Two Ways to Rome

A comparative study of digital vs. analogue open workplace innovation processes

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Abstract

This paper examines the implementation of workplace innovation (WPI) in a small and medium-sized enterprise (SME) in the textile sector by comparing a participatory approach conducted in analogue and digital formats. It addresses the question of whether, in SMEs with limited innovation resources, digital participation can enable outcomes comparable to those of analogue formats. The textile industry provides a relevant empirical context, as it faces both innovation- and sustainability-related challenges, such as the need to reduce waste and improve production efficiency while adopting new technologies.

In the study, employees participated in digital or analogue focus groups and contributed their perspectives to the design of paper-based dashboard prototypes for the cutting machines they operated. The evaluation focused on the acceptance of the focus groups, perceived WPI, and the usability ratings of the resulting paper-based dashboard prototypes. The descriptive findings did not indicate substantial differences between digital and analogue focus groups with regard to acceptance and perceived WPI. Likewise, the usability ratings of the paper-based dashboard prototypes showed only limited descriptive differences.

Overall, the study suggests that, under certain organisational conditions, digital participatory formats may represent a viable option for implementing WPI in SMEs. The findings indicate that the key issue lies less in the format itself than in how participation is designed and enabled within the organisational setting.

Given the single-case design and descriptive analysis, the generalisability of the results remains limited. Further research is needed to compare digital and analogue WPI processes systematically under standardised conditions.

Keywords: SME, Workplace Innovation, Open Workplace Innovation, digital participation, employee participation

Introduction

Employees operating machinery in SMEs are confronted with increasing amounts of data and heightened mental workloads, both of which intensify performance demands. Each machine or component may involve distinct software systems and operational requirements that employees must continuously monitor, while critical information is often provided in real time, creating the risk of information overload and increased stress levels among employees. The ongoing digitisation of manufacturing environments is introducing increasingly complex machines and procedures, thereby creating substantial challenges for employees (Gao et al., 2019; Snatkin et al., 2015). The COVID-19 pandemic further accelerated changes in workplace structures and has been linked to negative effects on well-being (Giorgi et al., 2022). Research indicates that new technologies may intensify work and be associated with adverse health outcomes such as elevated stress levels and emotional exhaustion (Dengler & Tisch, 2020). As a result, it is becoming increasingly difficult for employees to maintain an overview of relevant parameters and respond effectively.

The Job Demands-Resources Model posits that an escalating workload represents a job demand that can result in heightened strain and diminished job performance, yielding repercussions for individual employees, such as burnout (Demerouti et al., 2001), and potentially an elevated risk of non-fatal injuries in SMEs (Hilton & Whiteford, 2010). In addition, heightened job demands may negatively affect organisational outcomes such as productivity (Nurmasari et al., 2018; Sari et al., 2018). To mitigate these adverse effects, reducing employees' cognitive load is essential. Improved human-machine interfaces can help to alleviate mental workload while enabling employees to focus on the most relevant parameters (Wickens et al., 2021). In this study, paper-based dashboard prototypes providing critical information were developed for the cutting machines. Their technical implementation adjacent to the machinery was not feasible within the project period, so the evaluation remained limited to paper-based prototypes. The underlying objective of reducing employee strain while supporting organisational goals such as productivity is therefore highly relevant.

WPI provides a promising framework for aligning employees' well-being and organisational performance (Oeij et al., 2023; Kesselring et al., 2014). The advantages of this approach are extensively documented and include heightened profitability, greater customer satisfaction, and improved employee motivation (Oeij & Vaas, 2016; Pot, 2011).

In light of growing economic pressures on SMEs, we must also consider the relevance of WPI beyond employee health and well-being. Recent evidence shows that German SMEs continue to face difficult economic conditions (Schwartz & Gerstenberger, 2025), while innovation activity remains under pressure, particularly among smaller firms (Zimmermann, 2025). In this context, the effective use of technological opportunities becomes increasingly important, especially where firms operate with limited innovation resources. At the same time, high energy and production costs have become a major factor affecting competitiveness for companies in Germany and Europe, leading to challenges in maintaining profit margins and investing in innovation (Schwartz & Gerstenberger, 2025). In addition, geopolitical tensions, stricter trade rules, and the growing fragmentation of global value chains have made international trade

conditions less stable (European Central Bank, 2024). Under these conditions, the question is not only whether digital technologies can be adopted but also whether they can be implemented in ways that support effective, feasible, and resource-conscious innovation processes in SMEs. This makes the design of participatory approaches particularly relevant for examination, as SMEs require innovation processes that are not only acceptable to employees but also workable under constrained organisational conditions, such as limited budgets and staffing resources (Zimmermann, 2025).

For SMEs, the concept of open innovation (OI), defined as the integration of external and internal ideas (Chesbrough, 2003), is particularly relevant because these firms often face resource constraints. Participation in OI enables SMEs to collaborate with different stakeholders and thereby foster innovation (Hossain & Kauranen, 2016; Franken & Franken, 2020). Open Workplace Innovation (OWPI) can be conceptualised here as a promising strategy, combining external impulses with the active involvement of employees in the innovation process. The COVID-19 pandemic has also shaped the context in which firms pursue technological and organisational innovation. In Germany, it was associated with declining demand, supply chain disruptions, and production stoppages, resulting in considerable economic contraction (Hutter & Weber, 2020). At the same time, it accelerated the uptake of digital innovations such as remote work and online communication, thereby increasing the relevance of digital forms of collaboration and participation (Giorgi et al., 2022; Bertschek, 2020). This development provides an opportunity to compare established analogue forms of participation with digital approaches that gained prominence during and after the pandemic.

Against this background, the present study examines the comparative application of a participatory approach in analogue and digital form in the context of WPI in a German textile manufacturing SME. More specifically, analogue and digital focus groups were conducted with machine operators in order to develop paper-based dashboard prototypes for the machinery they operate. The study investigates whether the two participation formats differ with regard to acceptance and perceived WPI-related outcomes and, in doing so, shifts attention to the question of how participatory processes need to be designed in SMEs under conditions of digital transformation.

Theoretical Background

Mental workload is similar to physical workload in that it refers to the demands on the central nervous system's limited processing capacity (Wickens et al., 2021). The increasing expectations placed on individual employees to maintain a comprehensive understanding of the increasingly complex machinery they operate can be framed as mental workload, ultimately resulting in cognitive and physical strain (Schuette & Koeper, 2013). The Job Demands-Resources Model (JD-R, Bakker & Demerouti, 2017) identifies excessive mental workload as a job demand, defined as "[a] physical, psychological, social, or organisational aspect [...] of the job that require[s] sustained physical and/or psychological (cognitive and emotional) effort or skills and [is] therefore associated with certain physiological and/or psychological costs" (Bakker & Demerouti, 2007: p. 312). Such demands can lead to job strain and adversely affect job performance. This conclusion is consistent with findings showing that psychosocial working conditions are linked to adverse health-related outcomes, with distress, work satisfaction, and work ability acting as relevant mediating mechanisms (Van Hoffen et al., 2020). Increased job demands lead to job strain and fatigue, which constitute core elements of burnout (Demerouti et al., 2001). Furthermore, research indicates that heightened workload as a job demand may influence organisational outcomes, including productivity (Nurmasari et al., 2018; Sari et al., 2018).

The JD-R model proposes minimising job demands and augmenting job resources to enhance organisational outcomes. In this article, the newly developed paper-based dashboard prototypes are conceptualised as design artefacts intended to address mental workload as a job demand. Since employees engaged in focus groups and actively participated in the development of the dashboard concepts, the process can be interpreted as addressing elements of social support and autonomy as job resources, potentially mitigating the adverse effects of high job demands on exhaustion and strain (Bakker & Demerouti, 2017). In this sense, the study combines the design of a potential technological support tool with the enhancement of job resources through participation. The design of the dashboard prototypes specifically targets the reduction of obstructive job demands (Tims et al., 2022). In this study, new paper-based dashboard prototypes were designed to address job demands while also increasing job resources, such as autonomy, through participatory development (Ong & Johnson, 2023). In the context of digitally mediated participation, however, work design factors alone may not fully explain employees' experiences, as individual predispositions towards technology may also play a role. One potentially relevant construct in this regard is affinity for technology interaction (ATI). ATI, introduced by Franke et al. (2019), refers to an individual tendency to actively engage with and enjoy interacting with technology. It may therefore be particularly relevant in contexts in which participation is mediated through digital tools rather than face-to-face interaction. Conceptually, ATI may be related to Need for Cognition (Bless et al., 1994), as technological interaction frequently entails cognitive engagement and problem-solving. In the present study, ATI is included as an exploratory individual-level factor that may help explain employees' acceptance of the digitally mediated participation format. Considering ATI may therefore provide additional insights into how digitally mediated participation is perceived and accepted.

Research on WPI has intensified recently, revealing a plethora of interpretations and applications within both theoretical frameworks and practical settings. This plurality is also reflected in foundational contributions that frame workplace innovation as a multidimensional field of theory, research, and practice rather than a single uniform concept (Oeij et al., 2017). Oeij et al. (2023) categorise the discourse into various domains, including sociology and organisational studies, safety science and organisational research, economics, strategy and human resources, and psychology and behavioural studies. While these distinct streams of thought occasionally intersect, they collectively strive towards a "good job strategy" (Oeij et al., 2023, p. 216). Frequently, WPI is defined through its intended positive outcomes, such as heightened productivity or enhanced employee satisfaction (Kesselring et al., 2014), which makes the concept difficult to delineate and assess consistently across studies. The authors argue that WPI has been discussed as a useful framework for addressing current disruptive transitions, such as the COVID-19 pandemic, the climate crisis, and digital transformation. Oeij et al. (2023) assert that workplace dynamics influence broader aspects of life, emphasising the necessity for collaborative approaches among organisations and managers. This collaborative effort is facilitated through the implementation of WPI practices.

The theoretical understanding of WPI significantly contrasts across different research approaches, reflecting a divergence in applied research questions and designs. Predominantly employed methodologies include cross-sectional studies and questionnaires (Oeij et al., 2023; Newnham, 2021; Stoffers et al., 2021). In contrast, the third European Company Survey (Eurofound, 2015) employed interviews with managers, employees, and employee representatives, showcasing an alternative methodological approach. However, research actively promoting WPI practices and investigating their implementation within specific organisations remains scarce. Only a minority of studies have implemented some form of intervention (Rom & Green, 2023; Lebesby et al., 2023). This gap between conceptual discussions and practical implementation has been identified as a persistent problem in WPI research (Totterdill, 2015). Recently, WPI research has been characterised as fragmented, with the pursuit of a "good job" strategy suggested as a constructive objective across various research strands (Oeij et al., 2023). Especially for SMEs navigating the complexities of digital transformation, research that enhances the implementation of WPI practices could prove beneficial because it may provide practical frameworks and strategies for addressing the specific challenges. Against this background, digital tools in manufacturing should be viewed not only as technical artefacts but also as elements of broader work system design and human-technology interaction (Wischmann, 2015). To the best of our knowledge, research on the adoption of WPI practices employing digital methods is limited.

The literature (Love & Roper, 2015) has thoroughly examined the distinct challenges SMEs encounter regarding innovation. From an open innovation perspective, these challenges are particularly relevant, as innovation in SMEs often depends on the ability to integrate knowledge, ideas, and impulses beyond formalised internal R&D structures (Bigliardi et al., 2020). These challenges often stem from limited financial and human resources, resulting in diminished capacity to prioritise innovation amidst the pressing demands of daily operations. Consequently, innovation processes may lack structure and organisation, further impairing internal capabilities (Hossain & Kauranen, 2016). In many cases, improvements and

innovations are spurred primarily by complaints or failures, suggesting that innovation often remains reactive rather than proactive. Even so, innovations are crucial for fostering economic advancement and growth (Prettner et al., 2018). However, there is a dearth of studies investigating various forms and success factors of innovation within SMEs (Hauschildt et al., 2022). Typically, product innovation is systematically integrated into SME practices, while other forms, such as process or social innovations, are not adequately addressed. Without the appropriate allocation of resources and authority, innovation efforts are likely to be overshadowed by established routines (Hauschildt et al., 2022).

In contemporary contexts, a significant number of these innovations incorporate digital components, such as new software for bookkeeping or enhanced communication tools, including chat applications (Arnold et al., 2016; Lindner et al., 2017). Despite these advancements, only 20 % of SMEs have initiated the digital connection of products and services, with the majority reluctant to invest more than €10,000 annually in innovation efforts. To bring about lasting change, it is necessary to take small, steady steps over time (Saam et al., 2016). Many SMEs perceive ongoing digitalisation as a vital opportunity to reposition themselves within the market; thus, a widespread digital transformation of company processes is imperative for most organisations (Holtkamp, 2019). In this sense, the adoption of WPI practices would reconceptualise innovation as an ongoing process (Kesselring et al., 2014), characterised not by a finite end product but by ongoing and interrelated practices that organise the innovation process (Howaldt et al., 2015) while accounting for the "inseparability of the human, organisational and technical dimensions" (Lohse et al., 2020, p. 421).

In this paper, we argue that WPI must actively engage those impacted by its outcomes, specifically the employees who operate the machinery. Consequently, the design and content of the dashboard concepts should be determined by these employees, while systematic expertise, particularly regarding the methodologies for gathering and synthesising their feedback, can be introduced through collaboration with external partners, such as researchers in this study. This approach can be understood here as reflecting an OWPI perspective that integrates the objectives of WPI, including stakeholder involvement and the fulfilment of both organisational and employee needs, with OI principles that leverage external ideas and knowledge.

In this context, WPI draws on both methodological expertise and employees' practical knowledge of work processes, thereby contributing valuable practical insights into the requirements for a dashboard. Enhanced autonomy, increased social support, job crafting, and diminished job demands may positively affect motivation and job performance and may help mitigate exhaustion (Bakker & Demerouti, 2017). These anticipated outcomes, along with the overarching advantages of WPI (Oeij et al., 2023), underscore the merit of implementing a WPI approach.

This study is primarily focused on comparing analogue and digital formats for conducting the WPI process. In doing so, it addresses a gap in WPI and OWPI research. While prior work has highlighted the relevance of participation, comparatively little attention has been paid to the format through which participation is organised and experienced in SMEs. This is particularly

relevant for SMEs, where resource constraints, limited formalised innovation structures, and operational pressures make the design of feasible and effective participatory processes especially consequential. The COVID-19 pandemic has catalysed the exploration of digital solutions, which may present a flexible and potentially cost-effective alternative, but it remains unclear to what extent format-related differences matter once employee participation is meaningfully designed and embedded.

Consequently, our research question is, "Do digital and analogue participatory methods lead to similarly positive assessments of acceptance and perceived workplace innovation?" This, in turn, informs the question of how WPI can be implemented in SMEs under conditions of digital transformation. To structure the exploratory comparison of analogue and digital participation formats, the following theory-informed propositions are used as analytical orientations.

Proposition 1: Employees' perceptions of influence and relevance within participatory formats are positively associated with acceptance and perceived WPI.
Proposition 2: The perceived participatory value of a format is shaped by the clarity of the process design and the extent to which employee input is meaningfully incorporated.
Proposition 3: Participatory formats structure interaction processes and thereby influence features such as immediacy, procedural structure, and vulnerability to interruptions.
Proposition 4: ATI constitutes a potential influencing factor in digital participation, although its relevance may be moderated by the usability and quality of facilitation of the digital setting.

Methodology

Sample and General Procedure

This study follows the Design Science Research (DSR) perspective, as it combines the identification of a practical organisational problem with the iterative development and evaluation of an artefact intended to address that problem. In DSR, researchers generate knowledge not only by observing organisational phenomena but also by designing and assessing artefacts in context (Hevner, 2007). In the present study, the paper-based dashboard prototypes constitute the artefacts, while the focus groups served to elicit user requirements and inform prototype development in a workplace innovation setting.

The data were obtained as part of an ongoing collaboration between TU Chemnitz and an SME located in a rural region of Saxony specialising in the development and production of technical nonwoven textiles. The company operates under a 24/7 shift system. To investigate the research question, both digital and analogue focus groups were conducted within the SME. The two participation formats were not implemented simultaneously. Rather, digital focus groups were conducted first with employees working at cutting machine one, followed by analogue focus groups with employees working at cutting machine two. The findings from these sessions were subsequently used to develop two separate paper-based prototypes for the two cutting machines. The usability of the resulting paper-based dashboard prototypes

was subsequently assessed using the System Usability Scale (SUS), a widely used instrument for evaluating perceived usability (Brooke, 1996; see also Grier et al., 2013). Figure 1 summarises the project phases in chronological order: requirements elicitation through focus groups, artefact design based on the qualitative analyses, and a later evaluation of both paper-based prototypes.

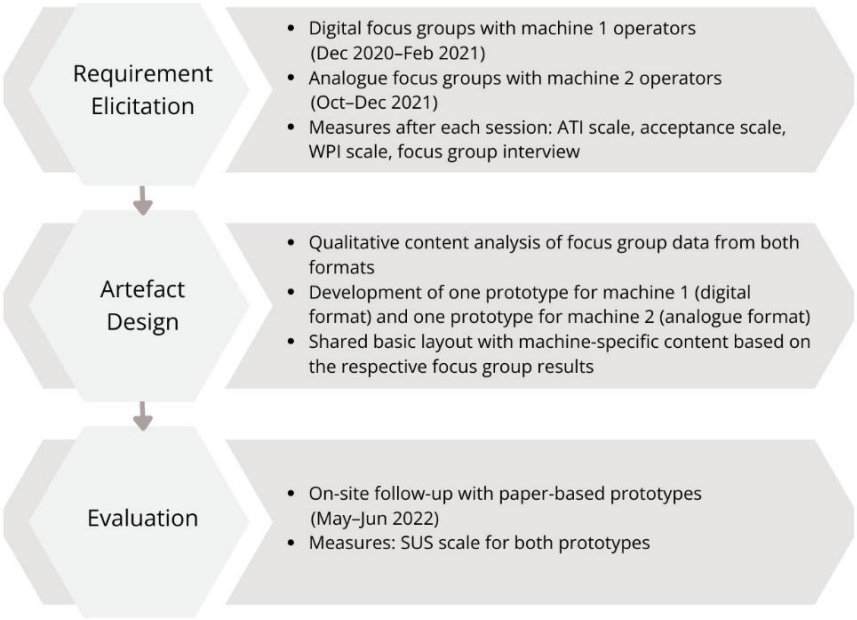

Figure 1: General procedure (source: own illustration)

Notes: ATI: Affinity for Technology Interaction scale (Franke et al., 2019); Acceptance Scale based on van der Laan et al. (1997); WPI scale: exploratory workplace innovation scale based on Kesselring et al. (2014); SUS: System Usability Scale (Brooke, 1996; see also Grier et al., 2013).

Procedure during Focus Group Meetings

In the digital focus groups (n = 16), employees operating the first cutting machine were interviewed, while the analogue focus groups (n = 14) comprised employees operating the second cutting machine. Because participation had to be organised around the shift system, the focus groups were conducted in several small sessions rather than as one joint meeting per condition. On average, about three employees participated per session. Each focus group session lasted approximately 20 minutes and took place shortly before or after the respective shift.

Initially, participants completed the ATI questionnaire (Franke et al., 2019). In the digital condition, the moderator joined via BigBlueButton, while the participants were physically present together in a conference room at the company and followed the interview via projected video and presentation. For the analogue groups, the same questions were presented on-site by an interviewer in person. This means that the distinction between digital and analogue refers to the mode of moderation and communication, not to a fully remote versus fully co-located participant setting.

The comparison of digital and analogue focus groups follows prior methodological work showing that internet-based and face-to-face focus groups may differ in interactional characteristics while still generating meaningful qualitative data (Nicholas et al., 2010). Participants were encouraged to share their thoughts and articulate their ideas aloud. Immediately after each focus group session, participants completed the acceptance scale (Van der Laan et al., 1997) and the exploratory WPI scale (Kesselring et al., 2014) to assess the respective participation format. Thus, the comparison between digital and analogue formats concerns post-session evaluations of acceptance and perceived WPI, whereas the qualitative interview content was used to inform prototype development separately for each machine.

The two formats were conducted in separate project phases and with different machine teams. However, because all participants worked in the same organisation, informal exchange between employees across machines outside the sessions cannot be ruled out. Demographic and job-related background variables beyond machine assignment were not systematically collected for analytical comparison and could therefore not be controlled for in the present study. The interview questions and the WPI scale, specifically developed for this study, are described below.

Focus Group Interview

To gather data on which information employees considered relevant for a revised machine display and how this information should be presented, participants took part in a guided focus group interview comprising five open-ended questions:
During which working step would looking at the display be of help?
Which working steps and information are absolutely necessary to be displayed?
Which critical working processes, associated with a higher potential for mistakes, should be emphasised?

How should the information be displayed?

How could a display assist you in maintaining focus and attention over the long term?
The purpose of the interview was not only to identify relevant display content, but also to collect ideas regarding ergonomic and supportive display design from the perspective of the machine operators. The interviews were transcribed and analysed using an inductive content-analytic procedure following Mayring and Fenzl (2019). Relevant interview passages were paraphrased, and semantically similar paraphrases were condensed into recurring content patterns, documented in analysis tables. These tables served as the basis for selecting the display elements for the respective paper-based prototypes by identifying which contents were mentioned most frequently across the focus groups. The qualitative analyses were conducted separately for the digital and analogue focus group data and informed the development of the respective machine-specific paper-based dashboard prototypes. Given the exploratory and practice-oriented character of the study, no formal intercoder reliability coefficient was calculated.

Workplace Innovation Scale

To assess participants' perceptions of the WPI process, an exploratory scale was developed based on selected guiding questions proposed by Kesselring et al. (2014). Rather than measuring realised organisational WPI outcomes, the scale was designed to capture how participants perceived the quality, relevance, and anticipated impact of their participation in the focus group-based innovation process. Employees evaluated all items using a five-point Likert scale, with one indicating complete disagreement and five indicating complete agreement. The scale midpoint was three. Based on the data collected in this study, internal consistency was high (Cronbach's $\alpha = .89$). The instrument should therefore be understood as an exploratory measure of perceived WPI-related participation and expected effects rather than as a validated measure of actual WPI implementation success.

The first subscale addressed employees' perceived willingness and opportunity to participate in the WPI process. It was derived from the guiding question of whether employees and managers are willing and able to engage in workplace innovation (Kesselring et al., 2014, p. 4). The present study narrowed its focus to the employee perspective. The two items were:

- "Through the interview, I feel that I can bring my opinions and needs into decisions concerning the company."
- "Through participating in the interview, I feel part of a larger process."

The second subscale focused on the process dimension of WPI, based on the guiding question "How do employees and managers engage in fundamental and continuous processes enabling workplace innovation?" (Kesselring et al., 2014, p. 4). Again, the formulation was adapted to the employee perspective. The items were:

- "I would also like to be involved in other developments in the company to this extent."
- "Participation in such developments motivates me at work."

The third subscale addressed anticipated outcomes and impacts of the WPI process, based on the guiding question "What are the targeted outcomes and impacts of workplace innovation?" (Kesselring et al., 2014, p. 4). The items were:

- "Participating in the interview and its results will have a positive impact on my everyday work."
- "The participation and evaluation of such an interview will improve working in the company."

Taken together, the scale was used to compare digital and analogue focus group formats with regard to employees' perceived inclusion in the process, their willingness to participate in similar future developments, and their expectations regarding the potential benefits of the WPI process. It should therefore not be interpreted as a direct measure of actual workplace innovation outcomes but as an exploratory measure of perceived participatory quality and anticipated impact.

Content validity of the exploratory WPI scale was supported through a theory-driven and practice-informed development process. The items were derived from key WPI dimensions described by Kesselring et al. (2014), especially employee participation, continuous engagement, and perceived outcomes, and were adapted to the specific organisational context of the participating SME. In addition, item wording and relevance were discussed within the project context to ensure their practical applicability to the focus group-based WPI process. Given the small sample and the exploratory character of the instrument, the scale is not presented as a fully validated measure but as a context-specific tool for assessing employees' perceptions of the participatory WPI process.

Results

Initially, the data gathered from the focus group meetings are presented. Subsequently, the process of developing paper-based prototypes derived from these focus group sessions is described. Finally, the results of the usability evaluation are reported and linked to the research question.

Focus Group Meetings

Because all relevant machine operators participated in one of the focus group meetings, descriptive statistics were used to compare the digital and analogue focus groups with regard to the scales deployed. Results are presented in Table 1. The descriptive statistics indicate no pronounced differences between the two formats with regard to ATI, acceptance, and perceived WPI.

	Digital focus group meetings				Analogue focus group meetings			
	M	*SD*	Skewness	Kurtosis	*M*	*SD*	Skewness	Kurtosis
ATI	3.935	0.561	0.346	-0.646	4.111	0.469	0.540	0.710
AM	0.976	0.589	0.442	-0.504	0.991	0.441	-0.642	-0.551
Satisfaction	1.036	0.562	0.314	-0.511	1.107	0.507	-0.493	-1.471
Usefulness	0.929	0.645	0.264	-0.373	0.862	0.427	-0.535	-0.393
WPI scale	3.726	0.601	0.476	0.482	3.548	0.416	0.280	-1.339

Table 1: Descriptive statistics of focus group meetings (source: own calculations)

Notes. M: Mean; SD: standard deviation; ATI: Affinity for technology interaction scale; AM: simple scale for acceptance measurement with subscales satisfaction and usefulness; WPI scale: workplace innovation scale

Comparing the scales across the digital and analogue focus groups, none of the means differed markedly. Across the ATI questionnaire, the acceptance scale and its subscales, and the WPI scale, mean differences were smaller than the respective standard deviations.
Accordingly, the descriptive patterns do not point to pronounced differences between the analogue and digital focus groups in their ratings of interview acceptance and perceived WPI, as represented by the three subscales referring to individual participation, process, and outcomes of WPI. These descriptive findings should not, however, be interpreted as evidence of

equivalence between the two formats. Furthermore, employees did not differ markedly in their affinity for technology interaction at the descriptive level.

To examine whether ATI was associated with the interview ratings, a Kendall's tau correlations were calculated. Neither the correlations between ATI and the simple acceptance scale (r = .079) nor that between ATI and the WPI scale (r = -.059) were significant (p > .05) for the digital focus groups. Similarly, no significant correlation was found for the analogue focus groups (p > .05). Thus, the data do not indicate a systematic relationship between ATI and the evaluation of the focus group format.

For the digital focus groups, 90 paraphrases were collected. Recurring themes across the digital sessions concerned production progress, order identification, anticipation of the following order, and the need for concise and easily interpretable visualisations. Across all digital focus groups, participants agreed that displays should present essential order-related information in a concise and intuitive manner. This included the remaining duration of the current order, which one participant described as a useful feature already known from another production line: "Well, that's the remaining time, or something like that, … That wouldn't be bad here either." (Focus group one, digital, participant I3; translated by the author). The item or article number was also considered highly relevant, with one participant stating that it was "the most important thing" (Focus group two, digital, participant I2; translated by the author).

With regard to visualisation, participants favoured simple formats, for example a horizontal bar, which was seen as "actually the most obvious" way to display progress (Focus group two, digital, participant I1; translated by the author). In addition, participants stressed that information on the subsequent order should be visible, as "the follow-up order would still be important" (Focus group three, digital, participant I2; translated by the author).

For the analogue focus groups, 48 paraphrases were collected. Recurring themes concerned production progress, running time, and concise presentation of information. Across all analogue groups, participants consistently expressed the need for information on the progress of the current order, complemented by running time and a short and precise display format. Item number and product number were mentioned equally often, while many other suggestions appeared only once. For example, one participant proposed the use of a percentage circle to indicate order progress: "Perhaps also the percentage circle, so that one knows how far the order has progressed" (Focus group 2, analogue, participant I3; translated by the author).

Additionally, preferences on how information should be displayed were voiced in both formats. Target-actual comparisons and graphic indicators of progress were mentioned in both types of focus groups, suggesting overlap in core informational needs despite possible differences in interaction dynamics during sessions.

Design of Prototype Concepts

Prototype A (see Fig. 2) was developed based on insights gathered during the digital focus groups. Information was selected according to the 10 most frequently mentioned paraphrases. This approach was guided by employees' expressed desire for the display to remain easily comprehensible and not overly complex. Only suggestions that were mentioned in at least three groups were adopted, indicating their relevance to more than half of the digital sessions. The incorporated information included the remaining duration of the order, the number of completed requirements, article number, product number, follow-up order, cutting speed and width, base material, and the degree of contamination of the textile rolls.

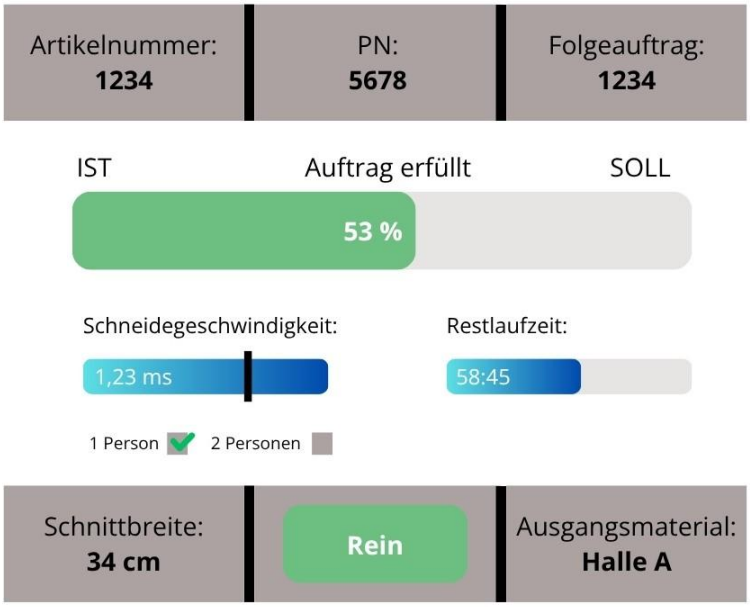

Figure 2: Prototype A based on digital focus groups (source: own illustration)

Notes: From left to right: the top row shows the article, product number, and follow-up order. The bottom row shows cutting width, cleanliness of material, and exit hall. The green bar shows order completion as a percentage. Below, cutting speed and remaining duration are shown.

Prototype B (see Fig. 3) was developed based on the analogue focus groups. Here, too, the most frequently mentioned information was prioritised and displayed prominently. Key metrics such as running metre, running time, article number, cutting width and cutting speed were emphasised. Because several items were mentioned with similar frequency, some information was organised into lists, which increased the complexity of this prototype. The header included information on the previous, current, and subsequent orders. In addition, the prototype contained a target-actual comparison related to process progress and running metre, a percentage-based progress indicator, and sections with further information on material, joins, cutting width, packaging, number of rolls or pallets, customer information, intended use, and delivery date. Design preferences such as short and concise presentation, simplicity, large font, and usability were also considered.

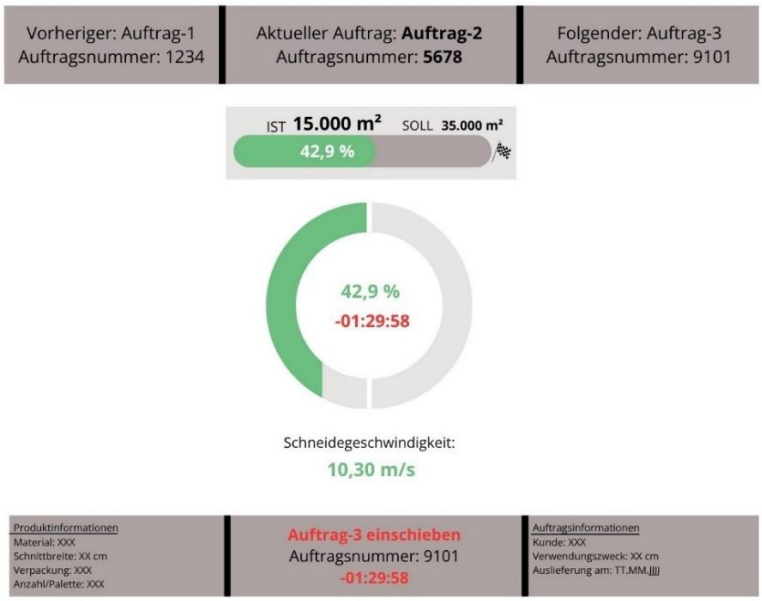

Figure 3: Prototype B based on analogue focus groups (source: own illustration)

Notes: From left to right: the top row shows the previous order along with its number, the current order and its number, and the next order with its corresponding number. The bottom row shows information about products, including material and packaging details, as well as orders that need to be slotted in, the remaining time, customer numbers, and delivery data. The green bar shows order completion as a percentage and in square metres. Below the percentage completion, remaining time and cutting speed are displayed.

Evaluation

Because the usability evaluation involved only a small and uneven subset of employees, descriptive statistics were used to evaluate the paper-based prototypes. The evaluation sample consisted of one participant from the digital focus group, nine participants from the analogue focus group, three employees who had not participated in either focus group, and two employees who could not recall whether they had participated in a focus group. The mean usability rating of Display A (M = 3.487, SD = 1.351) and Display B (M = 2.706, SD = 1.053) differed descriptively, with Display A receiving the higher average rating. This pattern should be interpreted cautiously and not as robust evidence that one prototype was better than the other, given the small and uneven evaluation sample. Using the converted SUS scores, Display A reached M = 87 (SD = 34) and Display B reached M = 68 (SD = 26). While these values suggest descriptively more favourable usability ratings for Display A, both prototypes received overall positive usability ratings, and no statistically robust difference between them can be concluded on this basis. Because implementation of the displays at the cutting machines was not feasible within the project period, the evaluation remained limited to paper-based prototypes and should be interpreted as a usability assessment of prototype concepts rather than an assessment of dashboards in operational use.

Discussion

The aim of this study was to investigate whether both digital and analogue participatory methods could facilitate WPI. Using digital and analogue focus groups, we collected requirements and ideas for the creation of two paper-based dashboard prototypes. Acceptance and perceived WPI were assessed for both participatory formats, while the later usability evaluation concerned the paper-based prototype concepts rather than dashboards in operational use at the machines. Taken together, the findings suggest that, within this exploratory case, both participatory formats were associated with positive ratings of acceptance and perceived WPI. The descriptive patterns did not indicate pronounced differences between the digital and analogue focus groups with regard to acceptance and perceived WPI. Slightly higher ratings were observed for the digital focus groups on some measures, and the paper-based prototype (Display A) developed from the digital sessions also received a somewhat higher usability rating in the small evaluation subsample. However, given the small and context-specific sample, the descriptive nature of the analysis, and the limited evaluation data, these differences should not be interpreted as evidence of superiority or equivalence of one format over the other. In addition, ATI was not systematically associated with acceptance ratings or perceived WPI in either group. Overall, the findings suggest that the key issue in this case was less whether participation was digital or analogue than how it was organised, enabled, and embedded in the organisational context. This does not mean that format was irrelevant, but rather that any format effects appeared to depend on the broader participatory setting in which the process took place.

With regard to the theoretical propositions, the findings provide cautious support for *Proposition 1*, as both formats were associated with positive ratings of acceptance and perceived WPI, indicating that employees perceived the participatory process as relevant, experienced some degree of influence within it, and evaluated it positively. *Proposition 2* is also cautiously supported since the descriptive findings do not point to marked differences in participatory value between digital and analogue formats, suggesting that process design and the meaningful integration of employee input may be at least as important as the participation format itself. *Proposition 3* is tentatively reflected in the qualitative and contextual material, as the two formats appeared to differ in interaction conditions that may have influenced immediacy, procedural structure, and vulnerability to interruptions, although these aspects were not systematically measured. By contrast, *Proposition 4* received no clear empirical support in the present data, as ATI was not systematically associated with acceptance or perceived WPI in either group. Accordingly, the *research question* can be answered only in a cautious and exploratory manner: in this case study, both digital and analogue participatory approaches appeared capable of supporting WPI processes, but similarities in perceived outcome ratings should not be taken to mean that the two formats are interchangeable in general.

More specifically, the present case suggests that participatory quality depended on how strongly employee input was integrated into the process and on whether the organisational setting enabled focused and meaningful participation. In the present study, these framing conditions included temporal aspects such as scheduling in relation to shift work, spatial conditions such as the physical setting of the sessions, social factors such as the presence of

supervisors, and procedural factors such as the coordination and standardisation of the sessions. These conditions did not merely accompany participation but formed part of the participatory architecture through which WPI was enacted.

Limitations

The present study has certain limitations that must be acknowledged. This investigation is a case study based exclusively on descriptive statistics. Thus, the results are not directly generalisable to other organisations. Although all employees operating the cutting machines participated in the focus group meetings, the sample size remains too small and context-specific to draw broad conclusions regarding the equivalence of digital and analogue participatory formats for WPI. Nevertheless, the findings may serve as preliminary indicators and provide a basis for future research across diverse organisational settings.

The standardisation of the focus group interviews was limited, as digital and analogue sessions were facilitated by different moderators and conducted under varying conditions. The analogue interviews took place in a lunchroom environment characterised by higher noise levels, interruptions from non-participating co-workers, and uneven time conditions across participants. In contrast, the digital focus groups were conducted in a quieter setting with the presence of a shift manager, potentially fostering higher engagement. These contextual differences may have influenced employee motivation and could partly explain the higher number of paraphrases generated in the digital focus groups. More broadly, the comparison does not isolate the effect of participation format alone, because it was intertwined with machine context, facilitation, and situational conditions.

Furthermore, the evaluation was restricted to paper-based prototypes and was affected by considerable sample mortality. Only one participant from the digital focus group and nine from the analogue group took part in the evaluation; three additional employees had not participated in either focus group, and two could not recall whether they had participated. This limits the ability to draw conclusions about potential differences between the two formats. Although each focus group session lasted approximately 20 minutes in both formats, resource expenditure and process costs were not systematically assessed beyond session duration. Therefore, no conclusions can be drawn about possible efficiency or effort-related advantages of digital formats. Access to organisational key performance indicators, such as productivity changes or sickness absence, was also unavailable. Future research could usefully complement participatory and usability-oriented measures with such organisational indicators where feasible, in order to capture WPI processes across multiple levels and over time.

An important conceptual limitation concerns the distinction between perceived WPI and actual organisational outcomes. The present findings primarily reflect employees' subjective perceptions of participation, process quality, and anticipated impacts, rather than objective measures of WPI. While perceived WPI represents a theoretically meaningful construct, particularly in participatory and employee-centred approaches, it does not necessarily translate into realised organisational outcomes.

More generally, the findings were likely shaped not only by participation format but also by contextual and organisational framing conditions, including the physical and social setting of participation, time pressure, managerial presence, and the degree of procedural standardisation. Although these factors were not systematically controlled, they shape the participatory environment in which WPI processes unfold and may affect both the quality and quantity of employee contributions.

Theoretical implications

The findings of this exploratory study contribute to the WPI literature by lending cautious support to the proposition that participatory process quality may be more consequential for perceived WPI-related participation quality and anticipated impact than the participation format alone. Across both digital and analogue settings, employees reported positive levels of acceptance and perceived WPI, which points to the relevance of meaningful participation, perceived influence, and organisational embedding in participatory WPI processes. More specifically, the findings suggest that the mode of participation should be analytically distinguished from the quality of participation. While the descriptive results did not indicate pronounced differences in perceived participatory value between the digital and analogue formats, the study also points to possible differences in interaction dynamics. This indicates that digital and analogue participation may differ less in their basic capacity to enable participation than in the specific interaction conditions through which participation is enacted.

From a theoretical perspective, the evidence supports a process-oriented understanding of WPI. Rather than conceptualising WPI as dependent on specific tools or participation formats, the present case suggests that enabling conditions such as transparent process structures, meaningful integration of employee input into decision-making, opportunities for genuine participation, and organisational support may be more central explanatory mechanisms. In this regard, the findings resonate with the OWPI perspective adopted in this study, which emphasises the interdependence of human, organisational, and technological dimensions. At the same time, the study does not suggest that digital and analogue participatory approaches are equivalent, nor that format is irrelevant. Instead, it indicates that possible format effects may be mediated by the broader participatory architecture and the organisational conditions under which participation takes place. Future theoretical research may gain from a clear differentiation between the mode and the quality of participation, as well as from a more systematic investigation into how various participatory environments influence interaction dynamics, inclusion, and innovation-related outcomes within organisational contexts.

Practical implications

The present case study's exploratory and non-generalisable character necessitates caution in drawing practical implications. For the focal SME, the findings suggest that digital participatory formats can represent a feasible way of conducting WPI processes under certain organisational conditions. In this case, the digital format appeared capable of eliciting relevant employee input and of supporting the co-creation of a dashboard concept in a manner that was

acceptable to participants. At the same time, the study does not indicate that digital formats should replace analogue participation in general, nor that the choice of format can be treated as inconsequential. Rather, the findings point to the importance of selecting and designing participatory formats in accordance with the specific organisational context, including operational constraints, available infrastructure, interaction conditions, and the need for meaningful employee involvement.

For practice, this means that the successful use of participatory formats in WPI depends not only on choosing between digital and analogue settings but also on carefully shaping the conditions of participation. SMEs should therefore pay attention to factors such as appropriate scheduling, a low-distraction environment, clear moderation, reliable coordination, and the meaningful integration of employee contributions into subsequent design decisions. In addition, the presence of managerial actors during participation processes should be considered carefully, as it may either support or inhibit employee contributions depending on the situation. Particularly under conditions of limited resources, the design of participation should aim to make employee involvement both feasible and substantively effective.

For SMEs in particular, this implies that digital participation may be a useful option where face-to-face participation is difficult to organise, but its effectiveness is likely to depend on careful facilitation and meaningful integration of employee contributions. Future studies should consider evaluating prototypes after technical implementation at the workplace, in addition to paper-based prototype assessments, and should also incorporate process-related effort and resource requirements where possible. If future research confirms these patterns across broader contexts, digital participation may in some settings prove advantageous not only in terms of flexibility but also in terms of organising participatory processes under limited organisational resources (Miebach, 2020).

Conclusion

This article examined the use of digital and analogue focus groups to support a WPI-oriented participatory process in a German SME. Perceived WPI was assessed using a questionnaire inspired by the WPI layers as defined by Kesselring et al. (2014). The findings suggest that both digital and analogue participatory formats were capable of supporting the participatory WPI process in the studied case. Descriptively, no pronounced differences were observed in acceptance or perceived WPI, although slightly more positive ratings were found for the digital format on some measures. However, these patterns should be interpreted with caution, given the single-case design, the small and context-specific sample, the descriptive nature of the analysis, and the limited evaluation data. Rather than indicating that digital and analogue participation are equivalent, the findings suggest that how participation was organised, enabled, and embedded in the organisational context was more consequential than format alone. In particular, the case suggests that the quality of participation depends not only on the format itself but also on framing conditions such as scheduling, the physical setting, interruptions, managerial presence, and procedural coordination. In this sense, the case study contributes to WPI research by suggesting that the quality and organisational embedding of participation

may be at least as important as the participation format itself, without implying that digital and analogue formats are interchangeable. At the same time, the case indicates that digital and analogue formats may differ in their interaction dynamics and implementation conditions, which may affect the overall effectiveness of participation in WPI processes. Further research with larger samples, more standardised comparison conditions, and longitudinal data following technical implementation of the prototypes is needed to assess more systematically how different participatory formats influence WPI processes and outcomes across organisational contexts.

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