Human-Centric AI for the Manufacturing Industry - Why do we need a holistic approach to ensure success?

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Abstract

Technological advances continue to reshape the workplace, offering benefits such as automation, remote work, and enhanced access to information. However, they also pose challenges to employee well-being, including increased workloads, work-home interference, job insecurity, and increased surveillance. In this context, Human-Centred Artificial Intelligence (HCAI) presents a valuable opportunity to redesign work environments that prioritize human well-being alongside productivity. Human-Centred AI should not only prevent harm but also promote engagement, satisfaction, and a sense of purpose. By fostering a more humane and fulfilling work experience, this approach supports long-term organizational health and employee flourishing. This position paper proposes a holistic and multidisciplinary approach to investigate the effects of HCAI development in the manufacturing industry. We argue that to truly support worker well-being, AI technologies must be designed and implemented drawing on multidisciplinary insights and in co-creation with users. This ensures that technological change is aligned with the physical, mental, and social dimensions of human experience. Developing HCAI requires a system perspective that integrates technological innovation with human values and workplace dynamics. Only through such a holistic and interdisciplinary lens can we ensure that AI technologies serve the people who use them.

Keywords

Human-centred AI, Sustainable workplaces, Worker well-being

1. Introduction and related work

AI-driven digitization is transforming industries and skill sets today, much like steam power did in the First Industrial Revolution. AI is shifting the industry to a novel level of automation with data-driven operations, requiring new skill sets and capabilities of human workers. Such disruptive transformations fundamentally alter the relationship between workers, their work, and their work environment. Although this shift could increase job demands and stressors, it also represents a significant opportunity to reimagine the workplace by fostering human-centric AI technology.

While the introduction of technology is often presented as improving work conditions (e.g., by enhancing work quality [1] and safety [2]), the impact of AI is often much more contradictory [1]. In

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the gig economy, for example, studies have shown that such technologies can affect worker behavior, well-being, the ability to resist exploitative conditions, and the sense of belonging [3, 4].

The importance of studying and harnessing the potential of AI is emphasised by the fact that the manufacturing industry faces a structural labour shortage, for example, on the Flemish labour market [5]. Europe's Industry 5.0 vision [6] highlights the importance for manufacturing companies to offer qualitative operator jobs to attract new talent, retain and motivate current workers and support their ageing workforce [7].

Investigating the impact of Human-Centred AI technology on the manufacturing industry is a complex matter and should be studied from a holistic perspective that not only includes technology-oriented research, but also—and perhaps more importantly–the human aspects and the implications for the social fabric inside manufacturing companies, resulting in a multidisciplinary effort.

In this paper, we discuss the research goals of such a project, financed by the "Bijzonder Onderzoeksfonds" (BOF in short) program of Hasselt University: "Human Centred Artificial Intelligence for Worker Well-being in the Manufacturing Industry". This project will focus on several key dimensions of well-being that are particularly relevant to the manufacturing industry and the introduction of AI technologies: physical, psychosocial, cognitive, and occupational well-being. The team is formed by researchers in the fields of human-computer interaction, environmental psychology, social science, organisational research and diversity, movement science, logistics, business informatics, and industrial engineering.

2. A multidisciplinary holistic approach for Human-Centred AI in the manufacturing industry

The aim of our project is to provide a comprehensive understanding of AI's effect on worker well-being in the manufacturing industry in order to facilitate the design and development of truly human-centric AI technology. With our research, we want to ensure that the integration of AI fosters an environment where technology safeguards and improves well-being by enabling researchers and practitioners to consider the human aspects when developing technology for the manufacturing industry (human-centricity). It is important to mention that while performing our research, we will not lose sight of how AI technology can help manufacturing companies to remain competitive in a very demanding market.

To achieve this goal, we will focus our efforts on answering three main research questions:

- What are the effects of AI technology in the manufacturing industry on worker well-being?
- How can AI technology be used, designed, developed and implemented in order to ensure or improve worker well-being in the manufacturing industry?
- How can we evaluate the effect of AI technology on worker well-being in the manufacturing industry?

We will explore models that integrate social dynamics with AI capabilities, ensuring technology aligns with human factors. Sociologists will investigate how operators perceive the influence of AI on the definition of the job, organisational scholars will explore the role of factors, such as HR policies, or team dynamics, in the effects of AI on well-being, while computer scientists will develop human-centric AI technology that give worker well-being a central place without necessarily sacrificing production efficiency. Meanwhile, health care experts will focus on incorporating physical and mental health considerations, creating a comprehensive approach to AI's role in worker well-being. Incorporating architectural insights, the team will also examine how AI can improve workspace layouts and make environment-aware recommendations, connecting physical design with digital interventions. A successful implementation of such technology requires validating the interventions efficiently. We will explore cost-effective validation methods, such as digital twins, to assess impacts on workers, processes, and policies. By integrating diverse perspectives (see Figure 1), our approach ensures AI solutions are not only technologically advanced but also socially and ethically grounded.

Figure 1: Overview of the different disciplines involved in this multidisciplinary approach

3. Our work plan

Novel technologies, such as AI and robotics, have increased attention on how these technologies impact employees' work and job quality, though their impact on physical, psychological, and social aspects of worker well-being is not yet fully understood [8, 9, 10]. With AI technology enabling the collection of detailed biometric worker data (e.g., heart rate, pupil dilation), there are new opportunities for companies to better understand and enhance worker well-being, highlighting the need for a deeper understanding of how biometric systems can improve well-being and work quality. We have organised our research into three main pillars:

Exploring the impacts and dynamics of AI technology on worker well-being. The first important pillar involves generating knowledge about the mechanisms of this AI-driven transformation to better understand its impact on workers' well-being. We need to understand how humans perceive their new roles (e.g., measuring perceived competence, job satisfaction, physical strain, and the fear of being replaced by technology or other workers), how they perceive the policies that guide the use of AI in the manufacturing industry, how digitization affects interpersonal relationships, and how companies manage the implementation of AI. To answer these questions, we will use a combination of theories and methods to capture the impact and dynamics of AI from a multidisciplinary perspective.

Designing HCAI technology for worker well-being in the manufacturing industry. Using the knowledge from the first pillar, we aim to investigate design guidelines for the development of future HCAI technology for the manufacturing industry (e.g., algorithms, design tools, assembly tools) to enhance worker well-being on different levels. On the level of the individual, for example, we will study tools to improve the workers' ergonomics through wearables that give real-time feedback to correct the working posture to avoid possible injuries. As we cannot ignore the cost- and profit-driven nature of the manufacturing companies, we will also do research on the level of the task and the processes to enhance existing training, support, and communication to take into account the well-being of the workforce. At the organisational level, data-driven recommender systems will empower organisational policy makers to craft informed, forward-thinking policies.

Designing Human-Centric evaluation frameworks for AI technology. To ensure the desired positive effect of AI technology on worker well-being, we need a bidirectional exchange of insights across various disciplines. This requires an evaluation framework that focuses on validating artefacts and interventions with a human-centric approach. The key components of this framework are a set of methodologies covering the different disciplines and using simulations—digital twins—of manufacturing

environments to analyse AI-based interventions in a controlled yet realistic setting. These digital twins should include human factors to ensure the deployment of new technologies that are effective and empathetic to the workforce's needs (e.g., with regard to perceived stress or interindividual relationships).

4. Expected outcome

Many industrialised countries face an ageing workforce [1, 2]. In Flanders, the situation is no different: a significant (and growing) portion of Flemish manufacturing operators is older than 55 years [3]. In our consortium, we are involved in the Flanders Make SOC [REF HERE], where we have a vast network of regional and international manufacturing companies covering different sectors. We will engage with these companies to collaborate closely by investigating their cases with case studies.

Sustainability The goal is to ensure sustainable jobs for workers, focusing on aspects such as job satisfaction, injury prevention and ergonomics, work-life balance, and overall well-being at work with the support of AI. Improving the work conditions to make it more sustainable will lead to people remaining active in the job market longer, addressing employee shortages. Healthier and longer careers benefit not only individual workers and companies but society and the economy as a whole by sustaining future growth. This ambition is fully in line with the SDG8 of the United Nations on decent work and economic growth and further relates to SDG3, 9 and 12 [11].

Inclusion By improving our understanding of the interaction between AI, human labour, and well-being, we can also create and design more jobs for people not ready for the regular job market. Our research can support the activities of Work Integration Social Enterprises (WISEs). These companies provide valuable job alternatives to people who, due to different circumstances (e.g., disability or ageing), are not ready for the regular job market. The unique requirements of workers in this type of companies open up opportunities for our research to study how AI technology can promote and facilitate their inclusion (e.g., designing adaptive technology for workstations or digital assistants that provide work instructions tailored to the specific physical or cognitive needs of the worker). Furthermore, this knowledge can also make the regular economy more inclusive and enable employees to transition more easily from sheltered employment to regular employment, which is also a goal of current labour market policies.

5. Challenge: Fostering interdisciplinary collaboration

It is both essential and challenging to bring together the many different disciplines to perform this research on HCAI for worker well-being. Each discipline brings along unique perspectives, methods, and terminology, which can potentially lead to overly separated results if not deliberately addressed. Therefore, we aim to foster interdisciplinary collaboration and integration by implementing a strategy that prioritizes bottom-up interactions among the different teams, for instance through weekly in-person meetings among PhD students and researchers from all involved disciplines. These sessions will go beyond regular status updates, as they will focus on, among others, collaboratively defining and sharing use cases that reflect the complexity of real-world AI deployment in work settings.

These common scenarios will be strongly linked to manufacturing companies in our region. By agreeing upon these common scenarios, we aim to create a context in which each discipline can contribute its own insights and findings, and help us to align our work. While this process poses several practical challenges, which we plan to discuss in this workshop, it is the ongoing dialogue that will enable us to co-create AI solutions that will have value across all these different disciplines.

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Declaration on Generative AI

During the preparation of this work, the authors used GPT-4 Turbo and Grammarly for grammar and spelling checking. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

References

[1] M. Krzywdzinski, S. Pfeiffer, M. Evers, C. Gerber, Measuring work and workers: Wearables and digital assistance systems in manufacturing and logistics, Discussion Papers, Research Group Globalization, Work, and Production SP III 2022-301, WZB Berlin Social Science Center, 2022. URL: https://ideas.repec.org/p/zbw/wzbgwp/spiii2022301.html.

[2] H. Chen, Y. Mao, Y. Xu, R. Wang, The impact of wearable devices on the construction safety of building workers: A systematic review, Sustainability 15 (2023) 11165. doi:10.3390/su151411165.

[3] L. Cameron, H. Rahman, Expanding the locus of resistance: Understanding the co-constitution of control and resistance in the gig economy, Organization Science 33 (2021). doi:10.1287/orsc.2021.1557.

[4] M. Möhlmann, L. Zalmanson, O. Henfridsson, R. Gregory, Algorithmic management of work on online labor platforms: When matching meets control, MIS Quarterly (2021). doi:10.25300/MISQ/2021/15333.

[5] Steunpunt Werk, Mismatch, https://www.steunpuntwerk.be/onderzoeksthemas/mismatch, n.d. Accessed: 2025-06-10.

[6] European Commission, Industry 5.0, https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/industry-50_en, n.d. Accessed: 2025-06-10.

[7] E. Dessers, S. Dhondt, M. Ramioul, J. De Schutter, L. Pintelon, W. Decré, W. Van Bockhaven, W. Coreynen, M. Looze, G. Hootegem, Towards a multidisciplinary research framework for studying the digital transformation of industry, European Journal of Workplace Innovation 5 (2019). doi:10.46364/ejwi.v5i1.523.

[8] S. Bankins, A. C. Ocampo, M. Marrone, S. L. D. Restubog, S. E. Woo, A multilevel review of artificial intelligence in organizations: Implications for organizational behavior research and practice, Journal of Organizational Behavior 45 (2024) 159–182. doi:https://doi.org/10.1002/job.2735.

[9] P. Budhwar, A. Malik, M. T. T. D. Silva, P. T. and, Artificial intelligence – challenges and opportunities for international hrm: a review and research agenda, The International Journal of Human Resource Management 33 (2022) 1065–1097. doi:10.1080/09585192.2022.2035161.

[10] S. Chowdhury, P. Dey, S. Joel-Edgar, S. Bhattacharya, O. Rodriguez-Espindola, A. Abadie, L. Truong, Unlocking the value of artificial intelligence in human resource management through ai capability framework, Human Resource Management Review 33 (2023) 100899. doi:https://doi.org/10.1016/j.hrmr.2022.100899.

[11] United Nations, The 17 goals | sustainable development, https://sdgs.un.org/goals, n.d. Accessed: 2025-06-10.