

Work systems in the context of digital work

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Abstract. The article gives an overview of research in the field of digital work and the terminology used there. Using a literature analysis, the characteristics of digital work are shown and related to the work system according to Alter. Alter's work system theory is an established approach in business informatics. The results of the elaborations show that the use of digital technologies has enabled a completely new way of working. Digital work is not only characterized by working on digital devices, but also by flexibility, new forms of work and an agile corporate culture. Especially participants in a work system are affected by digital work due to the features mentioned. But processes and the customer can also benefit from it.

Key words: Digitalization, literature review, digital work, work systems

1 Introduction

Artificial intelligence, Internet of Things, Blockchain and Cloud Computing are examples of new technologies that have emerged in recent years as a result of digitalization. The core of the digitalization is networking of products and processes and connection of the physical and virtual worlds. The technical foundation is the conversion of analog to digital data that can be used and distributed by numerous actors in networked systems [1]. Digital technologies entail new challenges in all areas of daily life. One of the new challenges is the change in the world of work towards digital work or "Arbeit 4.0". To evaluate the changes, it is recommended to consider "work" as a system. In this way, all components of "work", such as man, machine and information to be processed, can be included in the considerations. A long-established approach of such a system in business informatics is the work system of Alter [2].

In this context, the present contribution aims to determine the current state of research on the topic of "digital work". For this purpose, 2 research questions have been formulated.

RQ1: What features does "digital work" have and by which systems is it supported? The aim is to find out how "digital work" is defined and from when on "work" can be called "digital work". For example, is the use of a computer already sufficient criterion? In addition, research will be conducted to find out

which other systems and techniques, in addition to the classic computer, are still necessary to carry out work digitally.

RQ2: How does digital work influence the work system of Alter [2]? In the work system framework, according to Alter, nine elements are used which mainly emphasize the business concerns of a company and largely neglect IT. In this paper, we will therefore examine how digital work affects each of these elements.

In order to answer these research questions, a systematic literature analysis will be carried out first (Section 2) to find out the characteristics and prerequisites of digital work. The result (Section 2.2) shows that in addition to working with digital devices and the corresponding infrastructure to use them efficiently, aspects of digital work also include an appropriate corporate culture and media skills of employees. Section 3 will then look at the work system by Alter [2] and consider it under the influence of digital work. Especially the participants of the work system are affected by digital work. As new technologies influence the processes and activities in a system, the work of the participants who carry out the processes is also influenced. Section 4 discusses the limitations of our work. In the last section the main findings are summarised again and an outlook on future research is given (Section 5).

2 Characteristics and requirements of digital work

A systematic literature analysis is carried out to examine the characteristics and requirements of digital work. This chapter describes the exact procedure and the results.

2.1 Systematic literature review

The so-called snowballing approach by C. Wohlin [3] was used in the literature analysis. The databases dblp, Scopus and AIS eLibrary (AISeL) were searched using the search terms “digital work”, “work 4.0”¹, “new work”, “Digitale Arbeit” and “Arbeit 4.0”. The search terms refer to title, abstract and the keywords. As there were many hits (over 500), especially with Scopus, the search in this database had to be limited. Thus, “digital work” and “new work” were supplemented by the attributes “enterprise OR company OR business OR corporation”. This made sense as we are particularly interested in the role of digital work in companies. Educational institutions or medical facilities were not our focus at first. Furthermore, the search in the database dblp was limited to “digitale Arbeit” and “Arbeit 4.0” only, as the other search terms generated several thousand hits. The problem with dblp is that search terms cannot be further restricted. Thus, all contributions which contain the words “new” and “work”, for example, are displayed even if they are not related. Nevertheless, this database

¹ When evaluating the literature, it turned out that “work 4.0” is not a term used in English-speaking countries. “Arbeit 4.0” is a pure term from German literature and therefore cannot be translated 1:1.

was used because it is often referred to especially in the German speaking computer science. Table 1 gives an overview of the number of hits per database and search term achieved in June 2020.

Table 1. Number of hits per database and search term

Database	Searchterm	Results
dblp	Digitale Arbeit	27
dblp	Arbeit 4.0	16
scopus	TITLE-ABS-KEY (Arbeit 4.0)	28
scopus	TITLE-ABS-KEY (digitale AND arbeit)	19
scopus	TITLE-ABS-KEY (digi* AND "New work" AND (enterprise OR company OR business OR corporation))	37
scopus	TITLE-ABS-KEY ("digital work" AND (enterprise OR company OR business OR corporation))	88
scopus	TITLE-ABS-KEY ("work 4.0")	44
AISel	abstract:("new work") AND abstract:(enterprise OR company OR Business OR corporation)	4
AISel	abstract:("digital work") AND abstract:(enterprise OR company OR Business OR corporation)	10
AISel	abstract:("digitale arbeit") OR abstract:("Arbeit 4.0")	1

The initial search produced 274 results. The results were assessed on the basis of their titles and abstracts using predetermined criteria. Since the literature analysis is intended to provide an overview of the characteristics of digital work, posts that were focused on one area, such as employee qualifications or occupational safety were rejected. After the first screening, 44 contributions could be identified. From these results, a start set of four contributions [4, 5, 6, 7] was selected and then used for the backward and forward search. In backward snowballing, the reference lists of articles already found to be relevant were used to identify additional articles. In forward snowballing, the identification of new papers referred to the papers citing the paper under investigation. The citation references were identified using Google Scholar. This process was repeated with each new paper found to be relevant until no more new articles could be identified. The four contributions in the start set focus on different areas of digital work. Lindner et al. [6] have also carried out a literature analysis and defined the various terms around digital work, so it can be assumed that this contribution is well suited for backward searches. Hofmann and Günther [5] give an overview of Work 4.0 and its drivers as well as new forms of organization and work that arise from it. Dittes et al. [4], on the other hand, provide practical examples of how three different companies have introduced digital work and present the challenges of the introduction. Mrass et al. [7] provides a list of tools that exist in the area of digital work. Thus, the four contributions provide an input on different topics in the context of digital work.

2.2 Evaluation of the results of the literature review

According to Schwemmler and Wedde [8], digital work is defined as work with digital tools on digitized work objects. Thus, digital work describes work that is only made possible by digital technologies [9]. Digital technologies primarily refer to information and communication technologies such as computers, smartphones, etc.. Thus, digital work affects everyone who works at computers, in networks and with information [9]. Consequently, digital work can be characterised by the increased use of technology, digital communication, Internet use and mobile working [9]. If you look at the terms "digital work" you will involuntarily come across other terms that describe the work of the future and are strongly influenced by digitalization. Lindner et al. [6] give an overview of the various terms (among others): "Arbeit 4.0", New Work, digital workplace. "Arbeit 4.0" is the generic term for the future of the work [6]. This is influenced by digitalization, globalization and individualization [10]. "Arbeit 4.0" has a long range and, in addition to technological aspects, also includes topics such as qualifying employees and changing management principles [5]. New Work, on the other hand, describes the flexibilization of work places and times, "Work where you want, when you want and with whom you want" [6]. New Work is thus a part of "Arbeit 4.0", which is also based on the flexibilization of the work [10]. "Arbeit 4.0" also deals with the new or further development of the knowledge workplace. This demands and needs technological support [11] through digitalization and thus transforms it into a digital workplace.

"Arbeit 4.0", New Work, digital workplace / digital work are terms with different meanings, but they all have one thing in common. They are the future of work and one of their main drivers is digitalization. For this reason, we will use the terms synonymously in the following and use all the subject areas of future work to identify the characteristics of digital work.

The characteristics already mentioned (use of technology, digital communication, internet use and mobile working) are only a small part of the characteristics that define digital work. Digital work is more than just working on a computer or using new IT [4]. In the literature, the following additional features occur repeatedly, and will be discussed below:

- flexibilization of place of work and working hours
- collaboration with virtual teams
- new forms of work, such as home office or crowdworking
- specific requirements for the competences of employees
- agile Corporate Culture

Making work more flexible means being independent of place and time and thus being mobile [10]. For example, instead of working in the office, there is the option of working from home (home office). In order to be able to implement this flexible work design, the appropriate IT infrastructure must be available. ²

² It should be noted that not every workplace has the potential for flexible work design. This is particularly possible in office and knowledge work [12]

Access to essential work materials, data and information must be guaranteed. For this purpose, high-performance networks and end devices as well as the necessary software must be available [5]. If work usually takes place in teams or if there is regular coordination with colleagues, the prerequisites for effective collaboration in virtual teams must also be created. In this case, Lindner [13] suggests the following basic equipment: software for communication and collaboration (e.g. e-mail, chat programs, tools for joint document processing), software for task and process tracking, software for knowledge documentation as well as options for holding virtual meetings.

If these prerequisites are in place, completely new forms of work can be used in the world of work. In addition to home office, crowdworking and coworking spaces are among the new trends. In crowdworking, the employee increasingly becomes an entrepreneur of himself, and is enabled to temporarily participate in changing project-related work using Internet platforms (Durward et al. quoted in [5]). It does not matter where the crowdworkers are doing their work. One possibility would be renting a coworking space. Here, individuals rent a workplace for short or long periods of time and can flexibly book and use central infrastructures such as meeting rooms [14].

However, these new possibilities that digital work brings with it also place new demands on the employees. Media competence is becoming a key competence in the digital world of work [14]. Simply using the various tools is not the only challenge. The users need an understanding of the advantages and disadvantages of the applications in order to be able to determine the specific application scenarios [15]. In addition to these competencies, the ability to cooperate and communicate, as well as independence and planning competence, are required since the employees have to find their way around new forms of cooperation [16]. But not only the employees, also the management level has to adapt to the new working conditions. The increased flexibility, in particular, places higher demands on the superior's communication behavior [14]. The requirements for corporate culture have changed as well. Companies that are strictly hierarchically organized are becoming less and less important [14].

Due to the increasing competitive dynamics, companies must be able to react quickly to changing conditions. For example, the customer's requirements are constantly changing and it is necessary to break through strictly planned work or project processes and much rather create fast (intermediate) products in fast iteration loops, which are then tested on the real customer. In this process, the decision-making powers from classic hierarchies are placed as close as possible to the operatively responsible employees in order to enable a greater degree of self-control in the sense of short-term responsiveness [5].

3 The Work System Theory

Work System Theory (WST) is a long-established approach in business informatics that aims to support practitioners in the analysis and design of information

systems in organizations, taking into account both technical and business aspects. The literature analysis in Section 2 has shown that digital work cannot be reduced to IT alone, nor to business or individual aspects. A holistic system view is also advantageous here, which is why the following section will examine the suitability of WST for the analysis and design of systems for digital work. After a presentation of the WST approach, we will discuss on which aspects of a WST the special characteristics of digital work have an influence and which possibilities are conceivable for its realisation.

3.1 The Work System Framework

According to Alter [2], a work system is a system in which human participants and / or machines perform work using information, technology and other resources in order to produce certain products or services for customers. Typical business organizations contain work systems that source materials from suppliers, manufacture products, deliver products to customers, prepare financial reports and perform many other functions. Almost all systems in the value chain are IT-supported work systems. Alter [2] has set up a work system framework, which consists of 9 elements, as can be seen in Figure 1.

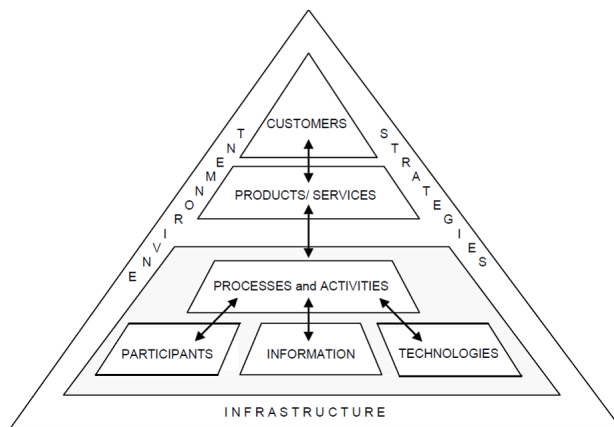


Fig. 1. The Work System Framework according to Alter [2]

Participants are people who perform work within the work system. It does not matter whether the work is IT-supported or not [17, 2].

Information is used or created by the work system. Information is expressed as information units that are used, created, recorded, transferred, stored, retrieved, manipulated, updated, displayed and/or deleted by processes and activities. The distinction between data and information is not important for understanding a work system, since only the information that is used or processed by the work system is mentioned [17].

Technologies are essential components of a work system. Technologies include both tools used by work system participants and automated agents, hardware/software configurations that perform fully automated activities [17].

Processes and activities take place in the work system to produce products or services for customers. A work system must contain at least one activity. Otherwise, it does nothing. Alter deliberately uses the term "processes and activities" because this is where activities are performed that may or may not have a defined beginning and end and therefore do not meet the definition of "process" [17, 2].

Products and services are the results of a work system that are produced for the benefit or advantage of customers [17].

Customers are recipients of products and services. A distinction is made between internal and external customers. Internal customers are employees of the company who are, for example, work system customers of the payroll system. External customers are customers of the enterprise [17].

Environment includes the relevant organizational, cultural, competitive, technical, regulatory and demographic environment in which the work system functions and which influences the effectiveness and efficiency of the work system [17].

Infrastructure includes relevant human, informational and technical resources that are used by the work system, but managed outside the work system and shared with other work systems [17].

Strategies that are relevant to a work system include the corporate strategy, the organizational strategy, and the work system strategy [17].

Processes and activities, participants, information and technologies are viewed as completely in the work system. Customers and products / services can be partly inside and partly outside the work system. Environment, infrastructure and strategies are seen as largely external, although they have a direct impact on the work system. The arrows within the work system indicate that the elements should be coordinated [2].

3.2 Analysis of the characteristics of digital work in the context of Work Systems

When looking at the work system according to Alter [2] in connection with digital work, the first step is to focus on the "inner circle" of the work system. The elements within the work system, i.e. participants, information, technologies, processes and activities, products / services and customers serve as a concept for coping with the changes within the organization that are triggered by new digital technologies [18].

Above all, digital work brings about changes for the participants. Alter deliberately uses the term "participant" instead of "user" in his framework to make clear that the participants considered in the work system do not necessarily use a computer for their work [2]. In the context of digital work, however, this aspect needs to be revised. In digital work, the use of a computer is essential and, accordingly, all participants are also users of software and hardware. By using appropriate software, such as content management system, and hardware, such as notebooks instead of stationary PCs, work can be made more flexible. The information needed to carry out processes and activities can be accessed independently of location and time through technologies such as cloud computing, allowing employees to carry out work activities outside of the company without major restrictions [5]. Due to new forms of work such as crowd-working, the participants in the work system do not even necessarily have to be employees of the company. Media, verbalisation and visualisation skills as well as the ability to deal with a new form of increasingly indirect and accelerated communication [12] are among the skills that participants in the work system need to learn in order to be able to work together with other participants in the same system virtually, independent of time and place. But not only competence in using communication tools must be learned by the participants. New techniques make processes and activities more and more complex. On the one hand, this implies the possibilities for optimising workflows and increasing the efficiency and effectiveness of work processes [12], but on the other hand, it also means that the participants must be trained in the use of these new techniques. An agile corporate culture also means that employees are given more decision-making powers so that they can react immediately to new customer requirements. As customer requirements are constantly changing, a strictly hierarchical organisation and strictly planned processes must be avoided [5]. Shorter product cycles and faster innovation cycles [12] require a certain agility in processes and activities. New products or intermediate products must be created in fast iteration loops, which can then be tested directly at the customer [5]. The customer relationship or the importance of the customer in the work system also changes. Customers are better informed about competing products and expect their needs to be met to a large extent by competent contact persons and individualised "all-round solutions". Digitisation in particular offers immense potential for involving the customer base in the product development process [12].

By looking at the elements in the outer circle of the work system, the influence of the agile corporate culture becomes particularly visible. The system must be able to immediately perceive changes in the environment and react adequately in the short term [5]. Extreme innovative ability and quick action are prerequisites for successful existence in a market which is increasingly characterised by international competitors [5]. The work system can also benefit from the new forms of work, in which participants work in co-working spaces and thus gain access to participants in other work systems of other companies and their innovative ability [5]. These new forms of work, as well as flexibility, can reduce costs, since fewer resources such as office space are required [4]. However, social

drivers also have an influence on the implementation of digital work. Younger working people expect a modern working environment and make demands on the compatibility of work and private life [5] and thus on new forms of work and flexibilization.

For the implementation of digital work, corporate strategy, which is closely related to the corporate culture, is decisive. The digitisation of individual departments or even the entire company should be anchored in the strategy, otherwise digital work is hardly feasible.

3.3 Example of a Work System for digital work

In the following, a comparison between a process in which analogue work still takes place to some extent and a purely digital work process will be presented. In order to establish the connection to the Work System of Alter [2], the elements are listed in brackets at the appropriate place. As an short example, a sub-process (process and activities) of the production of switch cabinets (product) in an SME is described. The process starts when the client (customer) places an order. An engineer (participant) then prepares the schematic (information) in a designated programme (technology). This is printed out and handed over to an employee in the production department (participant). If the production employee has to make adjustments to the plan, this is done by hand on the printout. The print is then returned to the engineer, who enters the changes in the digital planning tool. The customer only sees the changes on the final product. The analogue part and thus the weak point in the exemplary work system is the transfer of the schematics from the engineer to the production employee. Here, there is a media break because the plan is first made available digitally, then printed on paper and then entered digitally again. Such media breaks can lead to errors, e.g. if the engineer enters the changes into the system incorrectly. If the production employee now also has access to the planning program and enters the changes himself, such errors can be avoided. Further advantages are less effort and thus fewer working hours for the usually better paid engineers, and an increase in efficiency and product quality, because the customer or the managing director (environment) can also get the opportunity to gain insight into the production process from outside and to react promptly in case of desired changes. The prerequisite for this purely digital process to work is, above all, the competence and motivation of the production staff to use the planning tool. Digital work also has other positive effects on the process. The engineer who gave the employee a printed version of the schematic, in the original process, no longer has to physically sit in the office. He can also work from home or on the way and can handed over the schematic to the production employee via a shared folder. The customer can also have access to this folder and so he can make corrections or change requests at an early stage.

Finally, table 2 on page 10 gives an overview of the changes that the characteristics of digital work bring about. The table was created on the basis of the theoretical elaborations and the practical example.

Table 2. The influence of digital work characteristics on work system elements

	Flexibilization	Collaboration	New forms of work	Competences of employees	Corporate Culture
Participants	independent of place and time	need media skills	do not have to be employees in the company	skills in using the new tools	more responsibility and decision-making authority
Information	must be accessible from anywhere	must be able to be shared with everyone at all times	must be accessible from anywhere and shared with everyone	competence in using the tools to get the information	
Technologies	introduction of new / additional technologies	introduction of new / additional technologies	introduction of new / additional technologies	only technologies that can be operated by the participants can be used	introduction of new / additional technologies
Processes/Activities	entails new technologies, which influence the effectiveness and efficiency of processes			can become more complex	can be made more agile
Products/Services	entails new technologies, which also offer the opportunity to offer new products and services.				shorter product and innovation cycles
Customers	can reach his contact person at any time, e.g. also on business trips	virtual collaboration tools can also be used to communicate with customers			requirements can be implemented faster / can be involved earlier in the process
Environment	crucial for attracting younger participants		profit from other participants other companies (e.g. through co-working spaces)		changes must be responded to immediately
Strategies	The strategy should focus on digitisation and digital work in general.				
Infrastructure	resources can be partially saved (e.g. office space, Freelance instead of permanent employees)				

4 Limitations

The limitation of the work lies mainly in the literature analysis. On the one hand, only three databases were searched and thus, perhaps, important contributions

were not found. Furthermore, the search terms "new work", "digital work" and "work 4.0" were not followed up in the database dblp. For example, the search with "new work" yielded more than 50,000 hits because the system searched for contributions with the single words "new" and "work". Since the evaluation was carried out by the author alone, and this would have resulted in a considerable amount of work, the search was aborted at this point. The evaluation of the found amounts was likewise accomplished only by the author, which led to a very subjective view of the literature and a further limitation of this contribution.

5 Conclusion and Future Work

In summary, various terms appear in the context of digital work, but they are all interrelated and describe the future of work, which is driven by digitalization, among other things. The term "digital work" is defined as working with digital tools. However, with the help of the literature research carried out, further characteristics of digital work could be uncovered. There is much more to digital work than the use of computers (RQ1). Through the use of digital technologies, a completely new way of working has been established. Working independently of place and time is one of the most important features of digital work. In this context, work in virtual teams has gained importance, which has led to new forms of work. The use of new technologies naturally also requires appropriate skills from employees and managers as well as an agile corporate culture. Examples of technologies that support digital work include collaboration and communication tools, in addition to unambiguous techniques such as mobile devices and appropriate Internet access. Regarding the work system of Alter [2], which consists of the nine elements participants, information, technologies, processes and activities, products and services, customers, environment, strategy, and infrastructure, digital work has a particular influence on the participants (RQ2). By using mobile devices and the possibility to work independent of location and time, they have a great deal of influence on the participants. Information needed for the execution of processes and activities can be accessed digitally and at any time through technologies such as cloud computing. By using new technologies, processes and activities can be made more efficient and effective. However, the prerequisite for this is the competence of the employees. In addition to using communication tools, for example, to work together in a virtual team, the participants must also master other tools and skills, as the processes are becoming more complex. Customer requirements are also increasing and are changing faster, so decisions have to be made directly by the employee. This is the only way to create new products in fast iteration loops and react adequately to changes in the environment. However, the implementation of digital work is above all dependent on the corporate strategy, in which the digitalization of work should be taken into account. For future research, it is necessary to investigate whether and how digital work is implemented in companies. Are all elements of the work system taken into account, or are there, as in the example shown, media breaks within the system? Furthermore, it has to be examined whether

all work systems within a company are digitally oriented or only the systems of certain departments.

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