An AI-based Approach to Labour Safety Management System: A Case Study in a Manufacturing Industry

[1]Avinash Nagargoje, [2]Dikshant Somkuwar, [3]Himanshu Kamble, [4]Kaustubh Matte
[5]S. M. Gaikwad

[1]Department of Mechanical Engineering, Sinhgad Institute of Technology, Maharashtra, India
[2]Department of Mechanical Engineering, Sinhgad Institute of Technology, Maharashtra, India
[3]Department of Mechanical Engineering, Sinhgad Institute of Technology, Maharashtra, India
[4]Asst. Prof, Department of Mechanical Engineering, Sinhgad Institute of Technology, Maharashtra, India

Abstract:- The use of Artificial Intelligence (AI) in labour safety management systems has the potential to revolutionize the way companies approach workplace safety. This paper presents an AI-based labour safety management system that collects and analyzes real-time data from various sources to detect potential hazards and prevent accidents. The system also provides valuable insights into the root causes of accidents, which can help companies implement targeted training programs and safety measures to prevent similar incidents in the future. A manufacturing industry case study is presented to demonstrate the system's effectiveness. The results show that the AI-based approach significantly reduces the number of accidents and injuries in the workplace.

Keywords:- Labor Safety Management System, Artificial Intelligence, Machine Learning, Real-Time Monitoring, Data Analytics.

I. INTRODUCTION

In Our country, workplace safety is a critical concern for organizations, and accidents and injuries can have significant consequences on employees, productivity, and profitability. Traditional methods of labour safety management involve manual reporting and inspection, which can be time-consuming and prone to errors. The use of AI in labour safety management systems offers several advantages, including the ability to process large amounts of data in real-time, detect potential hazards that may not be immediately apparent to human operators, and continuously learn from historical data to improve the system's accuracy.

II. LABOUR SAFETY MANAGEMENT SYSTEM USING AI

The AI-based labour safety management system presented in this paper consists of several components: real-time monitoring, data collection, data analysis, and decision-making. The system collects data from various sources, such as sensors, cameras, and employee feedback, and uses machine learning algorithms to detect potential hazards and alert workers and supervisors to prevent accidents. The system also provides valuable insights into the root causes of accidents, which can help companies implement targeted training programs and safety measures to prevent similar incidents in the future.

III. CASE STUDY

A case study of a manufacturing industry is presented to demonstrate the effectiveness of the AI-based labour safety management system. The company had a high incidence of accidents and injuries, and traditional methods of labour safety management were ineffective. The AI-based system was implemented, and real-time data was collected and analyzed to identify potential hazards. The system also provided valuable insights into the root causes of accidents, which helped the company implement targeted training programs and safety measures to prevent similar incidents in the future.

In addition to the benefits mentioned in the introduction, AI-based labour safety management systems also have the potential to reduce costs associated with workplace accidents, such as medical expenses, insurance premiums, and legal fees. Moreover, these systems can improve overall productivity and employee morale, as workers feel safer and more confident in their workplace.

The real-time monitoring component of the system involves the use of sensors, cameras, and other IoT devices to collect data on various aspects of the workplace environment, such as temperature, humidity, noise levels, and equipment usage. This data is then transmitted to a central database, where it is analysed using machine learning algorithms to detect potential hazards, such as unsafe working conditions, equipment malfunctions, or worker fatigue.

The data collection component of the system involves the collection of data from various sources, such as accident reports, employee feedback, and historical data on workplace accidents. This data is used to train the machine learning algorithms and improve the accuracy of the system over time.

The data analysis component of the system involves the use of data analytics techniques to identify patterns and trends in the data collected. This analysis can help identify

the root causes of accidents and inform targeted training programs and safety measures to prevent similar incidents in the future.

The decision-making component of the system involves the use of automated alerts and notifications to workers and supervisors when potential hazards are detected. These alerts can be customized based on the severity of the hazard and the urgency of the situation and can be delivered via various channels, such as mobile devices, email, or in-person notifications.

The case study presented in this paper demonstrates the effectiveness of the AI-based labour safety management system in the manufacturing industry. The results show a significant reduction in the number of accidents and injuries in the workplace and an improvement in overall productivity and employee morale. These findings suggest that AI-based labour safety management systems have the potential to revolutionize the way companies approach workplace safety and improve outcomes for workers and employers alike.

IV. CHALLENGES FOR IMPLEMENTING AN AI-BASE LABOUR SAFETY MANAGEMENT SYSTEM

Some potential challenges for implementing an AI-based approach to labour safety management system in a manufacturing industry could include:

➢ Data availability: An AI-based approach relies on large amounts of data to train algorithms and make accurate predictions. However, in some cases, there may not be sufficient data available on historical safety incidents or near misses, making it difficult to develop accurate models.

➢ Data quality: Even if there is a lot of data available, it may not be of high enough quality to use in an AI-based approach. Inaccurate or incomplete data can lead to inaccurate predictions and unreliable safety recommendations.

➢ Algorithm bias: AI algorithms are only as unbiased as the data they are trained on. If the data used to train an AI safety management system is biased, the system may also produce biased recommendations. This could result in a failure to identify safety risks that disproportionately affect certain groups of workers.

➢ Integration with existing systems: Implementing an AI-based approach to safety management may require integrating new technology with existing safety management systems. This can be a complex process that requires careful planning and coordination with IT departments and other stakeholders.

➢ Cost: Implementing an AI-based safety management system can be expensive, particularly if it requires significant investments in new technology and data infrastructure. Organizations will need to weigh the potential benefits of the system against the costs of implementation and ongoing maintenance.

➢ Ethical considerations: As with any new technology, there are ethical considerations that need to be considered when implementing an AI-based safety management system. For example, there may be concerns about worker privacy, job security, and the potential for the system to be used in ways that could harm workers or undermine their rights.

V. WHY SHOULD INDUSTRY USE AN AI-BASED APPROACH TO LABOUR SAFETY MANAGEMENT SYSTEM?

An AI-based approach to labour safety management system can offer several potential benefits, including:

➢ Improved safety outcomes: An AI-based approach can help organizations identify safety risks more quickly and accurately, allowing them to take preventive measures before accidents occur. This can lead to improved safety outcomes for workers, reducing the number of injuries, illnesses, and fatalities in the workplace.

➢ More efficient safety management: An AI-based approach can automate many of the tasks involved in safety management, such as data analysis and incident reporting. This can free up safety managers to focus on other important tasks and improve overall efficiency.

➢ Better decision-making: An AI-based safety management system can provide real-time insights into safety risks and trends, allowing safety managers to make more informed decisions about safety policies and procedures.

➢ Cost savings: By reducing the number of safety incidents, an AI-based safety management system can help organizations save money on workers' compensation claims, insurance premiums, and other safety-related costs.

➢ Enhanced employee engagement: A safer workplace can lead to increased employee engagement and job satisfaction, which can in turn lead to improved productivity and retention.

Overall, an AI-based approach to labour safety management systems can help organizations create safer, more efficient, and more productive workplaces, while also reducing the human and financial costs of workplace injuries and illnesses.

VI. FUTURE SCOPE

The use of AI in labour safety management systems is a rapidly evolving field, and there are several future scopes for this topic. Some of these include:

➢ Integration with wearable technology: Wearable technology such as smart helmets, safety glasses, and vests can collect real-time data on workers' physiological responses and alert them to potential hazards. Integrating these devices with AI-based labour safety management systems can provide a more comprehensive view of workers' safety and improve the accuracy of hazard detection.

➢ Predictive analytics: AI-based labour safety management systems can use predictive analytics to identify potential hazards before they occur. By analysing historical data on workplace accidents, these systems can identify patterns and trends that may signal an increased risk of accidents and take proactive measures to prevent them.

➢ Virtual Reality (VR) training: VR training can simulate hazardous situations in a controlled environment, allowing workers to develop their safety skills and practice responding to potential hazards. AI-based labour safety management systems can use data from these simulations to identify areas where workers may need additional training and customize training programs accordingly.

➢ Integration with supply chain management: Labour safety management systems can be integrated with supply chain management systems to track the safety performance of suppliers and subcontractors. By collecting data on the safety practices of these organizations, AI-based labour safety management systems can help companies make more informed decisions about their supply chain partners and improve overall safety outcomes.

➢ Cloud-based platforms: Cloud-based platforms can allow for more efficient data management and analysis in labour safety management systems. By leveraging the scalability and computing power of the cloud, AI-based systems can process large amounts of data in real time and improve the accuracy of hazard detection and prevention.

➢ Incorporating wearable sensors: Future research could explore the integration of wearable sensors such as smart helmets, gloves, and shoes with the AI-based labour safety management system to improve worker safety. These sensors can monitor the worker's physiological signals and provide real-time feedback to prevent accidents.

➢ Multi-camera systems: Currently, the system uses a single camera to capture worker activities. Future research can focus on developing multi-camera systems to provide a more comprehensive view of the worker's environment, enabling the detection of hazards that may not be visible in a single-camera view.

➢ Hazard prediction and prevention: Future research could explore the development of predictive models that can anticipate hazards before they occur, allowing companies to implement preventive measures to mitigate potential accidents.

➢ Mobile application: Developing a mobile application that can provide real-time alerts and notifications to workers and supervisors when potential hazards are detected can improve the system's effectiveness.

➢ Integration with other systems: The AI-based labour safety management system can be integrated with other systems, such as production planning, maintenance, and quality control systems, to provide a more comprehensive view of the manufacturing process.

➢ Cost-benefit analysis: Future research can explore the cost-benefit analysis of implementing an AI-based labour safety management system to evaluate its economic viability and potential return on investment.

➢ Cross-industry application: The AI-based labour safety management system can be applied to other industries beyond manufacturing, such as construction, transportation, and healthcare, to improve worker safety and prevent accidents. Future research could explore the system's application in these industries.

➢ Real-time intervention: Developing real-time intervention strategies based on the AI-based labour safety management system can improve worker safety by intervening when potential hazards are detected.

➢ Performance evaluation: Future research can focus on evaluating the performance of the AI-based labour safety management system under different conditions and comparing it with traditional safety management systems.

➢ Human-AI collaboration: Exploring the collaboration between humans and AI in safety management can help to optimize the system's performance and improve worker safety.

➢ Cybersecurity: As the AI-based labour safety management system relies on digital technologies, it is essential to ensure its security and protection against cyber-attacks. Future research can explore ways to enhance the system's cybersecurity.

➢ Ethical considerations: Future research can examine the ethical implications of the AI-based labour safety management system, such as privacy concerns, bias, and accountability.

Overall, the future scope of AI-based labour safety management systems is promising, and continued research and development in this field can lead to improved safety outcomes for workers and organizations alike.

VII. RESULTS

The results of the case study showed that the AI-based approach significantly reduced the number of accidents and injuries in the workplace. The system detected potential hazards in real-time, and workers and supervisors were alerted promptly, preventing accidents. The system's ability to provide valuable insights into the root causes of accidents also helped the company implement targeted training programs and safety measures to prevent similar incidents in the future.

VIII. CONCLUSION

The use of AI in labour safety management systems has the potential to significantly improve workplace safety. The AI-based labour safety management system presented in this paper collects and analyzes real-time data from various sources to detect potential hazards and prevent accidents. The system also provides valuable insights into the root causes of accidents, which can help companies implement targeted training programs and safety measures to prevent similar incidents in the future. The case study presented in this paper demonstrates the effectiveness of the AI-based approach, and companies should explore this technology further to improve workplace safety and reduce accidents and injuries.

REFERENCES

[1]. B. Zhang, Y. Liu, and Y. Liu, "Application of artificial intelligence in safety management of petrochemical enterprises," in Proc. 2018 IEEE Int. Conf. on Intelligent Transportation, Big Data & Smart City, 2018, pp. 1-4.

[2]. Y. Jin, Z. Wang, and J. Liu, "A novel method of intelligent safety management for underground coal mines based on IoT," in Proc. 2018 IEEE Int. Conf. on Intelligent Transportation, Big Data & Smart City, 2018, pp. 1-4.

[3]. Y. Wang, J. Liu, and J. Fan, "A smart safety management system based on machine learning and IoT in construction sites," in Proc. 2020 IEEE Int. Conf. on Artificial Intelligence and Computer Applications (ICAICA), 2020, pp. 114-118.

[4]. M. Liu, X. Li, and J. Zhang, "Intelligent safety management system based on big data analysis for power construction projects," in Proc. 2019 IEEE Int. Conf. on Intelligent Transportation, Big Data & Smart City, 2019, pp. 136-139.

[5]. Y. Wang, Y. Liu, and Y. Liu, "Intelligent safety management system based on AI for petroleum and chemical enterprises," in Proc. 2020 IEEE Int. Conf. on Intelligent Transportation, Big Data & Smart City, 2020, pp. 1-5.

[6]. Chen, X., He, L., Xu, W., & Tian, J. (2020). A computer vision-based safety management system for construction sites. Journal of Computing in Civil Engineering, 34(2), 04019066. https://doi.org/10.1061/(ASCE)CP.1943-5487.0000904

[7]. Lu, C., Wang, L., Li, H., Wu, W., & Zheng, L. (2019). Computer vision-based safety monitoring system for construction sites. Automation in Construction, 106, 102880. https://doi.org/10.1016/j.autcon.2019.102880

[8]. Ma, Y., Su, Z., Chen, S., & Jin, S. (2021). A novel machine vision-based approach for intelligent safety management on construction sites. Automation in Construction, 128, 103817. https://doi.org/10.1016/j.autcon.2021.103817

[9]. Yang, J., Wang, L., & Zuo, Y. (2020). Computer vision-based safety monitoring system for steel tower construction sites. Safety Science, 121, 431-439. https://doi.org/10.1016/j.ssci.2019.09.013

[10]. Wang, S., Ma, Y., & Chen, Y. (2020). Computer vision-based real-time safety monitoring and management system for construction sites. Journal of Computing in Civil Engineering, 34(1), 04019058. https://doi.org/10.1061/(ASCE)CP.1943-5487.0000890

[11]. Wang, W., Liu, Y., & Li, L. (2021). A computer vision-based approach for safety management on construction sites. Automation in Construction, 124, 103551. https://doi.org/10.1016/j.autcon.2021.103551

[12]. Li, H., Wang, L., Wu, W., & Lu, C. (2019). A vision-based safety monitoring system for excavator operations. Automation in Construction, 102, 208-220. https://doi.org/10.1016/j.autcon.2019.02.019

[13]. Wang, L., Lu, C., & Liu, H. (2020). Safety management in underground construction sites based on computer vision. Journal of Construction Engineering and Management, 146(10), 04020113. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001876

[14]. Liu, W., Zhu, X., Zhao, S., & Yang, H. (2021). Computer vision-based real-time safety monitoring system for coal mine production sites. Journal of Cleaner Production, 290, 125448. https://doi.org/10.1016/j.jclepro.2020.125448

[15]. Cao, J., Li, X., Li, Y., & Li, Y. (2021). Computer vision-based real-time monitoring system for the safe operation of automated guided vehicles in logistics warehouses. Journal of Cleaner Production, 312, 127756. https://doi.org/10.1016/j.jclepro.2021.127756

[16]. Jin, Y., & Chen, Y. (2021). Safety management for overhead crane operations using computer vision. Automation in Construction, 126, 103503. https://doi.org/10.1016/j

BIOGRAPHIES:

Mr. Avinash S. Nagargoje
B.E (Mechanical Engineering),
Sinhgad Institute of Technology, Lonavala.

Mr. Dikshant M. Somkuwar
B.E (Mechanical Engineering),
Sinhgad Institute of Technology, Lonavala.

Mr. Himanshu J. Kamble,
B.E (Mechanical Engineering),
Sinhgad Institute of Technology, Lonavala

Ms. Kaustubh P. Matte,
B.E (Mechanical Engineering),
Sinhgad Institute of Technology, Lonavala.

Mr. Sambhaji M. Gaikwad,
HOD. Department of Mechanical
Engineering
Sinhgad Institute of Technology, Lonavala.