and [7] – in order to investigate information work and supportive infrastructures. Some results of this work are presented here.

2 Information Workers and Their Technology Profiles

To be precise about the terminology and the subject under investigation a characterization of information work profiles will be presented first. Subsequently, differences in the technological equipment as supportive infrastructure in form of selected technology profiles will be presented. The chapter closes with an assessment of the quality of the information and communication technology in use.

The findings presented here originate from an empirical study by Spath et al. [6]. It is based on the ongoing online-survey "Information Worker Check". The answers of 1020 German speaking respondents from January until December 2008 were considered and evaluated. The respondents were to 68.5% male and 31.5% female. The age of the respondents was well spread (age up to 29 years 12%, age 30-39 31%, age 40-49 37%, age 50 and older 20%). 22% of the respondents were in upper or middle management, 24% in lower management and 54% had no leadership position.

2.1 Knowledge Workers Are Information Workers – An Empirical Typology

Not all information work is knowledge work; however knowledge work is to a significant share information work. While seeking, handling, and acting upon information are general activities of both information and knowledge work, the distinctive characteristics of knowledge work are complexity with respect to the tasks, autonomy of the knowledge workers with respect to the work process they are engaged in, and newness with respect to the work results.

Focusing on these three constructs and accordingly formulated questionnaire items information workers have been surveyed for to learn about their characteristics, needs and current support through work infrastructure. The full sample of 1020 respondents displayed the following characteristics with respect to the indices computed based on the questionnaire items related to the three constructs: newness (average μ=4.87, standard deviation σ=1.14, number of data sets considered with respect to this variable n=975), complexity (μ=5.48, σ=1.04, n=979), and autonomy (μ=4.77; σ=1.31, n=805) each based on a 7-level Likert-scale. All questions related to a construct had to be answered by a respondent for his data to be considered in computing the results.

Through performing a cluster analysis four different types of knowledge workers were identified. As can be seen in Figure 1, a first cluster of respondents – hereafter called Type A – is characterized by comparatively low values with respect to all three indices computed (newness, complexity and autonomy). This profile is best described as "knowledge-based" work where experience and knowledge may be important however where only little own decision-making is needed, where newness

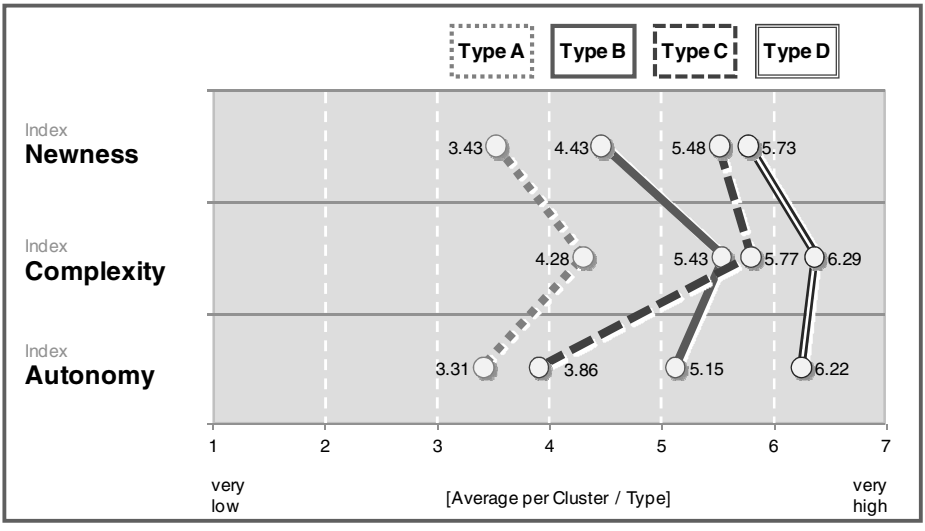

Fig. 1. Knowledge worker types and their profiles

is underrepresented with respect to the work results and where job complexity is below average. This profile relates to jobs with standardized processes and a significant share of routines (e.g. assistants).

The second cluster identified – Type B – represents respondents that perform knowledge work of average complexity and below average degree of newness with above average autonomy. This profile therefore stands for people performing "knowledge-intensive" work, i.e. tasks that require significant education and/or long-term experience in a particular field of work. This type B could for example be represented by a specialist in a particular occupation.

Type C – the third cluster identified – is characterized through high values with respect to the newness of the task and above average complexity but also through a below average autonomy. This profile also reflects "knowledge-intensive" work, however in contrast to Type B there is more newness with respect to the "what" and less autonomy with respect to the "when, where, and how" involved. Typical representatives of this cluster are for example engineers in development units who are bound to certain processes and laboratories.

The last cluster identified in this study – Type D – represents persons whose job profiles are to a very high degree characterized by newness and complexity of the tasks and who enjoy very high autonomy. The respondents in this cluster perform "knowledge" work in the narrowest sense possible. Their knowledge and experience needs constantly to be expanded, renewed, and revised in order find ever new solutions for the problems that arise. Representatives of this cluster are for example researchers but also consultants.

Returning to statement made earlier that not all information work is knowledge work however that knowledge work is to a significant share information work it becomes obvious that Type A and Type D are at different ends of the knowledge worker spectrum.

However, irrespective of their knowledge worker type all knowledge workers perform to a significant amount information work – with different purposes and different needs. It is this information work that can be supported directly by the work infrastructure, e.g. by ICT. Since this equipment serves primarily the handling and transmission of data and information rather than knowledge (which is a human trait) in the following we refer to "information work" and "information worker" as the encompassing terms for respective activities and persons. The typology introduced above will be sustained wherever appropriate for stressing the different requirements on information work infrastructures.

2.2 Information Worker Technology Profiles

A different group of questionnaire items addressed to the set of technologies and technological devices used by the respondents. In particular it has been of interest whether different types of information workers have access to different types of work infrastructure. At the same time potential differences in the daily use of the technologies and technological devices has been investigated.

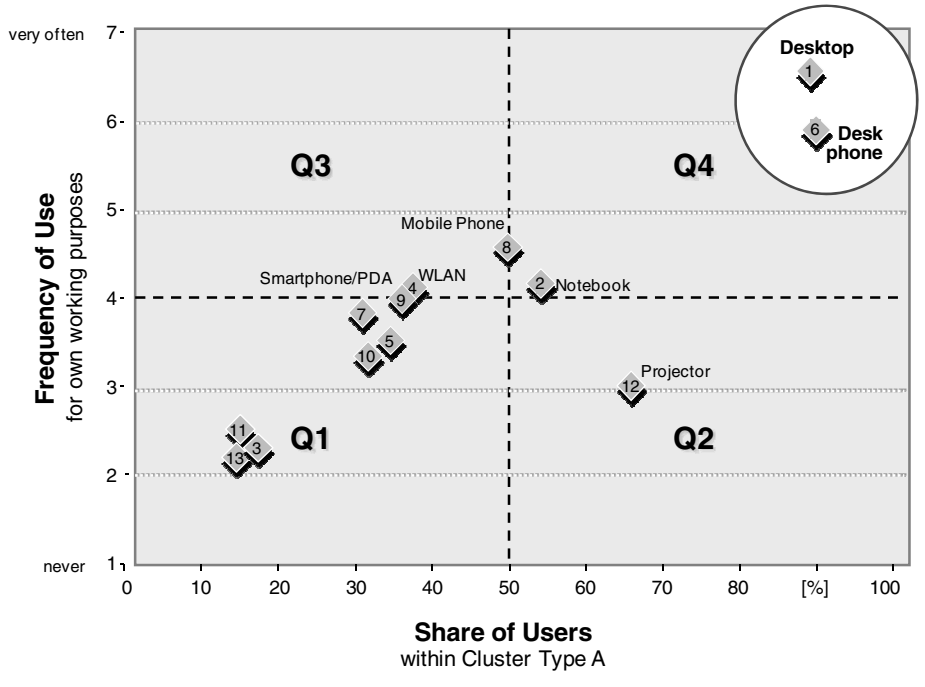

Fig. 2. Use of ICT available to information worker Type A

For this purpose typical technology profiles have been generated based on the data from the different clusters introduced above. These data sets have been evaluated with respect to the share of effective users of a particular technology or device and the

frequency of its use. As a result portfolio have been generated, two of which will be presented here. The portfolio of Type A (Fig. 2) will be contrasted to the portfolio of Type D (Fig. 3).

Within the cluster of Type A 90% of all respondents have access to a desktop personal computer and a desk phone. These two ICT devices are also the most commonly used for own working purposes. In addition, about half of Type A respondents have a notebook, wireless network access, and a mobile phone available and in more frequent personal use. This set can be described as a "basic set" of ICT for performing information work. In contrast, within the cluster of Type D a quite extensive set of nine different technologies and devices is available and frequently used by the respondents. The core of this set consists of a notebook and a mobile phone, both available to about 95% of the respondents. It becomes obvious that the high autonomy of Type D knowledge workers implies the need for mobile devices and flexible technologies.

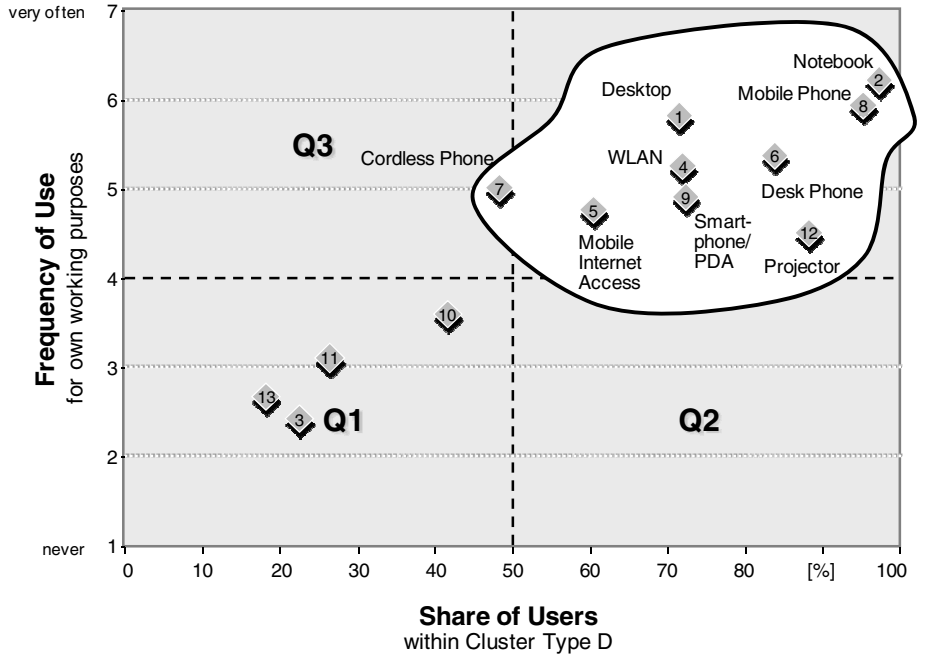

Fig. 3. Use of ICT available to information worker Type D

2.3 Quality of the ICT Set Available to Information Workers

For computing an index of ICT quality a set of questionnaire items has been evaluated that addressed different aspects of the technological work infrastructure. Particularly issues that are relevant to the general availability, functionality as well as the ease of use were investigated. Included were questions related to

- the accessibility of messages and documents irrespective of source and location;

- the reliability and stability of the ICT infrastructure;
- the availability of seamless solutions and general media consistency;
- the fulfillment of individual technological requirements;
- the general satisfaction level with the ICT equipment.

For the total sample the index of ICT quality demonstrates significant room for improvement (average μ=4.84, standard deviation σ=0.99). Highest scores were achieved with respect to the reliability and stability of the ICT infrastructure. On the low side, missing seamlessness and a rather low availability of the technological work infrastructure were the most important quality deficiencies.

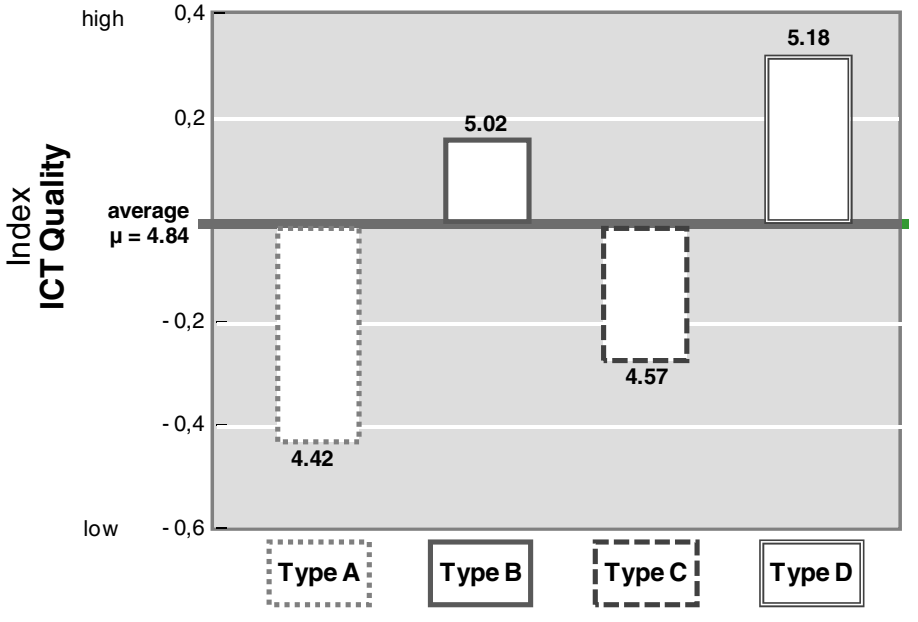

Fig. 4. ICT Quality Index for the different types of information workers

In a more detail analysis, the data shows a variation of the ICT quality index by the different clusters of respondents. While knowledge workers of Type A display the lowest quality of their technological work infrastructure, respondents of Type D have access to ICT of comparatively highest quality (Fig. 4).

3 OFFICE21® Information Worker's Workplace

As the results of the survey in the previous chapter show the higher the need for autonomy and consequentially for flexibility of the workforce, the more mobile and of higher quality the technological equipment becomes. In the same vein, the rollout of ever smaller and flexible devices in combination with increasing needs for communication and collaboration and supportive applications (e.g. e-mail push) changes the

way people work and how organizations function. For example, why should somebody still go to the office, if the ICT set allows for location independent work? In spite of the availability of high-end video conferencing systems, e.g. telepresence solutions, the need for formal or informal face-to-face interaction with colleagues and collaborators will rather increase than decline due to the nature of concurrent work processes. Unfortunately, the technological solutions designed for mobility and flexibility, are not optimized for co-located collaboration.

For better supporting information workers in this respect a workplace has been conceptually designed and prototypically implemented within the OFFICE21® project at Fraunhofer IAO that addresses the needs of flexible knowledge workers when in the office. The so-called Information Worker's Workplace (IWWP) provides a better work infrastructure for individual work as well as for small team or project meetings.

Fig. 5. a. /b. OFFICE21® Information Worker's Workplace – The original prototype [5]

As the pictures (Fig. 5) illustrate the most obvious characteristic of the IWWP is the triple-display setting. For individual work it provides a significantly enlarged desktop and for small meetings – whether co-located or distributed – it allows for parallel visualizations of different application windows. It is this simultaneous interaction with several applications (e.g. e-mail, browser, instant messaging, web conferencing, text document, presentation etc.) that to a large extent describes today's computer-based information work. Beyond that the IWWP supports an RFID-based login for personalization of the work environment – both physical (e.g. desk height or light brightness) and virtual (e.g. automated call-rerouting or personal settings of the periphery devices). A special functionality of the IWWP is its physical adaptability (compare Fig. 5.a. and Fig. 5.b.) for supporting informal communication and spontaneous interaction at the workplace. It abolishes the frequent search for a small meeting room or a projector by allowing connectivity for several persons at once.

4 Increasing Information Worker Productivity

Investing in better information work infrastructure – and particularly in ICT – is required to raise the productivity level of individuals and consecutively that of

organizations. Several studies conducted at Fraunhofer IAO, e.g. [5], [6] and [7], prove a positive relationship between the quality of the personal technology set of information workers and their individual performance and productivity.

4.1 Multi-display-Settings Increase Productivity

To prove that the investment into higher quality work infrastructure like the IWWP presented in the previous chapter are worthwhile a laboratory experiment has been undertaken at Fraunhofer IAO [7]. The study is based on the results of 67 information workers. About two thirds of the participants were male and one third female. The average age of the sample was 32.5 years. Participants were required to extract information from different sources, think of the right solution and produce a textual result. Participants who used a three-display workplace completed this task faster, i.e. more efficient, and more accurately, i.e. more effective, than in a conventional one-display setting. This is particularly relevant for information workers who often need to process multi-source digital information, e.g. scientists, engineers or administrative staff. At first for all study participants an individual productivity benchmark was calculated based on the time required and the points achieved for correctly solved partial tasks. In a second step, the participants were divided into different groups: one group completed the next task continuing using a single-display-setting. One other group contrasted here was given a workplace with three interconnected displays of the same type to form one single desktop – matching the IWWP setting.

The results of the experiment were in their clarity surprising. The group that continued using a single-display setting increased its productivity at this task on average by 1.9 percent. This outcome can be explained by the regular learning effect. The group using a triple-display setting was significantly more productive. On average the participants in this group raised their productivity level by 35.5 percent. These statistically highly significant results were achieved without any previous training or indications how to make best use of the triple-screen setting.

The users' reaction to the triple-screen setting was also very positive. In a post-test survey the participants reported on average considerably higher satisfaction levels with the increased display system in comparison to the single display users. A similar result has been produced by the Information Work Study by Spath et al. [6]: A statistically significant linear positive correlation between monitor size and user satisfaction has been identified.

4.2 Information Work Performance

For not mistaking the different measures and methodologies used in the different studies here the term performance is used to indicate that the measure "Information Work Performance" is like "ICT Quality" an index based on several questionnaire items [7]. It consists particularly of items referring to effectiveness (using the right means to achieve the goals set), efficiency (the effort made to achieve these goals), task-related communication (effort and intensity), collaboration quality and organisational process efficiency.

The computed full sample Information Work Performance Index (μ= 4.32; σ=1.02) shows that there is a lot of improvement potential. In addition, the data shows, that information workers rate their effectiveness with respect to right means and processes highest while they rate their efficiency with respect to time and effort to reach their goals lowest. Interestingly, also in this case, similar differences among the clusters of information workers become visible (Fig. 6). Again, information workers Type A scored lowest while those of Type D highest.

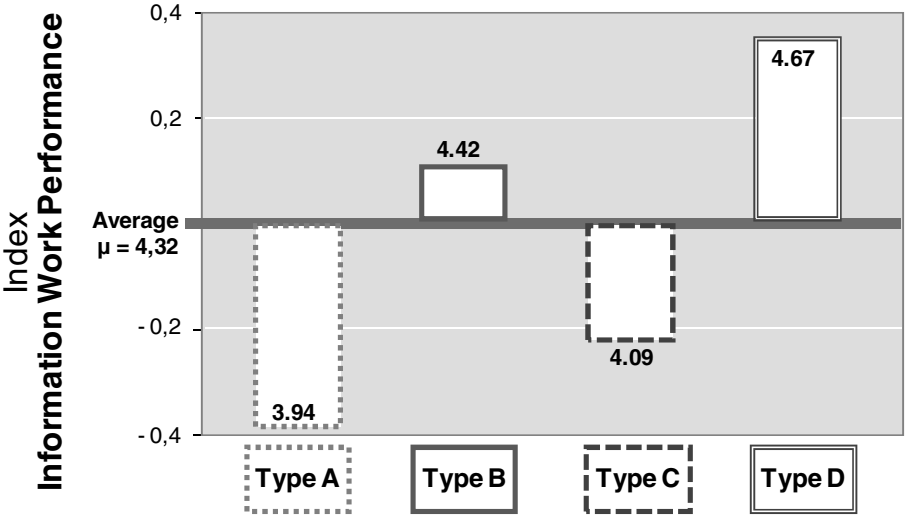

Fig. 6. Information Work Performance Index for the different types of information workers

5 Summary and Conclusion

The empirical findings presented here show that different types of knowledge and information work can be distinguished; that for different types of information work different sets of technologies and devices are in use; and that the ICT Quality and the Information Work Performance vary with the different types of information work. In addition, the OFFICE21® Information Worker's Workplace was presented. Based on a laboratory experiment it was proved, that productivity can be significantly increased by providing a multi-display setting similar to the IWWP.

In conclusion: Productivity of information workers is increased by providing supportive information work infrastructure. The statistically significant positive correlation between ICT Quality and Information Worker Performance (Figure 7) proves that one lever to higher productivity levels is information work infrastructure. Referring to Davenport's comment [3], deployment of appropriate and high-quality infrastructure for information workers is not a fad but a clear necessity.

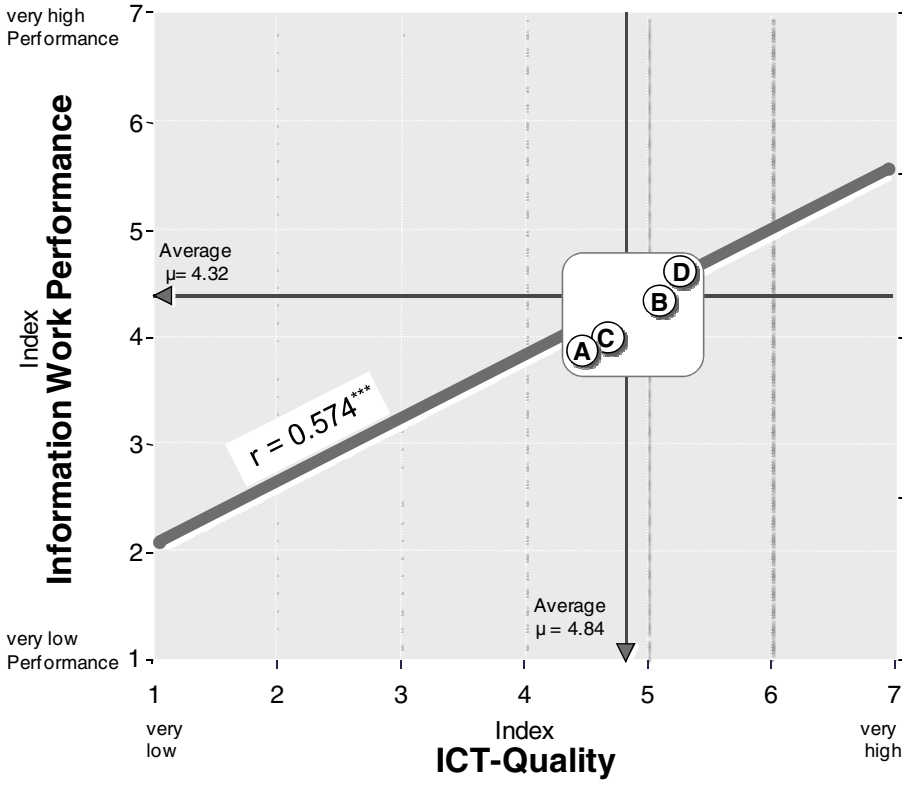

Fig. 7. ICT Quality correlates to Information Work Performance

References

1. McAfee, A., Brynjolfsson, E.: Investing in the IT That Makes a Competitive Difference, Harvard Business Review, 98–107 (July-August 2008)
2. Vluggen, M., Bollen, L.: A reply to [1]. Harvard Business Review, 110 (January 2009)
3. Davenport, T.H.: Let them all be power users. The HBR List: Breakthrough Ideas for 2005. Harvard Business Review, 41–42 (February 2005)
4. Kern, P., Bauer, W., Haner, U.-E.: Optimierte Infrastruktur für Wissensarbeit. Mensch und Büro 2, 36–37 (2007)
5. Greisle, A.: User-Study E-Work II – Information Worker Performance. Research Report. Fraunhofer IAO, Stuttgart (2006)
6. Spath, D., Kelter, J., Rief, S., Bauer, W., Haner, U.-E.: Information Work 2009. Fraunhofer IRB, Stuttgart (2009)
7. Haner, U.-E., Leuteritz, J.-P., Bauer, W., Hoffmann, S.: Knowledge Work Productivity and Multi-Monitor-Settings (in publication)