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TOWARDS SMART ASSISTANCE SYSTEMS FOR PHYSICAL AND MANUAL TASKS

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Research-in-Progress

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Abstract

Although automation of physical work is continuously accelerated by advances in information technology, many complex tasks, such as in manufacturing, assembly or maintenance still require human work. In this context, Smart Physical and Manual Task Assistance Systems (SPMTAs) support workers by adapting to their current situation or task. Since the importance of physical work is still evident in a digitized economy, there is a need for properly designed SPMTAs in order to increase job satisfaction and performance of workers by taking off physical and cognitive strain. However, scientific literature on how to design SPMTAs is sparse. Combining sociotechnical systems and work design theory, we derived propositions and conducted interviews with workers of a German car component manufacturer as part of a design science project. The company uses three SPMTAs for assembly, final inspection, and tool management. As a result, we elicited 18 design requirements for SPMTAs to increase job satisfaction and performance. In this research-in-progress paper, we present our preliminary results and discuss next steps.

Keywords: Physical Work Assistance, Smart Technology, Sociotechnical Systems, Work Design Theory, Design Science

1 Introduction

In the digital era, factories are becoming increasingly smarter by leveraging potentials of modern information technology (IT) for production and manufacturing tasks. Thereby, more and more physical and manual tasks (P&MTs) are accomplished by smart interconnected devices, machines and products (Lasi *et al.*, 2014). In this context, studies predict that over 80% of the P&MT workforce's time spent for labour-intensive, repetitive tasks in highly predictive environments can be automated in the near future. However, complex P&MTs, which also heavily rely on creative thinking, subjective evaluation, and control or maintenance of robots, are still less likely to be conducted by technology. About 74% of the time spent for completing such tasks will remain within the domain of human workers (McKinsey, 2017). Studies like this show, that although our lives and work are increasingly infiltrated by smart technologies, there is still a need for human engineering in many areas. Consequently, P&MTs are very like to be an important economic factor within the next decade, making it essential from a management point of view to ensure a high level of satisfaction and performance of P&MT workers.

However, the proliferation of IT causes tremendous changes for such tasks. From a practical perspective, the changing roles of P&MT workers, e.g., of machine operators who suddenly become co-creators of economic value by interacting with smart technology, demands a lot of flexibility, willingness to change, and the ability to learn new ways of working from workers. From an information systems (IS) theoretical lens applying a sociotechnical systems perspective, the use of smart technology changes existing configurations of humans, technologies, and information and may enable entirely new such structures (Medina-Borja, 2015; Breidbach and Maglio, 2016). However, while the majority of recent IS research has focused on how to design smart technology or the interaction to co-create value (e.g., Kortuem *et al.*, 2010), the importance of supporting P&MTs through smart technology is often neglected. Against the backdrop of novel job situations, we argue that increasing job satisfaction and performance of P&MT

workers by designing assistive smart technology is an essential research topic. Thereby, the term "smart" often refers to a list of potential characteristics of a system interacting with humans, such as learning, contextual adaptation, and data-driven decision making (Beverungen *et al.*, 2017). Smart assistants already enhance and support many areas of personal life (Knote *et al.*, 2018; Knote *et al.*, 2019). In a work context, smart assistants do not necessarily have to relieve the worker of physical strain but can provide cognitive support in handling complex P&MTs, e.g., by ensuring an immediate transfer of required work information to the workplace and back to the planning system (Aehnelt and Bader, 2015). We refer to smart assistive systems that support P&MTs as smart P&MT assistants (SPMTAs).

In this research-in-progress paper, we investigate how P&MT workers interact with existing SPMTAs. The ultimate goal of our research is to develop a design theory for the design of SPMTAs that increase P&MT workers' individual job satisfaction and performance (Gregor and Hevner, 2013). While extant literature (especially in the domain of human-machine interaction) mainly focus on ergonomic design and adaption to increase satisfaction and performance, none of them approaches these goals with a holistic foundational theory. Compared to prior research and to the best of our knowledge, our completed research is also the first to explore how smart technology can be designed to increase job performance and job satisfaction of P&MT workers applying a structured design science process including literature work, requirements elicitation interviews, and artefact design and evaluation in context. Hence, this paper shows the first step towards this goal. Applying a sociotechnical system lens on the P&MT work system, we first derived propositions and then conducted 13 semi-structured, exploratory interviews with P&MT workers of a German car component manufacturer. The company has deployed three different SPMTAs, one in assembly, one in final inspection, and one for tool management. The goal of our interviews was to elicit design requirements for SPMTAs as foundation for our overall research goal.

The remainder of this paper is structured as follows: In section 2, we elaborate on the theoretical foundations, namely SPMTAs and P&MTs within sociotechnical systems. Therein, we derive propositions that guide our exploratory interviews. Afterwards, in section 3, we describe our method of conducting qualitative, exploratory interviews. Our results are described in section 4 by summarizing the elicited SPMTA design requirements. We end with expected contributions and future work in section 5.

2 Theoretical Background

2.1 SPMTAs

As SPMTA, we understand each system that assists P&MT workers by the means of smart technology. Smart technology thereby refers to systems that can be regarded as cognitively advanced due to different characteristics, such as learning, contextual adaptation, data-driven decision making or self-* abilities, where * includes regulation, learning, awareness, organization, creation, management and description (Beverungen *et al.*, 2017). The support of P&MT through SPMTAs is thereby not limited to the relief of physical strains, such as lifting-up workpieces to a comfortable height according to the individual worker's body size but may also include reducing cognitive load by providing useful information and guidance related to the workpiece at hand.

However, SPMTAs or the support of P&MT in general have yet been primarily researched from an ergonomics perspective in disciplines other than IS or closely related fields like computer science, such as engineering or human-machine-interaction. However, some exceptions from this rule do exist. Paelke (2014) created a graphical user interface for Augmented Reality glasses that assist factory workers in assembly tasks. The system consists of sensors and software that calculates the current position of the person and decides about important information. Then, the system generates an augmentation displayed in the user's field of view. Having evaluated the system, tests showed high acceptance rates of the device and suggested ideas for researching visualization techniques, user friendly interaction and technological opportunities to make common tasks easier. Highlighting the importance of effective exchange of consultations, Kassner *et al.* (2017) conceptualized the "Social Factory", a social network for machines and human workers with the goal to improve the connection between workers, manufacturing machines, and the data created. Workers observe the machine status, errors and scheduled production tasks. The machines send sensor data to a knowledge repository that interprets them via an analytics middleware to provide solution suggestions. Therefore, complex production environments become intuitive, cooperation among users improves and problems are resolved more easily. The authors evaluated the social network via a use case scenario and aim to implement improved text analytics, push notifications and user feedback integration in the future. Another example documented by Scheuermann *et al.* (2016) is a smart glove for hands-free scanning processes in production. The hardware is connected to sensors and operated by a smartwatch. Evaluation results state a significant decline of errors and increased efficiency as well as a reduction of hand fatigue and increased user acceptance.

While all these examples express salient design knowledge, one can argue that the contribution of IS to P&MT support through smart technology is sparse. One potential reason for this circumstance may be the belief of IS researchers that physical work and ergonomic design lies in the core of other disciplines. While we agree on this, we also argue that IS can and should make clear contributions to this field for at least two reasons. First, a major part of IS is to derive requirements from different stakeholders in various domains and conduct a scientifically reasonable design of useful artefacts. Second, both the investigation and the design of smart technology in and for different use contexts, e.g., as part of complex sociotechnical systems, is one of today's core challenges for IS research (Medina-Borja, 2015).

2.2 Sociotechnical Systems and Work Design Theory

Looking through a sociotechnical systems lens (Bostrom and Heinen, 1977), developing SPMTAs requires the acquisition of knowledge for both the social and the technical subsystems. Whereas the social subsystem comprises organizational structures, people and their interrelations, the technical subsystem covers technologies and tasks. In the past, IS researchers have made tremendous efforts to analyse the relation between each component from different theoretical perspectives, e.g., between task and technology (Goodhue and Thompson, 1995; Dennis *et al.*, 2001; Zigurs *et al.*, 1999) and people and technology (Davis, 1989; Venkatesh and Davis, 2000; Venkatesh and Bala 2008), to name just two popular streams. In our work, we focus on the interrelations between P&MTs, SPMTAs and workers, because our units of analysis are individual workers and how their perceptions of tasks and technology use may shape SPMTA design.

Generally, regarding the relation between P&MTs and SPMTAs, technology will more likely increase individual performance and be used if its capabilities match the tasks that users must perform (Goodhue and Thompson, 1995). Applied to the context of SPMTAs, we assume that the performance of individual workers will increase if the SPMTA seamlessly supports the P&MTs to be conducted.

Further, considering the relation between workers and SPMTAs, two major concepts have been found to be important in numerous contexts: perceived usefulness and perceived ease of use. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" and perceived ease of use as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). In the context of mandatory IT use, which is usually the case for work-related IT use, a third important concept directly may affect the use of IT, namely subjective norm Venkatesh and Davis (2000). Subjective norm is a "person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein and Ajzen, 1975, p. 302).

Last, in order to guide an interview-based exploration of P&MT workers' perceptions, i.e., design a semi-structured interview, we must understand the nature of P&MTs and how workers perceive them regarding job satisfaction and performance. We therefore use work design theory (WDT) as an overarching framework. Honouring job satisfaction as the most important affective attitude to increase behavioural outcomes, such as job performance, WDT attempts to explain the effects of factors that motivate individual workers on these outcomes (Hackman and Oldham, 1976; Herzberg *et al.*, 2011; Morgeson and Humphrey, 2006). WDT describes how work is accomplished based on work characteristics and in context of the range and nature of tasks associated with a job (Morgeson and Humphrey, 2006).

Prior research found that perceived *autonomy*, *task variety*, *task identity,* and *feedback* are critical drivers for individuals' job satisfaction (Thatcher *et al.*, 2002). Autonomy is thereby referred to the degree of self-determinacy and dependency on others (Fried and Ferris, 1987). Task variety is understood as richness, non-monotony and challengingness of different tasks that workers must perform in their job (Lambert *et al.*, 2001). Prior research defines task identity as the extent to which individuals can complete an entire piece of work from the beginning to the end and its results can be easily identified (Sims *et al.*, 1976; Ang and Slaughter, 2001). Feedback from tasks reflects the degree to which appropriate, direct and clear information about the worker's effectiveness of task performance is given by the task (Hackman and Oldham, 1976).

2.3 Propositions

The abovementioned theoretical considerations contribute to our research in two ways. First, they guide our exploration of P&MT workers' perceptions as general theoretical assumptions for structuring our interview questionnaire. Deriving propositions from well-established theory helps to find a direction and a structure for qualitative exploratory research endeavours (Yin, 2014). Second, after being contextualized by the results of interviews with workers, these propositions help us specify design requirements for SPMTA design. Thus, the four WDT drivers as well as the suggested effects between the other parts of the sociotechnical system help us shape a first understanding of what an SPMTA should accomplish in order to increase job satisfaction and performance. Focusing on the WDT components, it is important to notice that design goals should not impede positive effects of ease of use, usefulness, and social norms.

From a WDT perspective, an SPMTA should consider workers' desirable level of *autonomy*. Finding the right balance of autonomy for individual P&MT workers, however, requires that physical and cognitive skills fit to the respective task. For example, a recently hired trainee will most likely be unfamiliar with the task or technology and thus requires more support from experienced workers. Furthermore, the demand of autonomy may vary depending on whether a worker finds the SPMTA easy to use or useful for the task as well as on his or her individual believes regarding the expectations of colleagues or supervisors.

Proposition 1: To increase job satisfaction and job performance, an SPMTA should ensure that users can work autonomously to a degree that fits their tasks as well as their physical and cognitive abilities.

Furthermore, since especially P&MTs tend to be perceived as monotonous in the long-term, the design of SPMTAs should allow for *task variety*. Thereby, the variety of tasks may be both selective and limited to the capabilities of individual workers or allow for fast improvement of skills. We expect an SPMTA to be more satisfactory and to positively influence job performance if it empowers or promotes conducting a variety of tasks. Thereby, task variety does not only account for the diversity between different tasks but also for steps within a particular task. However, although variety and cooperation with others should be promoted, this should not be done at the cost of ease of use and perceived usefulness due to increased system complexity.

Proposition 2: An SPMTA should provide variety both across different P&MTs and within a single P&MT to increase job satisfaction and job performance.

WDT suggests that users tend to be more satisfied and perform better when they can easily identify what they have accomplished. Hence, an SPMTA that supports the identification of input and output relations as well as task results is likely to be more accepted and will positively contribute to intentional and behavioural outcomes. Thereby *task identity* should not impede ease of use or usefulness of the system. Furthermore, task identity mechanisms may lead to unwanted comparison with co-workers (e.g., regarding task progress or accomplishments) and thus may impact social norm.

Proposition 3: An SPMTA should provide the opportunity to easily identify task accomplishments of individual workers to increase job satisfaction and job performance.

In addition, workers will more likely to be satisfied and efficient when they receive direct feedback from tasks. Feedback should thereby be provided for both failures and accomplishments. However, control mechanisms should not impede fluent task performance with too frequent feedback. Furthermore, if recognized by others, direct feedback from tasks (e.g., through sound signals) may impact social norm.

Proposition 4: To positively contribute to job satisfaction and job performance, feedback from tasks should be given by the SPMTA in a clearly understandable and guiding manner.

3 Method

For the purpose of our study, we follow the three-cycle design research approach proposed by Hevner (2007). Compared to classical design and development approaches, design research is well-acknowledged in IS and describes a systematic process of artefact development and evaluation that relies heavily on continuous problem (re-)definition and artefact validation within the problem context as well as knowledge acquisition and artefact validation against existing research (Hevner, 2007; Hevner *et al.*, 2004). In this research-in-progress paper, we focus on the rigor cycle and the relevance cycle that, in conjunction, produce the requirements for the design cycle. The results of the rigor cycle are represented by the investigation of prior work and the development of guiding propositions (section 2). The relevance cycle is informed by these results and, in addition, contextualizes and (dis)proves the theoretical assumptions through 13 qualitative interviews with P&MT workers who use three different SPMTAs. The goal of the relevance cycle is to obtain an in-depth understanding of workers' perceptions on the SPMTAs and how they support their P&MTs. In addition, we asked them how they think SPMTA design can be improved according to their tasks. Finally, we synthesized results of both the relevance and the rigor cycle to state design requirements for SPMTAs to improve job satisfaction and performance.

4 Preliminary Results

4.1 Overview

To assess design requirements according to the three SPMTAs, we conducted qualitative exploratory, semi-structured interviews (Myers and Newman, 2007; Schultze and Avital, 2011; Yin, 2014) with P&MT workers of a German manufacturer and supplier of car components. The company uses three SPMTAs for their product line to support workers in various tasks. SPMTA-1 is used in the assembly line. It provides information and guidance to handle a particular workpiece (e.g., a gearbox casing) and observes the quality of work through sensors and manual input requests. SPMTA-2 supports workers in final inspection of components through information, guidance and surveillance of inspection tasks. SPMTA-3 supports tool management. It allows for the use of distributed tool data across all production processes. Based on tool identification and user role, tools are visualised and data are aggregated in a comprehensive form for workers who develop, install or maintain tools for production. Aiming to reveal cross-system requirements, our relevance cycle comprises 13 semi-structured user interviews. Table 1 shows interviewees and their roles. Interviews had an average length of 1.5 hours. Guided by our theoretical propositions, we mainly asked open questions to assess workers' subjective evaluation of the SPMTA in use and elicit requirements for SPMTA development. The interviewees' statements were reflected and analysed to elicit suitable design requirements for SPMTAs to increase job satisfaction and performance. Consequently, design requirements reflect what was perceived as good in the respective case and where interviewees see opportunities for improvement. Interviews were recorded, transcribed and coded by two researchers independently. Since all interviews were conducted in German, transcripts were translated to English afterwards.

As a result, we elicited a total amount of 43 requirements, of which 18 address one or more of our propositions. All other requirements usually focus on non-functional system goals, such as robustness or efficiency of the SPMTA, that do not directly map to the purpose of our study. Due to space limitations and the focus of our study, result presentation focuses on the 18 SPMTA design requirements which address our propositions. However, we kept the remaining requirements to inform our forthcoming design cycle where appropriate.

System	Description	Interviewees
SPMTA-1	Supports workers in the assembly line by providing rich information and guidance and observes component assembly.	1 Assembly Operator (IN 1) 2 Supervisors (IN 2,3) 2 Workers with mixed roles (IN 4,5)
SPMTA-2	Supports workers in final inspection by providing information and guidance and observes inspection tasks.	4 Quality Assurance (QA) Inspectors (IN 6-9)
SPMTA-3	Supports development, installation and maintenance of production tools through aggregation and visualization of tool data.	4 Tool Providers (IN 10-13)
IN 1-13: Interviewees		

Table 1. Interviewees and roles per SPMTA

4.2 SPMTA Requirements

Table 2 shows the 18 SPMTA design requirements that fit our design goal. A proposition is fully addressed, if the requirement perfectly fits to the core of the theoretical assumption. A proposition is partly addressed, if it contains information that covers the core of the proposition but focuses on another design goal. For example, fail-safe operation is first and foremost a technical, non-functional requirement. However, technical failures may negatively affect task identity as they interrupt work processes and require workers to focus on resolving the failure instead of the actual task. The WDT component feedback may also be affected by technical failures, as frequent negative or corrective failure alerts may confuse or even annoy workers and increase social pressure among colleagues. In the following, we present the 18 design requirements that emerged from the interviews together with exemplary interview excerpts as justificatory data.

According to the interviewees, an SPMTA should observe P&MTs as precise as possible to prevent workers from processual mistakes (R1).

> "[…] still, the monitoring of errors is better. Employees can work the way they want, but the preventive detection of errors makes it easier - that they can do nothing wrong anymore. Even if one works differently than ten other people." (IN1).

It further should be able to adapt to the physical characteristics of users (R2) while allowing for hands-free control of the system (R3).

> "[…] if the system detected me at position 30 […], the workpiece would adjust to my height so that it is healthier for me to turn the screws or to press something easier or better. That would be the best-case scenario." (IN5)

Especially for SPMTAs that have access and control over other machines, the system must ensure a fail-safe operation (R4).

> "Clearly, free of failures, that it starts searching immediately when I say so and provides me with the information I need within seconds." (IN10)

However, in case of failure, the system should enable users to fix simple problems by themselves without consulting the support staff, as it is necessary, for example, during night shifts (R5).

> "Simplified, to me this means that the system offers me a solution, especially in complex situations. There are simple technical problems, to which I can fully comprehend, but there are also complex technical disruptions in which you don't know what to do. In this case, it would be helpful to receive options of action from the systems." (IN3)

To support familiarization with the system and to provide quick access to important functionality, the system should further allow for simple customization (R6).

> "[…] not necessarily control, but maybe changing the notification cycles. For example, sometimes we are annoyed because it is obvious that a notification is wrong, duplicated or triplicated. In this moment I would like to customize or delete it or change the order." (IN1)

ID	Requirement	SPMTA 1	SPMTA 2	SPMTA 3	Propositions AT	Propositions TV	Propositions TI	Propositions FB
R1	Appropriate observation of manual work	x	x	x	◐			●
R2	Ergonomic adaption to user characteristics	x	x	x				◐
R3	Hands-free interaction	x	x	x	◐			◐
R4	Fail-safe operation	x	x	x			◐	◐
R5	Easy self-help	x	x	x	●			◐
R6	Simple customization	x	x	x	◐		●	
R7	Various ways of working	x	x	x		●	◐	
R8	Support channel	x	x	x				●
R9	Automatic personalized login	x	x	x	◐		◐	
R10	Mobile use	x	x	x	◐	◐	◐	
R11	Empowerment for within-task variety	x	x			●	◐	
R12	Misentry suggestion	x		x				●
R13	Information accuracy		x	x	◐			◐
R14	Physical protection	x	x				◐	
R15	Focus on work/Seamless integration	x	x		◐	◐	●	
R16	Real-time feedback	x			◐			●
R17	Controlled action		x			◐	◐	
R18	Cooperation		x		●	◐		

◐ *partly addresses proposition;* ● *fully addresses proposition*
R1-18: Requirements; AT: Autonomy; TV: Task Variety; TI: Task Identity; FB: Feedback

Table 2. SPMTA requirements and mapping to propositions

Furthermore, as already proposed in the literature, systems should contribute and pay attention to the variety of P&MTs a worker conducts (R7).

> "For me, flexibility is a must. At the moment, we have to put the hammer here and take it there and so on. […] The system should allow to be more flexible in the future." (IN1)

Since especially experienced workers often discover bugs or system behaviour that does not perfectly match a certain P&MT, an SPMTA should provide a support channel to system developers (R8).

> "That, if I have a problem, the contacted person has know-how and can help me solve the problem, without asking five other persons. In other words, a quick response." (IN13)

An SPMTA should allow for an easy login to a personalized system environment (R9).

> "It has to be easy to login. In other words, the login must be possible with an easy password, preferably even without any password at all, because it is really annoying to enter a password every time." (IN 10)

In turn, especially for highly automated P&MTs, the system should provide access over mobile or wearable devices, such as tablets or smartwatches (R10).

> "I would benefit if the system was more mobile. […] Today I am the only person that controls the process. Really, the only one. My boss is on vacation. Then, there are situations when I am not available for a short amount of time […] and my colleagues would stand there and wait for me. […] In these situations, it would be helpful to have a mobile option that I am able to control

> the system from distance. […] Otherwise they need to call me, I must react immediately and start running. That is time-consuming." (IN1)

Furthermore, interviewees stated that not only different P&MTs should be conducted by workers but rather the system should provide variety within a particular P&MT itself (R11).

> "It also has to do with change on its own. The work is very monotone." (IN 3)

Manual data input, such as for some measurement tasks, should be subject to a check regarding mis-entries (R12).

> "And, for example, that I can't make incorrect entries. That the system automatically verifies whether the input is correct and in return gives feedback […]." (IN 10)

Information provided to the workers should be accurate, timely and comprehensible (R13).

> "Clearly, that we have 100% clean data." (IN 12)

Furthermore, besides relieving physical and cognitive strain, the SPMTA should ensure the physical protection of the worker at any time (R14).

> "[…] and makes sure that no part of the body, like a hand, is inside the machine. If this happened, it would be bad" (IN 8)

When interacting with the system, the worker should not lose focus on the actual P&MT performed (R15).

> "[…] that is a solution approach, but there are glasses existing, where I can see everything happening in front of my eyes. Right now, I must look at the screen, while being interrupted from the actual work process." (IN 9)

The SPMTA should further respond to successfully completed tasks or in case of failures (R16) and check actions for compliance with predefined processes (R17).

> "Well, if a system knows, or is able to notice, […] that this is not the right length, then it should show a red 'Stop' sign, telling you that this length is not right." (IN 11)

Finally, the SPMTA should facilitate cooperation in P&MTs (R18).

> "It makes me happy to work with my colleagues […]. Currently we are separated but can help each other" (IN 9)

Ten requirements could have been elicited that apply to each of the three SPMTAs presented. Whereas R11 to R15 address two cases, R16, R17, and R18 only apply to one.

4.3 Next Steps

In the next phase of our research, we will work towards a design theory (Gregor and Hevner, 2013; Gregor and Jones, 2007) for SPMTAs to increase job satisfaction and performance of P&MT workers. According to Gregor and Jones (2007), a design theory consists of eight components, i.e., purpose and scope, constructs, principles of form and function, artefact mutability, testable propositions, justificatory knowledge, principles of implementation, and expository instantiation.

We already specified the purpose and scope of the SPMTA to be developed and related the system to existing constructs and justificatory knowledge from sociotechnical systems (and adjacent) theory as well as WDT. The next step will be to define principles of form and functions according to the design requirements (Table 2). This will represent the SPMTA architecture with regard to theory and empirical results. In doing so, we will develop a prototype for evaluation purposes in a P&MT setting. More precise, we develop testable propositions according to which we will conduct two experiments to assess (1) whether artefact mutability (changes of state) of the SPMTA has an influence on job satisfaction and performance (within-subject design) and (2) whether the pure use of SPMTAs designed according to our theory will have an impact on these outcomes (between-subject design). Evaluation results will lead to a more robust design theory through revision, principles of implementation, and a stable expository instantiation.

5 Expected Contribution and Conclusion

In this study, we have presented 18 design requirements for SPMTAs to increase job satisfaction and performance. In detail, we combined sociotechnical systems theory and WDT in order to derive four propositions as part of the rigor cycle. In the relevance cycle, we conducted 13 interviews with P&MT workers to contextualize our propositions and elicit the requirements.

With our completed work, we expect to contribute to research by working towards a nascent theory of design and action (Gregor and Hevner, 2013; Gregor and Jones, 2007) on how to develop SPMTAs with a focus on job satisfaction and performance. We hence contribute to theory by laying the foundation of a novel design theory for SPMTAs which builds upon well-established theories of explanation and prediction (Gregor and Hevner, 2013). Further, we show that, although most research around P&MT is not conducted in the core of IS, we think that IS researchers have a unique value proposition to enter the field by either integrating and translating requirements from various domains to smart technology design for P&MT or by investigating the role and effects of smart technology on P&MT. Since there is only few prior work on SPMTAs that draws from well-established theory and in-depth empirical insights, there is a need for establishing knowledge on SPMTAS development and make it accessible for SPMTA developers. Hence, to practice, we expect to contribute applicable design knowledge that will help SPMTA developers specify and design SPMTAs regarding workers' job satisfaction and individual performance. This may reduce effort and cost in the development process.

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