

AI for Safety & Risk
Management: How Artificial
Intelligence Transforms
Occupational Safety, Hazard
Prediction, and Risk Control

Mohammed Hamed Ahmed Soliman

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AI FOR SAFETY & RISK MANAGEMENT: HOW
ARTIFICIAL INTELLIGENCE TRANSFORMS
OCCUPATIONAL SAFETY, HAZARD PREDICTION,
AND RISK CONTROL

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Preface

THE PURSUIT OF SAFETY has always been at the core of industrial progress. From the earliest factories of the Industrial Revolution to today's complex global supply chains, organizations have continually sought to protect workers, minimize hazards, and control risks. Yet, despite decades of advances in safety management systems, accidents and workplace risks persist—reminding us that traditional tools, while essential, are not enough on their own.

In parallel, a new technological wave has transformed the way industries think, plan, and operate. Artificial Intelligence (AI), once a distant concept, is now a daily reality in manufacturing, maintenance, quality, logistics, and healthcare. Its ability to process massive volumes of data, detect patterns invisible to the human eye, and predict outcomes with remarkable accuracy is creating a paradigm shift. It is only natural that safety and risk management should also evolve in this direction.

This book, *AI for Safety & Risk Management*, is written to address that very need. Unlike conventional resources that focus on either AI in general or safety in isolation, this handbook brings the two together, offering a structured, practical guide for applying AI across the full spectrum of occupational safety and risk control. From predictive hazard detection and computer vision for PPE monitoring, to AI-enabled root cause analysis, digital twins for scenario

simulation, and automated compliance reporting, this book explores how AI can serve as a true partner in achieving zero harm.

My perspective in writing this work stems from more than two decades of experience as an **industrial engineering professor, researcher, and executive advisor**. Over the years, I have authored more than one hundred scientific publications and numerous books that bridge theory and practice. These include *Lean for Non-Engineers*, *AI for Maintenance and Reliability*, *Risk Assessment Using FMEA*, *AI-Powered Lean*, and *Maintenance Strategy Optimization*. Each of these works reflects my passion for making complex concepts accessible and applicable, helping professionals and organizations improve their systems, reduce waste, and achieve sustainable excellence.

This book is a continuation of that mission. It is designed not only for safety managers and engineers, but also for leaders, policymakers, and practitioners who recognize that the future of safety will be shaped by intelligent technologies working alongside human judgment.

By reading this handbook, my hope is that you will discover new ways to integrate AI into your safety strategy, rethink how risk is identified and controlled, and ultimately, create safer and more resilient workplaces for the people who depend on them every day.

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Chapter 1. Introduction to AI in Occupational Safety



1.1 From Traditional Safety to Intelligent Safety

OCCUPATIONAL SAFETY has long been treated as a compliance-driven function. Organizations focused on meeting regulatory standards, documenting incidents, and reacting to hazards once they occurred. While these practices undoubtedly saved lives, they were largely **reactive** in nature.

The arrival of **Industry 4.0** — with connected machines, data-rich environments, and cyber-physical systems — has reshaped expectations. Today, companies are no longer satisfied with preventing yesterday's accidents; they want to **predict and prevent tomorrow's risks**.

Here is where **artificial intelligence (AI)** enters the picture. By analyzing vast amounts of structured and unstructured data in real time, AI enables safety systems to become **anticipatory rather than reactive**. Instead of waiting for an accident to happen, organizations can identify early warning signals, flag unsafe conditions, and intervene before harm occurs.

1.2 Why Safety Matters More Than Ever

WORKPLACE SAFETY IS not merely a compliance checkbox. It directly affects:

- **Human well-being:** Every accident avoided means lives saved and families protected.
- **Operational performance:** Downtime from accidents translates into lost productivity and higher costs.
- **Reputation and trust:** Customers, investors, and regulators increasingly evaluate companies on their safety performance.

The economic case is equally strong. Studies from OSHA and the International Labour Organization show that investments in safety yield measurable returns through reduced compensation costs, lower insurance premiums, and improved employee morale.

In the **AI era**, safety has evolved into a **strategic enabler** of competitiveness. Organizations that integrate intelligent safety practices not only comply with regulations but also gain resilience and efficiency.

1.3 The Role of AI in Redefining Safety

AI TECHNOLOGIES NOW play a central role in occupational safety across industries such as oil & gas, manufacturing, construction, and logistics. Their contributions can be grouped into three main dimensions:

1. **Perception** – AI systems, using computer vision, natural language processing (NLP), and sensor integration, perceive hazards that humans may overlook.
 - Example: Detecting whether workers are wearing PPE in real time.
2. **Prediction** – AI applies machine learning algorithms to forecast risk before it materializes.
 - Example: Predicting equipment failures that could lead to accidents.
3. **Prevention** – AI closes the loop by recommending or even executing interventions.
 - Example: Automated shutdown of machinery when unsafe conditions are detected.

Together, these dimensions move safety from a **static program** to a **dynamic, adaptive system**.