How Smart Services Affect Relevant Job Characteristics in Production Environments

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Abstract

Smart services and their associated technologies are more and more integrated in organizations. By using job design and different job characteristics as foundation, we show how the implementation of smart services affects employees. Thus, smart services are able to augment employees' jobs by giving them insight into processes and tasks, support them in their daily work life, or providing new flexibility and requiring new skills and knowledge. Possible adverse effects are a loss of control or social interactions.

Keywords 1

Internet of Things, Artificial Intelligence, Smart Services, job characteristics

1. Introduction

In recent years, production-oriented companies are increasingly becoming hybrid companies offering services in addition to their products. This transformation, also known as "servitization", is enabled by increasing possibilities of digital technology [1]. In particular, technologies such as the Internet of Things (IoT) or Artificial Intelligence (AI) are becoming more established in production-oriented companies [2]. This leads to intermediaries being bypassed and end customers being in contact with manufacturers through smart services. Smart services describe the combination of physical products and services with digital content [3, 4].

The use of these technologies, however, is not only changing companies' business models. Rather, these technologies and the associated services have an impact on resources, work processes, and employees within organizations [5]. Internal activities requiring adaptions to changing conditions of parameters can be automated with smart services taking over tasks that require some intelligence. Thus, it is important for employees to adapt their skills and knowledge towards understanding data-driven services.

Current studies mainly focus on the effects of smart services in a B2B environment [e.g. 6], analyzing how smart services affect business models. Research on smart services in B2C environments focuses on how smart services affect customers [6]. The effects of smart services on employees affecting the internal operational level are rarely considered in research. While there exists research on how IoT affects employees (e.g., empowering employees [7]) or how employees work with AI [8], the interplay between those technologies and their combination as smart services are barely investigated. Employees who are affected by smart services have such smart services and the incorporated technologies as "co-workers" and in a supervisory role. Therefore, we address the research question how employees are affected by smart services in their daily work life.

In order to answer the research question, this paper aims to present possible effects on employees and their job design based on different characteristics and the effects smart services have on them. This provides insight into the extent to which the benefits of service orientation and usage of technologies

can be transferred to the employee level. Furthermore, potential side effects that can arise from the implementation of smart services and the associated technologies will be highlighted.

2. The concept of Smart Services

Smart services in production environments describe automatic processes in which data from sensors is gathered, analyzed, and actions are executed throughout the whole production process. IoT and AI lead organizations to a more process-oriented structure [9] involving heterogeneous objects and data across department boundaries. Therefore, as [10] stated, smart services are more like smart service systems since there are multiple actors and resources within a network involved.

The services provided are called smart services as they combine existing physical products or physical services with new digital services [4]. Additionally, they use information and data from different contexts to fulfill customers' individual requirements and needs [11]. Nevertheless, the human is still one of the key factors within a smart service system. Human employees or customers are the centers of focus since their needs are the ones that need to be fulfilled [12].

Gathering data from sensors is enabled by IoT applications which enhance information and communication technology with sensors or actuators attached to objects. Thereby it is possible to generate and collect data from objects like machines or products [13]. Those data can be used to improve processes or the product itself. The sensors, actuators, or objects in which they are established are connected to a network, making it easy to exchange data among the actors within this network. It is even possible that the devices or products with these sensors are able to communicate without human intervention [14]. Another aspect of IoT is that it is possible to uniquely identify every object in this network, for instance, RFID tags. Therefore, it is possible to locate and respond to an occurring issue within a short time frame [1].

Since data generated by sensors has to be analyzed to enable flexible adaption to reality, data analysis typically requires AI-based systems. Using common static rules would require programming in advance for every possible situation. AI-based software enables these automated services to act smart, i.e., to adapt to changed parameters [15]. While earlier research assumed that service jobs can not be performed by AI, especially low-skilled jobs are taken over by AI [2]. The transition process is called augmentation and describes how AI is integrated into human tasks. If an AI learns how to perform certain tasks, it is able to do a job without human intervention [16]. Some services still need human intervention, for instance predictive maintenance which is one of the most common examples of smart services in organization [3]. While an AI analyzes the data from a machine and its parts, it only can send a notification that maintenance or a replacement is needed. The work has still to be executed by employees. Thus, employees can get a feeling of being controlled by technology [17].

3. Smart Services' impact on job design of employees

The implementation of smart services in an organization affects the design of work and thus employees. Work design includes the structure and processes of how and by whom work is done and describes the relationships between work elements [18]. New technologies have an impact on job design and its characteristics [19]. Those characteristics can be derived from job characteristic theory, and the most relevant [8] are used as a foundation in this paper to elucidate the effects of smart services on employees' jobs. They can be comprised as task variety, task autonomy, interactions between work elements, the skill & knowledge as well as responsibility job [8, 19-21]. If an employee has a positive association towards job characteristics, it can lead to positive outcomes such as an increased performance or job satisfaction [21]. Therefore, it is important to point out the effects, technologies like smart services has on them.

Smart services can increase the variety of tasks of an employee since sensors and actuators deliver new data that can be used to create new tasks. Tasks can be standard, routine tasks or tasks that require complex information processing. Also, tasks that need low cognitive effort can be automated and taken over by AI. Thus, employees get more freedom to do complex tasks giving them an enriched feeling [19]. On the other hand, the variety decreases with higher automation. As a consequence, employees

will have more tasks relating to a supervisory role for machines and devices. They will only have to react when the system tells them, making the employees lose control over their work.

The freedom of employees to carry out their work as they want is described as job autonomy. The control over the methods and timing of doing one's work are two major aspects as well as the autonomy in decision making [21]. Technologies like AI and IoT are able to support and overtake making decisions. If supported in their decision-making process, employees can feel empowered as they gain the feeling of still being in control [22]. If they lose the ability to make a decision to a smart service, they lose this feeling of being in control [8]. Therefore, it can be assumed that also smart services, if executed and implemented correctly, can empower employees. The access to data and new information as resources leads to an increased feeling of being in control.

Smart services allow more interactions between humans and machines. These interactions of humans with intelligent objects provided by smart services are able to augment the job [19]. The amount of interactions with machines is likely to rise since more and more machines are connected to the Internet of Things, one of the foundations of smart services. With these interactions, the smart objects can provide nearly instant feedback to employees on their performance. Timely and accurate feedback is important to enhance the appropriate behavior of employees [18]. Since the products and objects used to perform smart services are equipped with sensors, the objects can give employees direct feedback on the performance [1], and if combined with technologies like AI, it is also possible to provide suggestions on how to deliver a better performance.

Implementing smart services will lead to more interdisciplinary teams [4], but employees have to be open to share their knowledge with others [11]. Contrary to that, AI-based smart services can also have a negative impact on employees since they can lead to fewer interactions between employees resulting in a loss of social relationships [3].

Dreyer et al. [11] stated that the qualification of an employee, also known as skills or knowledge, is one critical success factor when implementing smart services. They describe what is needed to do a job. Thus, the requirements of skills and knowledge of employees change due to digitalization in general and regarding smart services specifically. On the one hand, employees have to be able to interact with customers if the organization is offering smart services. On the other hand, they should know how to handle the data and where it comes from to understand the underlying processes. Therefore, more cognitive skills are necessary to make adequate decisions. Additional skills in coordination and communication between different departments will also become necessary since the teams become more interdisciplinary [19].

Responsibility is also affected by smart services. Responsibility describes the accountability for action. Since smart services take over certain tasks or decisions, the responsibility shift towards the system. Ultimately, employees who overwatch the system are still responsible [19]. Therefore, employees must understand the processes of how smart services execute tasks and make decisions to evaluate the outcomes and the associated consequences. This means that employees have to adapt their skills and knowledge as mentioned above to stay in control.

4. Implications and future research

The main goal of smart services is to deliver additional value to customers by using technologies such as IoT and AI. We show that smart services with the technologies incorporated have however also an impact on certain job characteristics of employees and, therefore, on their job performance and satisfaction [19]. The current literature on smart services is barely focused on the effects on employees while researchers, as well as organizations, become more and more sensible for the topic [3]. Research on IoT shows that IoT is able to enhance the work by data from sensors and the connecting of different objects. It allows empowering employees by giving them access to resources [7]. On the other hand, AI can take over tasks completely or support in their completion, e.g., decision making, by considering multiple aspects [8]. Smart services allow to combine these two technologies and enhance employees' production process even further by not only giving them access to new resources like data but by analyzing this data with AI. This results in new flexible ways of getting tasks done, interact with colleagues and machines and require new skills and knowledge of the employees.

Our analysis shows that due to the underlying technologies, smart services are able to augment current jobs of employees by providing them new insights. New skills and knowledge to perform and use these services are required. Employees need to understand how AI analyzes data and where its sources. Otherwise, it is possible that employees can get the feeling of losing control and being agents of the technology. Taken these aspects into consideration, smart services are, however, able to give employees more flexibility in their daily work life.

We contribute to current research by combining elements derived from job characteristic theory with smart services giving insight on the effects of smart services on selected job characteristics. Additionally, our paper provides an overview on how important job characteristics are affected and thereby which ones should be considered when analyzing the impact of smart services on employees. Finally, the results highlight how a specific artefact as a combination of IoT and AI has practical implications.

Practical implications are that production processes will be more central with the usage of smart services. Smart services using AI and IoT enable process-oriented thinking, which allows using objects and resources throughout the whole production process. The value-creation process is done by interdisciplinary teams which need different skills and knowledge to create value based on detailed data from different objects.

As with any research, our paper comes with limitations. First, our research is conceptional in the current stage. Therefore, future research should validate the assumptions by conducting empirical studies focusing on the impact of smart services on employees. Second, we target smart services as a combination of IoT and AI, which is a joint analysis while there might be specific effects of the underlying technologies that should be understood as well. Hence, analyses should also consider which effects stem from the technology itself and which effects occur with smart services.

Future and followed research should build on these first conceptions and provide an insight on how smart services in actual work environments affects job characteristics of employees. Therefore, a more detailed model like the one of Parker, Wall [23] can be taken into consideration and enhanced by antecedents like AI and IoT which are the underlying technologies of smart services. This study than can provide adequate insight on how smart services affect job characteristics and the interactions between them. Thus, challenges and advantages of smart services within work environments can be provided.

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