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Information ergonomics in eHealth

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Abstract

Maintaining performance in digital ubiquitous work environment is increasingly dependent on the quality of physical, cognitive and organizational ergonomics of work. Since digital work environment is the reign of most knowledge workers, there is a need to elaborate the study of work ergonomics by devoting attention to the issue of information ergonomics. In health care digitalisation has affected operation model thoroughly. It has affected how information is recorded, managed and distributed. Novel service models powered by digital channels offer now ways to practice professions as well as there are several outcomes regarding the whole service area. This paper is a summary of four research projects on how digitalisation affects knowledge work and how working is (re)shaped by sociotechnical work environments with reflection to eHealth. The conclusion in the paper underlines the digital transformation shaping the lives of knowledge workers. Discussion on how sociotechnical reshapes both individual and organisations, not to mention extended organisations. As the working practices as well as conventions and norms dictate the daily flow people have developed digital coping strategies. Paper also discusses the future of information ergonomics research in health care as way to find normative result for enhancing work in sociotechnical environment.

Keywords: information ergonomics, digitalisation

Introduction

Implementing digital operation models in health care has made a significant impact on different aspects of health care system. Most evidently, it has affected the way services are provided and produced. Recent research has shown that information management activities as well as service via digital means has affected the workflow of all health care service personnel, yet it should be also approached from the perspective of ergonomics and especially information ergonomics. Information ergonomics is way to approach sociotechnical work environments. As stated in Franssila et al [1], it is about show digital environments are adjusted to suit users, not how users should adapt to digital environment. Sociotechnical information system as defined by Lyytinen and Newman [2] it is the interplay between technology, actors, tasks, and structure. Berg [3] underlines role of technology when

embedded in work practices and vice versa. Berg & Goorman [4] emphasises the information rich operating landscape health care professional operate in and interact via information systems. On the other hand, Berg & Toussaint [5] define sociotechnical as manifestation of work processes and data flows, i.e. activity around and by information. In this paper sociotechnical system refers to technology enhanced activity system that supports spatial dispersion and asynchoronity for providing health care services.

This paper presents perspectives of information ergonomics based on taxonomy presented in Okkonen [6]. Technology related issues of information ergonomics consider interaction with different digital tools, systems and information channels, e.g. communication, information retrieval and storage and other information management related issues. Technology affects both human-computer interaction as well as human-human interaction. Themes of usability and user experience are topical in this context, yet low level of information ergonomics nor dysfunctionalities cannot be reduced to those. Conventions and habits, as well as individual skills, affect how individual positions oneself in digital environment and how the digital environment affects the performance. Moreover, the role of technology in this context too is dominant, as it defines the framework and functional boundaries.

Infrastructure related issues of information ergonomics consider socio-technological system that is somewhat manageable through applications and by instructions. Infrastructure consists of physical and digital environment, hardware and software, and intentions on purposeful use of those assets. Infrastructure affects ergonomics directly as technological restraint and via social factors. Social factors of information ergonomics affect vicariously as those are the products of interplay between individuals in digital environment. On the other hand, social factors can be seen as socially constructed conventions and set of explicit and implicit contracts. Social factors and infrastructure are closely of kin, but distinction should be made. Some infrastructural factors have very precise role and some social factors have not. For analytical purposes it is more useful to have two categories.

Individual factors of information ergonomics are the most obscure elements and variable too. The (micro) actions and decision individuals conduct and make during their active hours are dependent on the nature of the task and the work environment. As the work is more about managing and analyzing information, the most significant factor is digital work environment. There is a two-way effect. Digital environment has effect on how individual works and how the resources are utilized. On the other hand, individual has own habits of using digital resources, thus he/she has effect on the environment.

Digitalization of work may enable better use of knowledge [7,8]. It is expected to result in enhanced productivity [9-12]. It affects as well on efficiency [13,14]. However, when looking digitalization from the employee's viewpoint, it seems that the great expectations are not easily fulfilled. In fact, the effects of digitalization seem to be twofold: By bringing about ever more digital operation models, information systems, applications, user interfaces and operating systems to enhance productivity and efficiency of work, digitalization has led to increasing information load, hectic pace of work, multitasking, and interruptions [1] Studies confirm that users can experience ICT as demanding and stressful [15-17]. Another rather negative result of digitalization is potential weakening of social ties and reducing social inclusion: by increased use of ICT people tend to have less face-to-face contacts. In work context this may lead to weakening sense

of community, and consequently issues with trust and motivation. Consequences of inadequate information systems, such as decreased job satisfaction and engagement with the organization [18], can negatively affect work quality and productivity as stated in Okkonen [19].

Information ergonomics is to identify and manage information load at knowledge related work and develop methods for effectively suit different processes and conventions for individuals better cope demands of work. Information load can stem from the work content, work processes, the organization of work, work environment or the modes of action in the work community. So far, researchers have mainly approached loading factors at work in terms of cognitive load [20] and mental workload [21] In addition, the concept of information overload has become popular since the 1980s [22]. In general, information ergonomics is an issue of human technology interaction, socially constructed conventions and individual habits embedded to certain goal rational socio-technological system. Technology related issues of information ergonomics are about processes, environment, and organization of work, as well as the ones of social are about process, organization, modes of action and the ones of habits are work process, organization of work, and modes of action.

Technology related issues of information ergonomics consider interaction with different digital tools, systems and information channels, e.g. communication as discussed in Bordi et al [23]. Technology affects both human-computer interaction as well as human-human interaction. Themes of usability and user experience are topical in this context, yet low level of information ergonomics nor dysfunctionalities cannot be reduced to those. As depicted above, conventions and habits, as well as individual skills, affect how individual positions oneself in digital environment and how the digital environment affects the performance. Moreover, the role of technology in this context too is dominant, as it defines the framework and functional boundaries.

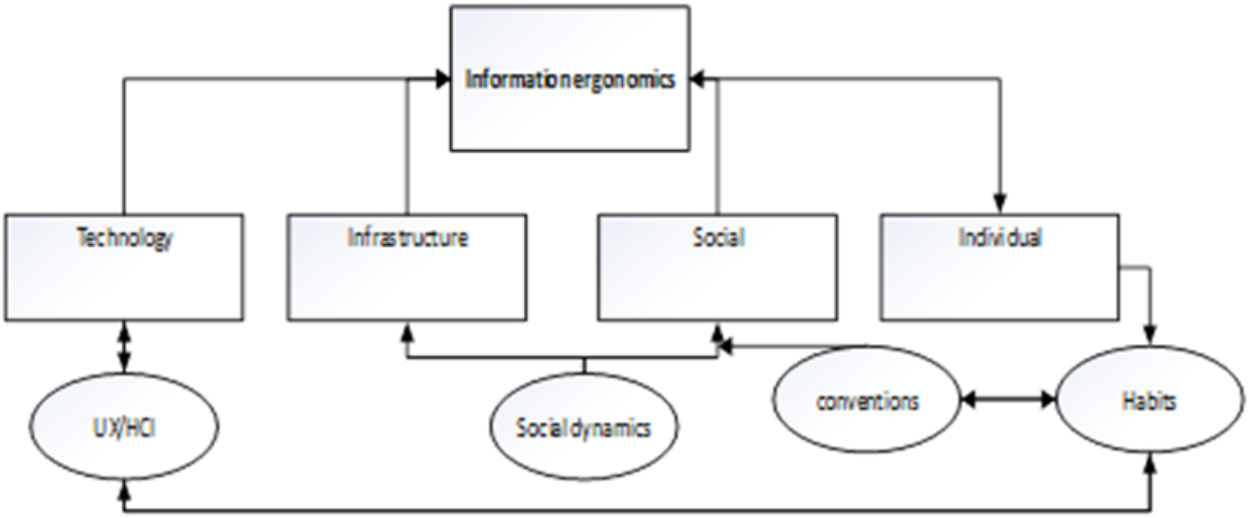

Figure 1. General framework of information ergonomics [6].

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To put above together, information ergonomics is issue of how user interacts with digital environment and by digital environment. The skills and habits are crucial factors for user experience; thus, user experience issues explain the functionality of human-computer apparatus to most extent. As the nature of knowledge work is about gathering, analysing and disseminating information and knowledge, digital work environment is also tool for cooperation and communication. Communication structure and mutual exchanges between different actors within the digital environment form other set of interaction schemes. In digitalized health care information ergonomics resonates with quality, patient safety, adequate working conditions and wellbeing as will be discussed in this paper.

Information ergonomics in three acts

Ergonomics in sociotechnical

The nature of information ergonomics was approached Franssila et al [1] by operationalising success factors and measures for sociotechnical related features of contemporary work. In particular, the operationalization and objective measurement of the dimensions of multitasking, interruptions at work, and practices for managing information load require more detailed research. In health care context it is mix of optimising workload and providing sufficient information in order to avoid friction. To identify relevant dimensions of information ergonomics, Franssila et al [1] made characterisation of the ergonomic attributes of knowledge work. The conceptual analysis in the study resulted in identification of key dimensions of information ergonomics. To this end, the findings of a study on cognitive overload by Kirsh [24] appeared to be particularly useful. To start with, information ergonomics deals with practices for managing information load – a crux issue for information ergonomics. According to Kirsh [23] a large amount of received information gives rise to cognitive load because the individual must decide for each received message or document whether it should be processed immediately or in the future, or whether it should be ignored. Issues such as these have mainly been examined from the perspective of personal information management as stated e.g. by Jones [24]. However, the

practices for managing information load in knowledge work are an insufficiently known factor in work productivity [25]. Highly relevant dimension identified in the conceptual analysis and field work was multitasking. It takes place when an individual is handling more than one task at the same time [26]. The third dimension of information ergonomics is interruptions at work that can either be caused by the work environment or be self-initiated [27,28]. Multitasking and interruptions cause extra information load because a shift from one task to other results in cognitive costs: An interruption/shift delays the restart of the original task. Empirical studies have shown that most interruptions are intentionally self-initiated, and they tend to be related to the use of ICT applications, such as checking one's e-mail [27]. As suggested by Kirsh [23], inadequate workplace infrastructure can give rise to cognitive load. For example, the higher the number of diverse information systems required at work, the more load that can appear.

The relationships between the exposure to information generated by an informational work environment, practices for managing information load at work, and responses to productivity and well-being at work require further elaboration yet connection was evident. Intervening variables mediating the effect of information load on productivity and well-being at work should also be taken into account. For example, that personality type and characteristics of organizational culture shape the above relationships.

Digital enablers and restraints of knowledge work

Okkonen et al [29] discusses the theme of sociotechnical of knowledge work by the actual workflow and different enablers and restraints of work. The implications to providing health care professional services is straightforward as there was recognised four main elements - physical work environment, organisational culture, motivation and information technology - as enablers and restraints of knowledge work. Health care was professional have distinct information demands for the right information on time. The enablers were typically the elements that facilitate the professionals' core work. In addition, the enablers helped the people to cope with their work pressure, handle the stress and cope with the heavy workload. Indeed, the aides were strongly related to the wellbeing at work. The core work of consisted of knowledge work actions, such as information acquisition, dissemination, creation and communication. The restraints were associated with the professionals' core work as well as wellbeing at work but in a negative way. Thus, challenges were considered as the elements that hindered the professionals to carry out their core work such as taking care of patients properly. Additionally, hindrances are seen as a reason for the heavy workload causing pressure for the professionals. In health care especially missing or incomplete information or non-functioning information systems caused additional stress.

The study raised lot of new elements that can act as enablers or restraints. These elements similarly affected the professionals' core tasks as well as the well-being at work either positively or negatively. However, they were emphasized and raised because they were closely connected to the special features of the different professions. These characteristics were specific to each profession and showed that the enablers and the restraints in the different professions cannot be completely the same. Therefore, a general and comprehensive model to support the knowledge work in different professions is relatively difficult to create as the special aspects of each profession could not be considered.

Key implications regarding health care are about performance. There seems to be three main categories of performance. The first category is individual performance supported by individual knowledge, skills, and working habits as well as functioning information infrastructure. The second performance category is about organisation supported by explicit operation procedures and socially constructed conventions. The third performance category is about social capital in sense of recognition of peers and key stakeholders in working domain. There categories are not exhaustive, yet as a conclusion of enablers and restraints they bring about the key issues related to knowledge work particularly. Especially in serving customers online, the limited interaction calls for supporting social and information infrastructure.

eHealth as sociotechnical activity system

Bordi et al [23] approaches sociotechnical by taking communication in digital work environment as a focal point. Vuori et al [31] takes more holistic view on digitalization in knowledge work, yet partly utilising the same dataset the finding can be summarised by reflecting it to taxonomy by Okkonen et al [6]. Vuori et al [31] presents key items related to sufficient work execution, self-efficacy, and efficiency, i.e. subjectively assessed productivity and information ergonomics. The findings could be categorized according to performance issues in relation to technology, infrastructure, social aspects, or individual aspects that are subject to digital work environments. These components were brought about when informants discussed their digital work environments and sociotechnical work settings.

Technology, per se, is affecting human technology interaction or user experience. Several people recognized their work habits having a strong relation to technology. In terms of productivity, technology is connected to self-efficacy since it deals with the ability to use and utilize technology. On the other hand, non-functioning or ill-functioning technology has a great impact over the control process and productivity. This is also connected to, in a sense, fragmentations since work does not have an even flow if technology has usability or dependability issues. Non-continuity disturbs the workflow and it has ill effect or providing services. In eHealth this refers both quality and safety as disturbance in process might cause distraction or block critical information flow or even halt the consultation.

Infrastructure is connected to technology and the planned structure of an organization; it determines workflow by the means of production. In the knowledge work context, this is mostly about ICT and information infrastructure. Communication infrastructure is also important; it dictates the modes of working and therefore has an impact on the sense of control and workflow. If technological issues and shortcomings are reduced, infrastructure is about how the work setting in organized, how information is stored and utilized, and how it manifests into the physical work setting. Infrastructure promotes efficiency thorough well-functioning practices by providing sufficient tools for working. Infrastructure is also related to self-efficacy since people have certain expectations of how it could, and will, support their performance in relation to their peers and stakeholders. This should be also acknowledged on the customer side as skill asymmetry is possible source for errors.

The social component has significance because of the organisational factors such as work conventions. Health care work setting social or cooperative factors define individual and organisational performance, yet regarding sociotechnical work environments, this seems to be one of the most misunderstood themes. Technological determinism is often

overruled by socially constructed conventions, thus those affecting the processes have more significance. Conventions have direct effects on productivity and efficiency through allocation of resources and, likewise, lead times. Moreover, established relationships enable quick problem solving as well as decision making. Acknowledging conventions supports a sense of self-efficacy and promotes a sense of control, thus reducing a negative stress factor that people cannot affect.

Individuals have several roles, and these vary when a context or situations change. In digital service environments, individual habits influence efficiency and overall performance. These habits are manifestations of conventions and reflect an individual style of working. These habits are often tacit, and in a sense people have only a vague idea of how their behaviour affects the others in the organization. In digital work environments, many actions and processes are conducted efficiently as technology supports workflow, yet unexpected ways of using technology may have an opposite effect. Individual tasks are performed easily, but those requiring iteration or communication are often more complex and some leverage is diluted by the vast use of ICT. Especially when working with customers or cross-disciplinary a double-check might be needed as discussed in Okkonen et al [29]

Looking at the social component, information practices and communication conventions play the most central role regarding productivity in knowledge work. Such MO requires coordinative actions by communication, yet it has a drastic effect on the ergonomic stages of the socio-technical system. Moreover, regarding individuals, the most evident findings related to how people maintain a balance between work and leisure during the day or week. Individual working habits are derived from organizational virtues, i.e. people are socialized to act according to certain ways, and this is shared within an organization. The findings resonate with previous studies that underline the effect of increased communication, diversity of task affecting the volume of communication, and how sociotechnical work environments cause a need for constant connectivity (see e.g. [32,6]). On the other hand, the self-inflicted interruptions or non-moderated digital work environment seem to cause stress [32,33]. Okkonen et al [6] discusses the effect of identified factors on work performance in knowledge work. The enabling factors i.e. autonomy, asynchrony, co-creation, efficient and fast knowledge flow, independency, and mobility were identified as key factors. Correspondingly, the factors constraining performance were as “always on” -mode, information overload, procrastination, stress and well-being, technological shortcomings, and time management challenges were discussed as restraints of knowledge work. They have either a positive or a negative effect on the performance of knowledge work actions. Considering health care work in by digital means those fit perfectly, yet some elaboration is still required. Especially spatial dispersion is considered somewhat problematic when serving patients as proximity lowers the burden of consulting other expert or augmenting skillset [34].

Conclusions on information ergonomics eHealth context

The findings presented in above are based on several studies on the topic of information ergonomics among health care professionals and other knowledge workers. The validity of the finding is by study triangulation. With these findings, this paper contributes primarily to the research on sociotechnical work environments. It is about setting knowledge work digital environment and how to

prioritize different performance factors or assess the importance of those. It contributes to research on information ergonomics as it elaborates how technology, people, and individual are forming complex activity system based on tacit, implicit and explicit rules, norms, conventions, and habits that shape activity called work. Moreover, as results underline information overload as a major issue in knowledge work organization also managerial implications can be drawn from it.

Those people working with high interdependent setting need explicit norms to build sustainable work habits as well as sustainable digital lifes. Sustainability here refers at least to how people are affected by interruptions, when they are addressed, how they are expected to react, and how work is spilled to leisure (cf. [33]). This is also issue of how individual habits should resonate with organizational conventions. Intraorganizational setting allows to set norms of productive working habits e.g. for communication behaviour that people are not expected to reply, or even check messages constantly. The setting is very also different when considering extended organization with large clientele. How they are supposed to be served? Especially on professional setting when service is attached to a person she or he is easily addressed and having pressure caused by digital work environment.

As stated above knowledge workers are affected by the expectations of constant connectivity (cf. [28]). As discussed in Bordi et al [30] communication channels serve several purposes in work and cannot be just neglected. As pointed out, people in different professions face the same pressure of being available and responding immediately. As the digital work environment is based on implicit expectations of short lead times also in communication activities, it causes a vicious circle of excess communication and task fragmentation and has effect on wellbeing. Especially working with patients the communication pressure is constant [29]. Moreover, previous studies have discussed the issue of how knowledge work is about digital communication to significant extent. The peers have their expectations about it, as well as the clientele and other stakeholders. Especially email seem to cause redundant work and stress (e.g. [30,35]. Diverse communication landscape leverages the even flow, yet it can cause constipation too if the time is spent with (somewhat trivial) communication through digital channels, people are procrastinating and trying to escape redundant tasks. Even in well-defined information systems the redundancy and unnecessary seeking, not to mention waiting, cause poor information ergonomics.

The future of sociotechnical environments in eHealth is about sociotechnical in general. As the modes of providing services become more diverse and independent of time and space the spill-over to leisure becomes more significant. The future of enhancing information ergonomics is set of advancing digital literacy through the life. It is not issue of school, nor it is issue of professional development. Thorough understanding on how digital environments affect work and leisure should be considered in all stages of life.

Digitalisation of health care service, not only intraorganisationally but also on customer interface too, sets new challenges to management of such activity system. There are several new vistas for further research. As stated in Okkonen et al 2018 [29] routine work is allocated to professionals as it possible by digital means of work. The first issue is about how optimal such arrangement is. Is it sub-optimisation in short term? Second issue is about the ergonomics of services. Do those serve their purpose and are professionals and customers able to use digital channels. The third issue is the

datafication of the health care, i.e. as all documents are digital and widely available the amount of information grows rapidly. It does not always serve the purpose, not especially in spatially dispersed and asynchronic operation model. Reflecting to year 2020 COVID-19 pandemic situation, the digitalisation has positive effects on resilience of the health care system as modes of operation could have been changed and digital operating model has been proven to be functional in large extent. However, when back to normal issues relating to information ergonomics in digitalised operating environments should be taken back on agenda. The most evident vista for research is to scrutinise the functionality of sociotechnical activity system of eHealth holistically. This is needed to enlighten the possible risks, and performance gains as well, as discussed in introduction. The functioning sociotechnical apparatus is ergonomic vehicle for providing safe and quality services with high practicality and wellbeing at work.

Conflict of interest statement

Author has no conflict of interest.

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