Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 5, No.1, May : 2024

AI-DRIVEN ERGONOMICS SOLUTIONS: A REVIEW OF IMPLEMENTATION CHALLENGES AND OPPORTUNITIES IN MANUFACTURING INDUSTRIES

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Abstract
Ergonomics is an important factor for any worker's health and productivity. The incorporation of ergonomic design concepts into the manufacturing industry has demonstrated the effects of product quality improvement, cost reduction, and a more satisfied workforce. Considering the recent technological advancement of artificial intelligence (AI), there is a rising consideration of adopting AI-driven solutions to ergonomic evaluations and interventions in the manufacturing process. This paper covers the whole scope of the use of AI-enabled solutions in manufacturing environments, with a focus on the challenges and advantages. This study focuses on the current trends of AI technologies, the use of them for ergonomic assessment, and their implementation, which will result in improved workplace ergonomics. The review analyzes a variety of AI potentials in manufacturing ergonomics, like predictive analysis, real-time monitoring, workflow optimization, automation of tasks, worker-customized equipment design, and adaptive workstations. Moreover, it highlights AI-enabled ergonomics solutions for manufacturing that can help in the education and training of staff, task support, collaborative robots, and ergonomics assessment. The paper uses case studies and examples to demonstrate successful implementations, challenges encountered, and their impact on worker safety and productivity. Lastly, the paper is going to highlight the path and chances for research on AI-based ergonomic solutions that should keep in mind the ethics of development, transparency, and innovation, so that AI may help to maximize ergonomics in manufacturing industries.
Keywords: Ergonomics, Manufacturing Industries, Artificial Intelligence, AI-driven Solutions, Implementation Challenges, Opportunities, Workplace Safety, Productivity, Human-Robot Collaboration.

I. Introduction

1.1 Overview of Ergonomics in Manufacturing Industries

Ergonomics in manufacturing industries plays a crucial role in ensuring the well-being and productivity of workers. Studies have shown that integrating ergonomics into manufacturing processes can lead to improved product quality and reduced costs [1]. Furthermore, the integration of lean manufacturing with ergonomics has been found to define productivity and well-being indicators in human-robot workstations, emphasizing the importance of considering ergonomic factors in modern manufacturing practices [2]. Additionally, the benefits of human-centered design in industrial practices, particularly in the redesign of workstations, have been highlighted as essential for promoting ergonomic improvements in manufacturing settings [3]. Moreover, the reduction of ergonomic risks through the implementation of automated systems, such as automatic tape packaging machines, demonstrates the potential for automation to optimize production processes while offering better working conditions for operators [4]. These findings underscore the significance of ergonomics in manufacturing industries and the potential for integrating ergonomic principles into various aspects of industrial practices to enhance worker well-being and overall productivity.[5]

1.2 Introduction to AI-Driven Ergonomics Solutions

AI-driven ergonomics solutions have garnered significant attention due to their potential to revolutionize ergonomic assessments and interventions in various industries, including manufacturing. The integration of wearable devices and artificial intelligence (AI) has been explored to evaluate and control physical loads or postures, demonstrating the potential for AI to enhance ergonomic

assessments through advanced sensor technologies [6]. Furthermore, a systematic review by highlights the use of wearable sensors and AI for physical ergonomics, emphasizing the promising perspectives for diagnostic, prognostic, and preventive applications in ergonomics [7]. Additionally, provide insights into the application of industrial artificial intelligence in the context of Industry 4.0, shedding light on the challenges and outlook for integrating AI in industrial settings [8]. Moreover, present research trends in AI applications in human factors healthcare, indicating the growing interest and advancements in AI-driven solutions for addressing human factors, which can be extended to ergonomic interventions in manufacturing industries [9]. These references collectively underscore the potential of AI-driven ergonomics solutions to transform ergonomic assessments, interventions, and preventive measures in manufacturing industries, offering valuable insights for the integration of AI technologies to enhance workplace ergonomics. By synthesizing these references, it is evident that AI-driven ergonomics solutions hold significant promise for revolutionizing ergonomic assessments and interventions in manufacturing industries. The integration of wearable devices, advanced sensor technologies, and AI presents opportunities for more comprehensive and proactive approaches to ergonomic evaluations, with the potential for diagnostic, prognostic, and preventive applications. Furthermore, the challenges and outlook for integrating industrial artificial intelligence in the context of Industry 4.0 highlight the need for addressing potential barriers and leveraging AI technologies to optimize ergonomic conditions in manufacturing settings. Overall, these findings emphasize the transformative potential of AI-driven ergonomics solutions in enhancing workplace ergonomics and promoting the well-being of workers in manufacturing industries.

1.3 Purpose and Scope of the Review

The purpose of this review is to comprehensively analyze the current state of AI-driven ergonomics solutions in manufacturing industries. This includes an examination of the latest advancements in AI technologies, their application in ergonomic assessments, and their impact on improving workplace ergonomics. The review will also explore the benefits, challenges, and prospects of AI-driven ergonomics solutions, as well as their potential implications for the manufacturing industry. By synthesizing existing research and developments in this field, this review aims to offer valuable insights for researchers, practitioners, and decision-makers seeking to enhance ergonomics in manufacturing through AI-driven approaches.

II. AI-driven Ergonomics Solutions: Concepts and Technologies

The integration of wearable devices and artificial intelligence (AI) has been explored to evaluate and control physical loads or postures, demonstrating the potential for AI to enhance ergonomic assessments through advanced sensor technologies. Wearable sensors and AI offer promising perspectives for diagnostic, prognostic, and preventive applications in ergonomics. Furthermore, the development of AI technologies continues to advance, providing opportunities for the integration of AI in human factors and ergonomics research. Additionally, the design and interaction with machine learning and AI in the context of ergonomics have been addressed, highlighting the significance of considering human factors in AI design processes.

These insights are supported by [10], who discuss the significance of human-AI interaction in advancing ergonomic assessments and interventions, emphasizing the role of wearable sensors and AI technologies in AI-driven ergonomic solutions.

2.1 Definition and Scope of AI-driven Ergonomics Solutions

The scope of AI-driven ergonomics solutions encompasses a wide range of interdisciplinary applications and implications. These solutions have been explored in various domains, including healthcare, industrial settings, and human-computer interaction, reflecting the diverse potential of AI in addressing ergonomic challenges. In the context of healthcare, AI-driven solutions have been investigated for their potential to improve clinical decision-making, preventive care, and rehabilitation. Wearable sensors and AI technologies have been integrated into robotic exoskeletons for upper limb rehabilitation, demonstrating the potential for AI to enhance rehabilitation outcomes and promote

ergonomic advancements in healthcare [11]. Furthermore, the application of AI in peer-to-peer lending markets and pre-visit planning in ambulatory care highlights the diverse applications of AI-driven solutions beyond traditional healthcare domains, emphasizing the potential for AI to optimize processes and decision-making in various contexts [12], [13].

In industrial settings, AI-driven ergonomics solutions have been examined for their potential to empower human-robot collaboration, improve operator welfare and safety, and enhance efficiency on the shop floor [14]. Additionally, the use of AI to prevent work-related musculoskeletal disorders and streamline modeling in multiple domains reflects the potential for AI to mitigate ergonomic risks and optimize processes in industrial environments[15]; [16].

Moreover, the integration of AI in human-computer interaction and journalism underscores the broader implications of AI-driven solutions in shaping user experiences, transforming newswork, and influencing decision-making processes [17]; [18]. The potential for AI to support ethical decision-making, risk assessment, and resource management in the context of modern distributed computing systems further highlights the multifaceted scope of AI-driven ergonomics solutions [19]; [20].

Overall, the scope of AI-driven ergonomics solutions extends across diverse domains, encompassing healthcare, industry, human-computer interaction, and decision-making processes. The interdisciplinary nature of AI-driven ergonomics solutions underscores their potential to revolutionize various aspects of work, healthcare, and user experiences, emphasizing the broad and transformative impact of AI in addressing ergonomic challenges.

2.2 Overview of AI Technologies Used in Ergonomics: Machine Learning, Computer Vision, Natural Language Processing and Robotics

The integration of AI technologies, including machine learning, computer vision, natural language processing, and robotics, has been a subject of extensive research in the context of ergonomics. Studies have explored the application of computer vision in assessing ergonomic risks, such as computer vision syndrome among office workers, highlighting the prevalence and risk factors associated with this condition [21]. Additionally, AI-based wearable robotic exoskeletons have been investigated for upper limb rehabilitation, demonstrating the potential of AI to enhance motor rehabilitation through wearable technologies [11]. Furthermore, research trends in AI applications in human factors healthcare emphasize the need to integrate AI-enabled technologies with human factors and ergonomics principles for better use and workflow integration [9].

In the field of robotics, AI technologies have been leveraged to optimize human-robot collaboration and design collaborative robots with a focus on ergonomic indicators, aiming to generate efficient robot designs and improve human-robot interaction [22]. Moreover, AI-driven solutions have been explored in the context of surgical procedures, such as laparoscopic and robotic surgery, to evaluate postural ergonomics and user comfort during surgical interventions [23], [24], [25]. The potential for AI to disrupt the medical profession and its implications for healthcare ergonomics have also been subjects of debate and investigation [26].

Furthermore, the application of AI technologies in construction robotics and human-robot teams has been examined, particularly in hazardous work areas, aiming to improve productivity and shield construction workers from strenuous work and accidents [27]. Additionally, the evaluation of ergonomic risks using machine learning techniques and computer vision-based rapid entire body analysis (REBA) estimation has been a focus of research, highlighting the potential of AI in assessing ergonomic risks and improving workplace ergonomics [28].

The intersection of AI, cognitive ergonomics, and human-computer interaction has also been a subject of interest, emphasizing the need for synergy between AI and cognitive ergonomics to create intelligent interactive systems and enhance decision-making processes [18], [29], [30]. Moreover, the collaboration between humans and AI in decision-making processes has been recognized as an increasingly significant area of study, reflecting the evolving landscape of AI technologies and their impact on human activities [31].

These references collectively underscore the diverse applications and implications of AI technologies, including machine learning, computer vision, natural language processing, and robotics, in the field of ergonomics. From healthcare and rehabilitation to industrial settings and human-computer interaction, AI-driven solutions have the potential to transform ergonomic assessments, interventions, and decision-making processes, offering valuable insights for enhancing workplace ergonomics and user experiences.

2.3 Applications of AI in Ergonomics for Manufacturing Industries

Some specific applications of AI in ergonomics for manufacturing industries:

a) Predictive Analysis for Hazard Identification:

Artificial intelligence machines can analyze the previous records of accidents, near-misses, and ergonomic risk factors and discover patterns that can lead to the prediction of hazards before they occur. Such as machine learning models able to process data from sensors, cameras, and others to ascertain whether the work process being carried out is inline with the health and safety regulations or to identify ergonomic deficiencies in manufacturing processes.

b) Real-time Monitoring of Ergonomic Risk Factors:

AI-powered monitoring systems can continuously assess ergonomic risk factors such as repetitive motions, awkward postures, and excessive force exertion in real-time. Computer vision technology can capture workers' movements and postures on the assembly line and recognize tensions that may result in strains. It can, either provide instant feedback or send alerts to the workers.

c) Optimization of Workflows and Processes:

Through AI algorithms, production data can be analyzed to determine the best method in which to rework and improve work patterns to minimize exposure to any ergonomic stress and maximize efficiency. For example, an AI-guided scheduling system can allocate jobs to workers in such a way that they are matched to their skills, capabilities, and ergonomics such that a substantial reduction in fatigue and enhancement of production can be met.

d) Automation of Repetitive Tasks:

AI-assisted machine system might be used in automating repetitive and physically exhausting tasks in manufacturing; thus it is very safe for the human workers to avoid ergonomic injuries. Co-bots which have integrated AI can restructure and modify production processes to accommodate any dynamic situations and assist human workers in many ways in the operation, such as safety and postures.

e) Customized Equipment Design:

AI-powered tools can create custom ergonomic solutions based on anthropometry and personal preference, among others. These include adjustable workstations, tools, and equipment that can be modified according to size, shape, and position of the user. These tools use machine learning algorithms to investigate the user data, which will result in optimum designs that eliminate the ergonomic risks and boost the comfortability and usability at the same time.

f) Adaptive Workstations and Tools:

AI-controlled systems can adjust their workstations and devices based on feedback from reaction sensors and user control as well. For example, AI-powered exoskeletons can provide physical support and assistance to workers performing strenuous tasks, reducing fatigue, and lowering the risk of musculoskeletal injuries.

III. Opportunities for AI-driven Ergonomics Solutions in Manufacturing

The integration of artificial intelligence (AI) in manufacturing presents various opportunities for the advancement of ergonomics solutions. AI technologies can be applied to address workforce training, task support, collaborative robotics, and ergonomics in the manufacturing industry [8]. The application of AI in manufacturing is multifaceted, involving the analysis of data and process dependencies at multiple levels, which can influence the future development of AI to better meet the needs of manufacturing [32]. Furthermore, AI technologies enable manufacturing systems to perceive the environment, adapt to external needs, and extract process knowledge, including intelligent production,

networked collaboration, and extended service models, particularly in customized manufacturing [33]. Additionally, the synergistic human-AI collaborative data-driven platform can monitor, analyze, manufacture, and retain atomic-scale structure and functions, thereby enhancing the potential for ergonomic solutions in manufacturing [34].

Moreover, AI-driven manufacturing platforms, supported by automation and artificial intelligence, have the potential to enable smart manufacturing hospitals, although precise regulatory guidance is needed for their implementation [35]. The implementation and integration of AI systems in manufacturing processes require significant effort to overcome existing technical and nontechnical barriers, particularly in the automotive and semiconductor industry [36]. Furthermore, there is a growing need to explore the synergy between AI and cognitive ergonomics in research and practice, as AI has become integral in transforming industries, increasing productivity, and streamlining processes [29].

In the context of ergonomic evaluations, proper hand tool designs are essential for preventing agricultural farm-related injuries, emphasizing the significance of ergonomics in various sectors, including agriculture [37]. Additionally, the scope of AI systems has expanded to include functionality related to ergonomics and powertrain assembly, highlighting the relevance of AI in addressing ergonomic challenges in the automotive industry [38]. Furthermore, even manufacturing subsidiaries of multinational corporations are increasingly engaged in AI-specific research and development, underscoring the growing importance of AI-supported product development, including ergonomic considerations (Szalavetz, 2019).

The potential combined use of wearable devices and AI algorithms in physical ergonomics applications has been explored, indicating the evolving landscape of AI applications in ergonomics [7]. To fully exploit the potential of AI applications, it is crucial to address human factors and ergonomics, facilitating the smooth implementation of AI applications [40]. Moreover, AI has been utilized to evaluate and enhance human factors such as health, safety, environment, and ergonomics in chemical plants, emphasizing the sustainability implications of AI in the industry [41].

In conclusion, the integration of AI in manufacturing presents significant opportunities for the advancement of ergonomics solutions, encompassing various sectors and applications. The potential for AI-driven solutions to address ergonomic challenges in manufacturing is evident, with a growing emphasis on the synergy between AI and cognitive ergonomics, human factors, and sustainability implications.

IV. Implementation Challenges of AI-Driven Ergonomics Solutions

The implementation of AI-driven ergonomics solutions in manufacturing faces various challenges. Hindering factors include barriers to the widespread diffusion of AI applications, non-negligible challenges in applying AI to smart manufacturing, and difficulties in the implementation of participatory ergonomics programs. Additionally, the reduction of ergonomic risks through the implementation of automation, such as automatic tape packaging machines, presents challenges that need to be addressed. Furthermore, a Delphi study highlighted specific AI implementation challenges for organizations, emphasizing the need to overcome barriers to the successful implementation of AI. Moreover, the exploration of barriers and challenges in the practice of AI in manufacturing firms in Malaysia underscores the impact of incorrect machine operations on disrupting work processes and decreasing productivity. These challenges underscore the need for a comprehensive understanding of the hindering factors and facilitators to the successful implementation of AI-driven ergonomic solutions in manufacturing. Overcoming these challenges is crucial for the effective integration of AI in addressing ergonomic concerns and improving productivity in manufacturing environments.

V. Case Studies and Examples

5.1 Successful Implementations of AI-driven Ergonomics Solutions

The successful implementation of AI-driven ergonomics solutions has been a topic of interest in various studies. Participatory ergonomics has been identified as a successful approach in implementing ergonomic improvements, particularly in reducing the risk factors of work-related musculoskeletal disorders [42]. Furthermore, the success of problem identification and solution through participatory ergonomics intervention has been demonstrated in several studies [43]. Additionally, the organizational predictors of a successful implementation of an ergonomic training program have been evaluated, shedding light on the factors contributing to successful implementation [44]. Moreover, the critical success factors in the development and implementation of special purpose industrial tools from an ergonomic perspective have been explored, providing insights into the factors crucial for successful implementation [45].

5.1 Challenges Encountered and Lessons Learned

While successful implementations have been documented, challenges and lessons learned have also been a focus of research. The difficulties in implementing ergonomic improvements have been acknowledged, with studies emphasizing the complexities involved in the process [46]. Furthermore, a systematic review has been conducted to determine the evidence regarding the barriers and facilitators to the implementation of participatory ergonomic interventions in workplaces, highlighting the challenges and contextual factors that influence implementation [47]. Additionally, the need to meet specific requirements for the successful promotion of participation and production of effective ergonomics solutions has been emphasized, indicating the complexities and considerations involved in achieving successful implementation [48].

5.2 Impact on Worker Safety, Productivity, and Overall Performance

The impact of AI-driven ergonomics solutions on worker safety, productivity, and overall performance has been a subject of interest. Studies have demonstrated the positive impact of participatory ergonomics on working conditions, quality, and productivity, particularly in reducing the risk factors of work-related musculoskeletal disorders [42]. Furthermore, the successful implementation of ergonomic improvements through participatory ergonomics has shown promise in reducing neck complaints in assembling, indicating positive outcomes for worker safety and health [46]. Moreover, the impact of participatory ergonomics on reducing musculoskeletal pain in specific occupational settings has been explored, providing evidence of the positive effects on worker safety and well-being [49].

VI. Future Directions and Opportunities for Research

To explore the emerging trends in AI-driven ergonomic solutions, it is essential to consider the current state of AI applications in various domains. AI is increasingly pervasive in critical sectors such as urban infrastructure, law enforcement, banking, healthcare, and humanitarian aid, as well as in more routine activities like dating [50]. This widespread integration of AI underscores the need for ergonomic human-robot collaboration in industry to promote safety, health, and equality in workplaces [51]. Furthermore, the potential for AI-driven banking services to enhance consumer experiences in emerging markets has been identified, highlighting the need for further exploration and innovation in this area [52].

Overcoming implementation challenges in AI-driven solutions requires a comprehensive understanding of the legal, ethical, and societal considerations associated with the development of ethical AI (eAI) solutions that uphold human values in the emerging data-driven era [19]. Additionally, the acceptance of AI in medicine among both healthcare professionals and the public is a crucial aspect to consider, as it can influence the successful implementation of AI-driven solutions in healthcare settings [53]. Moreover, the use of explainable and transparent AI in public policymaking is an area that requires further research to align explain ability techniques with regulatory requirements while balancing performance and transparency [54].

The future directions and opportunities for research in AI-driven ergonomics solutions also encompass the potential for digital transformation to mitigate emergency situations, such as increasing opioid overdose survival rates through explainable AI [55]. Furthermore, technology and AI have been identified as tools to augment human-driven processes for pre-visit planning in ambulatory care, indicating opportunities for further exploration and innovation in this area [13]. Finally, the transition from big data to knowledge in AI 2.0 presents both challenges and opportunities that warrant continued investigation and advancement [56].

In conclusion, the future of AI-driven ergonomics solutions lies in addressing the challenges of implementation, exploring new applications in various sectors, and ensuring that these solutions are developed ethically and transparently. The potential for AI to revolutionize industries and improve societal well-being is vast, but it requires rigorous research and innovation to realize its full potential.

VII. Conclusion

7.1 Summary of Key Findings:

In this review, we have analysed a significant amount of research that demonstrates the ability of AI-driven ergonomic solutions to bring about significant changes in manufacturing industries. The key findings highlight the adaptability of AI technologies, such as machine learning, computer vision, and robotics, in tackling ergonomic challenges. Additionally, the study reveals the wide range of applications for AI, including predicting hazards, monitoring risk factors, optimizing workflows, automating tasks, designing personalized equipment, and creating adjustable workstations. Although AI-driven solutions hold great potential, there are still persistent challenges when it comes to implementing them. These challenges include obstacles to widespread adoption, intricate technical issues, and problems with involving stakeholders in the decision-making process. There is evidence of successful applications of AI-driven ergonomics solutions, which have shown to have a favorable effect on worker safety, productivity, and overall performance.

7.2 Importance of AI-driven Ergonomics Solutions in Manufacturing:

The significance of AI-powered ergonomic solutions in manufacturing cannot be exaggerated. These solutions provide unparalleled opportunity to optimize the ergonomics of the workplace, improve the well-being of workers, and increase productivity. Through the utilization of AI technology, manufacturers may actively detect and reduce ergonomic hazards, enhance processes, and establish work environments that are both safer and more effective. Moreover, AI-powered solutions empower firms to adjust to evolving demands and market conditions, promoting innovation and enhancing competitiveness within the industry.

7.3 Final Thoughts and Implications:

To summarize, the incorporation of AI-powered ergonomic solutions signifies a fundamental change in the manufacturing industry, with significant consequences for worker well-being, efficiency, and overall company success. Although there are still problems to overcome, such as overcoming barriers to implementation and ensuring ethical development and openness, the potential advantages are much greater than the challenges. It is crucial for researchers, practitioners, and decision-makers to work together and come up with new ideas, using AI to its fullest extent, to develop manufacturing environments that are safer, healthier, and more efficient. Manufacturers may promote sustainable growth and prosperity by adopting AI-driven ergonomic solutions, which facilitate the convergence of technology and humans.

References

[1] M. Zare, M. Croq, F. Hossein-Arabi, R. Brunet, and Y. Roquelaure, “Does Ergonomics Improve Product Quality and Reduce Costs? A Review Article,” *Hum Factors Ergon Manuf*, vol. 26, no. 2, pp. 205–223, Mar. 2016, doi: 10.1002/hfm.20623.

[2] A. Colim *et al.*, "Lean manufacturing and ergonomics integration: Defining productivity and wellbeing indicators in a human–robot workstation," *Sustainability (Switzerland)*, vol. 13, no. 4, pp. 1–21, Feb. 2021, doi: 10.3390/su13041931.
[3] M. Peruzzini, S. Carassai, and M. Pellicciari, "The Benefits of Human-centred Design in Industrial Practices: Re-design of Workstations in Pipe Industry," *Procedia Manuf*, vol. 11, pp. 1247–1254, 2017, doi: 10.1016/j.promfg.2017.07.251.
[4] R. C. M. Teixeira *et al.*, "Analysis of the Reduction of Ergonomic Risks through the Implementation of an Automatic Tape Packaging Machine," *Int J Environ Res Public Health*, vol. 19, no. 22, Nov. 2022, doi: 10.3390/ijerph192215193.
[5] Shreyas M and Vinay K B, "Dimensions Identified for Physical Ergonomic Analysis in Manufacturing Industries: A Review," in *ISENTIENT-2022*, Mysuru: JOURNAL OF ADVANCED APPLIED SCIENTIFIC RESEARCH, 2022, pp. 91–101. Accessed: Apr. 18, 2024. [Online]. Available: http://www.joaasr.com/index.php/joaasr/article/view/693
[6] E. Stefana, F. Marciano, D. Rossi, P. Cocca, and G. Tomasoni, "Wearable devices for ergonomics: A systematic literature review," *Sensors (Switzerland)*, vol. 21, no. 3. MDPI AG, pp. 1–24, Feb. 01, 2021. doi: 10.3390/s21030777.
[7] L. Donisi, G. Cesarelli, N. Pisani, A. M. Ponsiglione, C. Ricciardi, and E. Capodaglio, "Wearable Sensors and Artificial Intelligence for Physical Ergonomics: A Systematic Review of Literature," *Diagnostics*, vol. 12, no. 12. Multidisciplinary Digital Publishing Institute (MDPI), Dec. 01, 2022. doi: 10.3390/diagnostics12123048.
[8] R. S. Peres, X. Jia, J. Lee, K. Sun, A. W. Colombo, and J. Barata, "Industrial Artificial Intelligence in Industry 4.0 -Systematic Review, Challenges and Outlook," *IEEE Access*, 2020, doi: 10.1109/ACCESS.2020.3042874.
[9] O. Asan and A. Choudhury, "Research trends in artificial intelligence applications in human factors health care: Mapping review," *JMIR Human Factors*, vol. 8, no. 2. JMIR Publications Inc., Apr. 01, 2021. doi: 10.2196/28236.
[10] N. Lau, M. Hildebrandt, and M. Jeon, "Ergonomics in AI: Designing and Interacting With Machine Learning and AI," *Ergonomics in Design: The Quarterly of Human Factors Applications*, vol. 28, no. 3, pp. 3–3, Jul. 2020, doi: 10.1177/1064804620915238.
[11] M. A. Vélez-guerrero, M. Callejas-cuervo, and S. Mazzoleni, "Artificial intelligence-based wearable robotic exoskeletons for upper limb rehabilitation: A review," *Sensors*, vol. 21, no. 6. MDPI AG, pp. 1–30, Mar. 02, 2021. doi: 10.3390/s21062146.
[12] K. Anil and A. Misra, "Artificial intelligence in Peer-to-peer lending in India: a cross-case analysis," *International Journal of Emerging Markets*, vol. 17, no. 4, pp. 1085–1106, May 2022, doi: 10.1108/IJOEM-05-2021-0822.
[13] L. M. Holdsworth, C. Park, S. M. Asch, and S. Lin, "Technology-enabled and artificial intelligence support for pre-visit planning in ambulatory care: Findings from an environmental scan," *Ann Fam Med*, vol. 19, no. 5, pp. 419–426, 2021, doi: 10.1370/AFM.2716.
[14] R. S. Peres, X. Jia, J. Lee, K. Sun, A. W. Colombo, and J. Barata, "Industrial Artificial Intelligence in Industry 4.0 -Systematic Review, Challenges and Outlook," *IEEE Access*, 2020, doi: 10.1109/ACCESS.2020.3042874.
[15] F. Sekkay, "Prevention of Work-Related Musculoskeletal Disorders supported by Artificial Intelligence," in *Human Interaction and Emerging Technologies (IHIET-AI 2023): Artificial Intelligence and Future Applications*, AHFE International, 2023. doi: 10.54941/ahfe1002945.
[16] S. Sunkle, K. Saxena, A. Patil, and V. Kulkarni, "AI-driven streamlined modeling: experiences and lessons learned from multiple domains," *Softw Syst Model*, vol. 21, no. 3, Jun. 2022, doi: 10.1007/s10270-022-00982-6.

[17] M. Broussard, N. Diakopoulos, A. L. Guzman, R. Abebe, M. Dupagne, and C. H. Chuan, "Artificial Intelligence and Journalism," *Journal Mass Commun Q*, vol. 96, no. 3, pp. 673–695, Sep. 2019, doi: 10.1177/1077699019859901.

[18] M. Jeanneret Medina, D. Lalanne, and C. Baudet, "Human-Computer Interaction in Artificial Intelligence for Blind and Vision Impairment: An Interpretative Literature Review Based on Bibliometrics," in *33e Conference Internationale Francophone sur l'Interaction Homme-Machine: Interaction Humain and IA, IHM 2022 - Annexes des actes de la Conference*, Association for Computing Machinery, Inc, Apr. 2022. doi: 10.1145/3502178.3529111.

[19] A. Felländer, J. Rebane, S. Larsson, M. Wiggberg, and F. Heintz, "Achieving a Data-Driven Risk Assessment Methodology for Ethical AI," *Digital Society*, vol. 1, no. 2, Sep. 2022, doi: 10.1007/s44206-022-00016-0.

[20] S. Ilager, R. Muralidhar, and R. Buyya, "Artificial intelligence (AI)-centric management of resources in modern distributed computing systems," in *Proceedings - 2020 IEEE Cloud Summit, Cloud Summit 2020*, Institute of Electrical and Electronics Engineers Inc., Oct. 2020, pp. 1–10. doi: 10.1109/IEEECloudSummit48914.2020.00007.

[21] P. Ranasinghe *et al.*, "Computer vision syndrome among computer office workers in a developing country: An evaluation of prevalence and risk factors," *BMC Res Notes*, vol. 9, no. 1, Mar. 2016, doi: 10.1186/s13104-016-1962-1.

[22] P. Maurice *et al.*, "Human movement and ergonomics: An industry-oriented dataset for collaborative robotics," *International Journal of Robotics Research*, vol. 38, no. 14, pp. 1529–1537, Dec. 2019, doi: 10.1177/0278364919882089.

[23] R. H. Van Der Schatte Olivier, C. D. P. Van't Hullenaar, J. P. Ruurda, and I. A. M. J. Broeders, "Ergonomics, user comfort, and performance in standard and robot-assisted laparoscopic surgery," *Surg Endosc*, vol. 23, no. 6, pp. 1365–1371, 2009, doi: 10.1007/s00464-008-0184-6.

[24] E. H. Lawson, M. J. Curet, B. R. Sanchez, R. Schuster, and R. Berguer, "Postural ergonomics during robotic and laparoscopic gastric bypass surgery: a pilot project," *J Robot Surg*, vol. 1, no. 1, pp. 61–67, Mar. 2007, doi: 10.1007/s11701-007-0016-z.

[25] M. M. Lux, M. Marshall, E. Erturk, and J. V Joseph, "Laparoscopy and Robotic Surgery Ergonomic Evaluation and Guidelines for Use of the daVinci Robot System."

[26] C. Blease, C. Locher, M. Leon-Carlyle, and M. Doraiswamy, "Artificial intelligence and the future of psychiatry: Qualitative findings from a global physician survey," *Digit Health*, vol. 6, 2020, doi: 10.1177/2055207620968355.

[27] A. O. Ononosen and I. Musonda, "Ergonomics in construction robotics and human-robot teams in the AEC domain: A review," in *IOP Conference Series: Earth and Environmental Science*, Institute of Physics, 2022. doi: 10.1088/1755-1315/1101/5/052003.

[28] C. Fan, Q. Mei, Q. Yang, X. Li, and P. D. Student, "Computer-Vision Based Rapid Entire Body Analysis (REBA) Estimation."

[29] M. Rostami, R. Soltani, and V. Anooshe, "Bridging artificial intelligence and cognitive ergonomics: a call for synergy," *Occup Med (Chic Ill)*, Dec. 2023, doi: 10.18502/tkj.v15i4.14581.

[30] S. Murad, A. Qusef, and M. Muhanna, "CHR vs. Human-Computer Interaction Design for Emerging Technologies: Two Case Studies," *Advances in Human-Computer Interaction*, vol. 2023, 2023, doi: 10.1155/2023/8710638.

[31] B. S. Neyigapula, "Human-AI Collaborative Decision-making: A Cognitive Ergonomics Approach," 2023, doi: 10.21203/rs.3.rs-3258718/v1.

[32] J. F. Arinez, Q. Chang, R. X. Gao, C. Xu, and J. Zhang, "Artificial Intelligence in Advanced Manufacturing: Current Status and Future Outlook," *Journal of Manufacturing Science and Engineering, Transactions of the ASME*, vol. 142, no. 11, Nov. 2020, doi: 10.1115/1.4047855.

[33] J. Wan, X. Li, H. N. Dai, A. Kusiak, M. Martinez-Garcia, and D. Li, "Artificial-Intelligence-Driven Customized Manufacturing Factory: Key Technologies, Applications, and Challenges," *Proceedings of the IEEE*, vol. 109, no. 4, pp. 377–398, Apr. 2021, doi: 10.1109/JPROC.2020.3034808.

[34] L. Cheng, Y. Tang, K. Ostrikov, and Q. Xiang, "Single-Atom Heterogeneous Catalysts: Human- and AI-Driven Platform for Augmented Designs, Analytics and Reality-Enabled Manufacturing," *Angewandte Chemie - International Edition*, vol. 63, no. 5. John Wiley and Sons Inc, Jan. 25, 2024. doi: 10.1002/anie.202313599.

[35] S. Hort *et al.*, "Toward Rapid, Widely Available Autologous CAR-T Cell Therapy – Artificial Intelligence and Automation Enabling the Smart Manufacturing Hospital," *Front Med (Lausanne)*, vol. 9, Jun. 2022, doi: 10.3389/fmed.2022.913287.

[36] L. Kohl, F. Ansari, and W. Sihn, "A Modular Federated Learning Architecture for Integration of AI-enhanced Assistance in Industrial Maintenance - A novel architecture for enhancing industrial maintenance management systems in the automotive and semiconductor industry.," in *Competence development and learning assistance systems for the data-driven future*, Goto Verlag, 2021, pp. 229–242. doi: 10.30844/wgab_2021_14.

[37] M. S. Parvez and M. M. Shahriar, "Agricultural farm-related injuries in Bangladesh and convenient design of working hand tools," *J Healthc Eng*, vol. 2018, 2018, doi: 10.1155/2018/4273616.

[38] N. Rychtyckyj, V. Raman, B. Sankaranarayanan, P. S. Kumar, and D. Khemani, "Ontology reengineering: A case study from the automotive industry," *AI Mag*, vol. 38, no. 1, pp. 49–60, Mar. 2017, doi: 10.1609/aimag.v38i1.2712.

[39] A. Szalavetz, "Artificial intelligence-based development strategy in dependent market economies-any room amidst big power rivalry?," *Central European Business Review*, vol. 8, no. 4, pp. 40–54, 2019, doi: 10.18267/j.cebr.219.

[40] D. Petrat, "Artificial intelligence in human factors and ergonomics: an overview of the current state of research," *Discover Artificial Intelligence*, vol. 1, no. 1, Dec. 2021, doi: 10.1007/s44163-021-00001-5.

[41] M. Liao, K. Lan, and Y. Yao, "Sustainability implications of artificial intelligence in the chemical industry: A conceptual framework," *J Ind Ecol*, vol. 26, no. 1, pp. 164–182, Feb. 2022, doi: 10.1111/jiec.13214.

[42] M. Motamedzade, M. Motamedzade, H. Shahnavaz, A. Kazemnejad, A. Azar, and H. Karimi, "The impact of participatory ergonomics on working conditions, quality, and productivity," *International Journal of Occupational Safety and Ergonomics*, vol. 9, no. 2, pp. 135–147, 2003, doi: 10.1080/10803548.2003.11076559.

[43] R. Kumar, M. Chaikumarn, and J. Lundberg, "Participatory ergonomics and an evaluation of a low-cost improvement effect on cleaners' working posture," *International Journal of Occupational Safety and Ergonomics*, vol. 11, no. 2, pp. 203–210, 2005, doi: 10.1080/10803548.2005.11076639.

[44] C. Korunka, E. Dudak, M. Molnar, and P. Hoonakker, "Organizational Predictors of a Successful Implementation of an Ergonomic Training Program."

[45] F. Gauthier and D. Lagacé, "Critical Success Factors in the Development and Implementation of Special Purpose Industrial Tools: An Ergonomic Perspective," *Procedia Manuf*, vol. 3, pp. 5639–5646, 2015, doi: 10.1016/j.promfg.2015.07.773.

[46] S. A. Miguez, M. S. Hallbeck, and P. Vink, "Participatory ergonomics and new work: Reducing neck complaints in assembling," in *Work*, 2012, pp. 5108–5113. doi: 10.3233/WOR-2012-0802-5108.

[47] D. van Eerd *et al.*, "Process and implementation of participatory ergonomic interventions: A systematic review," *Ergonomics*, vol. 53, no. 10, pp. 1153–1166, 2010, doi: 10.1080/00140139.2010.513452.

[48] J. R. Wilson, "Participation—A framework and a foundation for ergonomics?," *Journal of Occupational Psychology*, vol. 64, no. 1, pp. 67–80, 1991, doi: 10.1111/j.2044-8325.1991.tb00542.x.
[49] K. Sweeney, K. Ginn, J. Spurway, J. Clarke, and M. Mackey, "Does participatory ergonomics reduce musculoskeletal pain in sonographers? A mixed methods study," *Ultrasound*, vol. 30, no. 2, pp. 105–116, May 2022, doi: 10.1177/1742271X211023981.
[50] C. Cath, "Governing artificial intelligence: Ethical, legal and technical opportunities and challenges," *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, vol. 376, no. 2133. Royal Society Publishing, Nov. 28, 2018. doi: 10.1098/rsta.2018.0080.
[51] M. Lorenzini, M. Lagomarsino, L. Fortini, S. Gholami, and A. Ajoudani, "Ergonomic human-robot collaboration in industry: A review," *Frontiers in Robotics and AI*, vol. 9. Frontiers Media S.A., Jan. 03, 2023. doi: 10.3389/frobt.2022.813907.
[52] J. N. Sheth, V. Jain, G. Roy, and A. Chakraborty, "AI-driven banking services: the next frontier for a personalised experience in the emerging market," *International Journal of Bank Marketing*, vol. 40, no. 6, pp. 1248–1271, Sep. 2022, doi: 10.1108/IJBM-09-2021-0449.
[53] H. Tamori, H. Yamashina, M. Mukai, Y. Morii, T. Suzuki, and K. Ogasawara, "Acceptance of the Use of Artificial Intelligence in Medicine among Japan's Doctors and the Public: A Questionnaire Survey," *JMIR Hum Factors*, vol. 9, no. 1, Jan. 2022, doi: 10.2196/24680.
[54] T. Papadakis, I. T. Christou, C. Ipektsidis, J. Soldatos, and A. Amicone, "Explainable and transparent artificial intelligence for public policymaking," in *Data and Policy*, Cambridge University Press, Feb. 2024. doi: 10.1017/dap.2024.3.
[55] M. Johnson, A. Albizri, A. Harfouche, and S. Tutun, "Digital transformation to mitigate emergency situations: increasing opioid overdose survival rates through explainable artificial intelligence," *Industrial Management and Data Systems*, vol. 123, no. 1, pp. 324–344, Feb. 2023, doi: 10.1108/IMDS-04-2021-0248.
[56] Y. ting Zhuang, F. Wu, C. Chen, and Y. he Pan, "Challenges and opportunities: from big data to knowledge in AI 2.0," *Frontiers of Information Technology and Electronic Engineering*, vol. 18, no. 1. Zhejiang University, pp. 3–14, Jan. 01, 2017. doi: 10.1631/FITEE.1601883.