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Enhancing Occupational Safety in AI-Driven Supply Chains: Challenges and Solutions

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Abstract

Purpose: This paper explores the transformative impact of Artificial Intelligence (AI) and robotics in the fifth industrial revolution, particularly post-pandemic, where their adoption has significantly streamlined operations, reduced costs, and enhanced product development and distribution. Despite these advantages, their widespread use raises concern about occupational safety, including worker injuries and psychological harm.

Methodology: A systematic literature review was conducted to trace the evolution of workplace hazards and identify emerging risks associated with AI and robotics. The study also assessed strategies for mitigating these risks and evaluated the effectiveness of current regulatory frameworks in promoting occupational safety.

Findings: The research highlights that while AI and robotics reduce certain traditional workplace hazards, they introduce new risks such as human-robot collisions, algorithmic bias, and unintended consequences. Regulatory bodies are pivotal in developing and enforcing policies to safeguard workers. Additionally, organizations, AI developers, and individuals must collaborate to create safer workplaces.

Unique Contribution to Theory, Policy and Practice: This study contributes to the understanding of occupational safety in AI and robotics by identifying emerging risks, suggesting strategies for human-robot collaboration, and offering regulatory recommendations. It emphasizes a multi-stakeholder approach to ensure safe and effective integration of these technologies in the workplace.

Keywords: *Robotics, Artificial Intelligence, Occupational Safety, Robot-Human Collision, AI Regulations, Occupational hazards*

1. EMERGING TECHNOLOGIES AND OCCUPATIONAL SAFETY:

Robotics and artificial intelligence (AI) are double-edged swords that exacerbate or reduce occupational safety and health (OSH) inequalities. These technologies make up the fourth industrial revolution, transforming the workplace. Even though the concept of digital work has existed since the last century, the new digital work model is more advanced than the previous one. After the Second World War, the digital work model began with simple technologies such as gesture recognition. The new features, including automation, human-like intelligence, and human-robot interactions, make the present digital work new. Artificial intelligence has the potential to replace human intelligence, given that the technology mimics how human beings work and behave. Its only limitation is a lack of transparency when determining its working and inner structures. There is also a tendency for digital work today to focus on the invisible workings within immersive technology, reducing the visible work models (Staneva & Elliott, 2023). For example, digital contracts like blockchain technology reduce physical transactions and activities.

According to Rantala et al. (2022), almost 2 million employees die each year due to workplace-related risks. The concerns bring the economic burden of the practices to 3.9% of the global gross national product (GNP). According to Staneva and Elliott (2023), three dimensions affect workplace occupational safety: technological, people, and organizational. The technological dimension focuses on specific technologies, such as AI and robotics, replacing human intelligence through processes such as automation. There are conflicting results on whether AI will replace human jobs or transform the job market. One of the benefits of the technologies is that they relieve employees of doing manual, repetitive jobs, allowing them to focus on complex tasks that require critical reasoning. People can perform better and finish tasks faster and more efficiently through human-machine-mediated technology. The only drawback of the technological aspect is the need for more transparency in the workings of the technologies (Pishgar et al., 2021). The other domain is an organizational element. It looks at the technologies the organizations adopt. How they affect workplace safety. Organizations play an essential role in creating an environment of safety through the technologies they adopt and how they implement them. Digital technologies allow organizations to perform specific tasks. However, human oversight is vital due to the need for more transparency. Thus, Organizations must balance technology and human contribution to ensure their success and workplace safety.

The other domain, people-centric, examines individuals' competencies, skills, and knowledge. The people domain relies on technological potential and organizational factors. They determine the skills required, the competencies, and the knowledge needed. It is thus a flexible factor that can suffer due to the limitations of the causative factors. Worker trust and acceptance of the technologies impact their job as it can lead to job instability and threats. According to Shah and Mishra (2024), machines can handle loading and unloading tasks, reducing the environmental hazards that can harm typical workers, resulting in workplace injuries. It can lead to potential

safety concerns and increase errors. The skills and training required to operate the new technology can raise concerns over the increased risk of accidents or injuries. Workplace safety in AI and Robotics refers to the organizational measures to prevent injuries, disease, and fatalities. The measures prevent harm to workers as they interact with different technological tools.

2. ROBOTICS, ARTIFICIAL INTELLIGENCE, AND WORKPLACE SAFETY RESEARCH GAP:

The three domains of the digital work era outlined, including people, technology, and organization, affect workplace safety. The Occupational Safety and Health Administration (OSHA) reports that most injuries involving AI occur during the maintenance phase (Pishgar et al., 2021). However, the world has yet to realize the full capabilities of the two technologies, meaning they are evolving technologies. Frequent research ensures that workplace and worker safety remain prioritized as technology evolves. There is a growing trend of AI use within companies. The ever-increasing use of AI and robotics combined with shifting working models, the change in workforce demographics, and the potential job replacement necessitate research to uncover the different aspects of AI and robotics concerning workplace safety (Fisher et al., 2023). It is thus essential to explore the topic and determine the positive and negative impacts of AI and robotics on workplace safety. It also helps to review the current safety protocols and provide future direction to promote workplace safety. The research will provide recommendations for the future workforce to reduce the impact of the new digital technologies on workplace safety as they evolve. The research questions include:

RQ1: What are the new occupational hazards that AI and Robotics integration into organizations present, and how do they compare to the traditional ones?

RQ2: How can organizations optimize human-robot collaboration for maximum safety, and what safety protocols can help mitigate the associated risk?

RQ3: What is the role of regulatory framework in shaping the industry and impacting the adoption of AI and Robotics, and do they timely respond to emerging risks

3. MATERIALS AND METHODOLOGY:

A systematic review is a suitable research methodology for the inquiry. It refers to synthesizing evidence from existing research on the subject topic. The process is comprehensive and transparent to ensure it identifies, evaluates, and analyses the studies to summarize the current evidence (Mohamed Shaffril et al., 2020). The systematic review aims to analyze studies focusing on unraveling the impact of robotics and AI on workplace safety with a specific focus on human-robot collaboration and safety protocols. The search strategy involved researching multiple databases using keywords relating to AI, robotics, workplace safety, and human-robot collaboration. Reputable and credible databases such as Science Direct, PubMed, Cochrane, and ACM digital library were vital in finding peer-reviewed sources. A two-stage screening process

played a role in ensuring the studies were relevant and credible. The initial screening took place, focusing on the title and abstract of the article. Two independent reviewers took charge of the screening to ensure that only relevant studies were included. The inclusion and exclusion criteria used included the publication of the sources, the English language, and relevance.

The second screening process utilizes a full-text review approach to ensure the studies' relevance and narrow down the sources. The data extraction method utilized the standard form that captured the relevant critical information on the study design, industry, sampling, technologies used, and safety measures and their outcomes. Data synthesis is the other process used to analyze the data so that it makes sense. Thematic synthesis of the data helped to come up with themes to explore the issue. The last stage is an interpretation of the study, which takes place in the vital summary of findings and discussion.

4. FINDINGS AND DISCUSSION:

4.1 RQ1: What Are the New Occupational Hazards that AI and Robotics Integration into Organizations Present, and How Do They Compare to The Traditional Ones?

4.1.1 Traditional Occupational Hazards:

Physical, psychological, and ergonomic hazards are among the traditional occupational hazards that affected workers before AI and robotics, as Figure 1 shows (Shah & Mishra, 2024). Some hazards were associated with the worker's exposure to different substances, such as abnormal temperatures, defective illumination, abnormal air pressure, noise, and ultraviolet infrared and microwave radiation (Daly & Segate, 2023). Others included inadequate lighting in warehouses, physical labor affecting health, and the lack of protection on machines. While some hazards are present in specific working environments, such as manufacturing companies, others are found within all working environments. Physical injuries are fatal as they lead to tissue damage due to the effect of harmful forms of energy, such as radiation. At the time, organizations devised different strategies to tackle the issue, including tracking systems and ranging radars.

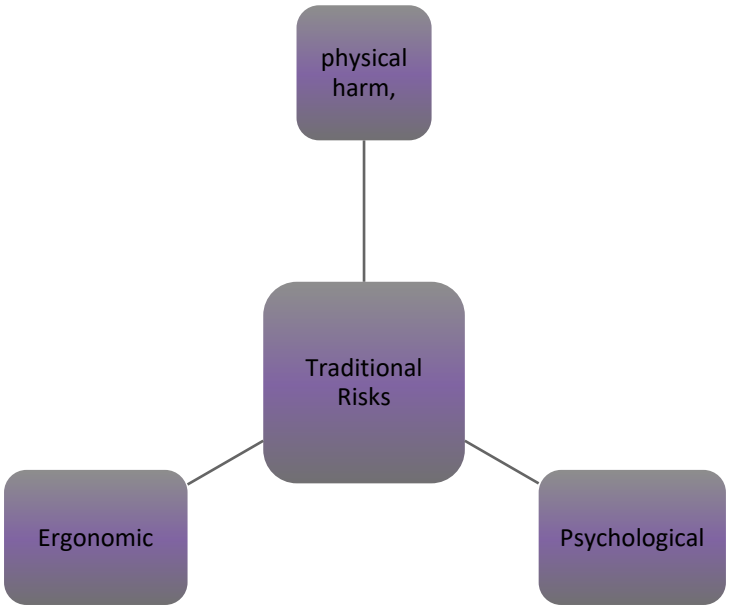

Figure 1: Traditional occupational hazards

4.1.2 Psychological Hazards:

The other type is the psychological hazards that affect the workers, which are both traditional and still present with AI and robotics (Daly & Segate, 2023). They included heavy workloads, short deadlines, occupational stress, and the psychological distress arising from physical hazards such as exposure to toxic chemicals. They affected the patient's health, leading to stress and cardiovascular diseases. Poor working environments increase strain, burnout, and fatigue among workers. The ergonomic hazards were the third traditional hazard before the emergency of AI and robotics. They referred to the physical conditions that led to musculoskeletal disorders among the workers (Staneva & Elliott, 2023). They included the poor work designs that led to injuries. Some of the jobs required specific poses that led to physical injuries. Other factors include insufficient breaks, high pressure, inadequate workplace furniture, and repetitive motions due to physical labor.

4.1.3 AI and Traditional Hazards:

With the emergence of AI and robotics, some traditional hazards were overcome. Regarding physical hazards, AI and robotics have replaced human workers with robots. Such a strategy helped protect the workers from bodily harm from manufacturing products and running types of equipment (Staneva & Elliott, 2023). The reduced physical labor helped reduce the risk of injuries regarding exposure to harmful substances. Robotics and AI helped by providing robots to work in high-risk industries to eliminate workers' exposure to toxic chemicals or noises that would harm them. However, even though the new age technology overcame the traditional hazards, it also

came with its set of hazards that affect the worker's safety. For example, the human-robot interaction has various risks that affect the workers. According to OSHA, collisions and interference are high, causing physical injuries to the workers. There is also the element of misinterpretation and miscommunication that leads to a breakdown of the systems, leading to effects such as mechanical hazards and electric shocks. Moreover, despite the technology limitations, people still need to be more on the tools, leading to complacency with severe consequences such as neglect of safety (Fisher et al., 2023). The traditional workplace hazards are no more. However, the safety concerns brought about by AI and robotics are equally fatal and need addressing.

4.1.4 Occupation Safety Concerns Arising from AI and Robotics:

4.1.4.1 Human-robot collision:

Robotics and AI pose cyber-physical, social-technical, and mental risk factors for humans, thus threatening work safety (Berx et al., 2022). Human-robot interaction is essential, given that robots cannot operate in isolation. They operate with humans through the collaborative workspace, thus posing a risk as Figure 2 outlines impacting worker safety. Organizations must keep the collaborative workspace safe for the humans involved. Therefore, collaborative robots characterize the 4.0 industrial revolution. Cobots are complex systems that pose a danger to the human beings working alongside the technology. Since the technology uses innovative elements and physical objectives during collaboration, it poses cyber-physical harm to the individuals operating it. Physical pain can arise when there is a collision between the operator and the robots within the collaborative working space. According to the simulation by Robla-Gomez et al. (2017), humans' pain during collision is beyond the acceptable threshold. Injury occurs as a result of physical and psychological effects on the operators. Some familiar places affected by the issue include manufacturing companies, warehousing, and logistics. One of the factors that makes the problem hard to solve is the evolving nature of AI. As it evolves, there is no telling the risks; thus, it becomes unpredictable and dangerous to the human-robot operators.

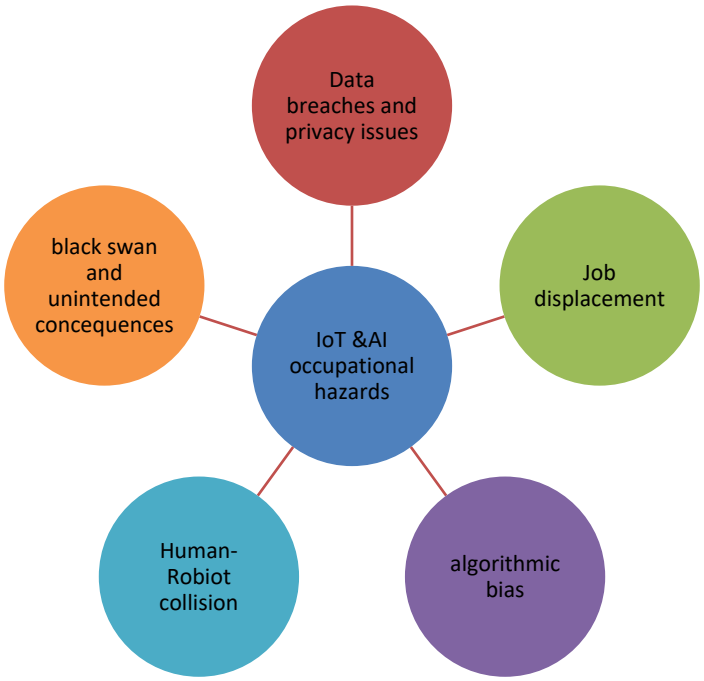

Figure 2: Types of Threats brought about by AI and Robotics

4.1.4.2 Black Swan and Unintended Consequences:

The other safety hazard brought about by AI and robotics is unintended consequences. These arise because of how AI interprets and works with data. It also introduces the element of black swan events and unintended consequences. Even though black swan events are rare, they are high-impact, severe, and hard to predict, increasing the risk of unintended consequences among humans working within collaborative environments (Daly & Segate, 2023). There are various ways that the events manifest, and some include system failures and also unexpected interactions between the AI systems. All these possible events increase occupational safety risks. Agins, the complexity of the AI systems makes them susceptible to unforeseen outcomes, given that they are evolving. Therefore, the autonomous nature of the AI systems implies that they can react in different ways to different situations that the developers did not anticipate causing potential harm. The fact that AI is evolving and learning new things is another factor contributing to the black swan and its unintended consequences. It adds another layer of unpredictability to the system as it is unclear what patterns they are learning. There is a possibility of diverting from the original programming in unexpected directions.

4.1.4.3 Algorithmic Bias:

The other element of robotics and AI systems that poses an occupational hazard to worker safety is algorithmic bias. Many organizations are integrating AI and robotics into their systems, and one of their roles is to help in decision-making and increase efficiency. However, AI and robotics come with an element of bias that can manifest in different ways, such as hiring practices, task allocation,

and evaluation practices. The implications of biases in such processes affect occupational safety, given that it may lead to discrimination, a lack of consideration for individual differences, and skewered decision-making by the organization (Belenguer, 2022). What makes the bias present is the fact that the AI systems make use of historical data to learn. Therefore, it is likely to replace the past or the historical discrimination, thus perpetuating the same ills from the past. Companies have been trying to investigate the issue because they were operating under biased algorithmic systems. An example is ProPublica, a nonprofit which discovered that there was an algorithmic bias discriminating against African Americans in the bid to reduce the likelihood of recidivism among defendants by the judges (Belenguer, 2022). Such past cases reveal that there are dangers to using AI that may affect the safety of the workers, leading to occupational hazards.

4.1.4.4 Job insecurity:

The other issue leading to occupational safety hazards is that AI and robotics could replace humans. The rise of AI and robotics integration into the organization poses a fear among the workers regarding their job security, which affects their mental health and safety. On the one hand, the technologies offer significant productivity and job efficiency potential. However, they pose a threat to most of the traditional jobs available in the different sectors of work (Wang et al., 2024). Many workers are thus finding themselves at risk of unemployment. The initial impact of the two technologies was the decline in low-skill labor as big companies adopted robotics to work within factories and on farms. However, as automatons grow, AI takes over most tasks. Therefore, the rise in the ratio between the robot per worker among specific industries reveals that there are employment shits about to take place, and this affects workers' safety.

4.1.4.5 Data Privacy and Breaches:

Data privacy and breaches impact occupational safety. AI learns through historical data and processes, stores, and collects it. Thus, a vast amount of data is collected, and some of it includes sensitive information such as employee information and operational data. There is a risk of security breaches that have severe consequences for organizations and employees. For individual employees, there is a risk of identity theft, loss of intellectual property, and damage to their reputation (Yaacoub et al., 2021). The impact on the health of the employee is severe due to the psychological trauma, stress, and also legal liabilities that affect their overall health. The interconnectedness of AI systems makes them vulnerable to security threats. A breach in one part thus has the potential to affect the other. The issue is, therefore, worth noting and solving due to its impact on individual and organizational privacy.

4.2 RQ2: How can organizations optimize human-robot collaboration for maximum safety, and what safety protocols can help mitigate the associated risk?

It is vital to determine evidence-based interventions to address the risk that robotics and AI present to the workplace. Given that the economic burden of dealing with the issue amounts to 3.9% of

the global gross domestic product, addressing the problem would not only save lives but also save on the economic burden it places on the worldwide economy.

4.2.1 Worker Training:

Risk assessment and mitigation training for workers working with robots can help reduce the adverse effects of AI and robotics. The strategy is critical in addressing the safety hazards arising from human error. Most workers suffer injuries due to a lack of understanding of how technology works. Training the workers is an integral part of risk assessment and mitigation. Rantala et al. (2022) showed that training and coaching staff on risk assessment and mitigation significantly reduce the rates of injuries caused by AI and robotics. When the risks remain unidentified and uncontrolled, it is due to human collaborators' limitations in the OHS risk assessment skills. There are critical components that workers need to understand when working with robots. The components include general hazard awareness, specific hazard knowledge, and situational awareness (Huck et al., 2021). The concepts are essential in understanding how the robots work and timely assessing the risk to prevent adverse outcomes. Employees get to understand the issues of data privacy, security breaches, algorithmic biases, robot-human collision, and the concept of unintended consequences, which makes them vigilant in preventing adverse outcomes. Highly engaging training is critical as the workers get practical knowledge and training. Some recommended training includes the visual hazard identification exercise, participatory workshops, and traditional lecture and course training methods. The intervention helps to develop a safety thinking and safety culture within the specific industries that allow for the timely identification of risk and mitigating it before it causes damage to the workers.

4.2.2 HUMANISE Method:

Incorporating AI and robotics through the HUMANISE method can help address the psychological, interaction risks, and physical hazards that workers face. HUMANISE aims to improve the intelligent system and manage Cobot's working environments to improve the employees' safety. One of the components of the system is the smart management module, whose role is to utilize machine learning models and the visual environment to send instructions and information to the control module. On the other hand, the control module adapts to Cobot's behaviors and supports the workers in improving their efficiency at work in real-time. Figure 3 shows the flow of the process. In doing so, it ensures that workers are safe. The third component is the perception encoder, which processes visual information in real-time, thus guaranteeing continuous data feeding into the system (Lopez-de-Ipina et al., 2023). Doing it ensures a safe working environment and a safe psychosocial work environment. The monitoring process utilizes real-time feedback data to support workers through intelligent risk management.

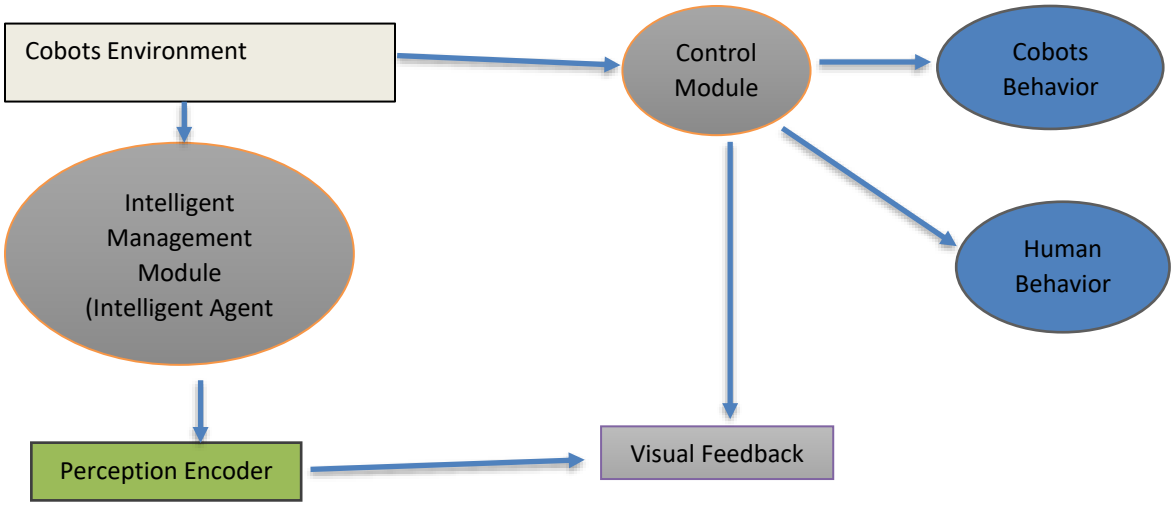

Figure 3. HUMANIZE process

4.2.3 Human-centered, Explainable AI:

Human-centered, explainable AI use is critical to reducing workers' risks. Workers in distinct industries, especially in manufacturing, face many occupational risks relating to their physical health, musculoskeletal diseases, and the polluted industrial environment. In a study done among the manufacturing industries, the development of the occupational health protection profile was a prerequisite for the managers to determine the functional work ability status of the patients. After that, AI helped produce the workers' next medical appointment and the severity of the issues affecting the musculoskeletal system. Therefore, using the CatBoost regression model is vital in prediction accuracy, allowing companies to prioritize occupational safety through risk assessment and determining the potential severity of health issues (Mollaei et al., 2022). One of the intervention's strengths is that it provides transparent insights that ergonomists and occupational physicians can understand. It facilitates preventive care and also targeted care for the workers. It thus allows for continuous monitoring of the employee's health and work capacity, ensuring that the managers assign fair job responsibilities given the workers' status. Not only does it help to enhance their health, but it also retains their jobs as the manager only assigns the employees to jobs that are safest for them given their health status.

Another study done to ensure explainability in the use of AI in journalism showed that the use of human-in-loop played a role in promoting the explainability and transparency of the AI systems, thus reducing the risk of occupational hazards. However, one limitation of the solution is that the system relies heavily on historical data, which means that it needs to account for other factors within the environment. Therefore, there is a limit on how AI can help promote occupational safety (Simkute et al., 2021). Using the model allows the operators to exercise their human judgments and integrate them into the decision-making process. In that way, human beings maintain their

agency; they understand the algorithmic processes and exercise accountability in the final decision. Some frameworks and guidelines governing the process are expertise, risk, and time.

Regarding expertise, the AI output should consider the individuals' expertise level to promote understanding. The risk factor is also crucial, as the system can assess the risk of the situation and provide a rationale for the recommendations based on the required and critical information. The time factor helps the operators understand the information provided within the given timeframe to make an informed decision. The three components of the human design system play an essential role in ensuring human oversight and reducing the risks of AI and robotics systems.

4.3 RQ3: What is the role of regulatory framework in shaping the industry and impacting the adoption of AI and Robotics and recommendations to improve their responsiveness

There have been increasing concerns over the regulatory framework's role in regulating the industry and ensuring occupational safety amid the use of AI and Robotics. Policymakers must understand robotics and AI's impact on human beings beyond physical safety (Martinetti et al., 2021). As AI evolves, so does the definition of AI change. Different stakeholders must know the full extent of AI capabilities and their risks and hazards. Thus, the regulatory framework and policymakers must understand the concept to be proactive in regulating the technology and carrying out continuous iteration of the policies so they remain relevant.

4.3.1 Clarify AI and Robotics Concepts:

One role of the regulatory framework is to explain the different concepts relating to AI and robotics. At the moment, the definitions of terms could be more precise, which can confuse the development and implementation of different policies. For example, according to Martinetti et al. (2021), there is no explicit reference to robots/Cobots in defining AI. Various authors have varying definitions of the term, and that can affect the policy enforcement process. There is a need for consensus in defining AI and other vital terminologies, such as robotics. Such specific definitions are also essential in regulation and standardization processes. The safety concept regarding robotics and AI use is another definition that needs addressing. As more AI capabilities are unveiled, new safety risks and hazards will be introduced. For example, the safety hazards within the manufacturing industry may not be the same as those experienced by journalists. Such variations can affect the definition and, consequently, regulation enforcement. Such ambiguity and lack of specificity affect the industry and the workers' health as there is improper implementation of regulation. It leads to misinterpretation of the risk levels and incorrect categorization, consequently compromising worker safety. Also, it leads to inadequate transparency among the stakeholders, making it hard for employees to understand the AI systems, leading to decreased trust and increased anxiety that affects their health. Therefore, the regulatory framework must define terms, be clear, and remain updated on the new AI capabilities and associated risks.

4.3.2 Set Standards of Operations and Policies:

The other vital role of the regulatory framework is to provide the standards of operation and ensure compliance. According to OSHA, there are currently no standards for the robotics industry, which leaves workers vulnerable to potential risk (Martinetti et al., 2021). There is a need for a policy recommending the safety practices companies can enforce to protect their employees. The policies will close the AI accountability gap, preventing exploitation of workers through the loss of life and other damages to their health and overall well-being. The other facet of the role is to assess the ethics of using the technologies, given the potential algorithmic bias that affects equality within populations. Such harms need to be identified and documented so that people can develop AI systems that are not biased and cause unintended consequences. Such policies promote transparency within the AI system developers, which makes it easy to understand how they work and trace their effects and impact on the population. The other implication of having such frameworks is that they help carry out ongoing risk assessments. The continuous risk assessments aim to monitor the systems to determine the impact on worker safety. It also helps to identify and mitigate potential risks, promoting occupational safety. Currently, gaps in the regulatory framework need to be addressed to ensure they are relevant and promote worker safety across different industries.

5. CHALLENGES IN REGULATION OF AI AND ROBOTICS FOR WORKERS SAFETY:

There is a great need for governments and international bodies to evolve with the emerging technologies and rising concerns over worker safety. There are issues of safety. Ethics and transparency are the most concerning, given their impact on the population. Unlike the traditional system, where the rules have operated for years, the case makes developing flexible and adaptive regulations necessary. The situation presents a new challenge for the regulators to remain updated with the technologies and ensure that they put measures in place to ensure the ethical use of the technology and the safety of the stakeholders involved (Rantala et al., 2022). Developing the policies is complex due to the reasons outlined in Figure 4, which shows collaboration with the technology experts and understanding the technologies' impact on different stakeholders. AI evaluator roles are emerging to help shape the regulatory environment and analyze loopholes that may pose safety and ethical concerns. Such collaborators with regulators assist the bodies to stay up-to-date with the current technologies and ensure the policies are flexible and adaptive.

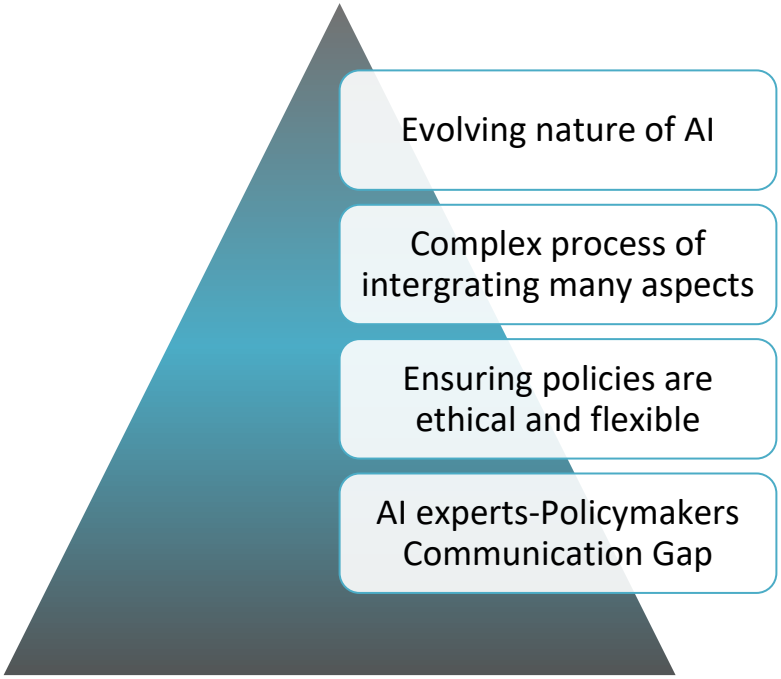

Figure 4: Challenges in Regulation

Ethics play a role in AI regulations, given that they are the basis for workers to trust the technology and reduce adverse incidences. As AI matures, ethical considerations become necessary to ensure fairness, accountability, and transparency (Zhang et al., 2021). Organizations need to develop ethical AI, which minimizes some adverse effects, including algorithmic bias. The policies need to lay down guidelines for AI development to reduce the unintended consequences that impact people's lives. An example is algorithmic bias, which affects hiring practices by discriminating against certain people, widening the social disparities between races and populations (Barredo Arrieta et al., 2020). Thus, the policies must consider the ethical implications, making the process complex for policymakers and regulatory bodies. However, ensuring the policies are ethical builds trust among the users and workers as they foster a responsible and secure approach to AI technology use and development.

Implementing policies that affect worker safety presents challenges. One challenge is the efficacy of the policies. Some policies are overreached, while others need to be adequate, making enforcing the policies and getting the desired outcomes hard. There are allegations of biases in developing the regulations as they stifle innovation (Zhang et al., 2021). There seems to be no balance between regulation and innovation, as there are complaints from the stakeholders either way. Part of the mismatch is the information gap between the regulatory bodies and the innovators (Barredo Arrieta et al., 2020). When the two parties are not in alignment, the policies developed can stifle innovation. There is a need for collaboration between the two parties to understand the technologies. Also, AI developers must ensure transparency, which is crucial in developing sound

policies. Since some of the AI is unexplainable, developing sound policies is hard. Such challenges make it hard to develop sound policies.

One suggested intervention is using a collaborative approach in developing regulations and policies. This approach involves the active engagement of the stakeholders, ensuring a complete understanding of the evolving AI landscape (Farina et al., 2024). The collective effort and real-time information sharing play a role in balancing innovation with ethics and safety in developing the policies. The policy development process is complex, and collaboration makes the process easier by providing essential knowledge and information. The collaborative approach is also beneficial because it reduces the cost and resources involved in policy development. Having all the stakeholders present ensures that the policies developed are sound, relevant, and flexible. The complaints raised reduce the cost of developing and amending the policies. Given the evolving nature of AI, collaboration lays the foundation for future AI development endeavors and safety (Farina et al., 2024). It can facilitate proactive strategies in mitigating AI risks, which promote accountability, transparency, and fairness in the regulation and AI development processes.

6. CONCLUSION:

In summary, robotics and AI play an essential role in the economic growth of nations, given the benefits they bring. Traditionally, they helped overcome some of the hazards affecting workers, such as physical harm, by introducing robotics. Robotics replaced the manual jobs that caused physical, mental, and ergonomic harm to the workers. It, however, replaced workers and led to a need for upskilling for people to remain relevant in the job market. However, AI and robotics are evolving technologies; since then, they have evolved in their capabilities. For example, today, there are autonomous cars. Despite the benefits of AI and robotics in worker safety, their presence presents other occupational hazards that are both physical and non-physical. Some include algorithmic bias, job replacement, human-robot collision, privacy breaches, and unintended consequences. Given that AI is still evolving, there is a need for proactive action to reduce the risk posed by AI to workplace safety. Currently, the impact of the hazard on worker safety is severe, given the reported cases of deaths due to human-robot collisions, unintended consequences, and data breaches leading to physical and psychological harm.

Proactive risk management through worker training in AI and robotics technologies promotes occupational safety. The training empowers them to learn how to use the technology, identify the risks, and mitigate them. The strategy is crucial as it addresses the human factors affecting workplace safety. Using AI tools such as the cobot within the HUMANISE model also helps to create a feedback mechanism that uses data to predict risk, thus helping to reduce its impact on employees. The other strategy is to ensure algorithmic transparency and accountability, which ensures that human beings participate in the decision-making process through the human design process. Lastly, the role of the regulatory framework is vital to ensure occupational safety for workers. Their role includes developing policies and developing a framework to ensure worker

safety. OSHA reports the lack of a regulatory framework for probiotics, which is alarming. Given the evolving nature of AI and robotics, the regulatory bodies must precisely define the terms, set the procedures, and enforce them. They also need to be proactive in understanding the new trends in AI and robotics and safety implications for workers. Staying updated will help develop relevant and effective policies that ensure workplace safety.

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