How Do Employees Perceive Digital Transformation and its Effects? A Theory of the Smart Machine Perspective

Completed Research Paper

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Abstract

Digital transformation continues to profoundly impact employees in organizations in many industries. While past research has extensively investigated the impact of digital transformation on organizations, we still lack a comprehensive understanding of the factors that are relevant to examine how employees perceive digital transformation and its effects. One theory that explicitly has been built to account for a digital transformation in the past is the theory of the smart machine. To provide insights about relevant factors, we apply the theory of the smart machine and develop and evaluate an instrument to measure several of its key concepts for the first time. We build on established research guidelines to provide a 36-item survey instrument to measure the concepts Introduction of IT, Effects of automation, and Effects of informating. Finally, we provide implications for practice and further research.

Keywords: Digital Transformation, Theory of the Smart Machine, Healthcare, Literature Review, Instrument Development

Introduction

Information technology (IT) innovations continue to profoundly transform organizations and employees' work practices in virtually all industries, including but not limited to media (Karimi and Walter 2015; Scott and Orlikowski 2022), manufacturing (Chen et al. 2022), and healthcare (Srivastava and Shainesh 2015). This phenomenon contemporarily is discussed using the term *digital transformation* (DT). DT is defined as the introduction of combinations of information, computing, communication, and connectivity technologies that trigger significant changes within organizations and industries (Vial 2019). For example, DT in the manufacturing industry is characterized by a shift toward data-enabled servitization through smart products demanding a new way of thinking from workers and enabling new, competitive business models (Chen et al. 2022). Similarly, practitioners and researchers expect the healthcare sector to profoundly change over the next years due to IT-based innovations (Bannon 2020; Edwards 2014; Newman 2017). A recent example is machine learning enabling patient-specific treatments (Snyderman 2014).

Research has already examined various organizational aspects of DT. Noteworthy examples are the analysis of implications for strategy (Baptista et al. 2020), overall structure (Karimi and Walter 2015), or governance (Gregory et al. 2018). In contrast, aspects that pertain to the individuals' perceptions of DT and its effects have just recently received increasing attention in research. For example, it has been explored how IT can introduce different stressors for employees impacting their well-being (Califf et al. 2020). Moreover, it has been investigated that in digital work, it is increasingly complex for individuals to work with advanced digital technologies such as AI. As a result employees have to adjust their work practices and activities to carry out tasks (Baptista et al. 2020). One recurring core theme in DT research is the underlying organizational transformation processes (Chanias et al. 2019; Wessel et al. 2021). Organizational transformation enabled by information technology (IT) and digital systems has been of long interest in the information systems (IS) discipline (Besson and Rowe 2012). A distinguishing factor between IT-driven transformation and DT is the emergence of a new organizational identity in the latter (Wessel et al. 2021). Fundamentally, this hinges on the perceptions of DT of the individual organizational members. In sum, these studies indicate that the DT and its effects considerably impact employees' perceptions. However, we lack a comprehensive, detailed understanding of the factors that are relevant to consider for examining DT and its perceived effects (Wessel et al. 2021). To that end, we still have an imprecise understanding of DT. We do not know how transformation processes unfold on the individual-level, which mechanisms are at work, and how perceptions impact in such transformations (Vial 2019; Wessel et al. 2021). We urgently need theories and empirical data support to guide us in understanding how employees perceive DT and its effects (Chen and King 2022; Vial 2019).

One theory that explicitly has been built to account for a DT in the past is the *theory of the smart machine* (TSM) (Burton-Jones 2014; Zuboff 1988). TSM provides a parsimonious and useful theory to describe and explain the use of advanced IT and digital tools, the resulting DT and its effects . Burton-Jones (2014) argues that, with recent calls urging researchers to account for the unique nature of IT (Robey et al. 2013), to adopt socio-technical thinking (Sarker et al. 2013), and to study power (Leonardi and Barley 2010), Zuboff's work stands out as a particularly relevant work for today's IS researchers. Its stringent and emphasized inclusion of subjective and emotional context, while also including the organizational and managerial environment lead us to suggest TSM to be exceptionally well-suited as a theoretical foundation. Especially the relationships between fine-grained concepts included in the TSM are prime candidates to add to the socio-technical debate within IS research, similar to recent research explaining social-technical effects by building on subconscious or subjective perceptions (e.g., Hennel and Rosenkranz 2021). Building on the importance of subjective perceptions, these relationships rooted in subjective perceptions could explain why long-standing insights into change management (e.g., Todnem By 2005) did not yield more successful DT projects. To date, however, IS researchers have not directly tested Zuboff's work, either in whole or in part (Burton-Jones 2014, p. 91). Most researchers citing Zuboff have done so to refer only to its concepts, not to its relationships or for testing the theory. For example, research has used TSM in explorative settings to discuss IT's capability to automate and informate (Cunha and Carugati 2018; Surendra and Nazir 2019). Still, there is no research available that operationalized and validated TSM concepts, which severely limits its general applicability. Because TSM focuses on fundamental characteristics of IT and digital tools (such as its representational capacity) and fundamental characteristics of society, institutions, and organizations (such as power), the results of testing the theory today, with the effect of contemporary IT and digital tools, would be revealing (Burton-Jones 2014): If the results upheld Zuboff's concepts and relationships, it would underscore the enduring nature of these characteristics; if the results refuted her ideas, it would suggest that these characteristics might have fundamentally changed since the 1980s. "Either result would be valuable. In fact, it is remarkable that such a highly cited theory has not been tested to date" (Burton-Jones 2014, p. 93). Thus, we propose to operationalize TSM to make it usable for research and ask the following research question:

RQ: How can we conceptualize, operationalize, and measure the concepts of TSM in the context of DT, especially regarding its socio-technical dimensions?

In this paper, we report on the development and evaluation of a multi-item survey instrument, which can be used to test key concepts of the overall TSM model. For the evaluation of the survey instrument, we carry out card sorting procedures and a ranking task with IT and healthcare professionals. In doing so, the present work offers three contributions. First, we create and evaluate an instrument to measure key concepts of TSM for the first time. Thereby, we lay the foundation for examining further concepts and relationships in the overall model, which is a critical step toward validating the entire TSM model. Second, our developed instrument helps structure different domains of knowledge to inform the development of further theories (Vial 2019). Third, we provide insights about relevant factors of DT that should be considered by researchers and policy makers when examining the DT and its effects.

The Theory of the Smart Machine

The TSM was initially described by Zuboff (1988) and first put into a cohesive, testable model by Burton-Jones (2014). Burton-Jones (2014) describes the TSM using two related models representing two readings of the same theory: an overall model and a detailed model. Both models describe how the introduction of IT impacts organizational dynamics through *Automation* (i.e., the automated execution of tasks) and *Informating* (i.e., the availability of new information). While the overall model describes the effects of the IT introduction on the organization and workers in general, the detailed model comprises an in-depth view on effects that are related to the results of *Informating* and the *Dilemmas of Transformation*. Unlike the overall model, it shows how workers learn from information, how managers can use IT for monitoring and enforcement, and how workers react to increased monitoring and enforcement.

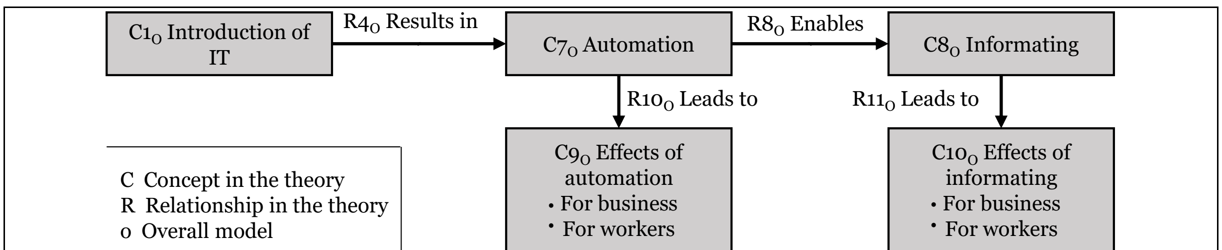

Figure 1. Research Model Based on the TSM (adapted from Burton-Jones, 2014)

Both TSM models can be viewed as causal loop models, where the relationships (R) represent the influence of one concept on another. This explicitly includes self-reinforcing cycles. For example, when technology is introduced, it can lead to conflicts between workers and managers, which can be worsened by a low commitment of managers to resolve the conflict, thus, creating a self-reinforcing cycle. Of the ten concepts (C) of the overall TSM model, we focus on five key concepts to create our research model (Figure 1): *Introduction of IT*, *Automation*, *Informating*, *Effects of Automation*, and *Effects of Informating* (Burton-Jones 2014, p. 11). We chose these concepts for two reasons: First, as noted by Burton-Jones (2014, p. 9) the concepts *Introduction of IT* and *Automation* are the key parts of the overall model. Second, taken together they form a logical unit and are directly concerned with IT. All other concepts are only influenced by the introduction of IT or determine the emphasis given to *Automation* or *Informating*. Also, from the definition of the concepts and relationships, it is evident that the chosen concepts are logically related as they all refer to the underlying IT, while the rest of the model focusses on social and organizational aspects.

The starting point of the overall model is the concept *C1o Introduction of IT* resulting in *C7o Automation*. *C7o Automation* in turn leads to *C9o Effects of automation* and *C8o Informating*, for which the consequences are captured by the concept *C10o Effects of informating*. In Table 1 we provide an explanation for each concept and the relationships present in the model.

A major difference compared to contemporary transformations is that TSM as outlined by Zuboff (1988) focused on how IT replaces machines and manual work with IS. Nowadays, often an old information system is replaced with a new one (Soliman and Rinta-Kahila 2020). Still, unless the software uses the same set of functions and representations (e.g., user interfaces), an employee must learn from scratch how to use the new software. Even if employees were already used to working with IT, it nevertheless can change their work practices. Thus, whenever IT is introduced in an environment where employees are familiar with similar IT-based processes, it can lead to the same or at least similar effects as in environments where IT replaces manual, non-IT-based work (for a recent example, see Surendra and Nazir 2019).

Concept	**Explanation**
C10 Introduction of IT	IT is a "[...] unique technical product that engenders change when introduced in organizations" (Burton-Jones 2014, p. 45). Here, the label "IT" is given to a product consisting of hardware and software. For example, in a healthcare setting, this can range from a technical product like care robots to software-related products that build on existing IT like a support system that helps analyzing medical images. Such IT has characteristics that can change work practices and introduce new working processes. Whenever IT is introduced, it results in *C70 Automation* (see relationship *R40)* as manual tasks and processes are supported by automated sub-systems or completely taken over by IT.
C70 Automation	*Automation* refers to "[t]he execution of a set of decomposed and rationalized activities by means of technology" (Burton-Jones 2014, p. 46). The decomposed and rationalized activities can be thought of as process steps that were formerly carried out manually and are henceforth carried out by IT. This could be, for example, the automated collection and analysis of data that had to be sourced and processed by hand before IT was introduced. The essence of this concept is that automation simply takes work off employees' shoulders. *Automation* leads to certain effects for business and workers that can be summarized as the potential to displace the human presence in working processes (see *R100*)
C80 Informating	*Informating* refers to "the recording of information about work done through information technology" (Burton-Jones 2014, p. 46). This also includes the representation of information in IS (Burton-Jones 2014). Thereby, activities and events are made more transparent as they are translated into usable information. The recorded and represented information about work done through IT include data that are related to a task as well as metadata about a task (Burton-Jones 2014, p. 46). For example, consider a system that enables employees to exchange data needed for work, like an email system. The information contained in the system is not only the data related to work but also metadata such as information about the person who sends a request for data and the process during which the email was sent. A critical aspect of this concept is that it can occur automatically and unintended (Burton-Jones 2014). So, whenever IT automates, it has the inherent, autonomous power to informate. Still, informating cannot happen without automation; it necessarily builds on automation. This is depicted with relationship *R80*. Also, *Informating* leads to certain effects that are bound to change the nature of work through the availability of new information (see relationship R110).
C90 Effects of automation	This includes a variety of different effects, which are separated into effects for business and effects for workers (Burton-Jones 2014). The effects for business encompass productivity increasements, fewer mistakes, fewer people needed to accomplish work, and thus a decreased dependence on human talent, the reproduction of the status quo, meaning that the current managerial hierarchy is reinforced. This can lead to further negative effects, such as employee resistance, which can eventually lead to the depletion of knowledge and a lack of innovation. Effects for workers are that less process knowledge is necessary to carry out tasks and less involvement in managerial activities. Still, the latter can be a negative effect when workers feel they do not have a say in how their activities are coordinated. Apart from that, effects for workers exclusively pertain to the reduced sociality of the work environment.
C10 Effects of Informating	This includes a variety of effects that occur due to the availability of new information about work processes, activities and events (Burton-Jones 2014, p. 46). The effects are divided into effects for business and effects for workers. The effects for business include more meaningful jobs, higher innovativeness, more learning opportunities, and an increased competitive advantage. The effects for workers include opportunities to learn from new information, innovate and take on more responsibility as well as the destruction and (re)creation of knowledge. These effects occur because employees can act on the available information and further improve their work environment and their work processes.

Table 1. Explanation of the TSM concepts in the Research Model based on Burton-Jones (2014)

Moreover, what is more important is that in contrast to the 1980s, IT based on machine learning and artificial intelligence are self-adapting. This is significant advancement over traditional digital artifacts, where the same instance of an action would yield a deterministic output in every execution, and where human programmers would be required to adjust its behavior. Some digital actors may even sacrifice expected decision quality in single routine performances in favor of retrying and exploring alternative routine performances (Pentland et al. 2020) such as web service selection algorithms (Ardagna and Pernici 2007). These kinds of digital actors might be prone to introduce variation to the routine (Pentland et al. 2020) and are, essentially, non-deterministic in their automation behavior. Interestingly, this shift is included in the TSM concepts *Automation* and *Informating*. The deterministic output refers to *Automation* as the established, automated process steps are carried out in the same way. In contrast, the non-deterministic, self-adapting perspective is equivalent to a greater emphasis on *Informating*, when an adaptive system provides workers with feedback and information based on their past actions.

Another central feature of TSM is the differentiation between the introduction of IT, automation, and informating instead of describing IT as one comprehensive object. Although other well-established theories such as the IS success model (DeLone and McLean 2003) also differentiate between similar concepts, such as "system quality" and "information quality", they often do not include factors that relate to automation, nor how information is used. TSM includes a variety of different effects related to automation and informating, which are not captured by these theories, such as the opportunities an informating strategy can provide or the authority conflicts that arise due to new information provided to workers. Thereby, factors that determine the use of IT can be carved out in a more differentiated way: "The power to automate stems from the algorithms and machinery that allow IT to perform computational tasks so quickly and accurately. The power to informate stems from the ability of IT to record data about the work being performed through it, creating a new resource that organizations can use to learn and improve." (Burton-Jones 2014). As DT entails the introduction of IS (and therefore IT), this distinction of effects has been applied successfully in recent research (e.g., Jarrahi 2019). Again, as research has only focused on discussing the concepts *Automation* and *Informating* (Cunha and Carugati 2018; Surendra and Nazir 2019), we operationalize and make measurable key concepts in TSM.

Lastly, in light of recent research on differences between IT-enabled organizational transformation (ITOT) and DT (Wessel et al. 2021), TSM is well-suited to measure DT. Like ITOT, DT leverages IT to improve business outcomes and change work practices. Thus, aspects related to IT and to its effects as the perceptual target should also be included for a measurement instrument for DT. Therefore, our excerpt of TSM with its focus on *Introduction of IT* and its effects (*Effects of Automation* and *Effects of Informating*) is a good fit to measure DT and its effects. Moreover, DT and ITOT differ in two aspects, which are important for measuring DT. While the use of IT in DT leads to a new or redefined value proposition and to a new organizational identity, it does not in ITOT. Instead, the existing value proposition is supported, and organizational identity is reinforced. For DT this parallels the process outlined in TSM. The changes introduced through leveraging IT (i.e., *Automation* and *Informating*), and its effects for organizations can represent a value proposition change. More importantly, the perceptions of the introduction of IT that is leveraged to improve business outcomes and its effects (esp. the fundamental changes to a worker's roles and responsibilities) in sum are likely to represent factors of a new organizational identity. This change in value proposition and organizational identity becomes evident throughout the process of transformation. Thus, at the point where organizations engaged in a fundamental transformation and move towards a new value proposition and a new organizational identity, TSM can be applied to measure DT and its effects.

Research Design

To analyze the perceptions of the effects of DT, we developed a survey instrument based on TSM. We tested the instrument in the healthcare industry as this industry currently faces a major DT (Bannon 2020; Snyderman 2014). The instrument development process was based on the method proposed by Recker and Rosemann (2010) and Moore and Benbasat (1991) and was carried out in four stages. In the first stage, item creation, we reviewed the literature and generated an initial pool of items. Stages two to four are concerned with evaluation of the validity and reliability of the candidate items. In stage two, we identified items that have a high potential to show construct validity in terms of convergent and discriminant validity. In stage three, we dropped items that have little potential for high content validity. In stage four, we further reduced the set of items to enhance their potential reliability and validity.

Given that the conducted procedures were carried out with a German-speaking sample, the construct definitions and created items in stage one and the instructions in stages two to five were designed in English and then translated to German. Back-translation was used for all stages stage to ensure the correctness of the translation (Brislin 1970). During all stages participants were encouraged to ask questions via video conferences or e-mail to clarify any misunderstandings.

Item Creation

During the item creation stage, concepts, constructs, and an initial pool of candidate items were defined based on prior literature. We reviewed the literature based on vom Brocke et al. (2009) and Webster and Watson (2002), starting with keywords sourced from the concept definitions and descriptions (Figure 2).

Similar to Burton-Jones (2014), the literature was limited to the journals in the AIS Senior Scholars' Basket of eight Journals. Forward search was only conducted starting from Burton-Jones (2014). For the relevant papers identified during keyword search, this was not feasible as the present work considers major IS theories and seminal papers. For example, according to Google Scholar the measurement instrument developed by Moore and Benbasat (1991) alone accounts for over 11,800 citations. Instead, a greater variety of keywords was used for the literature review. For the concepts *C10 Introduction of IT* (Set 1), *C70 Automation* and *C90 Effects of automation* (Set 2), and *C80 Informating* and *C10 Effects of Informating* (Set 3) Burton-Jones' (2014) suggested definitions were adopted as initial definitions. In the search terms, we did not differentiate between *Automation* and its effects, nor between *Informating* and its effects. Instead, we assumed that every study that referred to the *Effects of Automation* or *Informating* would also refer to their respective predecessors.

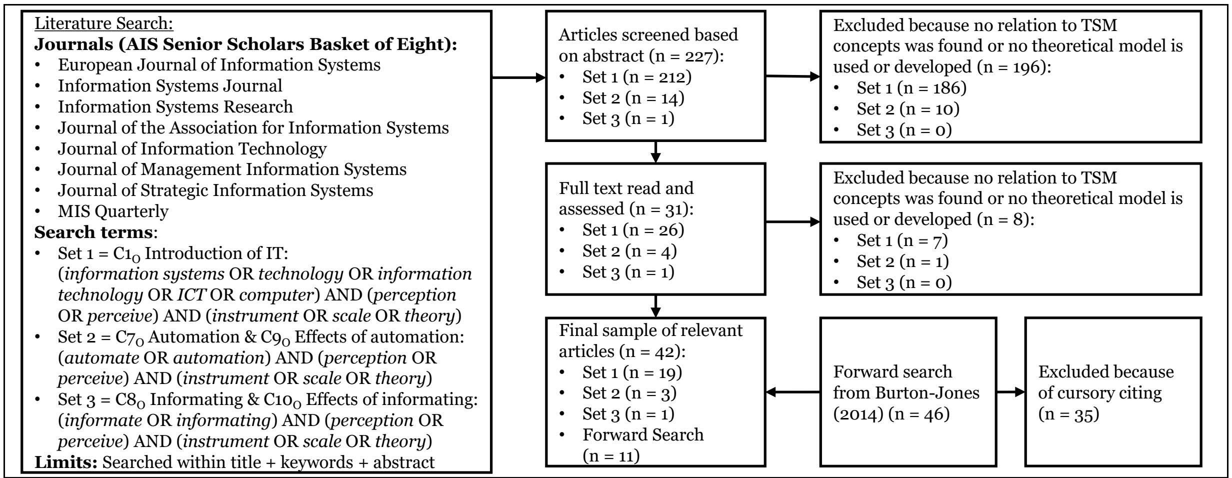

Figure 2. Illustration of the literature review process

The perceptions of the concepts *C10 Introduction of IT*, *C90 Effects of automation*, and *C10 Effects of Informating* were considered as latent theory constructs. For these, the description by Burton-Jones (2014) was confirmed and related subconstructs were identified during the literature search and mapped to the latent theory constructs (Table 2) (Recker and Rosemann 2010). The description and supporting quotes provided by Burton-Jones (2014) were examined to define the mapping criteria. For example, the mapping of *Introduction of IT* was based on the description that IT has specific characteristics and engenders change. The relevance of articles was assessed based on whether they provide information on the dimensions of the considered concepts. Hence, articles that related to the concept descriptions or provided suitable subconstructs for the concepts were included. When the articles included aspects that were relevant to more than one concept, they were mapped accordingly.

Based on the mapped articles per latent theory construct, we generated a list of suitable subconstructs. Next, a pool of suitable candidate items was created to measure the identified subconstructs based. This was done in two steps. First, we identified items from existing scales identified in the literature review that reflected the subconstruct definitions (Recker and Rosemann 2010). If required, the items were prepared to fit the subconstruct definitions. Second, new items were created based on the subconstruct definitions if during literature review it was felt that the identified set of items did not reflect all dimensions of a latent theory construct (Moore and Benbasat 1991). Into the definition of the identified items from the two steps, the actual behavior (e.g., using a system), the target of the behavior (e.g., genome sequencing), and the context of the behavior (e.g., for a medical diagnosis) were included (Ajzen and Fishbein 1980).

Concept	Mapping Criteria
C10 Introduction of IT	Change induced by IT, characteristics that can be perceived during interaction with IT
C70 Automation	Automated execution of a set of tasks, process changes due to automation, replacement of manual tasks with automated tasks
C80 Informating	Transparency increasement, recording of information, representation of information
C90 Effects of automation	Fewer people needed for routine work, decreasing dependence on human talent, antagonism from the work force, productivity increasements or sociality reduction
C10 Effects of Informating	Accelerated learning, performance improvement, mutual participation and responsibility, competitive advantage, joint learning, depletion of knowledge

Table 2. Mapping Criteria for the identified articles based on Burton-Jones (2014) description

Subconstructs and items sourced from the retrieved articles that dealt with effects of *Automation* and *Informating* were included for the latent theory constructs *C9o Effects of automation* and *C1o Effects of informating*, respectively. Following the definition provided by Burton-Jones (2014, p. 44), other subconstructs that refer to general characteristics of IT instead of effects related to it, were assigned to the latent theory construct *C1o Introduction of IT*. We acknowledge that this overall approach might not yield an exhaustive catalog of items. For instance, inhibiting factors in IT introduction (Bhattacherjee and Hikmet 2007) were not included initially. However, aspects of these concepts are nevertheless included in, for instance, the dilemmas of transformation and additional aspects, such as the loss of power and control will be included in the further validation of TSM.

Substrata Identification

In this stage, we identified items with a high potential for construct validity in terms of convergent and discriminant validity. The domain substrata were identified with an own category test, where eight judges sort the candidate items into construct categories and provide their own label for these (Recker and Rosemann 2010). For that we recruited a panel of judges (including IS academics, practitioners, and students with an age ranging from 20 to 30) who had a sound understanding of the characteristics of relevant domain phenomena (i.e., the *Introduction of IT*, *Automation*, and *Informating* and their effects). Although it is advisable that the experts are familiar with the healthcare domain, at this stage methodological experts are preferred. This is because it is more important for content validity to cover the content domain than covering the context of the domain (Recker and Rosemann 2010). To clarify any misunderstandings, the own category tests were carried out during an online video conference.

The judges were given instructions that the items are to be grouped in terms of meaning so that they are most similar within one category and most dissimilar to other categories (Recker and Rosemann 2010). In the instructions the card sorting procedure was explained with an example that introduced the judges to possible ways of sorting different items related to aspects of an automobile. This was done to make the judges familiar with the task that should be carried out. The example intentionally included ambiguous items (Recker and Rosemann 2010). This not only helps to ensure that judges get the idea of the underlying construct but also makes them more aware of ambiguous items (Moore and Benbasat 1991). To test the instructions for comprehensiveness and comprehensibility, two of the eight judges were asked to complete the task as well as to comment on the wording and length of the instructions. The instructions were then revised based on the feedback received from the judges.

Before providing the items to a judge, the item pool was shuffled so that each judge saw them in random order (Moore and Benbasat 1991). For each of the three latent theory constructs *C1o Introduction of IT*, *C9o Effects of automation*, and *C10o Effects of Informating,* the eight judges were provided with instructions and were asked to complete the sorting procedure. To reduce subjectivity in this step, two judges each met to discuss their categorization and create joint labels. We did not include *Automation* and *Informating* in the sorting procedure as we assume that they are objective measures. This is because, both can be measured using the relative number of automated tasks or the relative amount of information that could be collected. For *Automation*, consider the number of automated tasks divided by all tasks carried out in an organization. For *Informating*, consider the amount of information collected divided by the possible amount of information that could be collected during the use of IT in an organization. Moreover, we argue employees' perceptions are mainly impacted by the resulting effects of these. If needed, an indicator variable asking employees to state their perception of how many tasks are automated or how much information about work is collected and represented in a system can be included.

The resulting cluster labels were analyzed to come up with a joint label of the categories (clusters). Following Davis (1989), the results show cluster similarity if at least more than half of the items are consistently placed into the same category. The items in a cluster can then be considered to be similar in meaning (Davis 1989). If items were not placed into one cluster in at least half of the cases, this can imply potential conceptual confounding (Recker and Rosemann 2010). Moreover, the item placement ratio suggested by Moore and Benbasat (1991) was used for the analysis of the inter-judge agreement. If items were repeatedly placed into the same cluster, they are considered to have a high item placement ratio. For these items this also indicates a high probability for displaying high construct validity and reliability. These clusters also allowed us to examine whether judges placed the items in the intended target cluster and yielded another indicator of construct validity. Eventually, the resulting clusters could be "considered to adequately reflect distinct domain substrata for the considered construct" (Recker and Rosemann 2010).

Item Identification

For the third stage, the same pool of candidate items from stage two was used in a ranking task. For this task, the same judges from stage two were instructed to assess on a 7-point Likert scale how well the items fit the definitions of the constructs that shall be measured with these items. During this task, judges could also provide informal feedback via text boxes. This resulted in a revised set of items that had a high potential for high content validity. For analyzing the results of the item assessment, the responses were averaged and ranked. Using the results of the former stage, items were culled if they had a low rank or are not part of an identified domain substratum. Concretely, items were culled when the item placement ratio of all judges was lower than 38% (3/8) or when the item placement ratio of the pairs of judges was lower than 50% (2/4) (Recker and Rosemann 2010). Thus, even if an item receives a relatively high rank, it might still be culled.

Item Revision

In the fourth stage, an index card sorting test was employed to further reduce the revised pool of items from stage three (Recker and Rosemann 2010). During this stage, the scales are shortened to contain as few items as possible while maintaining reliability and validity levels. For this test, a new panel of seven judges was asked to assign items to the latent theory constructs to draw conclusions about whether items reflected these (Recker and Rosemann 2010). Here, the panel of judges included healthcare professionals (i.e., one paramedic, one physician, and five medical students with an age ranging from 20 to 30) from different domains and levels of education. The index card sorting test was conducted via an online survey.

For the card sorting round, the seven judges were instructed to sort the items into provided categories, (i.e., the three latent theory constructs *C10 Introduction of IT*, *C90 Effects of automation*, and *C10 Effects of Informating)*. The instructions were tested for comprehensibility and comprehensiveness with a separate judge by reading them to that judge (Recker and Rosemann 2010). Also, each judge received the pool of items shuffled into a random order. In all sorting rounds, judges were also provided with a category "Too ambiguous/ Does not fit". They were instructed to sort an item into this category if they felt that an item is too ambiguous (fits into more than one category) or indeterminate (does not fit into any category). This was done to ensure that judges do not force items into a category (Moore and Benbasat 1991). Again, an information sheet including a trial sorting was provided to ensure that judges understand the instructions.

For the analysis of the responses, Moore and Benbasat's (1991) item placement ratio and Cohen's (1960) Kappa were used to assess the inter-judge reliabilities of the sorting result. While Cohen's Kappa yields a good indication of the overall reliability of the classification scheme, the item placement ratio can be used to identify problematic areas (Moore and Benbasat 1991). For example, if a construct has a low placement ratio, it can indicate that the items intended to measure this construct are too ambiguous. If items were sorted into the intended category in less than 43% of the time, they were culled depending on whether the content domain was still covered by other items (Recker and Rosemann 2010).

Results

Item Creation

Overall, the literature review yielded enough evidence to indicate the validity of the description of the latent theory constructs. Except for the concepts *C80 Informating* and *C100 Effects of informating*, the descriptions by Burton-Jones (2014) were used as definitions for the latent theory constructs. As both the retrieved articles and Burton-Jones (2014) indicate that the representation of information is an essential dimension of *Informating*, we included the presentation of information in the description. The following definition for *Informating* is adopted: "The recording and presentation of information about work done through information technology". In the detailed model, Burton-Jones (2014) provides another indication of this differentiation. The concepts *Textualization of work* and *Visibility/transparency* indicate that information is recorded and can be observed by the users of a system. In addition, we added task-related knowledge reduction to the *Effects of Informating*, as the information a system provides can free the worker from the requirement to keep task-related information in mind (Surendra and Nazir 2019).

Noteworthy, in the literature search, several articles referred to, used or extended classic IS theories and models such as the Technology Acceptance Model (TAM) (e.g., Karahanna et al. 1999), Unified Theory of Acceptance and Use of Technology (UTAUT) (e.g., Hess et al. 2014), IS success model (e.g., Wixom and Todd 2005), or innovation diffusion theory (see for example Moore and Benbasat 1991; Young et al. 2016). Some articles also referred to the measurement instrument developed by Moore and Benbasat (1991). Hence, we included these theories in the screening for relevant subconstructs. This adds to the validity of our measurement instrument, as these theories build on an extensive body of research on IT perceptions and look at introducing IT from different perspectives.

Subconstructs for Introduction of IT

In the retrieved literature we identified four subconstructs for the concept *Introduction of IT*: *Voluntariness (VOL), Image (IMG), Perceived Ease of Use (PEOU)*, and *Visibility (VIS)*. Table 1 shows the adapted items. VOL of use is a relevant characteristic during the interaction with IT. The use of the introduced IT is assumed to be either compulsory (mandated) or supplementary (voluntary). Using a system is not voluntary, when supervisors require employees to use the system (e.g., when non-use is punished) (Venkatesh et al. 2003). Still, the use of introduced IT can be perceived as voluntary when it in fact is not. For example, when introducing a new radiology system for managing clinical images of patients, the new IT system will likely replace the old IT system. As it is likely that the old IT system is disposed, a worker can hardly stick to using the old IT system. The use can be perceived as supplementary when introducing IT that does not replace an old system but rather coexists with existing systems (e.g., a genome sequencer with analysis software). This idea of voluntariness is also backed by articles in the retrieved literature (Hess et al. 2014; Karahanna et al. 1999). In the detailed model of TSM this also touches on the concept *Managers use of technology for enforcement*. When managers want to enforce a certain use behavior, they can mandate the use of the system (Burton-Jones 2014). In addition, the concept V*isibility/transparency* states that if technology increases the visibility of workers' activities, supervisors can use the information for monitoring, thus, possibly affecting the perceptions of voluntariness. As all the identified articles use the scale of Moore and Benbasat (1991), the definition of the construct and items was adopted for the present work. Thus, for this study the construct voluntariness is defined as "[t]he degree to which use of [a system] is perceived as being voluntary, or of free will" (Moore and Benbasat 1991, p. 195).

Item	Item description	RA	#	R1	R2	R3
IMG1	People in my organization who use the system have more prestige than those who do not.	7	1	.88	.75	0
IMG2	People in my organization who use the system have a high profile.	5.75	3	.88	.75	.14
IMG3	Having the system is a status symbol in my organization.	6.63	2	.88	.75	0
PEOU1	My interaction with the system is clear and understandable.	6.63	2	.88	1	.14
PEOU2	It is easy for me to become skillful at using the system.	6.25	5	1	1	.57
PEOU3	I find the system easy to use.	6.75	1	1	1	.43
PEOU4	Learning to operate the system is easy for me.	6.63	2	1	1	.71
PEOU5	Interacting with the system does not require a lot of my mental effort.	6.38	4	1	1	.29
PEOU6	I find it easy to get the system to do what I want it to do.	6.25	5	1	1	.43
VIS1	I have seen what others do using a system like this.	5.38	1	.88	1	.14
VIS2	I have seen a system like this in use in other hospitals.	4.63	2	.88	1	.43
VIS3	I know other hospitals that use a system like this.	4.13	3	.88	1	.29
VOL1	My use of the system is voluntary.	7	1	1	1	.29
VOL2	My supervisor does not require me to use the system.	6.63	2	1	1	.29
VOL3	Although it might be helpful, using the system is certainly not compulsory in my job.	6.13	3	1	1	.29
VOL4	My superiors expect me to use the system.	6.13	3	1	1	.43
PUA1	Using the system improves my performance in my job.	6.75	2	1	1	.57
PUA2	Using the system in my job increases my productivity.	7	1	1	1	.71
PUA3	Using the system enhances my effectiveness in my job.	6.5	2	1	1	.86
PUA4	I find the system to be useful in my job.	6.38	4	.88	.75	.43
PUA5	Using the system enables me to accomplish tasks more quickly.	6.63	1	1	1	.86
PUA6	*If I use the system, I will increase my chances of getting a raise.*	*3.88*	*7*	*.38*	*.25*	-
PUA7	Using the system improves the quality of work I do.	6.5	2	1	1	.57
PUA8	Using the system makes it easier to do my job.	6	6	1	1	.57
RES1	I have no difficulty telling others about the results of using the system.	6.5	2	1	1	.43
RES2	I believe I could communicate to others the consequences of using the system.	6.25	3	1	1	.14
RES3	The results of using the system are apparent to me.	6.63	1	.88	.75	.14
RES4	I would have difficulty explaining why using the system may or may not be beneficial.	5.75	4	1	1	0
SQR1	The system enables my supervisor(s) to monitor my activities more closely.	6.38	3	1	1	0
SQR2	The system enables my supervisor(s) to have more control over my activities.	6.25	4	1	1	.29
SQR3	My managers use the system to secure their authority.	6.63	2	.88	1	.29
SQR4	The system does not lead to changes in the organizational hierarchy.	6.75	1	.63	1	.57

Item	Item description	RA	#	R1	R2	R3
SR1	I miss face-to-face contact with my co-workers since the system was introduced.	6.75	1	1	1	.43
SR2	I feel isolated in my work environment since the system was introduced.	6.75	1	1	1	.57
SR3	I miss the emotional support of coworkers since the system was introduced.	6.63	3	1	1	.57
SR4	I miss informal interaction with others since the system was introduced.	6.63	3	1	1	.57
LS1	Knowledge gained by using the system will be helpful to me for my work in the future.	6.38	4	.38	.50	.43
LS2	The system provides me with information that had been previously unknown to me.	6	5	.63	.75	.43
LS3	Information provided by the system uncovers aspects of my work environment that have been previously unknown to me.	6.5	2	.63	.75	.57
LS4	Information provided by the system helps me to better understand my work environment.	6.75	1	.50	.50	.71
LS5	*Information provided by the system helps me to stay close to the work environment.*	*5.38*	*7*	*.25*	*.25*	-
LS6	*Information provided by the system helps me to increase my focus in the work environment.*	*4.63*	*8*	*.13*	*0*	-
LS7	*Information provided by the system helps me to test assumptions about the work environment.*	*6*	*5*	*.25*	*.50*	-
LS8	Information provided by the system helps me to improve insights about the work environment.	6.5	2	.50	.50	.57
PPC1	*Information gained by using the system gives me greater control over my work.*	*6.88*	*1*	*.25*	*.50*	-
PPC2	Information gained by using the system enables me to make a decision without consulting my supervisor(s) or co-workers.	6.5	3	.63	.75	.29
PPC3	Information gained by using the system enables me to work more independently of my supervisor(s) or co-workers.	6.38	4	.75	.75	.14
PPC4	Information gained by using the system enables me to structure my work more independently.	6.63	2	.63	.75	.29
PPC5	Information gained by using the system enables me to implement more of my own ideas for my work.	6.25	5	.63	.75	.71
PPC6	Information gained by using the system gives me more freedom in my work.	6	6	.63	.75	.29
PS1	*The way the information is presented by the system improves my performance in my job.*	*6.25*	*5*	*.38*	*.50*	-
PS2	*The way the information is presented by the system increases my productivity in my job.*	*6.13*	*9*	*.38*	*.50*	-
PS3	*The way the information is presented by the system enhances my effectiveness in my job.*	*6.13*	*9*	*.50*	*.50*	-
PS4	I find the way the information is presented by the system to be useful in my job.	6.38	3	.38	.75	.43
PS5	*The way the information is presented by the system enables me to accomplish tasks more quickly*	*6.25*	*5*	*.50*	*.50*	-
PS6	The way the information is presented by the system improves the quality of work I do.	6.5	1	.38	.50	.43
PS7	The way the information is presented by the system makes it easier to do my job.	6.5	1	.50	.75	.43
PS8	The way the information is presented assists me in my job.	6.25	5	.50	.75	.57
PS9	I find the way the information is presented by the system to be helpful in my job.	6.25	5	.38	.75	.29
PS10	The way the information is presented by the system helps me to combine information from different sources.	6.38	3	.50	.75	.86
PS11	*The way the information is presented by the system helps me to keep track of my working processes.*	*6.13*	*9*	*.50*	*.75*	
PUI1	Using the information provided by the system improves my performance in my job.	7	1	1	1	.29
PUI2	Using the information provided by the system in my job increases my productivity.	7	1	1	1	0
PUI3	Using the information provided by the system enhances my effectiveness in my job.	6.63	3	.88	1	.29
PUI4	*I find the information provided by the system to be useful in my job.*	*6.25*	*7*	*.63*	*.25*	-
PUI5	Using the information provided by the system enables me to accomplish tasks more quickly.	6.63	3	.75	.50	.14
PUI6	*If I use the information provided by the system, I will increase my chances of getting a raise.*	*4.25*	*8*	*.25*	*0*	-
PUI7	*Using the information provided by the system improves the quality of work I do.*	*6.63*	*3*	*.63*	*.25*	-
PUI8	Using the information provided by the system makes it easier to do my job.	6.38	6	.75	.50	.29
TKR1	Information provided by the system reduces the need to have previous knowledge for my tasks.	6.88	1	.38	.75	0
TKR2	Information provided by the system would enable new employees to perform my tasks with less previous knowledge.	6.75	2	.50	.75	0
TKR3	*Information provided by the system reduces mental effort needed for my tasks.*	*4.75*	*4*	*0*	*.25*	-
TKR4	I think the information provided by the system lowers training needs for new employees.	6.63	3	.50	.75	.14
WEI1	Using the information provided by the system enables me to improve my work environment.	7	1	.63	1	.43
WEI2	Using the information provided by the system enables me to improve the quality of services in my work environment.	6	4	.63	.75	.43
WEI3	Using the information provided by the system leads to innovation in my work environment.	6.63	3	.50	.50	.57
WEI4	Using the information provided by the system enables me to improve work processes in my work environment.	6.88	2	.38	.50	0
WEI5	Using the information provided by the system helps to surpass the performance other hospitals.	4.63	8	.63	1	.29
WEI6	Using the information provided by the system helps to keep up with the performance of other hospitals.	4.88	7	.50	1	.43
WEI7	Using the information provided by the system helps to surpass the performance other divisions.	5.63	5	.38	1	.71
WEI8	Using the information provided by the system helps to keep up with the performance of other divisions.	5.63	5	.50	.75	.43

Table 3. Items and Panel Results for the Three Latent Theory Constructs

Notes: *RA*: Ranking average received in the item identification stage; *#*: Absolute rank based on RA; *R1/R2*: Item placement ratios received in card sorting rounds 1 and 2 in the substrata identification stage; *R3*: Item placement ratios received during card sorting in the item revision stage. Items that are shown in *gray and italic* were culled in the substrata identification stage; Items in *gray* were culled in the item revision stage.

PEOU is one of the most referenced constructs in the literature. It captures an important characteristic of IT that can alter the nature of work. We included the PEOU as subconstruct for the concept *Introduction of IT*. This was done for three reasons. First, in the retrieved articles it is noted that PEOU is an important aspect of system quality (DeLone and McLean 2003). Second, in the IS success model it is included a predecessor to *User Satisfaction*, *Use/ Intention to Use* and usability. These both can be assumed to be effects of the IT introduction that relate to the concepts *Effect of Informating* or *Effect of Automation*. Third, Wixom and Todd (2005, p. 91) argue that "being able to effectively interact with the system is a necessary condition to obtaining useful information from it". This again provides support for the logical order of concepts (i.e., that PEOU must precede *Informating*). The construct definition and the items are adopted from Venkatesh and Bala (2008). Hence, we define PEOU as "the degree to which a person believes that [using a system] will be free of effort" (Venkatesh and Bala 2008, p. 276).

VIS was included based on the measurement instrument provided by Moore and Benbasat (1991). This was done to include positive or negative perceptions due to familiarity with the IT. Familiarity includes a direct contact (i.e., that the system has already been used) and an indirect contact with such a system (i.e., seeing it or hearing from it). These contacts can be in an employee's own environment (i.e., the organization or the team) or in another environment (i.e., friends of an employee that work in another organization). The definition of this construct and items are adopted from Moore and Benbasat (1991). Hence, VIS is defined as "the degree to which the results of [a system] are visible" (Moore and Benbasat 1991, p. 203).

Subconstructs for the Effects of Automation

In the retrieved literature we identified four subconstructs for the concept *Effects of Automation, namely Result Demonstrability (RES), Perceived Usefulness of Automation (PUA), Status Quo Reproduction (SQR)*, and *Sociality Reduction (SR)*. All adapted items are shown in Table 1.

RES is included to account for a general understanding of how a system works (i.e., how systems perform tasks). In the retrieved literature, this construct is included as an effect of an automated system (Karahanna et al. 1999; Venkatesh and Bala 2008; Wixom and Todd 2005). This construct can be an indicator of the *Effect of Automation* work force antagonism when employees understand how a system is used to exert increased control by managers. As an effect, this view also implies that the user understands why a system automates certain tasks, which tasks are automated, and to which degree the understanding of *Automation* is the prerequisite for this construct. In the context of DT this can also refer to a worker's understanding of how a system transforms by creating new results and improving a worker's performance. Both the construct definition and the items are adopted from Venkatesh and Bala (2008). Thus, RES is defined as "the degree to which [...] the results of using a system are tangible [...]" (Venkatesh and Bala 2008).

PUA is included to capture the aspects that relate to performance improvements and fewer mistakes (Burton-Jones 2014). Perceived usefulness is one of the most prevalent dimensions of IT perceptions in the literature (Hess et al. 2014; Venkatesh and Bala 2008). Moreover, this construct has been validated in many studies on UTAUT (Dwivedi et al. 2019) and TAM (King and He 2006). The construct definition is adopted from Davis (1989) as the reference to the enhancement of job performance fit well to the effects named by Burton-Jones (2014). Thus, PUA is defined as "The degree to which a person believes that using a [...] system will enhance his or her job performance (Davis 1989, p. 320). Still, to account for the diversity of the theories, items from TAM3 (Venkatesh and Bala 2008), UTAUT (Venkatesh et al. 2003) and Moore and Benbasat (1991) were screened and adopted as well. For example, we included the item PUA7 as the reference to the quality of can be an important factor in an healthcare context (Moore and Benbasat 1991).

SQR captures workers' perceptions of the degree to which technology is used to strengthen and to consolidate the managerial hierarchy. Managers can use technology for increasing their authority and their control over the workers' activities. It is likely that "without organizational innovation, a traditional hierarchical approach to authority will remain" (Burton-Jones 2014, p. 54). This concept is not mentioned in the retrieved literature. It can only be noted indirectly, for example, when new IT leads to no changes in the managerial hierarchy (Davis and Hufnagel 2007). In the detailed model of TSM, this effect is mentioned in the concept *Opportunity to develop and express competence*. Managers actively limit these to reproduce the status quo. Also, the concept *Managers' use of technology for enforcement* refers to the fact that managers want to stay in control (Burton-Jones 2014). Taken together, the process of how the status quo is reproduced is neither explicitly defined in any of the found articles, nor are there items available related to this topic. Thus, we created the following definition for SQR: The degree to which a system is used to consolidate the managerial hierarchy and the status quo. Based on the dynamics and effects outlined in TSM, we created four items for this construct.

SR can occur when technology replaces face-to-face communication. For example, an increase in perceived isolation has already been measured in the context of remote work (Golden et al., 2008). None of the articles identified during literature search referred to this effect of automation. Thus, based on the descriptions by Burton-Jones (2014) we define SR as "the degree to which a system decreases the sociality of the work environment". As we did not find items in any of the retrieved articles, related literature was searched for the reduction of social aspects. This led to the article by Golden et al. (2008) who measure the reduction of social aspects due to remote work. Four eight items were deemed suitable and adopted for this context.

Subconstructs for the Effects of Informating

In the retrieved literature we identified six subconstructs for the concept *Effects of informating*, namely *Perceived Usefulness of Informating (PUI), Perceived Support (PS), Learning Support (LS)*, *Perceived Process Control (PPC), Task-related Knowledge Reduction (TKR)*, and *Working Environment Improvement (WEI)*. Adapted items are shown in Table 1.

PUI is included to capture aspects that relate to "performance increasements" and an "increased pace of change" noted by Burton-Jones (2014, p. 46) for the concept *C100 Effects of informating*. Several of the studies identified in the literature search referred to performance increasements and a higher pace of change as an effect of informating capabilities (see for example Kohli and Kettinger 2004; Wixom and Todd 2005). In contrast to the construct *PUA*, this construct refers to the performance increasements due to information provided by a system instead of using a system. The construct definition is based on Davis (1989) definition of perceived usefulness and includes a reference to the information the system provides instead of the system itself. Thus, this construct is defined as "the degree to which a person believes that using the information provided by a system will enhance his or her job performance". Again, to account for the diversity of the theories, items from TAM3 (Venkatesh and Bala 2008), UTAUT (Venkatesh et al. 2003) and Moore and Benbasat (1991) were screened and adopted as well.

PS captures the usefulness of the presentation of information in a system. It is thus closely related to *PUI*. While *PUI* depends on the quality of the information, *PS* depends on how well it can support an employee's activities and processes due to its representational capacity. This dimension is motivated by the idea to capture the effects related to both the recorded information and to its presentation. This is also supported by the identified articles from the literature review (Wixom and Todd 2005). A noteworthy example is provided by Surendra and Nazir (2019). They argue that an informating perspective should include aspects related to how well IT can support an individual for carrying out tasks. They call this dimension "ready-to-handedness", which refers to the reduced cognitive load when a process is represented in the system such that process steps do not have to be kept in mind. Thereby, they reach a seamless integration of the process steps that prior to the introduction of the new system had to be carried out manually (Surendra and Nazir 2019). The construct definition is based on Davis (1989) definition of perceived usefulness and included a reference to the support the system provides. Based on the knowledge provided by the various articles identified during literature search, this construct is defined as "the degree to which the way the information is presented by the system supports a person's tasks so that process steps do not have to be kept in mind". The included items for this construct thus only refer to the way the information is presented in the system as the usefulness of the information is already captured by *PUI*.

LS captures the perceived opportunities information presented by a system can provide for learning and improvement. When processes, events, and activities are explicitly captured in the system, workers can learn from this information by identifying flaws and optimizing their process activities (Burton-Jones 2014). With the recorded information, an informated system can facilitate learning and support the process steps carried out by a worker and can thereby increase the quality of work and performance. In the definition of the *Effects of Informating* the opportunities for learning are mentioned both for workers and the business in general. This includes the use of the gained knowledge to improve processes or products, which can finally lead to innovations in organizations. From the definition of *C80 Informating*, one implication for work can be deducted. Technology "(...) provides a deeper level of transparency to activities that had been either partially or completely opaque" (Burton-Jones 2014, p. 46). The way how users take advantage of this mechanism is learning. A system providing the user with a representation of information about processes, activities and events can provide users with information that has had been previously unknown to them. In the detailed model of TSM a the concept *Exploit informating potential* refers to a way of learning by exploring, experimenting, and improving based on the new information about the work (Burton-Jones 2014). This is also driven by how well the system allows the user to develop tacit knowledge that frees time and cognitive resources for new insights. In the detailed model of TSM this path is included with the concept *Intellective Mastery* (i.e., intellective skills in tacit form). Taken together, the learning support is defined as "the degree to which the information provided by a system improves the understanding of the work environment”. Items for this construct were created based on the descriptions by Burton-Jones (2014) and based on the descriptions in the articles identified during literature search.

PPC refers to a worker’s control over activities in the work process. A characteristic of informating functionality is the opportunity to take control of and reflect on a work process. With increased control over the processes, a worker can gather information and come to a decision without depending on information from managers or coworkers (Surendra and Nazir 2019). Based on the description by Surendra and Nazir (2019) PPC was defined as “the degree to which a system enables a person to actively enhance their work environment”. As only Surendra and Nazir (2019) and Burton-Jones (2014) describe this construct, the items were created based on these descriptions.

TKR refers to the fact that IT can make existing task-related knowledge obsolete by providing enough information to an employee, although the *Introduction of IT* can require learning of new ways of working. On the one hand this means that a worker does not have to keep in mind a cumbersome process but is guided through the tasks. On the other hand, expertise that was necessary to carry out a task is no longer needed and can lead to a decrease of expertise related to the task. Based on the description by Burton-Jones (2014), we define: “The degree to which a system reduces the need for task-related knowledge”.

WEI relates to the overall benefits noted by Burton-Jones (2014). These include improvements due to added value by workers and higher competitiveness, which were not captured by any other construct, nor in any of the identified articles of the literature search. The IS success model provides a similar construct with *net benefits* (DeLone and McLean 2003). This is different from *LS* in that it captures the transformational process improvements. Burton-Jones (2014) differentiates these *Effects of informating* from learning and productivity or efficiency gains. The improvement of organizational processes, products, and services through innovation is different from mere productivity or efficiency gains. While the constructs *PUI*, *PUA,* and *PS* refer to this as an improvement of a user's work or situation, *WEI* refers to the impact of the use of the additional information that the system provides on the working environment (organization). In other words, this construct captures a worker's perceived impact of using the information gained by using the system. Based on these descriptions, this construct is defined as “the degree to which a system enables a person to actively enhance their work environment”. Items WEI 1 to WEI 4 for this construct were created based on the descriptions by Burton-Jones (p. 46). Items WEI 5 to WEI 8 are based on Vandenbosch and Higgins (1995) who provide a scale for the perceptions of competitiveness. Items for comparative advantage were developed based on the idea that the system leads to an improvement of the working environment when comparing it to other working environments known to a user (e.g., other hospitals).

Overall, the backtranslation of the constructs, subconstructs and items required one revision round, in which eight of the items were revised. The German translation of the study material is available on request.

Substrata Identification

This stage reports the results of the own category tests that were carried out with eight judges. The results for that card sorting rounds related to subconstructs of the concepts *Introduction of IT, Effects of automation*, and *Effects of informating* are illustrated in columns R1 and R2 of Table 1. The table reports on the placement ratios comparing the results of all judges (R1), and the placement ratios comparing the results of every pair of judges (R2). Based on the placement of items into categories it was examined whether judges placed an intended construct within the target construct. The coding of items into categories was carried out in German to prevent errors due to repeated translations. The German categories that were coded into the intended target cluster are available on request from the authors. Based on this coding, the placement ratios for every category and for every item were calculated. All the items of the latent theory construct *Introduction of IT* passed the required threshold of 38 % (i.e., at least 3/8 of judges placed the items into the intended category). For the *Effects of automation* PUA 6 did pass the threshold for all judges but failed to pass the threshold for pairs of judges. PUA 6 was repeatedly placed into an own category by judges referring to payment or organizational aspects. Thus, we decided to cull this item. For the *Effects of informating* the items LS 5, LS 6, LS 7, PPC 1, and TKR 3 failed to achieve the minimum required placement ratios. Also, LS 5, LS 6, TKR 3, PUI 4, PUI 6, and PUI 7 failed to achieve the minimum placement ratio for the pairs of judges. As a result, these items were dropped from the respective scales. Items that were dropped during this stage are shown in italic and as grey rows in Table 1. In sum, the overall placement ratios still indicate that the identified pool of items displays high content validity and high construct validity in terms of discriminant and convergent validity.

Item Identification

The results of the ranking tasks are also reported in Table 1. The table contains the rank (#) and the ranking average (RA) that indicates the average fit the judges gave to the respective items. A low value indicates that judges did not see a good fit. Based on the rank no additional item was culled from the item pool of the concepts *Introduction of IT* or *Effects of Automation*. From the item pool of *Effects of* Informating PS 1, PS 2, PS 3, PS 5, and PS 11 were culled based on their rank.

Item Revision

The result of the card sorting from the seven recruited judges is also shown in Table 1 (R3). The result indicates that most of the items related to the characteristics of *introduction of IT* (*IMG*, *VIS,* and *VOL*) were not repeatedly placed in the intended target construct. Also, most of the items related to *RES* and *SQR* were misplaced in the *Effects of Automation*. Only RES1 and SQR4 received acceptable placement ratios. For the concept *Effects of Informating* all items related to *PUI* and to *TKR* were repeatedly misplaced. Also, from *PPC* only PPC5 had enough support for being kept in the first stage of the card sorting rounds. The average Kappa was calculated to be 0.089, indicating only a low, non-reliable inter-judge agreement. Also, the overall item placement ratio was low compared to those required by Recker and Rosemann (2010, p. 24). The concept *Introduction of IT* received an overall placement ratio of 30%, *Effects of automation* 40%, and *Effects of informating* 40%. The resulting final item pool is shown as white rows in Table 1.

Discussion and Implications

Based on TSM our research yielded a parsimonious, evaluated, survey instrument to measure employees' perceptions of DT in the healthcare industry. In the first stage we could identify subconstructs and items for the latent theory constructs *Introduction of IT*, *Effects of automation*, and *Effects of informating*. It is interesting to note that the identified articles for *Effects of automation* almost exclusively dealt with productivity increasements. Only two articles referred to other effects. This is in line with the IT perception literature, which refers to this as net benefits and usefulness of IT (Dwivedi et al. 2019). However, this also indicates that other, unintended factors in the *Effects of automation* need further research.

In examining TSM, we find that policy makers such as supervisors play a crucial role in the process of introducing IT innovations in context of DT. Through the concept C*hoice and commitment to fundamentally innovate*, they determine which emphasis is given to the automating and informating aspects of IT (Burton-Jones 2014). They can either choose to pursue an automating strategy or an informating strategy. With an automating strategy, they can choose to suppress the informating process to prevent that employees get access to new information. With an informating strategy, they can choose to support employees' aspirations to learn from and use new information about their work. Note that an informating strategy does not exclude but still builds on *Automation* (i.e., *Automation* must take place at least to some degree; for a recent example how to implement an informating strategy see Surendra and Nazir 2019). Burton-Jones (2014) also states that an informating strategy requires supervisors to change responsibilities and authority in order to empower employees to leverage the potential of new information. While the informating strategy is considered to resolve the dilemmas of transformation, the automation strategy is considered to consolidate the status quo, missing out on opportunities to fundamentally innovate (Burton-Jones 2014). However, an appropriate strategy for researchers and policy makers in context of DT needs to be determined by future research by further validating and extending the TSM model.

We also find that in contrast to existing IS theories dealing with perceptions of IT – for example, TAM3 (Venkatesh and Bala 2008), UTAUT (Venkatesh et al. 2003), or the IS success model (DeLone and McLean 2003) – TSM takes a more holistic perspective. It includes more aspects of the socio-technical and organizational environment in which a system is used. For example, in relation to the socio-technical environment, TSM includes effects that pertain to the negative and positive feelings of employees due to the increased potential to monitor their activities with IT (Burton-Jones 2014). Also, as an aspect of the organizational environment, the perceptions of competitive advantage are included, which is only partly comprised in the *Net Benefits* construct of the IS success model (Burton-Jones 2014). Another important aspect of the competitive environment that is missing in TAM3, UTAUT, and the IS success model, is the concept *C50 Market necessity*. Especially for the analysis of digital transformation, this is a crucial factor, as this also takes into account disruptions of industries that require strategic responses (Vial 2019, p. 122).

Although the culling in the last stage (item revision) led to a more parsimonious survey instrument, the inter-judge agreement on culled items was low. A plausible reason for that is that the online card sorting procedure was carried out with an online survey tool. Here, it could not be verified that the judges read the provided instructions thoroughly. Although, we actively encouraged judges to ask questions via email to clarify any misunderstandings, no judge asked a question. If the procedures would have been carried out in a face-to-face setting (e.g., via an online video conference), this might have made it easier for judges to approach us. Another possible explanation is the inclusion of the category "Too ambiguous/ Does not fit". While four judges placed a plausible number of items into this category, three judges placed between 38% and 58% of items into this category. This might indicate that the sorting was not conducted conscientiously.

It is interesting to note that not a single item for the subconstructs IMG, PUI, and TKR received a placement ration higher than 29% in the last stage. As the items of PUI refer to productivity and job effectiveness, the judges might have intuitively assigned these items to *Effects of Automation* or *Introduction of IT*. This is because the judges might have perceived productivity to be directly connected to the degree of automation. Intuitively, the more tasks are automated, the fewer tasks need to be carried out. For IMG this might occurred because the gained image was perceived as a result of using IT and not as a characteristic of the *Introduction of IT*. For TKR, this might have occurred because the judges did not perceive the information the system provides as a long-term effect. Rather they might have thought that the reduction of knowledge occurs within the *Effects of Automation* as the knowledge that was necessary to carry out a task is no longer needed when this task is automated.

Our study includes various limitations. First, our focus on the AIS Senior Scholars' Basket of eight excluded several publications in other outlets and thus limits the results of the literature review. Also, the employed keywords and the focus on IT adoption related constructs, especially for the *Introduction of IT*, might have limited the breadth of the retrieved literature and hence the breadth of identified characteristics of IT. Future research should thus consider a broader range of outlets and keywords, including specific important drivers of DT such as AI, big data analytics. Related to that we find that the choice to focus on perceived characteristics of IT might limit the view on the *Introduction of IT* construct. Future work should also consider including constructs related to the extent to which workers perceive the nature of work affected. Second, we chose to assume objective measures for the concepts *Automation* and *Informating*. Future research could also include subjective measures to account for their specific properties such as the perceived significance of automated tasks. Third, in the last stage of our instrument development process only seven judges could be recruited. As a result, we did conduct more than one card sorting round. Also, we obtained only a low kappa in the last stage. Future research should thus reexamine the evaluated item pool in more card sorting rounds. Fourth, in the last stage we were able to recruit only young healthcare professionals. Experienced healthcare professionals were underrepresented in this stage and should be included in future attempts to validate TSM. Forth, our focus on healthcare professionals might limit the scope of this research to this domain. Yet, the results might still be relevant for organizations in other sectors impacted by DT.

Conclusion

We operationalize TSM and develop a survey instrument to measure employees' perceptions of IT innovations in the context of DT. With our conceptualization we provide relevant factors that enhance our understanding of DT. Policy makers and researchers should consider these factors when examining the perceived effects of DT to carefully design for a more sustainable DT.

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