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Thomas Neukirchen and Matthias Klumpp

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Digital Logistics, Strategic Cognitive Readiness and Employee Training

Thomas Neukirchen[1] *and Matthias Klumpp*[1]

1 – FOM University of Applied Sciences

Purpose: We consider long-term structural implementation risks connected to digitalization in production and logistics. Similar to considerations regarding automation, we identify areas of potential corporate benefits and corresponding necessary adjustments in task descriptions and employee behavior.

Methodology: Case study using an interactive process analysis and annotations method (interaction room) for a digitalization effort in a German power plant component company, including employees in digital developments early on. Survey of the concept of strategic cognitive analysis for logistics digitalization (systematic literature research).

Findings: Analysis of the concept of strategic cognitive readiness is given for logistics digitalization and related to training requirements. This is connected to the presented case study which results in (i) augmented and digitalized process (ii) employee training requirements regarding strategic cognitive readiness.

Originality: The concept of strategic cognitive readiness, originating from a military context, had been widely identified as a core variable with regards to successful automation prior to related widespread adoption. Nonetheless, recent research shows that measures aimed at effectively integrating employees, if taken, have fallen short in many cases.

Keywords: Digitalization, Training, Cognitive Readiness, Case Study

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1 Introduction

Digital logistics requires new perspectives and analyses regarding cognitive and psychological risk prevention due to the increased mental workload in automated systems. The aim of this threefold interdisciplinary approach is to arrive at efficient digitalization measures, co-developed with employees who remain adaptable in the sense of strategic cognitive readiness (Grier, 2012) while sustaining their psychological health and wellbeing. This is achieved by numerous activities intersecting with the three mentioned leverage points, such as process analysis and digitalization strategy, risk assessments, process optimization and competence development, workshops for leadership, cooperation and self-management, introduction of a digital error culture etc. This article discusses the foundations for the approach, gives an outline of project activities and assesses the joint approach (employee-centered digitalization and training) to the digitalization of a particular process (offer preparation) in a company (German power plant components). The approach is motivated by the following context: A number of challenges connected with digitalization in logistics and production exhibit similarities to considerations voiced during the advent of widespread automation in the 1970s and 1980s (Thackray, 1980; Bainbridge, 1983; Cummings, Gao and Thornburg, 2016; Frey and Osborne, 2017). Given that, contemporary and recent work both highlight that a number of issues, however accurately forecast, have not been prevented, nor mitigated. Thus, the question for useful lessons for digitalization drawn from analogous (unresolved) automation issues arises.

In this contribution, we address this question regarding possible consequences of digitalization for employees in logistics and production. For meaningful focus we narrow down our exploratory research to psycho-social matters and team-work, and with a view in terms of a reoccurring concept called 'cognitive readiness'. This term, which is explained below, ties together many important human-resources issues connected with automation shortcomings as well as digitalization risks. For different applications, definitions of the concept have to be adapted adequately and differentiation with respect to timescales and planning horizons need attention, as these surely deviate from the original military context of the term. As a condition for an optimal (cognitive) work performance, a balance of mental workload and stress is widely seen as prerequisite for maximal adaptability (Hancock and Warm, 1989; Guznov, Matthews and Warm, 2010), while an imbalance is likely to impair performance and, if persisting, to lead to profound psychological harm. On the other hand, a low workload and stress level is associated with boredom and detachment from tasks (Cooke, et al. 2010). Symptoms of the latter, such as impairments of short-term memory, perceptual focus, and attention seem as undesirable as those of an overwhelming workload that may even prevent any engagement in a task (Ewing and Fairclough, 2010; Paulaus, et al., 2009). Between these non-optimal states, an 'optimal' work experience and engagement have long since been established (Csikszentmihalyi, 2000). However, the flow-concept may not accurately incorporate changes to logistics work induced by pervasive digitalization (Lucke and Rensing, 2014; Zijm and Klumpp, 2017). Digitalization of processes can induce efficiency gains, of course, while the direction of changes in both quality and quantity of workload and stress are generally not a given. To ensure logistics digitalization takes place in a sustainable fashion on both sides (productivity and human resources), we propose a blend of measures on different timescales, intended to integrate employees into digitalization efforts as soon as possible to ensure both efficient use and preempt inadequate workload developments soon. Further, efficiency of use and prevention of psychological harm are covered with training workshops and risk assessments. The latter is conducted twice at least: during the digitalization process, that is, before a measure takes full effect and is to be used widely. Then, after particular processes have undergone digitalization to their full extent, another risk assessment will be scheduled to aid in prevention of long-term psychological risks and gain data on significant changes in the type of workload and its requirements induced by digitalization (Rintala and Suolanen, 2005; Vuori, Helander and Okkonen, 2019).Thus we will be able to systematically describe areas of potential for individual and corporate benefit and changes to be expected, induced by digitalization and constituting 'work 4.0' in logistics and production.

The specific research questions for this article are: Given that digitalization is viewed to induce substantial changes to logistics work environments (added complexity, density, collaboration etc.) and the corresponding employee capabilities (e.g. skills, knowledge, abilities, motivation), which conceptual recommendations can be given for the design of (team-) work and process design? The concept of strategic cognitive readiness, originating from a military context, subsumes important psychological components, many of which are likely to be either required or affected by digitalized Work 4.0 environments. We thus analyze the concept and explore its applicability in a company case study regarding integrative process analysis of a proposal preparation process for a German power plant component company operating in an efficient lot size one environment. Thus, further research questions for this article are: Which process steps/elements can be modified by digitalization in a way that employees are involved in the development of digitalization measures themselves? How does the concept of strategic cognitive readiness inform the participation of logistics employees in digitalization efforts? These recommendations will be given of a real industry case involving complex, labor-intensive and communication-heavy tasks with, and this merits emphasis, iteration factor one, meaning project structures largely eluding comprehensive standard procedures.

The remainder of the article is structured as follows: Section 2 defines 'strategic cognitive readiness' and gives an overview of its role in an automation and digitalization context. Relevant issues for digitalization and work 4.0 are derived. Section 3 elaborates on the method used to elicit areas of potential and significant process gaps. This method (scoping with annotations, interaction room (Book, Gruhn and Striemer, 2017)) involves relevant employees in a bottom-up process of identifying shortcomings in given company processes. This serves e.g. to develop and implement new software such as idea management apps with participation of the very end-users from a conceptual phase onward, thus maximizing usage likelihood. Further, this section presents an implementation roadmap for digitalization measures containing psychological risk-assessments during the initial phases of requirements definition as well as after implementation. This is meant to ensure efficient use of measures by employees and maintenance of psychological health in view of risks identified (i) during an initial interview phase with employees and (i) drawn from the literature. The specific company case presented in section four draws from both (i) and (ii) as well as the annotation method cited above. Section five concludes.

As we will be working towards a specific applied case to appear further below, we will assume throughout this contribution that the process a company will observe is complex in the sense that no efficiency can be gained would any single stakeholder override team decisions with their respective specialized knowledge, contracts are fixed before all make-or-buy decisions can be made (e.g. for manufacturing) and repetition factor is one, thus generally limiting the accuracy of history-based cost calculations.

2 'Cognitive Readiness' and its Role in Logistics Automation and Digitalization

'Cognitive readiness' has been used to refer to a concept from a military context (Walsh and Shingledecker, 2006). One working definition used by the Institute for Defense Analyses reads as "Cognitive readiness is the mental preparation (including skills, knowledge, abilities, motivations, and personal dispositions) an individual needs to establish and sustain competent performance in the complex and unpredictable environment of modern military operations" (Morrison and Fletcher, 2002). The authors identify ten psychological components for the concept in its original context: Situation awareness, memory, transfer of training, metacognition, automaticity, problem solving, decision-making, mental flexibility and creativity, leadership, and emotion. Decision-making, for instance, is there defined as the act of choosing a tactic or strategy, often primed by patterns learned beforehand. This is quite central to the understanding of cognitive readiness we will pursue, as it underlines that some aspects of this quality are accessible to systematic training while others are inherently individual.

Readiness is defined via distinction from effectiveness. The latter refers (in the current context as well as in the original military terminology) to some evaluation of an outcome of an individual's or team's effort towards an operational goal. The former is a predictor or predictive measure of effectiveness. Cognitive readiness is further determined by cognitive variables such as intelligence and personality, motivation, beliefs etc. Given conditions like or analogous to complexity, dynamics and scarcity of resources and strong time constraints, one may accept that cognitive readiness as a requirement applies to any individual or team having to react quickly to unpredictable and rapidly emerging issues (Morrison and Fletcher, 2002). Different accounts on the term cognitive readiness take into account timescales and planning horizons, leading, e.g., to differentiations such as operational - tactical - strategic cognitive readiness (Grier, 2012)). While the above definition by Fletcher corresponds to operational cognitive readiness, strategic cognitive readiness as defined for a military context by Grier (2012) appears most fitting for the treatment of (logistics) work environments since it adequately captures the quality of most tasks and their time horizon: "An individual's potential to perform assigned planning and organizational duties in the complex and unpredictable environment of military operations" (p.404). We explore the concept for a logistics work context, the military connotation does not apply here. Still, conditions necessary to enable employees to remain in the state of strategic cognitive readiness are potentially affected by pervasive digitalization measures. Further, efficient use, monitoring, and adaptation of these pervasive digitalization measures requires just the kind of optimal cognitive performance described by strategic cognitive readiness. In a sense, it is a reverse and preventive operating concept to organizational blindness/myopia (Knudsen, 2011).

2.1 Strategic Cognitive Readiness as a Work-related Concept

For any work context that requires prompt and adequate reaction to some emerging challenge, one may define prevention measures as training requirements. This applies even more to slightly less dramatic but usually more common scenarios where both non-routine situations occur and these may be characterized as abnormal, thus eluding any sole reliance on rule-based behavior (Sklet, 2006; Kluge, 2014). Opposed to the latter is knowledge-based behavior. This adds a less volatile dimension to the concept of cognitive readiness in a work context: Critical thinking and decision making are universal abilities which can be (recurrently) trained to a degree such that skill may be executed by individuals or teams under pressure, facing abnormal issues (Kluge, 2014). For many logistics and production work cases, time surely is essential. However, not so much on a scale of instances as in the military context but rather as one dimension of resource constraint. Still, for sophisticated tasks and complex operations, such as development of power plant components, the most adequate parts of heavily fragmented and widely distributed knowledge need to be both available and used. Classically, this would be a logistics problem in itself and digitalization is meant to dispose of that need exactly. Still, information quality and distribution can be critically influenced by quality of digitalization measures, e.g. as in our case, an efficient digital idea management for highly complex logistics and construction projects with iteration factor one. Kluge (2014) characterizes challenges posed by abnormal or non-routine situations as such that necessitate reliance on skills which remained unused for longer periods of time, and in the specific case of abnormal situations, such that are ambiguous and may contain major threats to a system while response time is limited. Extending these properties of cognitive readiness to requirements for a digitized system, e.g. intelligent digital idea management, the time dimension may lose some of its relevance with respect to the case we will treat further below. This, however, is ideally just due to formerly hybrid processes being seamlessly digitized. More essential for digitalization adding to a process with repetition factor one would be the timely availability of all relevant knowledge a company owns (e.g. construction specifications, granular time budgets) to gain most exact cost calculations, for instance. Work by Cummings, Gao and Thornburg (2016) or Thackray (1980), for instance, has identified numerous aspects of cognitive readiness and their interconnections. Those from automation and digitalization contexts specifically relevant to digital logistics work and employee training as discussed in this article are given in Table 1 along with representative sources. There (Table 1) we use terms and definitions as given in (Fletcher, 2004) and list literature which reports on these and analogously defined aspects relevant for digitalization contexts, respectively. In the case discussion in section four we relate workshop outcomes to these concepts to show worthwhile leverage points for employee training.

Table 1: Strategic cognitive readiness aspects relevant in automation and digitalization contexts

Components (Fletcher, 2004)	**Descriptions and sub-components**
Situation Awareness	Perception of environmental elements and events with respect to time or space, the comprehension of their meaning, and the projection of their future status (Cummings, Gao and Thornburg, 2016; Endsley, 2016; Gorman, et al., 2016)
Memory, Transfer of Training	Active, reconstructive ability to recall and recognize in the current operational situation patterns that will lead to likely solutions (Fletcher, 2004); ability to apply what is learned in one context to a different performance context. It can be measured by the ability to select and apply procedural knowledge gained in one context to another (“low-road” transfer) or by the application of principles abstracted from a set of contexts (“high-road” transfer) to another (Perkins and Salomon, 1992; Simoni and Bastian, 2018)
Metacognition	Metacognitive knowledge, regulation, experiences (Flavell, 1979); metacognitive awareness, including declarative, procedural, and conditional knowledge (Jacobs and Paris, 1987); metacognitive regulation skills (planning, monitoring, evaluating, (Schraw,

Components (Fletcher, 2004)	Descriptions and sub-components
	1998), problem solving, executive management and strategic knowledge (Zohar and Barzilai, 2013)
Automaticity	Ability to do things without occupying the mind with the low-level details required, allowing it to become an automatic response pattern (Bargh, Chen and Burrows, 1996; Bargh, 2014)
Problem Solving	Mental process: Use of generic or ad hoc methods in a structured manner aimed a solution of problems (Hayes, 1981; Schacter, Gilbert and Wegner, 2011, p.376)
Decision-Making	Cognitive process leading to the selection of a belief or a course of action among several alternative possibilities, might result in action, preference formation (Kahneman and Tversky, 1982) or choice from alternatives(Bellman and Zadeh, 1970; Bazerman and Moore, 2013)

2.2 Related Current Issues in Digital Logistics Work

Digital work developments in logistics and supply chain management encompass a multitude of factors, concepts and technologies. Major steps in this direction can be recognized in assembly and picking processes with the merger or formerly separated human and robot work areas. In current new settings, cobots work together in mixed teams with humans. At the same time, also artificial intelligence applications start to support blue- as well as white-collar workers. Many applications have been implemented like pick-by-voice or pick-by-light picking systems in intralogistics, as well as digital augmented systems in production or distribution logistics enabling new business model in platform economy systems (Klumpp and Ruiner, 2018a; Lang, et al., 2019). In such systems, the human worker is directed and steered by automated commands from the warehouse management or logistics software system in order to increase operational and picking efficiency. This brings new forms of capabilities and requirements for human workers, but also helps them to substitute physical with control tasks (Fletcher, et al., 2019). It also puts significant strain on the human cognitive system as not only a large number of commands by voice or digital light signals have to be computed and enacted, but also a semi-automated feedback mechanism has to be adhered to, in most cases scanning the picked goods with a barcode scanner in order to allow the computer system to document and control workers activities. In many cases, the question of human and cognitive workload has prevented the use of further automated systems as workers are not capable of dealing with too complex digital systems while implementing physical tasks in production and material handling. Furthermore, this leads to the question of a social sustainability of human work in logistics and supply chain management: If workers are not sufficiently motivated and integrated, the long-term success and integration of digital solutions in logistics work systems is endangered (Klumpp, Neukirchen and Koop, 2019; Klumpp and Zijm, 2019; Lang, et al., 2019; Oeshmy, et al., 2019).

Moreover, further digital developments are expected within the transportation sector. For example autonomous driving will bring deeply changed workplaces about – driving will no longer be a physical task in any sense it used to be like for the actual steering, shifting and navigation. Such tasks are automated and transferred to artificial intelligence entities. Instead, human operators will remain in the driver seat with supervision and strategy tasks like pilots are used to have since many decades (Demmel, et al., 2019; Fraedrich, et al., 2019; Klumpp, 2019). Therefore, situational awareness (traffic situation), customer contact and communication as well as strategic planning (platooning with other vehicles or safety preparation and inspection) will take over the working time of driving personnel instead of physical tasks. This will also require new competencies for the workers as for example technical insight, know-when (e.g. to interrupt automated systems) instead of know-how as well as customer and quality management approaches. This leads to the research and business practice requirement for logistics to develop measurement and mitigation concepts regarding mental workload in digital work settings (Arvan, et al., 2019; Emmanouilidis, et al., 2019). Furthermore, this might also open up questions of regulation and law making in the political arena in order to mitigate risks and fears connected to automation and AI applications in transportation and logistics (Klumpp and Ruiner, 2018b).

3 Materials and Methods

The case study has been conducted as an interactive process analysis in a German industry company (power plant components). The detailed methodology of workshops, annotations, interactive analysis and discussion is given below and in (Book, Grapenthin and Gruhn, 2014; Book, Gruhn and

Striemer, 2017). The literature studied for this article and specifically for the concept of strategic cognitive readiness (Fletcher, 2004; Grier, 2012) can be organized hierarchically, as a few widely accepted definitions have been presented. These refer to and consist of the components as listed in section 2, thus widely accepted definitions for these common components have been researched. Criteria for the inclusion of a definition have been number of citations and, if applicable, use in pertinent specialist dictionaries (e.g. VandenBos, 2015).

3.1 Interactive Process Analysis

The specific case analysis is outlined in section four. There we consider a German industry case to exemplify the concepts and ideas for early employee integration in digitalization projects. The company is a typical German machinery producer about 150 years old and connected to the electrical power generation plant industry. As specific components are constructed, produced and built into power plants worldwide, production and logistics processes are tailored towards an efficient lot size one environment. Regulation and service requirements are very high as also the nuclear power plant sector is addressed. In this section we consider one component of the interaction room method used to analyze a business process, in the case example preparation of an offer. Here, precision and completeness do not matter as much as arriving at a common understanding of desired typical procedures, data, interfaces etc. for all stakeholders. Company efforts regarding digitalization have been described along two dimensions as follows (Book, Gruhn and Striemer, 2017), p.64). It is helpful to keep these in mind when particular measures are being discussed further on, such as the concept of experimental spaces: Digital capabilities means that potential of digitalization is explored and researched systematically, resulting in a crisp strategy for areas/processes and ways in which digitalization investments will take place. This requires knowledge of products, distribution channels and detailed insights into customer demands. To be successful, a clear idea of available and useful technology and adequate contexts is indispensable, e.g. to automate interfaces and to integrate real-world objects. Leadership capabilities refers to knowledge and acceptance of the fact that new digitalization solutions have an emergent character. Necessarily, this knowledge extends to stakeholders regarding absence of precise predictability of IT projects. The important trade-off here is between keeping focus on the digitalization goals at hand and leaving space and means for experimentation.

The method we refer to (interaction room, (Book, Gruhn and Striemer, 2017)) offers procedures for all aspects of software development and digitalization, addressing, all stakeholders, objectives, interfaces etc. with a variety of "sub-rooms" and canvases, each of which can be put to use for single aspects such as objects, processes, integration etc. All these can be integrated into the whole comprehensive development endeavor, or, in the consulting-like context we use it here, particular "rooms" (such as the one for scoping) and canvases may be employed. We do so with adapting the process canvas to one particular company process. This represents the case study referred to earlier in this text. In section 4, this specific application will be detailed, while in this section a general description of the method is to follow. The whole interaction room idea is aptly described in (Book, Grapenthin and Gruhn, 2014; Book, Gruhn and Striemer, 2017) by its inventors. For the current purpose, we need not be concerned with the complete mapping procedure of a project since our company case presents us with an established process in need of improvement. Thus, in the language of the framework, a filled process canvas would be given already - we may assume a process map as given. The interaction room literature defines a sensible notation for the process canvas. However, in practice, one needs to consider conventions particular to the company case, if only for the sake of efficient communication. Thus the notation we give here will have been overridden in parts in the documentation of the company case in section four. One should keep in mind that this usually is a cooperative, interdisciplinary process in which a coach and a number of domain experts (e.g. controlling, finance, engineering, accounting, and marketing) partake. Because of this, adherence to UML-prescriptions (Fowler, 2010) always just follows intuitive modelling. Annotations are used to aid in expressing all matters that go beyond the limits of common process models. It is crucial to actually have stakeholders (usually employees) act this procedure out together by placing annotation symbols on a process map and discussing these subsequently. Crucial aspects such as value drivers, hidden cost potentials and risks will be specifically located on the process map and it is ensured that all stakeholders achieve common knowledge (Milgrom, 1981) on all critical issues. Additionally, the procedure reveals blind spots caused by complexity of a process. During a session, stakeholders receive physical symbols representing annotations to be placed on a process map visible to all participants. This way of adding natural language to a formal process model can help unravel a project's challenge and pitfalls early on instead of overlooking them with rigorous formalism. An annotation example would be a note attached on the process map with a "?"-symbol, representing uncertainty, which is categorized as a risk driver (contrasting e.g. value drivers). This annotation represents high risks for the current setup and its implementation and its analysis is prioritized. The ensuing discussion would have to address at least the questions for a definition of this source of uncertainty and required preventive action. The process analysis in section four illuminates both notation and the use/evaluation of annotations.

3.2 Digitalization Implementation with Psychological Risk-Assessment

If one wants to employ a risk assessment which ensures legal certainty, adhering to standards is a promising option. Using ISO 10075 as guidelines (Demerouti, et al., 2012), the following cornerstones for a risk assessment for psychological workload can be derived. There a tripartite structure is

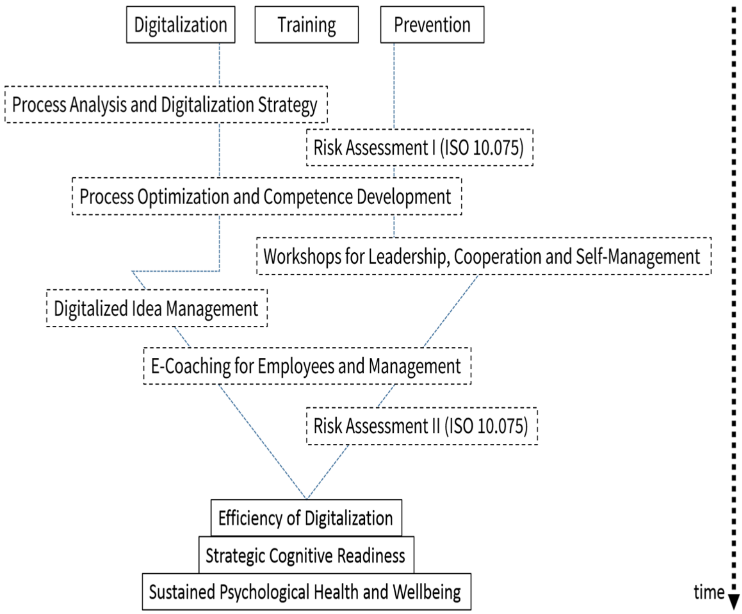

Figure 1: Analysis, optimization and evaluation steps scheduled for the research project; risk assessments (I, II) may be iterated.

given for measurements of work load, with the aim of considering aspects affecting health, safety, wellbeing, and productivity.

Basically, psychological stress and strain in risk assessments of digitized jobs have so far been insufficiently addressed. Although there is a standard for measuring mental workload (ISO 10.075), there is currently no adequate and proven instrument for measuring mental workload at the workplace, taking into account the specifics of digitized work. Therefore, a cross-sector requirement analysis tool for measuring mental stress and strain in digitized work systems should be used for practical application. In the following, this and the digitized business processes to be observed here are to be outlined (Figure 1 shows a chart of the procedure). The steps bracketed by the risk assessments are considered as an iterative procedure, that is, they can be run through several times as needed.

The core idea with the aim of understanding the specific situation in a single company is that of a "laboratory idea" or “experimental space”. In particular, protected learning spaces, employees, together with executives and works councils as experts in an integrated project approach, are actively involved in the development of digital design solutions. The variety of perspectives and the combination of top-down and bottom-up approaches should ensure greater efficiency, effect, and acceptance of the solutions.

4 Digital Logistics and Employee Training - Case

4.1 Proposal Preparation and Core Sub-Processes

The overarching goal for the case research activities is one particular value creation process, here it is preparation of an offer regarding a product. Leveraging digitalization for improved pricing implies improvements in the quality of calculations and pricing precision. Further, it means making better use of existing (decentralized) knowledge. Three core tasks have been identified to this end, each to be mapped to its individual effects and their contribution to the overall goal.

Table 2: Tasks and Desired Effects in the Observed Offer Preparation Process

Value Creation Process: Pricing/Offer Preparation (Lot Size One)	
Task	*Effect*
Digitalization and indexing of archives, integrative process analysis	Digital availability of experience-based knowledge, e.g. construction documents
Digitized time and attendance recording in construction	Transparency with mobile and granular recording, precise time budget allocation
Upgrades to idea management, including interfaces	Efficient idea management through integration, improved error culture

4.2 Annotations and Target-Performance Comparison

The most basic assumption is the trade-off between the optimal realization of a complex system involving human-computer interaction and efficient allocation of resources, including time. A comprehensive understanding of sufficiently complex matters is not attainable with maximum efficiency. This plain fact calls for abstraction and decision criteria for retention and omission of elements deemed important/negligible, respectively. The procedure we chose to employ is oriented towards value generation, which explains why the case described in this article focuses on sufficiently value-adding processes (Bergman, King and Lyytinen, 2002; Boehm and Huang, 2003; Grapenthin, et al., 2013). The crucial aim is to have relevant stakeholders arrive at a common understanding of a process and its identified shortcomings. There exist obvious and less obvious hindrances to this: These can originate from specializations and individual qualification, variations in documentation style between departments or inefficient prioritization of critical issues. Some of this can be explained by inherent redundancies and ambiguities of natural language: Here the trade-off is between the inefficiencies of natural language - available to all stakeholders - and formal, specialized languages (Pohl and Rupp, 2009; Book, Grapenthin and Gruhn, 2012; 2014). A systematic categorization of common understanding (explicit vs. implicit, true vs. false) has been given by Fricker and Glinz (2013). Table 3 highlights the categories of understanding that shall be discerned during the procedure.

During the process analysis workshop, annotations for the following issues were used: Value drivers, complexity, uncertainty, automation, dependence, manual task, need for training, media disruption. The remainder of this section will elaborate on each annotation (numbered 1-21) from the workshop session. The process is centered on a (desired) software solution for a calculation loop ('tool' in the following) that would ideally contain interfaces to customers, engineering, work preparation, ERP, and controlling.

Table 3: Categories of Common Understanding (implicit/explicit, relevant/irrelevant, true/false; Fricker and Glinz, 2013)

	Categories of common understanding	
Relevant, but Unknown/Unnoticed	Implicit, True, Relevant	Explicit, True, Relevant
	Implicit, False, Relevant	Explicit, False, Relevant
	Implicit, false, Irrelevant	Explicit, False, Irrelevant

Descriptions of exemplary improvement potentials are given in the following for each annotation in order to show the power of the implemented annotation method in digitalization projects: (1), manual task: According to employees in customer service, requests need to be handled since people need to interact, e.g. to unravel implicit requirements. (2), manual task: feedback channel, e.g. for completed projects, evaluation requires expert knowledge. (3), media disruption for historic reasons. (4), dependence: Mandatory verification of data generated by employees from assembly, complicated interface between current tool and proposal. (5), value driver: Calculation is a major value driver in general. Mutual dependence between flexibility and precision; major downside risk associated with design errors. (6), uncertainty: Lot size one environment limits the use of historic data. Company uses historically 'grown' database. (7), automation: Potential for automation, currently several interfaces between different types of software. (8), automation and media disruption: media disruption exists for feedback from engineering to tool, manual exchange of Excel-sheets. (9), need for training: Engineering employees need training to be able to use different file formats. (10), automation: Several different systems in use, fragmented across departments - employees express desire to consolidate this. The general link with strategic cognitive readiness is explained below. For example, the following process steps 11-19 require situation awareness on the assembly level (blue collar employees) and the component metacognition, specifically metacognitive knowledge, declarative and procedural knowledge on behalf of the employees in administration and engineering: (11), media disruption and automation: Interface between tool and work preparation does not exist. Manual transfer of data from Excel sheets to Access database. Reliance on historical data for scheduling. (12), uncertainty: Sub-processes in work preparation is not transparent, record of processes is fragmented rather than comprehensive, as is use of tools/software. (13), value drivers: Proposed digital tool would lower fragmentation of processes and increase transparency of work preparation, thus increasing adherence to schedules and quality. (14), need for training, to enable de-fragmentation of sub-processes and tool usage. (15), value drivers and automation: Time recording is not automated, which could increase precision decisively. (16), manual task: Assembly consist of diverse manual tasks which are mapped to time budgets via manual time recording using barcode scanning. (17 and 18), uncertainty: Mapping and recording of time budgets is currently highly non-transparent and imprecise. While product data sheets and schedules are extremely detailed, time recording is currently much less precise. (19), value driver: Which at-tributes do need recording, regarding their contribution to revenue generation? (20 and 21), uncertainty, dependence: Currently, no active cost monitoring during a project; dependence between tool and controlling.

All of these sites of digitalization potential have been unraveled during workshops with employees involved in the process by having them freely annotate process steps with very limited number of annotations. Beyond the detailed suggestions, it is evident that knowledge of this central process has been fragmented and explicit awareness of the listed shortcomings and potential risks was not given before the annotation procedure. In fact, it took some effort to get these employees to actually conduct the annotation process, as everyone was convinced of the sufficiency of their knowledge and efficiency of the current process (Hart, 1991). This highlights the need for training regarding awareness of such shortcomings and, ideally, aiming at enabling employees to conduct this type of inquiry independently. With reference to components of strategic cognitive readiness, situation awareness, while being more aptly replaced by sense making as requirement for the process analysis, is part of the requirements for assembly workers, whose activities are mapped to annotations 11-19. Thus, the component metacognition, and more specifically metacognitive knowledge, declarative and procedural knowledge with respect to sub-processes in assembly work and with respect to the whole process at the abstract level discussed in the workshop have been a main requirement. The annotation process itself requires individuals to plan, monitor, evaluate and revise their own thinking processes and products (Hartman, 2013). Automaticity, that is, the ability to do things without occupying the mind with the low-level details required, allowing it to become an automatic response pattern (Bargh, 2014), is connected to this in two ways: First, participants needed to be aware of assembly processes taking place in this manner to evaluate, which of these have potential for automation. Second, automaticity of social behavior (self-reported) played a role in participants' willingness to consider taking part in the process analysis a valuable activity. Problem solving, surely, is a requirement of the whole process analysis, while more specifically, the generic method (annotations and structured discussion) applied by participants to the problem (process analysis). For the choice of possible process improvements and their ranking, individual choices and individual and collective preferences had to be formed (decision-making). Specifically, decision-making procedures inherent to the annotation analysis or implied by it (e.g. the suggestive character of the annotation 'automation') needed to be made explicit in the discussion ensuing the annotation procedure, to achieve a preference order of process improvement measures supported by all stakeholders.

4.3 Synthesis: The Role of Employee Training in Fostering Strategic Cognitive Readiness

Necessary conditions to enable employees to remain in the state of strategic cognitive readiness (Grier, 2012) are affected by pervasive digitalization, and efficient use of digitalization measures requires just the kind of optimal cognitive performance described by strategic cognitive readiness. It is sensible to integrate efforts toward development and sustenance of it as soon as possible on a digitalization project timeline, preferably beginning with conceptualization and requirements definition phases, before even a single line of code has been written. Employee training ensures sustainability of the described state, and psychological risk assessments add to this as well as contributing to avoidance of adverse effects of digitalization on employee health and well-being. Idea Management (Oldham and Cummings, 1996) intersects with the process discussed in the case example and appears to be a good leverage point for employee-centered digitalization since its processes embody a company's error culture, and, by extension, its communication culture as a whole (Hand, 2016; Crama, Sting and Wu, 2019).

5 Discussion and Outlook

Since only one case study was implemented, applicability and transferability of the findings are limited. However, in viewing the annotations approach to digitalization process analysis in light of the strategic cognitive readiness requirements, a few general recommendations for logistics employee training can be derived: It is advisable to involve employees in (bottom-up) digitalization of processes as early on as possible to gain acceptance and an apt picture of implicit and explicit requirements (Book, Grapenthin and Gruhn, 2014). It is recommended to train employees in the annotations method in order to enable companies to iteratively assess and maintain requirements and process knowledge. Thus to this point in the research project, triangulation with the practical results is still insufficient and it will be crucial to gather further data from additional case studies in order to establish triangulation (Mangan, Lalwani and Gardner, 2004). This will take place over the course of the research project DIAMANT (2018-2021) when more company cases are examined and iterations of case studies like the one presented in this article take place. Applicability and transferability of current findings is quite limited, which is also due to limited ability of the authors to disclose company information. A more detailed process description, including a detailed process diagram would likely make the company recognizable as their (iteration factor one) product is quite unique. Later publications further down the project timeline are likely to present more comprehensive and detailed results.

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