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HUMANS AND HUMAN-CENTRIC AI IN IDUSTRY 5.0: EFFICIENT COLLABORATION OR UNETHICAL COMPETITION

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Abstract. Industrial revolutions are characterized by the fact that they introduce and prompt new requirements in production based on innovative technologies and products. Through them, they also change society's attitude towards innovation and its role in the social and labour aspects. In the transition between Industry 4.0 and Industry 5.0 (I5.0), and due to the fact that the role of humans in industrial processes is always a major factor, this paper examines the vision of I5.0 for an effective collaboration between humans and machines based on artificial intelligence (AI). The aim of the report is to examine the establishment of the relationship between technology and humans and its ethical and moral implications. The main research question of the paper is: Is it possible that as robots and machines with AI evolve over time and training, they will move from being collaborators with humans in the work process to direct competitors? The paper discusses the opinions of researchers who have dealt with the mentioned topics and questions. The aim is thus to systematize and analyse the knowledge on the subject. As a result, challenges and problems in the field are identified.

Keywords: Artificial Intelligence (AI); Human-Robot Collaboration; Industry 5.0

Introduction

Industrial revolutions can be seen as waves that are part of human history and that permanently change working conditions, economic and social life (Toffler 1980, pp. 25 – 34). In economic terms, industrial revolutions are characterized by the fact that they introduce an urge for new production requirements based on innovative technologies and products. Furthermore, in each successive industrial revolution, the role of the human workforce in the economic and industrial (production) process is altered in a direction that allows interaction between humans and the corresponding new technology (Koc and Teker 2019, pp. 304 – 311).

According to the report of the European Commission "Industry 5.0: Towards a sustainable, human-centric and resilient European industry", the fifth industrial revolution will not focus on how we can automate a particular work or production

process thanks to the introduction of new technology, but how and where the new innovations and technologies can support the worker in their function. In this way, the worker (the human being) will be at the centre and the smart technology will have to adapt to the workers' needs without infringing his personal and human rights (Directorate-General for Research and Innovation 2021).

In contrast to some of the previous industrial revolutions and eras, where the direction of transferring knowledge was only from human to machine, the current technological innovations in Industry 5.0 (I5.0) are allowing this knowledge transfer also from smart technology to a human. This also results in greater and more efficient interaction for both sides, where the machine enlarges its knowledge based on the human input and the human profits from the artificial intellectual (AI) skill and self-learning capabilities of the machine. Next to the advantages of this so-called human-AI collaboration, there is also some scepticism when it comes to topics related to job security and the risk of workers/humans being replaced by smart technologies, ethics and morality in machine data processing, challenges concerning the governance of smart technologies (such as AI) and many more. In order to find out, which are the current concerns resulting from the human-AI collaboration as part of I5.0, this report will analyse the different models of collaboration between humans and machines and what kind of issues could they cause for people and society. Originating from the theory about I5.0 and the report of the European Commission, this report will also try to answer the question of whether is it possible that as robots and machines with AI evolve over time and training, they will move from being collaborators with humans in the work process to direct competitors. Next to that, the report aims to examine the establishment of the relationship between technology and humans and its ethical and moral implications.

1. State of art

According to different theories and research papers, such as the one of Demir, Döven and Sezen (2019), one of the current major versions of Industry 5.0 (I5.0) describes and aims the collaboration between humans and robots in a way that they work together there, where it is possible and efficient (Demir, Döven and Sezen 2019, pp. 688 – 695). As a matter of fact, the human-robot collaboration could be seen also as an extension of Industry 4.0 (I4.0), and especially between humans and AI, which would require human creativity there where the robots deliver standard solutions. Based on this, it is expected that a lot of new types of jobs would emerge out of this human-robot collaboration, which would change the role of humans on the production factory floors (Demir and Cicibaş 2019; Gotfredsen 2016).

This new way of human-robot interaction is also a result of the ever-increasing demand for automated, intelligent, and more efficient robots. In order to be beneficial

for the business and society, AI robots should be able and competent to provide standard and efficient solutions to complex problems. In addition to that, they have to be in the situation to take decisions about some scenarios, which are currently taken by humans (Arslan et.al. 2022, pp. 75 – 88). Depending on the situation and the circumstances the generative AI could provide the humans with the needed information, service or even psychological support and so, enrich the human with new knowledge about the specific task, situation or consequences. Next to that, the AI tools could be used to assess the human condition in the work processes with high levels of concentration and if needed, reduce the stress by applying the needed measures. Consequently, this could increase the efficiency of humans in the work process and boost productivity, which would result in positive effects for the companies (Biolcheva and Valchev 2023). Similarly, the human-robot interaction could also result in the cooperative creation of new ideas, which could be seen as an enlargement and further development of the current algorithms (Pavlik 2023, pp. 84 – 93; Obrenovic et al. 2024).

As in each previous industrial revolution, the introduction of a new way of the collaboration between the machines and the humans in the I5.0 (based on the mentioned vision about it) also raises the question about possible issues during the human-robot co-working and the possible negative consequences for the humans out of it. Some of these possible issues pointed out by Demir, K., Döven, G., & Sezen, B. (2019) are issues related to the personal preference of each human to work or not to work with robots and the acceptance of the robots in the daily life as co-workers, issues based on the local and global legislation about human-robot co-working, issues concerning the ethical and moral side of this type of collaboration and negative opinion about the robots as co-workers based on the fear among humans to be replaced by them in the respective workplace. Another major issue discussed is also the level of competition between robots and humans for a specific task and whether should they be seen as competitors in the job market (Demir, Döven and Sezen 2019, pp. 688 – 695).

2. Methodology

In order to be able to give a proper answer to the main research question, a methodology for this paper had to be selected, which is capable of collecting and examining the whole available information and data about the research problem. Due to the fact that there are currently a lot of research papers, report articles and other types of academic papers, which are analysing the research question and I5.0 from different perspectives, it was decided to select the literature review as a main methodology of this paper. In this qualitative research method, it was decided to focus on literature discussing mainly the AI topic and its role within I5.0 In addition, one of the goals of the analysis would be to find quantitative results, such as survey results, which would also serve as a basis for the answer that will be given to the scientific question in this

research paper. The systematic analysis and the comparison of the different research approaches and results should then serve as a basis for further academic research in the area of I5.0 and the collaboration between humans and machines based on AI.

Collaboration between humans and robots in Industry 5.0: models of interaction, benefits and issues

Depending on the job type, the level of employment, the industry, etc., some of the possible issues during the human-robot co-working stated above could probably be verified while others could be seen as unjustified. According to Raisch and Krakowski (2021), the human-robot relationship in working environments could be seen from two perspectives: replacement or augmentation. The replacement point of view suggests that the robots will completely take over and conduct human tasks, which respectively would result in job loss for the substituted humans. On the other hand, the augmentation point of view corresponds to the vision of Demir, Döven and Sezen (2019) about I5.0 and future human-robot collaboration, which suggests that humans and robots will work together there, where it is possible and efficient (Raisch and Krakowski 2021, pp. 192 – 210). The augmentation perspective and the collaboration between humans and smart technologies, such as AI, towards more efficient services is also labelled as cobotics by Sowa et al. (2021), where the authors distinguish between four types of human-AI collaboration and also, they depict the extreme types of collaboration or non-collaboration (Sowa, Przegalinska and Ciechanowski 2021, pp. 135 – 142). These are the following (see Fig. 1):

1) Competing or working separately
2) Supplementing each other (competency-based task allocation)
3) Interdependent on each other
4) Hybrid of the two (fully collaboration between robots and humans and AI extends the efficiency of the human mind-set)

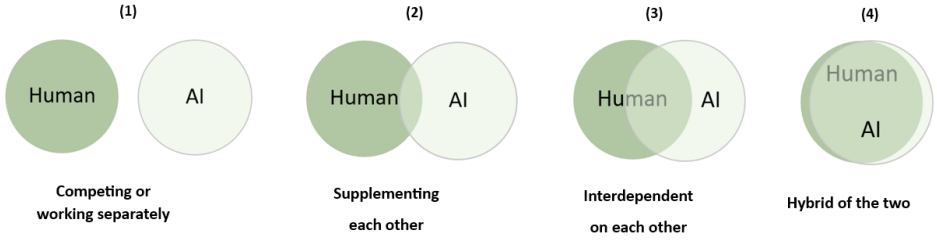

Figure 1. Levels of proximity of humans to AI at work
Source: Sowa, Przegalinska. and Ciechanowski (2021), p. 136

In addition to the four types of human-AI cobotics, the study of Sowa et al. (2021) focuses also on a quantitative survey among managers and managerial

tasks from different types of functional areas with the aim to analyse the synergies between human-AI collaboration at the management level. Based on the results of this quantitative survey, it was stated that a large majority of the participants in the study are basically not afraid that AI would replace them and take their jobs in the future, whereas younger groups of the participants are slightly more concerned that AI would replace them in the near future. On the other hand, the younger group of participants prefer to collaborate with human-like virtual assistants while the older group of the participants would like to work with less human-like virtual assistants, which shows negative collaboration between fear of losing the job because of AI and readiness to work with human-like virtual assistants (AI/Robots) (Sowa, Przegalinska and Ciechanowski 2021, pp. 135 – 142).

Proceeding from the perspective of Raisch and Krakowski (2021), it should be indicated that there is a difference between cooperation and collaboration in the human-robots interaction context (Kolbeinsson, Lagerstedt, and Lindblom, 2019 pp. 448 – 471). In the case, where the human and robots cooperate, the authors state that the participants in the work process are independently conducting tasks in a particular sequence towards shared goals. On the other hand, the collaboration between humans and robots is based on a sequence of actions, which are performed jointly by the participants towards a shared goal (Kolbeinsson, Lagerstedt and Lindblom 2019, pp. 448 – 471). This distinction between human-robot cooperation and collaboration plays an essential role in the context of human-robot interaction and in the way how the robots, such as smart technologies and AI, enlarge their knowledge about human actions and behaviour. Furthermore, this distinction could be seen as a major milestone within the human-robot relationship, because collaborating with humans the robots and the smart technologies have to achieve such an interaction level, which is similar to the one between two humans.

Similarly, to the theories about human-robot collaboration and cooperation expressed by Kolbeinsson, et al. (2019), Sowa, K. et al. (2021) and other authors, Fui-Hoon Nah et al. (2023) also support the idea that human-centered AI (HCAI) collaboration would not result into a human replacement by AI, but it would lead more to the situation where AI supplements the humans. A major factor in this HCAI collaboration is the so-called AI literacy, which requires a large number of competencies possessed by the users and humans in order to be able to efficiently and ethically use, communicate with and collaborate with the AI technology (Fui-Hoon Nah, et al. 2023, pp. 277 – 304) (Long and Magerko 2020, pp. 1 – 16; Ng, et al. 2021; Fast and Horvitz 2017). In the research paper of Fui-Hoon Nah et.al. (2023), the authors point out also some of the major challenges that industries could face by implementing the HCAI collaboration model and generative AI. Some of these challenges associated with the economy are related to the labour market issues caused by the implementation of generative AI and the HCAI collaboration model. It is expected that AI will reshape the labour market in various industries,

and it will lead to job losses for workers, especially for the job types, which will become redundant due to AI implementation (Zarifhonarvar 2024, pp. 100 – 116; Pavlik 2023, pp. 84 – 93). According to Zarifhonarvar (2023), the implementation of generative AI services will have a short-term and long-term impact on the labour market (Zarifhonarvar 2024, pp. 100 – 116).

– In the short-run, the implementation of generative AI services could initially go either way. From one point of view, the generative AI would probably result in the fully automation of some job activities and processes, which are suitable to be conducted by smart technologies, which would then lead to a decline in demand for some specific jobs and labour types. From another point of view, the introduction of generative AI could lead to economic growth, which could then introduce new types of jobs on the labour market and so, increase the demand for specific types of labour. All in all, the effects of the implementation of generative AI services would

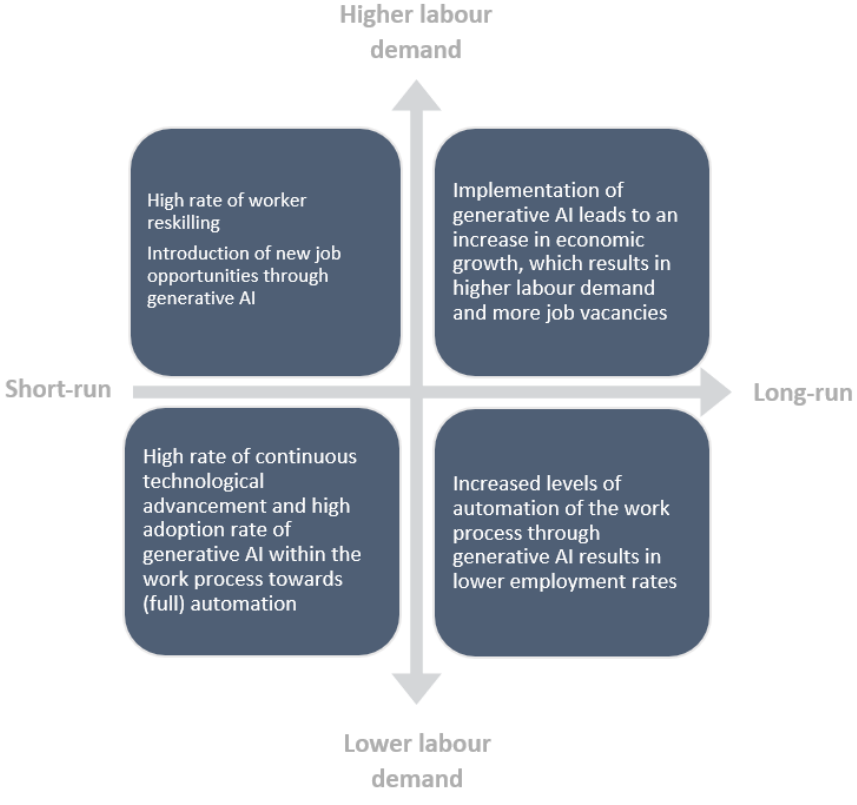

Figure 2. Impact of generative AI over the labour market in short-run and long-run

depend in short-run on the technological advancement, on the adoption rate of the technology and on the rate of reskilling the workers.

– In the long-run there are two probable scenarios of how the implementation of generative AI services would impact the labour market. The first one suggests that the adoption of generative AI services would positively affect productivity and respectively economic growth, which would increase the demand for labour, and this would result in a higher number of job vacancies and higher salaries for these positions. The second long-term impact scenario suggests that the adoption of generative AI services would lead to an even higher rate of (or complete) automation of some job activities and processes, which would then lead to less demand for human labour, a decrease in salaries for specific job types or workers and also lower employment rate. These consequences of introducing generative AI services would be even more significant in industries with a high rate of automation.

Nevertheless, it should be stated that the effects in both, the short and long-run, are hard to predict, because they are mostly unknown, and are dependent on a large number of factors and variables. Furthermore, it should be stated that the implementation and the adoption of generative AI services would impact more high-skilled jobs than low-skilled ones, which are highly impacted by automation and robotic technologies (Zarifhonarvar 2024, pp. 100 – 116).

Similarly to Demir, Döven and Sezen (2019), Fui-Hoon Nah et al. (2023) also point out the challenges related to ethics and governance, which industries could face by implementing the HCAI collaboration model and the generative AI. The reason for the concern about these ethical and moral issues comes from the fact that HCAI systems have to understand and always bear in mind human, social and cultural values. Next to that, the HCAI systems must take into account the ethical and sociocultural factors across the world and always respect people regardless of their nationality, race, religion, culture, etc. In order to be trustworthy partner, the HCAI systems must protect all of the personal and confidential information and so, ensure and protect the data privacy (Riedl 2019, pp. 33 – 36; Fui-Hoon Nah et al. 2023, pp. 277 – 304).

As a method of protecting data privacy and ethical standards, a large number of policies, draft laws, acts and regulations have been already published by the different authorities and countries worldwide (Global AI Law and Policy Tracker 2024). However, the separate establishment of regulatory frameworks and legislations in the respective countries and the not-yet-standardized approach to the international regulation of AI technologies may prove in the near future to be an obstacle to the global diffusion of these technologies and the ethical norms embedded in them. According to Qadir et al. (2022), implementation of such regulations and laws has to happen in a two-step process. In the first step, the policies and the regulations have to be designed as human-centered in order to be effective. In the second step, the AI algorithms and systems have to be based on this human-centered policies

and regulations (Qadir, Islam and Al-Fuqaha 2022, pp. 329 – 342). Next to this, the implicated AI model has to be understandable, and it has to be able to explain its decisions. If this is not the case and the AI model cannot explain its decisions in an understandable human way, then the transparency and respectively the ethics of the AI could be questioned. Besides transparency, other factors such as accountability and fairness are often seen as requirements in AI ethics (Vainio-Pekka et al. 2023, pp. 1 – 39).

3. Discussion

Similar to the theory about the short-run and long-run impact of AI on the labour market proposed by Zarifhonarvar (2024), it could be interesting to see, how this applies to the four human-AI collaboration models proposed by Sowa, et.al (2021). As can be seen in Figure 3 for each one of the human-AI collaboration models a short- and long-run scenario was proposed about its impact on the human-AI competition through time. In this context, it was assumed that the initial generative AI adoption rate within the work process would be high, and the labour supply would be inelastic, while the technological advancement and the human-reskilling rate would continuously improve over time. In the first human-AI collaboration model "Competing or working separately", a human-AI competition is expected in the short-run due to the full automation and robotization of some tasks within the work process, low rate of human re-skilling, and the inelastic labour supply. In the long run, this would lead to further separation of the human and AI tasks within the work process. However, in the long-run, this human-AI collaboration model would be largely dependent on the technological advancement of generative AI and the rate of human re-skilling. In the second human-AI collaboration model "Supplementing each other" it is expected that in the short-run the competition between humans and AI would be initially limited because the current AI technology could only conduct particular tasks of most of the work processes and the human competence knowledge is still superior. On the contrary, in the long-run, this collaboration method could be highly affected by the human-AI competition in the case, when the technology and knowledge advancement rate of the AI is higher than the human-reskilling rate. This would then mean that over time the AI technology could supplement more and more the human within the work process or even replace the human. Depending on the circumstances, the high level of competition in the long-run could be smoothened by eventual economic growth, which would increase productivity and so, increase the labour demand and the number of new vacancies. In the third human-AI collaboration model "Interdependent on each other" two types of scenarios were identified in the short-run, where both are dependent on the factor "human acceptance of AI technology" due to the fact that in this collaboration model humans are dependent on the AI (and opposite) towards achieving their goal. In the first scenario, there is high human acceptance of AI technology, which

initially leads to higher production rates, economic growth, and new job openings and so, to less human-AI competition. In the second scenario, there is low human acceptance of AI technology and initial high rates of technological advancement, which initially would lead to high competition. In the long-run, it is expected that this collaboration model would face a high rate of technological and knowledge advancement of AI (regardless of the scenario in the short-run). This would mainly happen because of the exponential learning process of AI technology about human habits and human decision-making within the work processes, due to the high level of human-AI interaction. Consequently, this could lead to high human-AI competition, or it could result in the implementation of the hybrid collaboration model in the long-run. In the last fourth human-AI collaboration model "Hybrid of the two" it is expected that this type of collaboration would be rare in the short-run due to the less technological advancement of the AI technology, lack of detailed information about the rules within this collaboration model or/and less human acceptance of the AI. Similarly, to the third collaboration model, a high human-AI

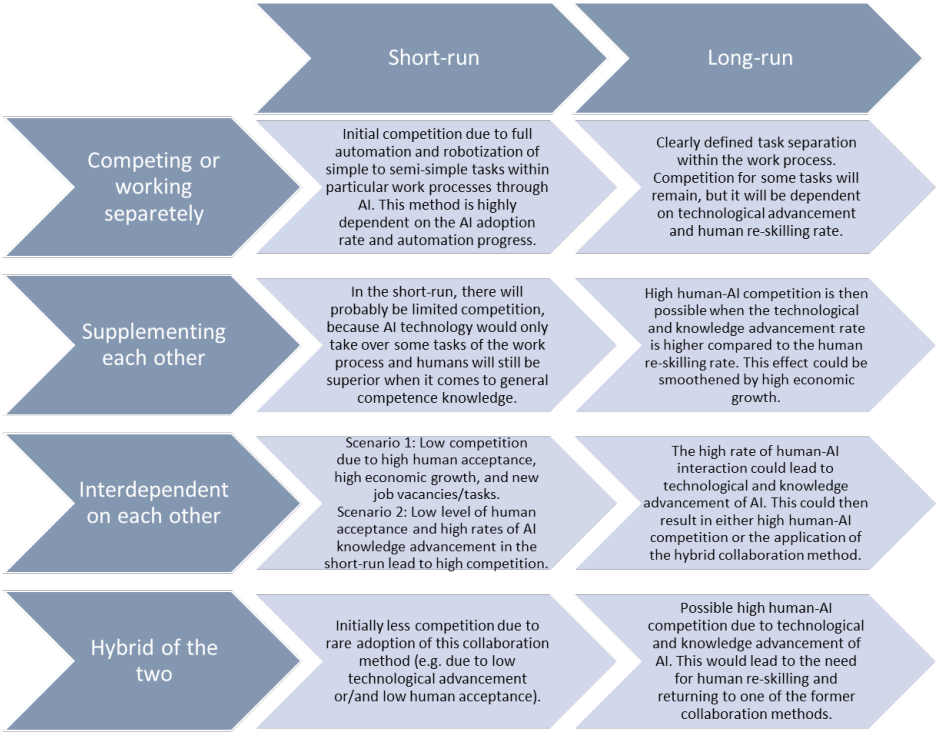

Figure 3. Short-run and long-run impact of the four human-AI collaboration models over the human-AI competition

competition is expected in the long-run, due to the technological and knowledge advancement of AI. In the long-run, there is also the risk that the transition from hybrid work with the human to replacing the human within the work process is possible. This would then lead to the need for human-reskilling and depending on its rate, this could lead to returning to one of the previous collaboration methods.

Conclusion

In conclusion, it could be stated that this research report analysed and reviewed various literature sources, which discuss the human-robot collaboration models in I5.0 and the issues related to them, such as the ethical and moral side of it and the possible human replacement by AI and robots. It was possible to examine the establishment of the relationship between technology and humans and to review possible models and levels of collaboration between humans and smart technologies, such as AI. Furthermore, for each one of the four human-AI collaboration types proposed by Sowa et al. (2021) a short- and long-run scenarios with their effects on the human-AI competition were developed. However, based on the analysed literature it could not be answered with certainty, if the robots and machines with AI will move from being collaborators with humans in the work process to direct competitors, as they evolve over time and training. Therefore, the topic should be an object of further future research analyses.

REFERENCES

ARSLAN, A.; COOPER, C.; KHAN, Z.; GOLGECI, I. & ALI, I., 2022, Artificial intelligence and human workers interaction at team level: a conceptual assessment of the challenges and potential HRM strategies. *International Journal of Manpower*, vol. 43 no. 1, pp. 75 – 88. DOI:10.1108/IJM-01-2021-0052.

BIOLCHEVA, P., & VALCHEV, E., 2023. Increasing CSR, through a Methodology for Intelligent Personal Efficiency of Employees. *Strategies for Policy in Science & Education-Strategii na Obrazovatelnata i Nauchnata Politika*, vol. 31, no. 6s. DOI:10.53656/str2023-6s-11-inc.

DEMIR, K., & CICIBAŞ, H., 2019. The next industrial revolution: Industry 5.0 and discussions on Industry 4.0. In: *4th International Management Information Systems Conference "Industry 4.0".*

DEMIR, K.; DÖVEN, G. & SEZEN, B., 2019. Industry 5.0 and human-robot co-working. *Procedia computer science*, vol. 158, pp. 688 – 695.

DIRECTORATE-GENERAL FOR RESEARCH AND INNOVATION, 2021. *Industry 5.0 – towards a sustainable, human-centric and resilient European industry*, European Commission – Research and innovation. Available at: https://research-and-innovation.ec.europa.eu/knowledge-

publications-tools-and-data/publications/all-publications/industry-50-towards-sustainable-human-centric-and-resilient-european-industry_en (Accessed: 21 April 2024).

FAST, E. & HORVITZ, E., 2017. Long-Term Trends in the Public Perception of Artificial Intelligence. *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 31, no. 1. DOI:10.1609/aaai.v31i1.10635.

FUI-HOON NAH, F.; ZHENG, R.; CAI, J.; SIAU, K. & CHEN, L., 2023. Generative AI and ChatGPT: Applications, challenges, and AI-human collaboration. *Journal of Information Technology Case and Application Research*, vol. 25, no. 3, pp. 277 – 304. DOI:10.1080/15228053.2023.2233814.

GLOBAL AI LAW AND POLICY TRACKER, 2024 *International Association of Privacy Professionals*. Available at: https://iapp.org/resources/article/global-ai-legislation-tracker/ (Accessed: 03 May 2024).

GOTFREDSEN, S., 2016. *Bringing back the human touch: Industry 5.0 concept creating factories of the future*. Available at: http://www.manmonthly.com.au/features/bringing-back-the-human-touch-industry-5-0-concept-creating-factories-of-the-future/.

KOC, T., TEKER, S., 2019. Industrial Revolutions and its effects on quality of life. *PressAcademia Procedia* (PAP), vol. 9, pp. 304 – 311.

KOLBEINSSON, A., LAGERSTEDT, E., & LINDBLOM, J., 2019. Foundation for a classification of collaboration levels for human-robot cooperation in manufacturing. *Production & Manufacturing Research*, vol. 7, no. 1, pp. 448 – 471. DOI:10.1080/21693277.2019.1645628.

LONG, D. & MAGERKO, B., 2020. *What is AI literacy? Competencies and design considerations*. CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, pp. 1 – 16. DOI:10.1145/3313831.3376727.

NG, D.; LEUNG, J.; CHU, S. & QIAO, M., 2021. Conceptualizing AI literacy: An exploratory review. *Computers and Education: Artificial Intelligence*, vol. 2, Article 100041, DOI:10.1016/j.caeai.2021.100041.

OBRENOVIC, B.; GU, X.; WANG, G.; GODINIC, D. & JAKHONGIROV, I., 2024. *Generative AI and human–robot interaction: implications and future agenda for business, society and ethics*. AI & SOCIETY, Springer-Verlag London Ltd, DOI:10.1007/s00146-024-01889-0.

PAVLIK, J., 2023. Collaborating with ChatGPT: Considering the Implications of Generative Artificial Intelligence for Journalism and Media Education. *Journalism & Mass Communication Educator*, vol. 78, no. 1, pp. 84 – 93. DOI:10.1177/10776958221149577.

QADIR, J.; ISLAM, M. & AL-FUQAHA, A., 2022. Toward accountable human-centered AI: Rationale and promising directions. *Journal*

of Information, Communication and Ethics in Society, vol. 20, no. 2, pp. 329 – 342. DOI:10.1108/JICES-06-2021-0059.

RAISCH, S. & KRAKOWSKI, S., 2021. Artificial intelligence and management: the automation–augmentation paradox. *Academy of Management Review*, vol. 46 no. 1, pp. 192 – 210. DOI:10.5465/amr.2018.0072.

RIEDL, M., 2019. Human-centered artificial intelligence and machine learning. *Human Behavior and Emerging Technologies*, vol. 1, no. 1, pp. 33 – 36. DOI:10.1002/hbe2.117.

SOWA, K., PRZEGALINSKA, A. AND CIECHANOWSKI, L., 2021. Cobots in knowledge work: Human – AI collaboration in managerial professions, *Journal of Business Research*, vol. 125, pp. 135 – 142, DOI:10.1016/j.jbusres.2020.11.038.

TOFFLER, A., 1980. *The Third Wave*. New York, United States of America, William Morrow and Company, Inc., pp. 25 – 34.

VAINIO-PEKKA, H.; AGBESE, M.; JANTUNEN, M.; VAKKURI, V.; MIKKONEN, T.; ROUSI, R. & ABRAHAMSSON, P., 2023. The role of explainable AI in the research field of AI ethics. *ACM Transactions on Interactive Intelligent Systems*, vol. 13, no. 4, Article 26, pp. 1 – 39, DOI:10.1145/3599974.

ZARIFHONARVAR, A., 2024. Economics of ChatGPT: a labor market view on the occupational impact of artificial intelligence. *Journal of Electronic Business & Digital Economics*, vol. 3 no. 2, pp. 100 – 116. DOI:10.1108/JEBDE-10-2023-0021.

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