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Human-centered approaches to AI-assisted work: the future of work?

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The speed and momentum at which AI-based applications currently proliferate are remarkable and, in many ways, unexpected. Whilst AI is by no means a new concept, even many AI experts were surprised by the rapid progress of generative AI, the most prominent example of which is ChatGPT (Dwivedi et al. 2023). Single-purpose AI applications (for further distinction see Fischer 2022) are also increasingly integrated in a wide range of workflow operations in many industries such as manufacturing, logistics, healthcare or construction, to mention just a few typical fields (e.g. Lee and Yoon 2021; Plathottam et al. 2023).

In the context of Industry 4.0, AI applications are predominantly used to address automation, process optimization, and efficiency goals, in an effort to address the demands of global hyper-competition (Pozzi et al. 2023). Industrial policies further encourage leveraging this automation potential of AI integration. Whilst AI-driven automation does not necessarily result in detrimental working conditions such as task fragmentation and work intensification, it does so frequently. To mitigate adverse side effects, a human-centered approach to AI-based work is frequently advocated that emphasizes employee participation and human well-being while streamlining processes (e.g. Huchler 2022; Kadir and Broberg 2021; Haipeter et al. 2024).

However, as Parker et al. (2017) have pointed out, we need to extend the humanization of work debate to new scenarios of AI-based work. The potential of AI goes beyond the rationalization of processes. It is also attributed as

a tool, medium or even collaborator (Anthony et al. 2023) to enhance accuracy, quality and creativity, to generate better outcomes and solutions for customers, clients and patients, or to establish new business models and strategies (Eriksson et al. 2020), while further developing the job roles of employees (Wilkens et al. *in press*; Galsgaard et al. 2022; Langholf et al. 2024) or fostering new human-AI team settings (Kluge et al. 2021; Berretta et al. 2023; Hagemann et al. 2023). Another vision that goes beyond efficiency needs and aims to elaborate on a more sustainable, resilient and human-centered way of doing business and designing jobs has become known as Industry 5.0 (European Commission 2021; Leng et al. 2022). Related ethical challenges are addressed in the context of software development (Mittelstadt et al. 2016), AI supply chain (Widder and Nafus 2023) but also with respect to the ethical purposes and moral standards of those stakeholders who make decisions on AI implementation (Ayling and Chapman 2022; Wilkens et al. 2023).

Work science offers important contributions to this ongoing debate, as it encompasses an impressive interdisciplinary body of research focused on integrating human-centered perspectives into technological innovation within the workplace (Grant et al. 2011; Parker et al. 2017). Given the evolving role of AI in business and society—whether through the process-oriented lens of Industry 4.0 or the purpose-driven vision of Industry 5.0—this research is essential for shaping the future, and it is continuously evolving. A recent Research Topic in the Journal *Frontiers in Artificial Intelligence: AI in Business* on “Human-Centred AI at Work: Common Ground in Theories and Methods” addressed the challenge of identifying commonalities and analyzing differences of different approaches. This ZfA Special Issue focuses specifically on recent German advancements in research on human-centered approaches to AI-assisted work, presenting two complementary research directions:

1. **Shifting the job design paradigm:** This research investigates how to balance corporate productivity needs with employee job demands and well-being from a sociotech-

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nical systems perspective, seeking innovative solutions for job design in the context of AI.

2. **Expanding the scope of human-centered work design:** This research reexamines the scope of human-centered AI at work, extending beyond operational employees to include ethical considerations from a multi-stakeholder perspective. It addresses the roles and responsibilities of analysts, software developers, and managers, focusing on accountability and ethical implications.

In the following, these research directions will be briefly elaborated, followed by an overview of the articles included in this Special Issue and a discussion of future research opportunities.

1 Shifting the paradigm: Transitioning human-centered job design from past to future

Historically, human-centered design (HCD) typically referred to the design process itself rather than a human-friendly outcome and was predominantly used in the context of technology development. In their seminal publication, Gould and Lewis (1985) described three key principles of the human-centered (technology) design process: 1. early focus on the user, 2. empirical measurement [of the interaction with the technology], 3. iteration informed by data from users. This emphasis on “user” participation has also been reflected in the often-cited ISO 9241-210:2019 and represented in anthropocentric approaches to “good work” design (e.g. Luczak 1992).

As companies navigate the evolving landscape of global market competition and technological advancements, the transition from traditional to forward-thinking human-centered job design becomes crucial. Intense global market competition and the immense pressure on companies to rapidly adapt and leverage new technologies drive the need for enhanced efficiency. Modern AI systems offer significant opportunities for automation and potentially reducing labor costs across various domains—from standardized tasks to more creative activities like writing, visualizing, or composing. This productivity boost must be viewed in the context of societal challenges, such as the demographic shifts occurring in aging societies like Germany, which exacerbate labor shortages across numerous industries, extending beyond just skilled workers (e.g. Ahlers and Quispe Villalobos 2022). Concurrently, workers are increasingly advocating for reduced working hours, less shift work, and greater flexibility, including remote work options, all while maintaining high levels of compensation (Otte 2024). Offering possible solutions to these demands of companies and employees, human-centered AI applications are be-

ing explored to develop new sociotechnical system designs that balance corporate productivity needs with employee demands. For example, AI can be used in ergonomic exoskeletons to relieve people during physically demanding tasks. In user-friendly decision support systems, it can prevent information overload. With gamification approaches that are designed to promote learning, AI can help building valuable skills. As such, AI systems can play a pivotal role in fostering social sustainability, i.e., promoting long-term employability and empowerment of workers, especially in regions and sectors that face structural challenges.

Despite the considerable potential of modern AI systems for promoting humane working conditions, many of the currently popular use cases (e.g., automated monitoring in pick-by-light systems, “bossware” to assess productivity metrics of home office work, algorithmic management of order picking) are reminiscent of the era of Taylorism and Fordism, in which people had little decision-making autonomy and were increasingly tasked with residual, fragmented activities that could not be automated—until they could. As such, there is often a high level of uncertainty among employees and union representatives when dealing with AI applications as well as concerns about job loss and disempowerment through AI systems. Hence, in the AI age, it remains vitally important to consistently consider the role of the affected workers in the development, testing and introduction of new technologies in companies. In other words: we will need to increase efforts to promote the shift from the still predominant technology-centered to a human-centered job design paradigm.

Whilst HCD is often used with the intention to promote human-friendly technology and job conditions, humane work is not inevitably an outcome of participative HCD processes. As Mütze-Niewöhner and Nitsch (2020) and others have argued in the context of modern technology deployment, due to the diverse interrelationships between the technology used and the classic fields of work organization, a number of dimensions—both at the company level (such as occupational safety and data protection) and at the level of the individual (such as interaction conditions, learning and development opportunities)—must be included in the job design process. As such, it requires considerable expertise to take the complex interactions within and between different work systems into account in order to determine the extent to which an AI-related job design measure promotes conditions that address human-oriented job design criteria well. Moreover, in order to address sustainability and ethical considerations, more expansive multi-stakeholder approaches are needed.

2 Expanding the scope: A multi-stakeholder approach to human-centered AI-assisted work

In the human-centered design of future AI-assisted work, a multi-stakeholder perspective is crucial for ensuring that AI applications align with broader sustainability and ethical goals. Human-centricity is—in harmonized interplay with sustainability and resilience—one of the three core characteristics of the Industry 5.0 vision statement describing a future society, in which the potential of AI is exploited for purposes in line with the sustainable development goals (SDG) of the United Nations (European Commission 2021; Leng et al. 2022). There is the overall idea that technology innovation and infrastructure serve our societies in terms of a carbon-free, healthy and inclusive environment, responsible consumption and production, equal rights of all participants, decent work and good life, where systems are reliable and resilient in order to protect and inspire human life.

A human-centered approach to AI (Shneiderman 2022) thus depends on the purposes and moral integrity of those who are responsible for decision-making (Ayling and Chapman 2022). Some governments and other proponents of human-centered AI thus focus on broad ethical principles (e.g., the Beijing AI principles state it should strive to “do good”) and AI properties such as transparency, privacy and security (Bingley et al. 2023). Applied ethics gives attention to all stakeholders along the AI development supply chain, the C-level and line managers as well as analysts, change agents, employee representatives or operators on the shop floor (Goodpaster 1991; Deshpande and Sharp 2022; Widder and Nafus 2023; Wilkens et al. 2023) as there are many ethical challenges directly related to the technology-incorporated biases (Mittelstadt et al. 2016), at the critical interface between systems where accountability is often dislocated (Widder and Nafus 2023) but also on the level of individual behavior (Ayling and Chapman 2022). In recent years, the number of national and international research initiatives that take such human-centered approaches to AI in the context of work has risen considerably. This Special Issue aims to highlight differences and commonalities in regional approaches to AI-assisted work.

3 Regional efforts to advance the human-centered AI agenda

To address region-specific AI-related challenges and foster opportunities in the context of work, the German Federal Ministry of Education and Research (BMBF) has initiated in 2020 the establishment of the first Regional Competence Centers of Work-related Research (German: Re-

gionale Kompetenzzentren der Arbeitsforschung). In accordance with the UN Sustainable Development Goals (SDG) and the European Commission’s push for an Industry 5.0, these Regional Competence Centers set a human-centered agenda to foster decent work by creating working conditions in which AI supports and complements workers, rather than replacing or controlling them.

This Special Issue presents some of the research efforts of these competence centers and highlights their approaches and contributions to human-centered AI at work. To offer some orientation to the reader before delving into the subsequent research accounts, the first article of this issue by Braun provides background information and an overview of the meta project *CoCo*. The following articles primarily contribute to the first of the research directions outlined above, shifting the job design paradigm in the context of AI-assisted work, but several also feature a broader perspective on ethical criteria and involved multi-stakeholders.

3.1 Articles elaborating on the shift of the job design paradigm of AI-assisted work

Latos et al. explore in their article from the perspective of the competence center *Arbeitswelt.Plus* the integration of artificial intelligence (AI) into personnel planning to enhance time autonomy in manufacturing environments. Their literature review assessed current AI applications in personnel scheduling and identified gaps in their ability to address human-oriented criteria such as individualized preferences and flexible working hours. To address these deficiencies, the authors propose a new two-stage planning model that combines conventional operations research with AI methodologies. It emphasizes a participatory approach to shift planning in an effort to promote both employee satisfaction as well as organizational efficiency. By evaluating AI and optimization methods against a number of human- and organization-oriented criteria, the authors aim to create a more balanced work system that integrates technological advancements with the social needs of employees.

Intelligent shift planning is also a topic pursued in the competence center *KARL*. As Baehr und El-Haji explain, AI in the workplace can open new horizons for improving organizational justice. In this context, the authors propose an algorithmic approach that focuses on quantifying task workload as a basis for fair task distribution. In their development process, the authors were met with numerous challenges, not the least of which was the complexity of real-world constraints. Not deterred by these challenges, they conclude “a workplace characterized by fairness, efficiency, and high employee morale remains a compelling vision worth pursuing”.

In another article from *KARL*, Baumgartner et al. take a different approach to human-centered AI as they explore the integration of AI technologies in offline travel counselling to enhance personal interactions, a task which used to be a core strength of traditional travel agencies. In their research, they applied HCD principles to understand the needs and perspectives of travel counsellors regarding AI-assisted systems. Through methods like participant observation and semi-structured interviews, it was found that the travel counsellors were generally open to AI innovations but also had concerns about potential devaluation of their roles. By involving stakeholders in the AI development process and focusing on improving work conditions while preserving the quality of personal interactions, the presented human-centered approach aims to create AI solutions that support rather than replace human agents, in an effort to ensure that technological advancements align with human values and professional integrity.

In order to gain a deeper understanding of the impact of AI on the individual in the workplace, Rick et al. from *AKzentE4.0* conducted a questionnaire-based study to examine the differences in the perception of work engagement between those who utilize AI systems and those who do not. The concept of work engagement describes employees who experience a positive, work-related state of fulfilment, characterized by vigor, dedication, and absorption. As such, the concept of work engagement is of considerable importance in organizational contexts, as it affects the success of both employees and the organization as a whole. The presented results suggest that while certain aspects of human-centered job design are equally important for AI users and non-users in terms of promoting work engagement, the role of supervisory support emerged as a pivotal factor in the context of AI-assisted work. The authors posit that one reason for this may be the changing role of supervision and the tasks of supervisors in the context of AI-supported work. Furthermore, they point out that for AI systems to be effective in the workplace, care should be taken to ensure that they do not replace, but rather promote meaningful work tasks.

Altepost et al. from *WIRKsam* aim to identify and improve organizational conditions in companies that are conducive to the successful introduction of AI technologies in the workplace. Using a mixed-method design, the authors examined various factors that are considered crucial for effective AI integration, including technology acceptance, access to IT infrastructure, workforce structure, organizational culture and participatory practices. In an interesting twist to traditional mixed-method research, they compared researchers' assessments with those of employees, which uncovered some commonalities but also telling discrepancies: Common to the assessments were the desire for involvement in AI development and the decision-making process. Interestingly, researchers estimated the technology affinity

of employees to be greater and health concerns to be lower than the employees themselves. Thus, the findings highlight yet again the importance of participatory approaches to technology deployment that involve the affected workers.

3.2 Articles expanding the scope to a multi-stakeholder approach to human-centered AI-assisted work

Further insights from *KARL* emphasize ethical issues surrounding the use of AI at work. The human-centered approach to AI outlined by Krings und Frey aims primarily at embedding ethical reflection and stakeholder participation into the AI development and implementation process. The article explicitly emphasizes the importance of ethical reflection on norms such as fairness, social sustainability and the creation of meaningful work, to inform human-centered approaches to AI-assisted work. The ethical reflection advocated by Krings und Frey aims to ensure that technological advancements enhance rather than undermine the quality of work life, balancing automation benefits with the preservation of human agency and dignity.

In contrast, Friedrich et al. from *KMI* present a practical approach to human-centered AI based on Design Science Research. They define and involve stakeholders from ten small and medium enterprises (SME) in a series of workshops in which AI solutions are co-created in an agile manner with iterative cycles of planning, implementation, execution and reviews. The article focuses on three SME which aim to implement AI-support for various planning tasks. Whilst participation is also a central tenet of this approach, employees' involvement began in later stages of the AI planning process and only if they were directly affected by the solution. Based on their experiences, the authors give directions to AI designers and developers who wish to take a human-centered design approach to the development of AI tools.

Finally, Langholf und Wilkens from the competence center *HUMAINE* present a methodological approach (clarifying AI Augmented individual roles—cIAIr) to anticipate role development during the process of technology implementation. Referring to a multi-stakeholder perspective, the authors illustrate how role clarity can be achieved in the interaction with AI when job profiles shift and how role development also includes collaboration with other departments and goal-oriented external communication with customers. The method based on a participatory design including all relevant stakeholders results in six basic roles that are rooted in role theory in terms of role identity, role innovation and role clarity.

4 Human-centered approaches to AI-based work in Germany's Regional Competence Centers: Is there common ground?

In light of the rapid technological advances in AI, one might argue that the need for human-centered approaches to AI-based work is greater than ever before—not just to counteract negative effects of technology-driven workplace changes, but to seize the opportunity to harness the potential of these technologies to benefit workers as well as employers and society at large.

The articles in this Special Issue highlighting current research efforts of the Regional Competence Centers reflect the international research landscape on human-centered approaches to AI in many ways. Whilst the Regional Competence Centers were created to address regional challenges and support key economic players in their respective regions, there is much common ground. They collectively highlight the multifaceted impact of AI on the workplace, emphasizing that successful AI integration requires a careful blend of technological innovation and human-centric considerations. By incorporating participatory approaches and ethical reflections, the studies aim to ensure that AI serves to enhance, rather than undermine, human roles and organizational dynamics. Finally, the variety in focus areas and methodological approaches reflects the diverse applications and challenges of AI across different work environments, highlighting the need for tailored strategies that consider specific organizational contexts and employee needs.

On the other hand, there is also commonality in that which is noticeably lacking. For example, well established usability and UX engineering principles and guidelines are rarely investigated in research on the development of AI systems that specifically aim to support workers. Furthermore, whilst HCD of AI systems seems likely to constitute a necessary prerequisite for the humane design of work systems involving AI, it is by no means sufficient. Hence, it is important that research efforts to determine key factors at the individual, group and organizational level that contribute towards productivity, psychological and physical health as well as personal development when working with AI systems continue and intensify. What is particularly needed in this regard are more systematic field study-based evaluations of AI-supported work regarding established criteria of humane work design which obtain and aggregate generalizable insights that can be applied by organizations, in particular SME that oftentimes lack the required resources and expertise to translate scientific insight into actionable guidelines. Even rarer are longitudinal studies on the effects of generative AI systems which are expected to transform work in radical ways, especially in knowledge intensive work domains.

As such, we are left to ponder many questions that demand answers which work scientists are ideally suited to deliver: Under which conditions is AI automation a viable solution to labor shortages? Can “AI overassistance” compound labor shortages in the long-term, when new employees no longer develop expert skills through their own experience? How can AI systems help to reduce the risk of developing mental and physical illness at work? How can we avoid devaluation of human labor? How can we utilize AI for more equality, integration and inclusion at the workplace? In which ways do organizational approaches to leadership and personnel development need to change? Considering the highly dynamic technological development of AI applications in its juxtaposition with the comparatively slow processes of rigorous research and even slower mechanisms of public research funding, the challenge of providing reliable, evidence-based advice to companies, social partners and political actors is only likely to grow for work scientists. Some of the names who dare to tackle this challenge are found in this Special Issue. Many more work on it in the Regional Competence Centers and around the globe, in an effort to shape work with AI for humans.

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