

Every one's Smart University

College of Management

Master of Management



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Research entitled:

Employing artificial intelligence applications in the process of monitoring and analyzing risks related to occupational safety and health: An applied study in the Saudi Electricity Company

A research project submitted in pursuit of a master's degree in management.

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2024

Acknowledgement

We are kindly expressing our thanks to **Dr. Walid Soliman** who guided and supervised us at every stage of the research and for his diligent and tremendous efforts. We would also like to add that this difficult research would not have ended without her kind guidance. We worked as a team and supported each other to go through the hard times and get this research done and submitted on time and as required. Thanks to all and each one in the team, this research would not be done and submitted on time without our cooperation and **Dr. Walid Soliman** help and his interest, cooperation, encouragement, and direction are gratefully and proudly acknowledged. All our wishes are to have a bright future and successful life.

Finally, we extend our thanks to our parents and family for instilling in us a desire and love for learning which have served as sources of endless energy that have propelled us through it all.

Abstract:

This research aims to study Employing artificial intelligence applications in the process of monitoring and analyzing risks related to occupational safety and health and it applied on the Saudi Electricity Company. The study relies on the descriptive approach, which is the most appropriate for research in the humanities and social sciences. It is based on describing phenomena, collecting data, analyzing, and discussing them with the aim of development. the study relied on questionnaires for employees of the Saudi Electricity Company (106 people) as an exploratory sample to verify the study tool. The finding showed that artificial intelligence is a recent and powerful technology that can transform industry and create new opportunities and challenges for occupational safety and health management. Artificial intelligence can help occupational safety and health professionals through using many applications such as virtual reality and augmented reality that can simulate realistic scenarios for training and education for workers. The study suggested that occupational safety and health professionals in the Saudi Electricity Company should evaluate and monitor the performance and impact of Artificial intelligence on occupational safety and health outcomes. They should also identify any gaps or issues that need to be addressed or improved.

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Chapter 1:

Introduction to the research

1.1 Introduction:

Artificial intelligence is currently part of everyday life for a large proportion of people around the globe. However, a consideration that is not often thought of is the effect that artificial intelligence may have on the health and safety of workers. Applications of artificial intelligence have been rapidly increasing and are typically in use to simplify or automate tasks. A large amount of previous research on artificial intelligence neglects to mention the role that artificial intelligence has on the health and safety of people while at work. (Mia Wichmann, 2022)

Occupational health and safety focuses on safeguarding the wellbeing of individuals at the workplace. Although, there are various occupational diseases associated with workplaces. In an era characterized by dynamic technological advancements, the well-being of the workforce remains a cornerstone of progress and sustainability. The evolving industrial landscape in the modern world has had a considerable influence on occupational health and safety (OHS). Ensuring the well-being of workers and creating safe working environments are not only ethical imperatives but also integral to maintaining operational efficiency and productivity. It can review the

advancements that have taken place with a potential to reshape workplace safety with integration of artificial intelligence (AI)-driven new technologies to prevent occupational diseases and promote safety solutions. (Immad A. Shah and SukhDev Mishra, 2024)

Occupational safety and health (OSH) at workplaces are routinely assessed to assure worker comfort, facilitate equipment use, protect from hazardous exposures, and prevent health hazards. Not only OSH experts but also researchers and managers have addressed a variety of components, including physical, chemical, biological, ergonomic, and organizational environments, with traditional methods until the Industry 4.0 era. Industry 4.0 refers to the improvement of workplaces by employing the digital revolution, such as Artificial Intelligence (AI), the Internet of Things (IoT), and smart devices. Rapid advances and large-scale integration of information technologies (IT) into workplaces, like sensors, mobile systems, massive data processing, and cloud technologies, affect not only the way workers work but also the content and the quality of work. Therefore, this new industrial era based on generated and stored information can also assist in measuring, assessing, and controlling health and safety issues more efficiently while being more effective. (Maheronnaghsha, et al., 2023)

In recognition of the Kingdom of Saudi Arabia's pioneering and civilizational role at the Arab, Islamic and global levels, the Kingdom of Saudi Arabia's Vision (2030) was launched to embody the ambitions and hopes it holds for its people. It is a vision that emphasizes the Kingdom's openness to the latest contemporary technological revolutions and benefiting from them in all areas and fields. And sectors, the most prominent of which is artificial intelligence, as an integral part of the Kingdom's vision (2030) and at a huge cost exceeding half a trillion US dollars, the foundation was laid for the city of NEOM, which is based on artificial intelligence, and in the future the number of robots will exceed the number of humans. (Samar Al-Hajaini and Lina Al-Farani. 2020).

1.2 Study Problem:

Artificial intelligence (AI) is at the core of the development of "Cyber-Physical Systems" that characterize the current paradigm shift in the world of work known as the Fourth Industrial Revolution. As such, understanding the impact of AI on the health, safety, and wellbeing of

workers is essential to the field of occupational safety and health. While not uniformly defined, artificial intelligence (AI) refers to systems built to execute intellectual processes of humans such as reasoning, identifying meaning, generalizing information, or learning from experience. Employers use numerous applications of AI to streamline business processes and increase worker productivity and safety. (Elizabeth Fisher, et al., 2023)

The utilization of AI in various aspects of the work process is extensive. The existing body of literature suggests that the influence of AI on human labor is mostly attributed to the utilization of computational techniques that depend on the acquisition and analysis of data to execute particular tasks. The application of this concept extends to other domains, including the coordination of machinery and industrial processes, workforce management with a particular focus on human resources, evaluation of consumer risks and benefits, and analysis of staff safety. The advent of AI has numerous prospects for advancement. However, it is imperative to acknowledge the significant hazards associated with its implementation. The influence of AI on employee health and safety is steadily growing. The emergence of novel AI applications in the future workplace gives rise to significant concerns regarding occupational health and safety (OHS). (Imran Aslan, et al., 2023)

The problem of this study is to examine the advancements that have the potential to transform workplace safety by utilizing emerging artificial intelligence (AI)-based technologies to improve safety solutions and reduce occupational diseases. The study's other issue is how to use artificial intelligence, more especially how to apply it in the Saudi Electricity Company, to monitor and analyze health and safety hazards in the Saudi corporate environment.

1.3 Study Questions:

The study seeks to answer the following questions:

1. What is artificial intelligence and what are its various applications?
2. What are occupational safety and health risks?
3. How can artificial intelligence applications be employed in the Saudi Electricity Company?

1.4 Objectives of the study:

In general, this research aims to study Employing artificial intelligence applications in the process of monitoring and analyzing risks related to occupational safety and health. In particular, this research aims to the following:

- To determine the concept, principles and ethics of artificial intelligence.
- To determine occupational health and safety guidelines and procedures in general and in the electricity sector in particular.
- To know the extent of interest in developing health and safety procedures in the Saudi Electricity Company.
- To discuss and analyze the employing of artificial intelligence applications in monitoring and analyzing risks related to safety and health.
- To Provide a set of recommendations to improve and develop occupational health and safety services within the Saudi Electricity Company through the use of artificial intelligence technologies.

1.5 Study Importance:

There has been a growing interest in utilizing Artificial Intelligence (AI) technologies in occupational safety and health. AI can perform various human functions, learn from experience, and adapt to new entries and settings. These emerging technologies can achieve significant contributions and provide better competitive advantages as compared to conventional approaches. These technologies have the potential to predict and prevent hazards, improve training and education, and increase the efficiency of safety management systems. (Suhairi, et al., 2023)

Artificial intelligence is an example of the great importance of scientific and technological advances in a global society. Artificial intelligence is having an increasing impact on employee health and safety. Artificial intelligence can fundamentally impact work management, even to the point where it can not only aid the work process but also manage it autonomously by making autonomous decisions based on the data collected. In such a situation, there is a new, hitherto

unknown relationship between the employee and AI. Artificial intelligence can also be used directly to improve employee health. Wearing exoskeletons can improve workers' productivity and promote health protection. An exoskeleton is a robot that a human wears in the form of a suit, constructed with an appropriate structure that improves the dynamics of the user's limbs and joints. (Maciej Jarota, 2023)

Artificial intelligence (AI) offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process data through algorithms, leading to widespread and profound changes in how work is done. AI is used in a range of applications and tools for assisted work and data analytics, allowing the automation of increasingly complex tasks, as well as automated or semi-automated workplace decision-making and management. The applications of AI in working processes range from cobots, wearable technologies and assistive tablets on production assembly lines, chatbots in factories, warehouses and call centres, and smart personal protective equipment (PPE), to algorithmic processes in human resource (HR) applications such as people analytics and 'gamification'. AI may create opportunities but also new challenges for occupational safety and health (OSH), its management and regulation. (Elizabeth Fisher, et al., 2023)

1.6 Study Hypotheses:

- H1: There are various principles and ethics that govern the performance of artificial intelligence work.
- H2: There are many applications of artificial intelligence used in different fields and industries.
- H3: There are many risks related to occupational safety and health in the Saudi work environment.
- H4: There is a possibility to employ applications of artificial intelligence applications in monitoring and analyzing risks related to safety and health in the Saudi Electricity Company.

1.7 Study Methodology:

The study is based on the case study approach, which is a method of studying types of research that does not require selecting an entire study population, or a study sample that represents the majority of the population. The aim of this is to describe the nature of the phenomenon,

Study Tool:

In this study, a questionnaire will be used to be distributed to employees of the Saudi Electricity Company to measure how can artificial intelligence applications be employed in the Saudi Electricity Company?

Statistical processing methods:

To achieve the objectives of the study and analyze the data collected, many appropriate statistical methods will be used using the Statistical Package for Social Sciences (SPSS).

Frequencies and percentages will be calculated to identify the personal and functional characteristics of the study individuals and to determine the individuals' responses to the statements of the main themes included in the study tool.

- Factor analysis; To measure the validity of the study tool.
- Cronbach's Alpha coefficient; To measure the stability of the study tool.

After that, the following statistical metrics will be calculated:

- The standard deviation will be used to identify the extent to which the responses of study individuals deviate, but as one of the expressions of the study variables, and for each of the main axes, from its arithmetic mean.
- Anova analysis of variance will be used to determine the statistically significant differences between the demographic variables and the study axes.
- One Sample T Test: This is to test the significance of the sample members' agreement on the questionnaire's axes.

1.8 The limits of the study:

Spatial boundaries: Applying the study to the Saudi Electricity Company in the Kingdom of Saudi Arabia.

Time limits: Application of the study in the academic year 2024

Objective Frontiers: Study of applications of artificial intelligence to monitor and analyze risks related to safety and health.

1.9 Literature Review:

Study (Pishgar, et al., 2021):

The field of artificial intelligence (AI) is rapidly expanding, with many applications seen routinely in health care, industry, and education, and increasingly in workplaces. Although there is growing evidence of applications of AI in workplaces across all industries to simplify and/or automate tasks there is a limited understanding of the role that AI contributes in addressing occupational safety and health (OSH) concerns.

This paper introduces a new framework called Risk Evolution, Detection, Evaluation, and Control of Accidents (REDECA) that highlights the role that AI plays in the anticipation and control of exposure risks in a worker's immediate environment. Two hundred and sixty AI papers across five sectors (oil and gas, mining, transportation, construction, and agriculture) were reviewed using the REDECA framework to highlight current applications and gaps in OSH and AI fields.

Results showed that The REDECA framework highlighted the unique attributes and research focus of each of the five industrial sectors. The majority of evidence of AI in OSH research within the oil/gas and transportation sectors focused on the development of sensors to detect hazardous situations. In construction the focus was on the use of sensors to detect incidents. The research in the agriculture sector focused on sensors and actuators that removed workers from hazardous conditions. Application of the REDECA framework highlighted AI/OSH strengths and opportunities in various industries and potential areas for collaboration. As AI applications across industries continue to increase, further exploration of the benefits and challenges of AI applications in OSH is needed to optimally protect worker health, safety and well-being.

Study (Maciej Jarota, 2023)

this article examines current occupational safety and health legislation. Issues related to occupational safety and health monitoring of employers using artificial intelligence were also the subject of the study. The social sciences' perception of human labour is not insignificant in assessing the new relationship at the employer-AI-employee level. The proposed model for regulating AI by the EU legislator is insufficient. First and foremost, there is no clear indication of the employer's obligations towards employees concerning occupational health and safety. Certainly, the essence of the EU law should be to establish the role of the employer in the process and of the Labour Protection Authorities, on the assumption that AI is only a working tool and not a subject of the law. Authorities should work together with employers to achieve the regulation objectives. Consideration should be given to introducing a responsive method of regulation in EU law, whereby the employer's application of employee health protection standards would be reviewed by the Authority to ensure that the objectives of the regulation are met. Depending on achieving a specific outcome or failing to meet the set targets, the Authority could intervene by applying appropriate punitive, incentive or reward mechanisms to the employer. Such a system of action, supported by providing adequate information to employers about the new risks associated with using AI, makes it possible to mobilise employers to take specific measures to protect employees' mental and physical health.

Study (Elizabeth Fisher, et al., 2023)

Artificial intelligence (AI) has the potential to either reduce or exacerbate occupational safety and health (OSH) inequities in the workplace, and its impact will be mediated by numerous factors. This paper anticipates challenges to ensuring that the OSH benefits of technological advances are equitably distributed among social groups, industries, job arrangements, and geographical regions. A scoping review was completed to summarize the recent literature on AI's role in promoting OSH equity. The scoping review was designed around three concepts: artificial intelligence, OSH, and health equity. Scoping results revealed 113 articles relevant for inclusion. The ways in which AI presents barriers and facilitators to OSH equity are outlined along with priority focus areas and best practices in reducing OSH disparities and knowledge gaps. The scoping review uncovered priority focus areas. In conclusion, AI's role in OSH equity is vastly understudied. An urgent need

exists for multidisciplinary research that addresses where and how AI is being adopted and evaluated and how its use is affecting OSH across industries, wage categories, and sociodemographic groups. OSH professionals can play a significant role in identifying strategies that ensure the benefits of AI in promoting workforce health and wellbeing are equitably distributed.

The published literature was identified using scientific databases of Embase, PubMed, and Google scholar including a lower time bound of 1974 to capture chronological advances in occupational disease detection and technological solutions employed in industrial set-ups.

Results showed that AI-driven technologies are revolutionizing how organizations approach health and safety, offering predictive insights, real-time monitoring, and risk mitigation strategies that not only minimize accidents and hazards but also pave the way for a more proactive and responsive approach to safeguarding the workforce. As industries embrace the transformative potential of AI, a new frontier of possibilities emerges for enhancing workplace safety. This synergy between OHS and AI marks a pivotal moment in the quest for safer, healthier, and more sustainable workplaces.

Study (Arana-Landín, et al., 2023)

The aim of this article is to know the impact that the different Industry 4.0 technologies have on occupational health and safety risks, with special attention to the new emerging risks generated. To achieve this objective, an analysis of the literature was carried out. It allowed us to design a survey that was answered by 130 managers and/or technicians of pioneering companies in the development of Industry 4.0 technologies. Next, 32 of these projects were selected and a multiple case study was conducted through 37 in-depth interviews. Moreover, other source of information was analyzed (project reports, technical reports, websites).

The findings highlight that the analyzed technologies (Additive Manufacturing, Artificial Intelligence, Artificial Vision, Big Data and/or Advanced Analytics, Cybersecurity, Internet of Things, Robotics and Virtual and Augmented Reality) help to reduce occupational health and safety risks (physical and mechanical). However, its impact depends on the type of technology and

the method of application. Influences in new emerging risks (mainly psychosocial and mechanical) have been detected in all technologies except in Internet of Things. In addition, additive manufacturing, artificial intelligence, machine vision, the internet of things, robotics and virtual and augmented reality help to reduce ergonomic risks and artificial intelligence, big data and cybersecurity psychosocial risks. The results obtained have implications for policy makers, managers, consultants and those in charge of managing occupational health and safety risks in industrial companies.

Study (Cengiz Akyıldız, 2023):

The primary aim of this study is to review the transformation of occupational health and safety (OHS) practices in the digital age, particularly considering the onset of Industry 4.0. The study seeks to understand the emergence of OHS 4.0 methodologies and their implications for enhancing performance, reducing risks, and addressing workplace challenges. The overarching objective is to explore the innovations in the OHS domain influenced by digitalization and ascertain the benefits and challenges of integrating digital methodologies into OHS practices. A comprehensive literature review was conducted, scanning multiple sources to gather insights on the innovations brought about by digitalization in the OHS domain. The study further analyzed contemporary research and application areas of new technologies in occupational health and safety. Findings from the study confirm that the integration of digital technologies into the OHS domain can lead to a significant reduction in workplace accidents. However, as workplaces embrace digital processes, new types of risks emerge for employees. In adapting to digitalization, there are recognized challenges in areas like privacy, security, clarity, and responsibility. Digitalization has redefined the landscape of OHS, ushering in an era of OHS 4.0. While the digital methodologies offer significant advantages in reducing workplace accidents and enhancing performance, they also present new risks and challenges. As the workplace undergoes rapid changes due to technological advancements, there's a pressing need to develop OHS approaches that align with the demands of the modern age, ensuring that health and safety remain paramount amidst uncertainties in applicability.

Study (Suhairi, et al., 2023):

This study aims to investigate the current state of the field of Artificial Intelligence (AI) and Machine Learning (ML) in Occupational Safety and Health (OSH) and to understand how AI and ML can be effectively used to improve workplace safety and health. The findings of this study support the potential of AI and ML in improving workplace safety and health, as well as identifying key challenges such as data privacy and security, ethical considerations, lack of standardization, and integration with existing systems. Overall, this study makes a significant contribution to the field of OSH by providing a comprehensive overview of the current state of the field and by highlighting the potential and challenges of AI and ML in enhancing workplace safety and health.

Study (Ghindescu Negură, et al., 2024):

This paper aims to make contributions regarding the forecasting and identification of new and emerging Occupational Safety and Health (OSH) challenges related to how digitization would change automated systems, work equipment and tools used, how work is organized, business models, hierarchies and relationships, the characteristics of the force of work, responsibilities for OSH management, skills, knowledge and information needed to work.

The result of the prospective case study and the context overview paper has the role of anticipating risks and identifying priorities, to contribute to the development of OSH practices and policies in the field of CDI, as a result of the impact of digitization in view of places of safe, ecological work in which the elimination/minimization of psychosocial risks is a priority. The approach considered to be effective is the one that involves key institutions, social partners and other stakeholders and focuses on three key priorities:

- anticipating and managing changes in the context of green, digital and demographic transitions.
- improving the prevention of work accidents and occupational diseases and making efforts towards an approach based on the principle of "zero deaths at work".
- increasing preparedness to respond to current and future health crises.

Study (Immad A. Shah and SukhDev Mishra, 2024)

In an era characterized by dynamic technological advancements, the well-being of the workforce remains a cornerstone of progress and sustainability. The evolving industrial landscape in the modern world has had a considerable influence on occupational health and safety (OHS). Ensuring the well-being of workers and creating safe working environments are not only ethical imperatives but also integral to maintaining operational efficiency and productivity. This study aims to review the advancements that have taken place with a potential to reshape workplace safety with integration of artificial intelligence (AI)-driven new technologies to prevent occupational diseases and promote safety solutions.

Research Gap:

After extrapolating and analyzing previous studies, we note that previous studies dealt with the issue of the impact of artificial intelligence on occupational health and safety in general and did not address the practical application to specific companies, nor did previous studies address the practical application to the electricity sector, so we are conducting the current study to fill that research gap through Applying it to the electricity sector in the Kingdom of Saudi Arabia, specifically measuring how to employ artificial intelligence applications in identifying and addressing occupational safety and health risks in the Saudi Electricity Company.

However, there is a lack of research on the practical applications of artificial intelligence in occupational safety and health in companies. For addressing the identified gap, it is important to answer the following research question: What are the future opportunities and the challenges for artificial intelligence application in the occupational safety and health risks background in the Saudi Electricity Company?

Chapter 2:

Theoretical Framework of the Study

2.1 Overview of Artificial Intelligence:

2.1.1 What is Artificial Intelligence (AI)?

Artificial Intelligence term was coined by John McCarthy in 1956. He defined it as "the science and engineering of making intelligent machines." AI is the branch of computer science which deals with the study and design of intelligent agents that perceives its environment and takes actions which maximize its chances of success. AI may be defined as: "The ability to hold two different ideas in mind at the same time and still remain the ability to function". But AI must include the learning from past experience, reasoning for the decision making, inference power and quick response. Also, it must be able to take decisions on the basis of priorities and tackle complexity and ambiguity. Machines programmed to carry out tasks, when carried out by humans would require intelligence, are said to possess artificial intelligence. AI's scientific goal is to understand intelligence by building computer programs that exhibit intelligent behavior by using symbolic inference, or reasoning inside the machine. AI definition is not time independent. It gives the judgment of any system by keeping time in mind. (Gyanendra Singh, et, al., 2013).

Artificial Intelligence or AI in short, simply means the intelligence of machines and the branch of computer science that aims to create it. It is the area of computer science focusing on creating machines that can engage on behaviors that humans consider intelligent. The primary aim of AI is to produce intelligent machines. The intelligence should be exhibited by thinking, making decisions, solving problems, more importantly by learning. The ability to create intelligent

machines has intrigued humans since ancient times and today with the advent of the computer and 50 years of research into AI programming techniques, the dream of smart machines is becoming a reality. Researchers are creating systems which can mimic human thought, understand speech, beat the best human chess player, and countless other feats never before possible. Artificial Intelligence (AI) is a broad branch of computer science that is focused on a machine's capability to produce rational behavior from external inputs. The goal of AI is to create systems that can perform tasks that would otherwise require human intelligence. AI manifests itself in everyday life via virtual assistants, search prediction technology, and even ride-hailing services. (Bibel, W., 2014)

2.1.2 Elements of Artificial Intelligence:

Today, in the quest to create intelligent machines, the field of AI has split into different approaches or techniques based on varying opinions by researchers, on the most promising methods and theories. These methods could be considered as elements of AI. The techniques or methods include: (Flavián, Carlos, et, al., 2020)

- Expert Systems.
- Neural Network.
- Fuzz Logic.
- Genetic Algorithms.

2.1.3 Technologies that are based on Artificial Intelligence:

AI is composed of many different technologies, all advancing at an increasingly fast pace. Following are the AI technologies most relevant: (Haenlein M & Kaplan A., 2019)

Machine Learning: Machine learning enables software robots to accomplish predefined tasks without being programmed for each specific scenario. For example, machine learning algorithms are used in banking to detect fraud, predict how many loan applications a bank will receive in the next ten years, and determine creditworthiness.

Big Data Analytics: AI needs big data to operate, so fintech companies must gather and store substantial amounts of financial data. This need for capacity is a challenge since many banks and financial institutions have outdated IT infrastructures that cannot accommodate the huge amounts of digital information they must gather and analyze.

Deep Learning: Unlike machine learning, deep learning uses a hierarchical approach to processing data. Hierarchical means that it can process multiple layers of information at once. AI systems can process raw data to determine the initial conditions of these data sets necessary for a result.

2.1.4 Artificial Intelligence Applications:

AI notably is an interdisciplinary field that draws its roots, and requires knowledge in fields such as physiology, mathematics, psychology, economics, linguistics, neuroscience, control theory and so on. These fields apply to AI as follows: (Vijai, D. C., 2019).

- **Philosophy:** This field is necessary to demonstrate the logic and methods of reasoning mind as physical system foundations of learning, language, rationality.
- **Mathematics:** This provides the formal representation and proof algorithms, computation, (un) decidability, (in) tractability probability.
- **Psychology:** This is necessary in the adaptation phenomena of perception and motor control experimental techniques (psychophysics, etc.) of AI.
- **Economics:** This provides the formal theory of rational decisions.
- **Linguistics:** This provides the knowledge representation grammar.
- **Neuroscience:** This field is necessary for the plastic physical substrate for mental activity
- **Control theory:** This field provides study of the homeostatic systems, stability simple optimal agent designs in AI.

Some of the applications of Artificial Intelligent as implemented by AI methods include: (Makridakis, S., 2017)

- **Heavy Industries and Space:** Robotics and cybernetics have taken a leap combined with artificially intelligent expert systems. An entire manufacturing process is now totally automated, controlled and maintained by a computer system in car manufacture, machine tool production, computer chip production and almost every high-tech process. They carry out dangerous tasks like handling hazardous radioactive materials. Robotic pilots carry out complex maneuvering techniques of unmanned spacecrafts sent in space. Japan is the leading country in the world in terms of robotics research and use.
- **Finance:** Banks use intelligent software applications to screen and analyze financial data. Software's that can predict trends in the stock market have been created which have been known to beat humans in predictive power. In August 2001, robots beat humans in a simulated financial trading competition. Financial institutions have long used artificial neural network systems to detect charges or claims outside of the norm, flagging these for human investigation.
- **Medicine:** A medical clinic can use artificial intelligence systems to organize bed schedules, make a staff rotation, and provide medical information.
- **Weather Forecast:** Neural networks are used for predicting weather conditions. Previous data is fed to a neural network which learns the pattern and uses that knowledge to predict weather patterns.

2.1.5 Artificial Intelligence Governance in KSA:

As Sophia – the social humanoid robot developed by Hong Kong based company Hanson Robotics and was activated on February 2016 has become the first robot to be granted a citizenship in the history, The Kingdom of Saudi Arabia is the first country in the history to grant a citizenship to a robot. (Business Insider) This historic event shows to what extent the Kingdom of Saudi Arabia looks at AI as an important strategic choice, it outlines the next era in which the Kingdom intends to hold a high distinguished position among the world's nations that consider AI as a great hope and the new foundation for the new technological revolution that promises humanity better solutions in all fields. In line with this creative spirit, Kingdom of Saudi Arabia has decided to adopt Digitization and AI as the key enablers of its new era, as it explained in its Vision 2030, working on its project of building an Information and Communications Technology (ICT) infrastructure for the 21st century. Ministry of Technology, Industry and Digital Capabilities is

working now to enhance the digital capabilities of workforce to align with AI applications such as the Internet of Things (IOT) and Blockchain, which is leading the kingdom to adopt a major educational reform, that is why the Ministry of Technology is working side by side with Ministry of Education to meet changing demands of the workplace, through introducing digital skills in K12 education, along with reforming university curricula to make it matching future needs. (Syed Munawwar Ahmed, 2019)

At present, a wide number of governmental and private agencies are working together to support the idea of entrepreneurship and innovation. One of this efforts' reflection is the building of a network of innovation labs where students and entrepreneurs can explore ideas, learn about and test innovative business models. The Ministry of Technology has recently launched an innovation platform called FekraTech, encouraging every concerned one to share his innovative ideas; in one round, about 4000 proposals have been received, many of these proposals where really valuable, for example, a proposal of invention called Nahla, an AI-based chatbot helps people of chronic diseases to learn about and better manage their condition. Kingdom of Saudi Arabia has been calling for global contractors in technology field few years ago, Amazon, IBM and Alibaba are negotiating now for partnerships with kingdoms officials, while the Chinese tech conglomerate Huawei is already committed to training of 1500 local engineers. Kingdom aims to approach a better life for Saudi people through all of these steps. However, efforts have been made for the sake of the employment of AI in the improvement of life conditions of Saudi people is not limited to government agencies, but private sector and community institutions particularly universities have their important role. (Walaa Magdy Rezk, 2022)

An Important example of the of this approach is the matter of managing crowd flows near Kaaba during pilgrim, in the aftermath of 2015 tragedy in which more than 2000 pilgrims lost their lives as a result of rush in Mina, two professors of Umm Al-Qura University introduced a research project using computer vision to manage crowd flow near Kaaba. "Deep learning algorithms can count the number of people in a scene with up to 97.2 percent accuracy. A heat map signals a warning when density exceeds 4–5 people per square meter, and the system can also monitor crowd circulation speed for safety purposes" (Medium.com) Kingdom of Saudi Arabia has sensed recently the growing fatal danger of traffic accidents on kingdom's roads. Therefore, and in line with its approach to tackle society's troubles throughout creative intelligent solutions, KSA

government has begun a long-term cooperation process with technology companies whether they are local or global to get the best solutions, one of these companies is Hazen company. (Zainab A. Hawsawi, 2021)

2.1.6 Artificial Intelligence (AI) & Mega Projects:

The land of the future, where the greatest minds and best talents are empowered to embody pioneering ideas and exceed boundaries in a world inspired by imagination”, with these words, NEOM’s founding council began its presentation of this giant project’s vision. It is needless to say that a “world inspired by imagination” needs much more than human’s traditional methods, i.e., Artificial Intelligence is a basic player indeed. Experts describe the end goal of this giant project as “to shift from oil to high tech and put Saudi Kingdom at the forefront to technological advances. This is the post-oil era” (Inverse). Perhaps, this description points to the importance and depth of this project, which forms a long-term strategic challenge of experts and decision makers in the kingdom, to move the kingdom from one age to another, and from a place among the others to another one at the forefront of the globe. All of this gives an important impression on the interest the kingdom attaches to this project. (Areej Algumzi, 2022)

By 2025, global revenues from AI are expected to rise to \$90 billion, growing on average by 45 per cent each year. Beyond this, longer term estimates project AI contributing to a 14 per cent growth of global GDP by 2030, ‘the equivalent of an additional \$15.7 trillion’. Accordingly, AI represents a very significant commercial opportunity, and by pulling together trends and networks in this technology, Vision 2030 seeks to diversify the Saudi economy. To signal Saudi Arabia’s commitment in this area, several grand gestures have already been made. For example, Saudi Arabia has become the first country in the world to grant citizenship to an AI-driven humanoid robot called Sophia. More substantially, the Kingdom is also in the process of building a new megacity called Neom, a mix of Arabic and Greek meaning ‘new future’. Positioned in the north-western Tabuk province, this new ‘independent international zone’ will span territory from Saudi Arabia, Egypt and Jordan, covering an area of approximately 26,500 km². That is seventeen times the size of London, and only marginally smaller than Belgium. While Saudi Arabia is not relinquishing sovereign law within this space, it promises to be independent of the Kingdom’s existing governmental framework. (OZ HASSAN, 2020)

According to the Association of Certified Fraud Examiners, 13 percent of businesses employed AI to detect and prevent fraud in 2019. Moreover, 25 percent more businesses intended to utilize these technologies in 2020. Banks also use artificial intelligence to deter and prevent another common type of financial crime, which is money laundering, by recognizing the irregular activity and decreasing the cost of analyzing Know Your Customer schemes, as shown in the below graph, the use cases of AI in the financial services industry as of 2020.

In October 2017, the research arm of the Islamic Development Bank, the Jeddah-based Islamic Research and Training Institute, it had signed an agreement with local firm Ateon and Belgium-based SettleMint, to do a technical feasibility study with the plan to use blockchain technology to develop sharia-compliant products, aiming to support financial inclusion efforts across its member countries. In May 2017, Al Rajhi Bank completed a cross border transaction within a few seconds using Blockchain. In February 2018, Saudi Arabia's central bank signed a deal with U.S.-based Ripple to allow banks in Saudi Arabia to use Ripple's software to instantly settle payments sent into and out of the country. As part of their Vision 2030, presented in April 2016, the Saudi Arabia Government launched a Financial Sector Development program. The program seeks to achieve five objectives: Financial diversity, financial inclusiveness, financial stability, Digital transformation, and Depth of the financial sector.

2.1.7 The Saudi Data & Artificial Intelligence Authority (SDAIA) Vision:

In April 2016, the Crown Prince Mohammed bin Salman Al Saud introduced Saudi Arabia's Vision 2030 that identifies the long-term goals and expectations of the Kingdom of Saudi Arabia (KSA). The Saudi Data and Artificial Intelligence Authority (SDAIA) was established in August 2019 by a Royal Decree to facilitate the transition and help achieve Vision 2030's goals and reach KSA's fullest potentials. SDAIA's core mandate is to support and drive the data and AI agenda within the Kingdom, and its vision is to position KSA as a global leader in the elite league of data-driven economies. To properly fulfill its mandate, SDAIA announced in October 2020 the National Strategy for Data and AI (NSDAI) with an ambitious vision put in place "Where the best of Data and AI is made reality". The aim is to achieve the ambitious vision through a multi-phased approach, focusing on addressing national urgencies by 2025, building foundations for competitive advantage in key niche areas by 2030, and becoming one of the leading economies utilizing and

exporting data and AI after 2030. The three core entities within SDAIA are the National Data Management Office (NDMO), the National Information Center (NIC), and the National Center for Artificial Intelligence (NCAI) that help deliver the promise of a data-driven and AI-supported government and economy. (Ziad A. Memish, et, al., 2021)

2.2 Overview of occupational safety and health:

2.2.1 Definition of Occupational Health and Safety:

OHS is often referred to as an important resource for companies in their ambition to create a good working environment. Health and Safety in the workplace is very important to ensure that an organization provides a safe working environment for its employees and to minimize the risk of accidents and injuries. (Angel Machabe, Vartikka Indermun, 2013)

Occupational Safety and Health (OSH) is a multidisciplinary field that comprises the analysis, recognition, prevention, and control of occupational hazards to protect and assure the workers' health and welfare. According to the World Health Organization (WHO), OSH embraces all the parameters involved in health and safety and focuses on the prevention of risks at work. (Lourdes Salvador, Duong Thinh, 2016)

Occupational health and safety are a discipline with a broad scope involving many specialized fields. It encompasses the social, mental, and physical well-being of workers that is the whole person. Occupational health deals with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards. The health of the workers have several determinants, including risk factors at the workplace leading to cancers, accidents, musculoskeletal diseases, respiratory diseases, hearing loss, circulatory diseases, stress related disorders and communicable diseases and others. As per the definition adopted by the Joint International Labour Organization (ILO) & world health organization (WHO), ILO/WHO Committee on Occupational Health. It has the following components: (Eboibi, et al., 2017)

- Promotion and maintenance of the highest degree of physical, mental, and social well-being of workers in all occupations.
- Prevention among workers of departures from health caused by their working conditions.

- Protection of workers in their employment from risks resulting from factors adverse to health.
- Placing and maintenance of a worker in an occupational environment adapted to his physiological and psychological equipment.

2.2.2 History of Occupational Health and Safety:

The concept of health and safety in the workplace started with the Industrial Revolution in United Kingdom (UK) and United States (US). In the Act of 1833, the Factory Inspectorate was created in UK. The aim of the inspectorate was to control the employees' welfare and regulate working conditions. In addition, it became vital to enforce the laws such as working hours of children, young persons, and women in textile industries. Moreover, regulations such as children prohibition to work at night and obliged to attend to school for two hours, six days of the week were compulsory. Workers were given the right of one hour lunch break. Following the Act of 1833, other Factory Acts were promulgated, where drastic changes in work conditions took place and more industries were incorporated in the following acts. Prevention of workers injuries was mandatory by designing safety work systems, accidents in the factories should be reported, the principle of employers' liability was added, the detection of hazards and industrial diseases was approached. Consequently, public, and private institutions that audit and enforce safe occupational practices were created and strengthened. The Health and Safety at work Act of 1974 provided a comprehensive framework to industries, which is reflected in UK's lowest number of non-fatal accidents and second lowest number of fatal accidents at work in Europe. (Lourdes Salvador, Duong Thinh, 2016)

2.2.3 Objectives of Occupational Health and Safety:

The prime objective of OHS at a global level is to ensure that health and safety is accessible to every worker employed in any sector across the economy. The World Health Organization (WHO) since its inception has included elements of occupational health in its policy. The need to protect the worker from occupational health hazards and promote safety of all at the workplace has been emphasized in key documents of WHO - the Constitution of the WHO, Declarations of Alma Ata Declaration, Global Strategy on Occupational Health for All, WHO General Programs of Work

and several resolutions of the World Health Assembly. According to the document, Global Strategy on Occupational Health for All, the ten high priority objectives proposed by the strategy are as follows: (Muhammad Qasim, et al, 2014)

- Strengthening of international and national policies for health at work and developing the necessary policy tools.
- Development of healthy work environment.
- Development of healthy work practices and promotion of health at work.
- Strengthening of OHS.
- Establishing of support services for occupational health.
- Development of occupational health standards based on scientific risk assessment.
- Development of human resources for occupational health.
- Establishment of registration and data systems, development of information services for experts, effective transmission of data and raising of public awareness through public information.
- Strengthening of research.
- Development of collaboration in occupational health and with other activities and services.

2.2.4 Principles of Occupational Health and Safety:

Occupational health and safety are a multi-disciplinary field, covering issues related to law, medicine, technology, economics, and industry specific concerns. The core occupational health and safety principles put forth by the ILO are as follows: (Benjamin O. ALLI, 2008)

- All workers have rights. Workers, as well as employees and government, must ensure that these rights are protected and foster decent conditions of labor. As the International Labor Conference stated:
 - Work should take place in a safe healthy environment.
 - Conditions of work should be consistent with workers' well-being and human dignity.
 - Work should offer real possibilities for personal achievement, self-fulfillment, and service society.

- Occupational health and safety policies must be established. Such policies must be implemented at both the governmental and enterprise levels. They must be effectively communicated to all parties concerned.
- There is a need for consultation with the social partners (that is, employers and workers) and other stakeholders. This should be done during the formulation, implementation, and review of such policies.
- Prevention and protection must be the aim of occupational health and safety programs and policies. Efforts must be focused on primary prevention at the workplace level. Workplaces and working environment should be planned and designed to be safe and healthy.
- Information is vital for the development and implementation of effective programs and policies. The collection and dissemination of accurate information on hazards and hazardous materials, surveillance of workplaces, monitoring of compliance with policies and good practices, and other related activities are central to the establishment and the enforcement of effective policies.
- Health promotion is a central element of occupational health practice. Efforts must be made to enhance workers' physical, mental, and social well-being.
- Occupational health services covering all workers should be established. Ideally all workers in all categories of economic activity should have access to such services, which aim to protect and promote workers' health and improve working conditions.
- Compensation, rehabilitation, and curative services must be made available to workers who suffer occupational injuries, accidents and work-related diseases. Action must be taken to minimize the consequences of occupational hazards.
- Education and training are vital components of safe, healthy working environments. Workers and employers must be made aware of the importance and the means of establishing safe working procedures. Trainers must be trained in areas of special relevance to different industries, which have specific OHS concerns.
- Workers, employers, and competent authorities have certain responsibilities, duties and obligations. For example, workers must follow established safety procedures; employers must provide safe workplaces and ensure access to first aid; and the competent authorities must devise, communicate, and periodically review and update occupational health and safety policies.

- Policies must be enforced. A system of inspection must be in place to secure compliance with occupational health and safety and other labor legislation.

2.2.5 Management's Duties and Responsibilities according to Occupational Health and Safety:

If necessary, one or more persons from top management should be given the responsibility, authority, and duty to collaborate with workers' representatives to: (Angel Machabe, Vartikka Indermun, 2013)

- ☐ Develop, apply, and periodically monitor and evaluate the occupational health and safety management system.
- ☐ Periodically report on the operation of the occupational health and safety management system to the highest management level; and
- ☐ Promote the participation of all members of the organization.
- ☐ Conduct regular worksite visits to communicate with workers and identify deficiencies to be resolved; promote and participate in regular meetings specifically held to discuss safety and health issues or introduces the discussion of these issues in regular daily meetings.
- ☐ Observe if and how workers adopt work routines that could have serious consequences and set up a dialogue to discuss alternative ways of performing work.
- ☐ Show an interest in the causes of occupational accidents and in how they have been taken care of. After an accident, assure workers that management cares for them, especially while victims are recovering.
- ☐ Serve as an example by using personal protective equipment in work areas that require it and always respect existing prevention standards.
- ☐ Adopt a participatory leadership and heed the opinions of the members of the organization to establish the necessary confidence; establish and foster an organizational structure that supports activities of the risk prevention and risk control programs.
- ☐ Secure the necessary financial and human resources to ensure that the occupational health and safety system functions well.

2.2.6 The Risk of Occupational Health Hazards:

Health hazards involve the risk of illness or accidents in the workplace. An occupational hazard is something unpleasant that a person experiences or suffers, as a result, while doing their job. Occupational hazard as the term signifies both long-term and short-term risks associated with workplace environments and is a field of study within occupational safety and health and also public health. There are several types of occupational hazards such as biological, chemical, physical, and psychosocial hazards: (Suparna N. S., Ajeet Jaiswal, 2021)

1. **Biological Hazard:** Biological hazards refer to biological substances that threaten the health of human beings and other living organisms. These hazards may include toxins such as from viral sources or microorganisms, that are harmful to human health.
2. **Chemical Hazards:** Chemical hazards are a type of occupational hazard which involves exposure to chemicals in the workplace. There are hundreds of chemical hazards in our environment; it may include carcinogens, immune agents, neurotoxins, reproductive toxins, and dermatological agents. Long-term exposure to chemicals such as silica dust, engine exhaust, and tobacco smoke increases the risk of health diseases such as stroke and high blood pressure.
3. **Physical Hazards:** The physical hazard agents are those that can cause harm with or without contact. Radiation, heat, temperature, vibration, and noise are examples of this. The physical hazards cause injuries and illness in several industries.
4. **Psychosocial Hazards:** Psychosocial hazards are occupational hazards that affect the employees' psychological health. These hazards affect their ability to take part in an environment without their colleagues. Workplace violence, stress is examples of psychosocial hazards. The Ergonomic hazards include heavy lifting, repetitive and forceful movements, and awkward postures that arise from improper work methods and improperly designed workstations and equipment. These ergonomic hazards affect musculoskeletal disorders which in turn can affect the nerves, muscles, and supporting structure of the body.

2.2.7 New occupational health policy trend in Saudi Arabia:

The Saudi government has for many years been of the view that occupational health should be synchronized and delivered by the government in the same approach as any other safety and health related issue. Recently, there have been shifts in the Kingdom of Saudi Arabia to take a far more

holistic approach to workplace safety and health, focusing on the wider wellbeing and health program shifting towards adaptation of best practices for Saudi people. The Saudi occupational health systems have developed over last decades, by focus on health interventions to ensure that workers have suitable work-related health support, helping them adapt the psychological and physical demands which workplaces put on them specially as they get older. The Saudi occupational health and safety has never been mainstreamed into the wider health agenda, to maintain the responsibility for occupational health and safety with the factories and employers. This situation continues to this day, however; Saudi ministry of health tries to implement occupational health services for all employees, with some exceptions to other private sector employers. At the same time other workers have taken the advantage of the growing number of private sector and taking decisions to outsource the issues of workplace health and safety on the grounds of cost. (Adnan Khasawneh, 2014)

The Saudi ministry of health keeps on working with a broad range of stakeholders to promote and improve workplace health and safety for working population. However, though these initiatives are welcome in the Saudi Kingdom, whereas others think it's still away from a comprehensive, occupational health service that should be delivered to working Saudi population. Given the wider ongoing attention to health and safety, it is a suitable time to examine health provision and how ministry of labor and ministry of Commerce and Industry can be involved in shaping the work-related health and safety of the future, besides an examination of current occupational health resources, and how the services can be developed. (Seifeddin Ballal, et al., 2012)

2.2.8 The National Policy on Occupational Safety and Health in Saudi Arabia:

The enhancement of occupational safety and health (OSH) following national standards and regulations, and international treaties and agreements, to which the Kingdom is a party, is considered a vital necessity. Such efforts are compatible with economic and social development in the Kingdom of Saudi Arabia and reaffirm its status at the regional and international levels. In pursuit of the objectives of the national transformation program, and in keeping pace with the Kingdom's vision (2030), the National Policy on OSH has been prepared. This was done in cooperation with the International Labor Organization (ILO) and the relevant government agencies, and in consultation with the workers and employers' representatives. The Policy aims to achieve

the national vision in the field of OSH which is based on protecting the right of the worker against any danger that poses a threat to his safety or health and to promote the main priorities that the government of the Kingdom of Saudi Arabia seeks to achieve.

The government of the Kingdom of Saudi Arabia seeks, through the National Policy on OSH, to strengthen and develop the OSH system, and to support the protection of workers in various workplaces, at the national level, by local regulations, international treaties, and agreements to which the Kingdom is a party, and the best global practices which are appropriate to the Saudi labor market. The National Policy on OSH is based on the following pillars: (ministry of human resources and social development, 2021)

- **Firstly:** The principles of the National Policy on OSH.
- **Secondly:** The over-all objective and detailed objectives of the National Policy on OSH.
- **Thirdly:** Commitment to the enhancement and development of OSH.
- **Fourthly:** Regulating OSH and monitoring related performance indicators. Fifthly: Developing partnerships at the regional and international levels in the field of OSH.

2.3 Artificial Intelligence Applications and Occupational Safety and Health:

2.3.1 The Significance of Artificial Intelligence in The Work Process:

Artificial intelligence can be used in many ways in the work process. The literature indicates that the impact of AI on human labor comes down to the use of computational methods that rely on collecting and processing data to undertake specific actions. It can be applied, among other things, to coordinating machinery and industrial processes, managing the workforce (especially from an HR perspective), assessing customer risks and benefits, and analyzing staff safety. Artificial intelligence can fundamentally impact work management, even to the point where it can not only aid the work process but also manage it autonomously by making autonomous decisions based on the data collected. In such a situation, there is a new, hitherto unknown relationship between the employee and AI. Artificial intelligence can also be used directly to improve employee health. Wearing exoskeletons can improve workers' productivity and promote health protection. An exoskeleton is a robot that a human wear in the form of a suit, constructed with an appropriate structure that improves the dynamics of the user's limbs and joints. (Maciej Jarota, 2023)

Despite the many opportunities to use AI in the work process to support employee efficiency, there are also some challenges related to OHS. While AI can positively impact the healthcare risk management process, there are risks associated with its use. The primary risk is still related to the potential occurrence of workplace accidents that result in an employee suffering an injury at work. Even exoskeletons equipped with AI to assist a worker in movement or rehabilitation can cause injury when malfunctioning. Hence, it is advisable to put in place an appropriate occupational safety and health policy when using them. (Chesterman S., 2020)

AI implementation at work will result in societal shifts related to job security that will be influenced by existing social inequalities related to unemployment, digital divides, and skill gaps. These societal shifts are likely to disproportionately impact workers with lower SES, thereby creating additional barriers to OSH equity and aggravating existing social inequalities that are detrimental to health. Early in the scoping review search process, job security emerged as a conceptual domain due to its recurrence in the literature. The growing presence of AI at work, along with changing workforce demographics, shifting work arrangements, the digital skills gap, and increasing technological job displacement, makes understanding the relationship between AI and occupational health inequities a central question in Future of Work research. Workers are at risk of being outperformed by AI. AI has the potential to cause the loss of jobs in certain industries. As much as 40%–50% of the workforce, or more in developing countries, is vulnerable to technological job displacement. In care roles, for example, research suggests that the elderly may prefer robots to humans for certain tasks. (Elizabeth Fisher, et al., 2023)

Artificial intelligence (AI) offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process data through algorithms, leading to widespread and profound changes in how work is done. AI is used in a range of applications and tools for assisted work and data analytics, allowing the automation of increasingly complex tasks, as well as automated or semi-automated workplace decision-making and management. The applications of AI in working processes range from cobots, wearable technologies and assistive tablets on production assembly lines, chatbots in factories, warehouses and call centers, and smart personal protective equipment, to algorithmic processes in

human resource (HR) applications such as people analytics and ‘gamification’. AI may create opportunities but also new challenges for occupational safety and health (OSH), its management and regulation. Most of the discussion around AI is about the quantity of jobs, but it should also be about job quality, and OSH is a key aspect of this. (EU-OSHA, 2021)

While there are significant possibilities for workplace progress, and growth in productivity, there are also many ethical questions arising as AI is integrated into workplaces. Namely, stress, musculoskeletal difficulties, discrimination, heightened prevarication, and the possibilities for work intensification as well as job losses have been documented as risks to psychosocial as well as physical violence in digitalized workplaces. These risks are exacerbated when AI augments already existing technological tools for workplace management and design. AI exaggerates OSH risks in digitalized workplaces because it can allow for increased monitoring and tracking, and thus, can lead to micro-management, a prime cause of stress and anxiety. AI stresses the imperative for more authority to computation, prediction machines, robotics, and algorithmic processes at work. (Phoebe V. Moore, 2020)

2.3.2 AI in automation of tasks and occupational safety and health:

Robots embedding AI are becoming mobile, smart, and collaborative. Their use removes workers from hazardous situations and the quality of work is improved by handing repetitive tasks to fast, accurate and tireless machines. Cobots can also facilitate access to work for many people (ageing workers or with disabilities) and collaborate with human workers in a shared workspace. However, cobots’ increased mobility and decision-making autonomy, based on self-learning algorithms, could make their actions less predictable for the workers collaborating with them. (Immad A. Shah and SukhDev Mishra, 2024)

Artificial intelligence plays a crucial role in various aspects of the work process, revolutionizing how tasks are performed and managed. Through computational methods that analyze and process data, AI enables specific actions that impact labor dynamics. Noteworthy AI technologies encompass ML, DL, NLP, and rule based expert systems (RBES). These AI technologies have also made their way into occupational health, facilitating the examination of both structured and unstructured data. This technology finds application in diverse areas, such as coordinating

machinery and industrial processes, workforce management (especially from a human resource perspective), customer risk assessment, benefits analysis, and staff safety evaluation. OHS pertains to the domain of public health, with a specific emphasis on the analysis and observation of patterns related to illnesses and injuries occurring inside the workplace. Professionals in the respective domain utilize this body of knowledge to formulate and execute tactics and policies to mitigate risks that can potentially cause physical or psychological detriment, either presently or in subsequent periods. There has been a growing tendency toward incorporating AI research within the context of OHS. (Imran Aslan, 2023)

Currently, AI and Machine Learning ML are being used in a variety of ways to enhance occupational safety and health. One of the most common applications of ML is in the construction industry in preventive maintenance or injuries among workers by predicting the risk of injuries. Several machine learning models were developed to identify and prevent and predict the risk. In addition, AI and ML are also being used to analyze incidents and accidents that have occurred in the workplace, to identify the root causes and prevent similar incidents from happening in the future. AI and ML are also being used to monitor human behavior in the workplace, such as identifying workers who may be at risk of developing a particular illness or injury. Another application of AI and ML in OSH is in hazard detection, where the technology is used to identify potential hazards in the workplace or construction area, such as human intrusion judgement in static dangerous areas, the influence of human posture, intrusion direction, and falling from heights. This can help to improve the safety of workers by allowing organizations to take proactive measures to mitigate these hazards. (Suhairi Ahmad, et al., 2023)

2.3.3 Challenges and limitations of using AI for OHS:

While AI can offer many benefits for OHS, it is not a magic solution that can solve all problems. AI is still a developing field that faces many technical, ethical, social, and legal issues. Some of the challenges and limitations of using AI for OHS include: (Samer Ellahham, et al., 2019)

Data quality and availability: AI relies on large amounts of data to learn and improve its performance. However, data may not always be accurate, reliable, relevant, or representative of

real-world situations. Moreover, data may not always be available or accessible due to privacy, security, or ownership concerns.

Bias and fairness: AI may inherit or amplify human biases that can affect its outcomes and decisions. For example, AI may discriminate against certain groups of workers based on their gender, race, age, or other characteristics. Moreover, AI may not always be transparent or accountable for its actions and results.

Human-machine interaction: AI may change the way humans interact with machines, each other, and their work environment. For example, AI may reduce human autonomy, creativity, or responsibility. Moreover, AI may create new psychological or physical hazards for workers, such as stress, fatigue, or musculoskeletal disorders.

Ethical and legal implications: AI may raise ethical and legal questions that need to be addressed by OHS professionals and stakeholders. For example, who is responsible for the safety and well-being of workers when AI is involved? How can workers' rights and interests be protected when AI is used? How can OHS standards and regulations be adapted to accommodate AI?

2.3.4 Artificial intelligence applications in monitoring risks related to occupational safety and health:

Advances in digital technologies are inevitably shaping our future. From increasingly sophisticated robots that replace workers in customer-facing roles to additive manufacturing technologies (3D printing) that produce human organs, the potential of innovations in digitalization to meet growing demand and increase productivity is vast. However, increased levels of automation and the constant monitoring of workers by digital technologies will in many cases reduce person-to-person contact and increase performance pressure, with potentially detrimental effects on workers' mental health. Artificial intelligence applications in monitoring risks related to occupational safety and health as follow: (EU-OSHA, 2022)

1. Smart cobots:

Collaborative and smart robots, so-called cobots, will become a familiar presence in the workplace as highly developed sensors make it possible for people and robots to work together. Amazon already has 100,000 AI-augmented cobots supporting its distribution activities. Most cobots are equipped with self-optimizing algorithms, allowing them to learn from their human colleagues. With the increasing use of AI, robots will be able to carry out not only physical tasks but also increasingly cognitive tasks. Robots are already able to perform a variety of cognitive tasks autonomously, such as supporting legal casework or medical diagnoses, and will also become commonplace in customer-facing jobs. This means that the use of smart robots is expected in many different sectors and settings, such as in the care sector, hospitality, agriculture, manufacturing, industry, transport, and services.

Robotics allows us to remove workers from hazardous situations and improve the quality of work by handing repetitive tasks to fast, accurate and tireless machines. Cobots can also facilitate access to work for many people who are currently excluded, for example by supporting disabled people or ageing workers in the workplace. However, the growing proportion of mobile, smart robots in the workplace may increase the risk of accidents, as injury could occur from direct contact with robots or from the equipment they use. As smart robots are constantly learning, although efforts are made to factor in all possible scenarios in their design, they may behave in unanticipated ways. Workers having to keep up with the pace and level of work of a smart cobot may be placed under a high level of performance pressure. This may have negative impacts on workers' safety and health, particularly mental health. Increased working with robots will also significantly reduce contact with human peers and social support, which is also detrimental to workers' mental health.

2. Exoskeletons:

New body-worn assistive devices, so-called exoskeletons, have been introduced in some workplaces to support workers carrying out manual handling tasks while reducing the load on the muscular system. While the extent of their broader deployment is still unclear, exoskeletons have already proven to be beneficial in specific settings, such as for military applications or in medical care settings. Although the potential benefits of exoskeletons to support workers with physical impairments or to prevent work-related musculoskeletal disorders could be of value, it is also necessary to consider that such assistive devices give rise to new concerns in relation to OSH. The

long-term effects of exoskeleton use on physiological, biomechanical, and psychosocial parameters are unknown. And, in fact, according to the hierarchy of control measures, collective technical and organizational prevention measures should always be considered first and individual technical prevention measures such as equipping a worker with an exoskeleton are seen as the last resort.

3. Smart personal protective equipment:

Mobile miniaturized monitoring devices embedded in personal protective equipment (PPE) allow real-time monitoring of hazards and can be used to provide early warnings of harmful exposures, stress, health problems and fatigue. Real-time advice tailored to the individual can be provided to influence worker behavior and improve safety and health. Information could also be collated and used by organizations to help predict potential OSH problems and spot where OSH interventions at organizational level are required. However, effective strategies and systems and ethical decisions are needed in the context of handling the large quantity of sensitive personal data that could be generated. A malfunction, or the generation of incorrect data or advice, could also cause injury or ill health.

4. Virtual reality and augmented reality:

Virtual reality (VR) and augmented reality (AR) offer the advantage of removing many workers from hazardous environments, as they can be used for example to support maintenance tasks and for immersive training. AR could also provide contextual information on hidden hazards, such as the presence of asbestos, electricity cables or gas pipelines. But the reliability of AR is dependent on maintaining access to sources of relevant, high-quality information and on whether it is up to date. VR and AR devices may also be a source of risks because of distraction, information overload, disorientation, motion sickness and eye strain.

5. Additive manufacturing:

The use of 3D printing will become more commonplace. Bio-printing is increasingly being used to produce biological products or organs. Advances in 3D printing capabilities will create great opportunities, with the addition of a fourth dimension expected to enable the production of

materials that can change with time. All this comes with incredible potential, but possible new risks to workers' safety and health as a different population of workers is exposed to manufacturing hazards and dangerous substances, including dust, in decentralized, small, even micro, companies. As items produced by additive manufacturing are often one-offs, OSH standards are also difficult to define or enforce.

Chapter 3:

Study Methodology and Procedures

3.1 Methodology and research methods:

Study methodology: The study relies on the descriptive approach, which is the most appropriate for research in the humanities and social sciences. It is based on describing phenomena, collecting data, analyzing, and discussing them with the aim of development.

Study population: The population is defined as a group of clearly defined statistical units that are intended to obtain various data about the phenomenon or problem. The current study population consists of employees of the Saudi Electricity Company.

Study sample: The study included some employees of the Saudi Electricity Company (106 people) as an exploratory sample to verify the study tool.

Study tools: This study relied on questionnaires for employees of the Saudi Electricity Company. The questionnaire is a tool whose content includes a set of questions or phrases, including possible answers or opinions, with the aim of obtaining or confirming the answers of the sample members to the study questions.

3.2 Statistical processing methods:

The data was analyzed using the SPSS statistical package for social sciences (version 25).

The following metrics were computed: frequencies, means, standard deviation and percentages, Reliability was carried out to measure the results reliability of the questionnaire's statements.

Pearson Correlations, One-sample t-test and One-Way ANOVA to Test Hypotheses, and the statistical significance level was set at p 0.05, which corresponded to significance levels adopted in similar studies.

Study scale: In measuring the degree of possible responses to the items, the researcher relied on a five-point Likert scale, which is a method used in the field of statistics in distributing the weights of sample answers, which ranges from the highest weight (5) degrees represented in the answer field (strongly agree) to the lowest weight given (1) One score, which is represented in the answer field (strongly disagree) and between them there are three weights. The purpose of this was to allow the sample members to choose the accurate answer according to the sample members' discretion. As shown in the following table:

Response	Strongly Agree	Agree	Natural	Disagree	Strongly Disagree
Class	5	4	۳	2	1

3.3 Reliability:

Checking the consistency and stability is an indicator of the measure reliability, Reliability is the extent of how reliable the model in is measuring the intended construct. The use of the below mentioned criteria represents verification of measurement reliability:

Internal reliability: when the Cronbach's Alpha value is (0.70) or higher, then this type of reliability has been reached. The test of how positively the elements of a certain group are related to each other is achieved through Cronbach's Alpha the reliability coefficient. Cronbach's alpha is computed in terms of the average inter-correlations among the items measuring the concept. Table (1) shows that the results of Cronbach's alpha values are greater than 0.70, which indicates that there is both consistency and stability in the Questionnaire.

Table (1): Cronbach's Alpha results

Questionnaire axes	Number of Items	Cronbach's Alpha
Artificial Intelligence	7	0.821
Occupational Safety and Health Risks	7	0.843
Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health	11	0.939
Total	25	0.945

Table (1) shows that the results of Cronbach's alpha values are greater than 0.70, which indicates that there is both consistency and stability in the Questionnaire. Where the results of the analysis show that Alpha coefficient of the measurement as whole is (0.945) as the closer the value of Cronbach alpha (of the measurement) to 1 the more stable was the measurement.

3.4 Validity:

The apparent validity of the study tool:

To determine the validity of the study tool in measuring what it was designed to measure, it was presented to a number of arbitrators in different specializations, and the number of arbitrators reached (3), and they are:

1. **Dr. Ayman alAli:** PhD in (AI) Faculty of communications and electronics TVTC, Saudi Arabia.
2. **Ms .Hanan AlThaqafi:** Secretariat General Secretariat of the National Risk Council.
3. **Eng. Maatib Al-Bakmi:** Security systems project management Schneider company Saudi Arabia

Considering the opinions of the arbitrators, the researchers prepared the tool for this study in its final form and developed the questionnaire in its final form.

Validity is a measure of the degree of validity of the instrument. Testing the validity of the instrument was conducted using Pearson Correlations using SPSS. Based on the significant value

obtained by the Sig (2-tailed). The Correlations for all the individual items exceeded the recommended value of 0.5, and statically significant at ($p < 0.01$) as represented in tables (2, 3, and 4), which indicates that the Validity for all the items in the Questionnaire fulfilled all the needed requirements.

Table (2): Results of Pearson Correlations for all items of The First Axis

Item	Correlation
1. Artificial intelligence is systems that demonstrate intelligent behavior by analyzing their environment and autonomously executing actions to achieve certain goals.	0.689**
2. Artificial intelligence is making a machine behave in ways that would be considered intelligent if a human were doing so.	0.658**
3. Artificial intelligence is currently part of everyday life for a large proportion of people around the globe.	0.637**
4. Artificial Intelligence (AI) has the potential to significantly reduce risks caused by human factors in various domains.	0.649**
5. Artificial intelligence (AI) offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process data through algorithms, leading to widespread and profound changes in how work is done.	0.714**
6. Artificial intelligence has facilitated the emergence of new forms of worker management, as digital technologies based on artificial intelligence allow workers to be monitored and managed based on the collection of large amounts of data in a timely manner for decision-making.	0.716**
7. The Saudi Data and Artificial Intelligence Authority plays an important role in setting guidelines related to the ethics of artificial intelligence.	0.680**

The previous table (2) indicates that each individual items that measures the First Axis exceeded the recommended value of 0.5, and statically significant at ($p<0.01$), which is a good indicator on the consistency of the items with each other and this means that items of the First Axis are valid for what it measures.

Table (3): Results of Pearson Correlations for all items of The Second Axis

Item	Correlation
1. Occupational health and safety focus on protecting individuals and ensuring a safe working environment.	0.674**
2. Occupational safety and health in the workplace are routinely evaluated to ensure the safety of workers and the safe use of equipment and tools.	0.768**
3. Occupational health and safety relate to the field of public health, focusing on analyzing and monitoring patterns of illness and injury that occur within the workplace.	0.749**
4. The necessary technical capabilities must be provided to implement occupational safety and health procedures and regulations.	0.654**
5. There are many occupational hazards associated with the workplace, and lung diseases associated with exposure to hazardous chemical substances such as lead, beryllium, etc. remain among the most frequently diagnosed work-related conditions.	0.621**
6. Safety-leading indicators are a way to flag sites with higher risks. However, there is a lack of validated leading indicators to classify sites reliably according to safety risk levels.	0.775**
7. The Saudi Vision 2030 help in developing the national policy for occupational safety and health.	0.720**

The previous table (3) indicates that each individual items that measures the Second Axis exceeded the recommended value of 0.5, and statically significant at ($p<0.01$), which is a good indicator on the consistency of the items with each other and this means that items of the Second Axis are valid for what it measures.

Table (4): Results of Pearson Correlations for all items of The Third Axis

Item	Correlation
1. Artificial intelligence is a recent and powerful technology that can transform industry and create new opportunities and challenges for occupational safety and health management.	0.806**
2. The use of artificial intelligence applications in the field of occupational safety and health reflects the interest of the system and the company's senior management in occupational safety and health.	0.783**
3. Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Smart sensors that can monitor environmental conditions, equipment performance, and worker health.	0.793**
4. Artificial intelligence applications can monitor violations and unsafe behaviors related to occupational safety and health.	0.775**
5. Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Chatbots that can provide information, guidance, and support to workers and managers.	0.790**
6. Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Virtual reality and augmented reality that can simulate realistic scenarios for training and education for workers.	0.797**
7. Occupational safety and health professionals at the Saudi Electricity Company must keep up with the latest developments and trends in artificial intelligence and how they impact the management of risks related to occupational safety and health in the electricity sector.	0.840**
8. Occupational safety and health specialists at the Saudi Electricity Company must communicate with various stakeholders, such as officials and managers, to understand their needs, concerns, and expectations regarding the use of artificial intelligence and its applications in managing risks related to occupational safety and health.	0.787**

9. Occupational safety and health professionals in the Saudi Electricity Company should evaluate and monitor the performance and impact of Artificial intelligence on occupational safety and health outcomes. They should also identify any gaps or issues that need to be addressed or improved.	0.803**
10. Occupational safety and health professionals in the Saudi Electricity Company should seek to improve the design of Artificial intelligence applications by providing feedback and recommendations to the relevant parties.	0.876**
11. While Artificial intelligence can offer many benefits for occupational safety and health, but Artificial intelligence is still a developing field that faces many technical, ethical, social, and legal issues.	0.676**

The previous table (4) indicates that each individual items that measures the Third Axis exceeded the recommended value of 0.5, and statically significant at ($p < 0.01$), which is a good indicator on the consistency of the items with each other and this means that items of the Third Axis are valid for what it measures.

Chapter 4:

Data Analysis

4.1 Questionnaire Analysis:

Participants' demographics

The respondents' demographic data and characteristics are summarized using basic descriptive statistics such as frequencies and percentages to present a description of the collected data. Table (5) illustrates the frequency and percentage for demographic features of respondents in the study sample.

Table (5): Demographic Data analysis

Variables percentages	Categories	Frequencies	Percentages
Gender	Male	81	76.4%
	Female	25	23.6%
Age	18 – 25 Year	12	11.3%
	25 – 30 Year	12	11.3%
	30 – 35 Year	26	24.5%
	35 – 40 Year	25	23.6%
	More than 40 Year	31	29.2%
Education level	Pre-secondary education	0	0

	Secondary	11	10.4%
	University	79	74.5%
	Postgraduate	16	15.1%
Marital status	Single	26	24.5%
	Married	77	72.6%
	Divorced	3	2.8%
	Widowed	0	0
Professional Experience	Less than 5 years	18	17%
	5-10 years	18	17%
	10-15 years	28	26.4%
	15-20 years	15	14.2%
	More than 20 years	27	25.5%
Total		106	100%

Table (5) shows the demographic information of the respondents. When it **comes to gender**, the sample population is balanced with (76.4%) being males and (23.6%) being females.

Regarding the age of the respondents (29.2%) belong to the age group of more than 40 years old. (24.5%) to the age group 30-35 years old, (23.6%) to the age group 35-40 years old. (11.3%) to the age group 25-30 years old, and (11.3%) to the age group 18-25 years old.

Regarding educational level, more than (75%) of participants have a university education. Followed by those with Postgraduate education (15.1%). (10.4%) of participants had Secondary Education.

Regarding the Professional Experience of the respondents (26.4%) belong to the professional experience group 10-15 years. (25.5%) to the professional experience group more than 20 years,

(17%) to the professional experience group 5-10 years. (17%) to the professional experience group Less than 5 years, and (14.2%) to the professional experience group 15-20 years.

Descriptive Statistics of The Artificial Intelligence:

Table (6): Artificial Intelligence:

N	Items	Mean	Std. Deviation	Percentages	Agree	Ranking
1	Artificial intelligence is systems that demonstrate intelligent behavior by analyzing their environment and autonomously executing actions to achieve certain goals.	4.35	0.743	87%	Strongly Agree	3
2	Artificial intelligence is making a machine behave in ways that would be considered intelligent if a human were doing so.	4.34	0.674	86.8%	Strongly Agree	4
3	Artificial intelligence is currently part of everyday life for a large proportion of people around the globe.	4.14	0.940	82.8%	Strongly Agree	7

4	Artificial Intelligence (AI) has the potential to significantly reduce risks caused by human factors in various domains.	4.15	0.855	83%	Strongly Agree	6
5	Artificial intelligence (AI) offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process data through algorithms, leading to widespread and profound changes in how work is done.	4.41	0.598	88.2%	Strongly Agree	1
6	Artificial intelligence has facilitated the emergence of new forms of worker management, as digital technologies based on artificial intelligence allow workers to be monitored and managed based on the collection of large amounts of data in a timely manner for decision-making.	4.29	0.646	85.8%	Strongly Agree	5
7	The Saudi Data and Artificial Intelligence Authority plays an important role in setting guidelines related to the ethics of artificial intelligence.	4.35	0.676	87%	Strongly Agree	2
	Mean of First Axis	4.29	0.494	85.8%	Strongly Agree	

By observing Table (6), it is clear that the Artificial Intelligence has total mean (4.29) and total standard deviation (0.494). By comparing the total mean value to the Likert Scale, it is found that the value of the total mean is located between the values (Agree (4)) and (Strongly Agree (5)), but it is found that the value of the total mean is closer to (Strongly Agree (5)) which indicates the respondents' agreement of the Artificial Intelligence.

Table (6) shows results regarding **Artificial Intelligence** that includes 7 items in which statement of (Artificial intelligence (AI) offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process data through algorithms, leading to widespread and profound changes in how work is done) has highest frequency score (88.2%) and took the first place, statement of (The Saudi Data and Artificial Intelligence Authority plays an important role in setting guidelines related to the ethics of artificial intelligence) has taken the second place with frequency score (87%), statement of (Artificial intelligence is systems that demonstrate intelligent behavior by analyzing their environment and autonomously executing actions to achieve certain goals) has taken third place with frequency score (87%).

Descriptive Statistics of The Occupational Safety and Health Risks:

Table (7): Occupational Safety and Health Risks

N	Items	Mean	Std. Deviation	Percentages	Agree	Ranking
1	Occupational health and safety focus on protecting individuals and ensuring a safe working environment.	4.62	0.608	92.4%	Strongly Agree	1
2	Occupational safety and health in the workplace are routinely evaluated to ensure the safety of	4.57	0.585	91.4%	Strongly Agree	3

	workers and the safe use of equipment and tools.					
3	Occupational health and safety relate to the field of public health, focusing on analyzing and monitoring patterns of illness and injury that occur within the workplace.	4.39	0.641	87.8%	Strongly Agree	5
4	The necessary technical capabilities must be provided to implement occupational safety and health procedures and regulations.	4.59	0.581	91.8%	Strongly Agree	2
5	There are many occupational hazards associated with the workplace, and lung diseases associated with exposure to hazardous chemical substances such as lead, beryllium, etc. remain among the most frequently diagnosed work-related conditions.	4.34	0.741	86.8%	Strongly Agree	6
6	Safety-leading indicators are a way to flag sites with higher risks. However, there is a lack of validated leading indicators to classify sites reliably according to safety risk levels.	4.21	0.789	84.2%	Strongly Agree	7

7	The Saudi Vision 2030 help in developing the national policy for occupational safety and health.	4.56	0.663	91.2%	Strongly Agree	4
	Mean of Second Axis	4.48	0.467	89.6%	Strongly Agree	

By observing Table (7), it is clear that the Occupational Safety and Health Risks has total mean (4.48) and total standard deviation (0.467). By comparing the total mean value to the Likert Scale, it is found that the value of the total mean is located between the values (Agree (4)) and (Strongly Agree (5)), but it is found that the value of the total mean is closer to (Strongly Agree (5)) which indicates the respondents' agreement of the Occupational Safety and Health Risks.

Table (6) shows results regarding **Occupational Safety and Health Risks** that includes 7 items in which statement of (Occupational health and safety focus on protecting individuals and ensuring a safe working environment) has highest frequency score (92.4%) and took the first place, statement of (The necessary technical capabilities must be provided to implement occupational safety and health procedures and regulations.) has taken the second place with frequency score (91.8%), statement of (Occupational safety and health in the workplace are routinely evaluated to ensure the safety of workers and the safe use of equipment and tools.) has taken third place with frequency score (91.4%).

Descriptive Statistics of The Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and Health:

Table (8): Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health.

N	Items	Mean	Std. Deviation	Percentages	Agree	Ranking
1	Artificial intelligence is a recent and powerful technology that can transform industry and create new	4.41	0.629	88.2%	Strongly Agree	8

	opportunities and challenges for occupational safety and health management.					
2	The use of artificial intelligence applications in the field of occupational safety and health reflects the interest of the system and the company's senior management in occupational safety and health.	4.43	0.704	88.6%	Strongly Agree	6
3	Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Smart sensors that can monitor environmental conditions, equipment performance, and worker health.	4.46	0.619	89.2%	Strongly Agree	3
4	Artificial intelligence applications can monitor violations and unsafe behaviors related to occupational safety and health.	4.33	0.672	86.6%	Strongly Agree	11
5	Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Chatbots that can provide	4.38	0.639	87.6%	Strongly Agree	9

	information, guidance, and support to workers and managers.					
6	Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Virtual reality and augmented reality that can simulate realistic scenarios for training and education for workers.	4.42	0.629	88.4%	Strongly Agree	7
7	Occupational safety and health professionals at the Saudi Electricity Company must keep up with the latest developments and trends in artificial intelligence and how they impact the management of risks related to occupational safety and health in the electricity sector.	4.44	0.618	88.8%	Strongly Agree	5
8	Occupational safety and health specialists at the Saudi Electricity Company must communicate with various stakeholders, such as officials and managers, to understand their needs, concerns, and expectations regarding the use of artificial intelligence and its applications in managing risks	4.54	0.604	90.8%	Strongly Agree	1

	related to occupational safety and health.					
9	Occupational safety and health professionals in the Saudi Electricity Company should evaluate and monitor the performance and impact of Artificial intelligence on occupational safety and health outcomes. They should also identify any gaps or issues that need to be addressed or improved.	4.45	0.649	89%	Strongly Agree	4
10	Occupational safety and health professionals in the Saudi Electricity Company should seek to improve the design of Artificial intelligence applications by providing feedback and recommendations to the relevant parties.	4.46	0.588	89.2%	Strongly Agree	2
11	While Artificial intelligence can offer many benefits for occupational safety and health, but Artificial intelligence is still a developing field that faces many technical, ethical, social, and legal issues.	4.36	0.732	87.2%	Strongly Agree	10
	Mean of Third Axis	4.42	0.509	88.4%	Strongly Agree	

By observing Table (8), the Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health has total mean (4.42) and total standard deviation (0.509). By comparing the total mean value to the Likert Scale, it is found that the value of the total mean is located between the values (Agree (4)) and (Strongly Agree (5)), but it is found that the value of the total mean is closer to (Strongly Agree (5)) which indicates the respondents' agreement of the Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health.

Table (8) shows results regarding **Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health** that includes 11 items in which statement of (Occupational safety and health specialists at the Saudi Electricity Company must communicate with various stakeholders, such as officials and managers, to understand their needs, concerns, and expectations regarding the use of artificial intelligence and its applications in managing risks related to occupational safety and health) has highest frequency score (90.8%) and took the first place, statement of (Occupational safety and health professionals in the Saudi Electricity Company should seek to improve the design of Artificial intelligence applications by providing feedback and recommendations to the relevant parties) has taken the second place with frequency score (89.2%), statement of (Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Smart sensors that can monitor environmental conditions, equipment performance, and worker health) has taken third place with frequency score (89.2%).

4.2 The Hypotheses Test:

One Sample T-test to investigate the respondents' agreement of the Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health.

H1: There are various principles and ethics that govern the performance of artificial intelligence work.

Table (9): Results of One Sample T-test for H1:

N	Items	Mean	Std. Deviation	Significance level		
				T-test	P-value	Sig
1	Artificial intelligence is systems that demonstrate intelligent behavior by analyzing their environment and autonomously executing actions to achieve certain goals.	4.35	0.743	13.137	0.000	sig
2	Artificial intelligence is making a machine behave in ways that would be considered intelligent if a human were doing so.	4.34	0.674	14.342	0.000	sig
3	Artificial intelligence is currently part of everyday life for a large proportion of people around the globe.	4.14	0.940	8.117	0.000	sig
4	Artificial Intelligence (AI) has the potential to significantly reduce risks caused by human factors in various domains.	4.15	0.855	8.922	0.000	sig
5	The Egyptian Data and Artificial Intelligence Authority plays an important role in setting guidelines related to the ethics of artificial intelligence.	4.35	0.676	14.439	0.000	sig

From the above table (1) it can be concluded that: there is agreement of the study sample about that there are various principles and ethics that govern the performance of artificial intelligence work, with a T-test (P-Value less than 0.05), indicating the rejection of null hypothesis and the acceptance of alternative hypothesis, that supports There are various principles and ethics that

govern the performance of artificial intelligence work. Accordingly, this results supports acceptance of the first study hypothesis (H1).

H2: There are many applications of artificial intelligence used in different fields and industries.

Table (10): Results of One Sample T-test for H2:

N	Items	Mean	Std. Deviation	Significance level		
				T-test	P-value	Sig
5	Artificial intelligence (AI) offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process data through algorithms, leading to widespread and profound changes in how work is done.	4.41	0.598	17.312	0.000	sig
6	Artificial intelligence has facilitated the emergence of new forms of worker management, as digital technologies based on artificial intelligence allow workers to be monitored and managed based on the collection of large amounts of data in a timely manner for decision-making.	4.29	0.646	14.205	0.000	sig

From the above table (2) it can be concluded that: there is agreement of the study sample about that There are many applications of artificial intelligence used in different fields and industries.,

with a T-test (P-Value less than 0.05), indicating the rejection of null hypothesis and the acceptance of alternative hypothesis, that supports There are many applications of artificial intelligence used in different fields and industries, Accordingly, this results supports acceptance of the second study hypothesis (H2).

H3: There are many risks related to occupational safety and health in the Egyptian work environment.

Table (11): Results of One Sample T-test for H3:

N	Items	Mean	Std. Deviation	Significance level		
				T-test	P-value	Sig
1	Occupational health and safety focus on protecting individuals and ensuring a safe working environment.	4.62	0.608	20.680	0.000	sig
2	Occupational safety and health in the workplace are routinely evaluated to ensure the safety of workers and the safe use of equipment and tools.	4.57	0.585	20.492	0.000	sig
3	Occupational health and safety relate to the field of public health, focusing on analyzing and monitoring patterns of illness and injury that occur within the workplace.	4.39	0.641	15.580	0.000	sig
4	The necessary technical capabilities must be provided to implement occupational safety and health procedures and regulations.	4.59	0.581	21.131	0.000	sig

5	There are many occupational hazards associated with the workplace, and lung diseases associated with exposure to hazardous chemical substances such as lead, beryllium, etc. remain among the most frequently diagnosed work-related conditions.	4.34	0.741	13.042	0.000	sig
6	Safety-leading indicators are a way to flag sites with higher risks. However, there is a lack of validated leading indicators to classify sites reliably according to safety risk levels.	4.21	0.789	10.532	0.000	sig
7	The Egyptian Vision 2030 help in developing the national policy for occupational safety and health.	4.56	0.663	17.960	0.000	sig

From the above table (3) it can be concluded that: there is agreement of the study sample about that There are many risks related to occupational safety and health in the Egyptian work environment., with a T-test (P-Value less than 0.05), indicating the rejection of null hypothesis and the acceptance of alternative hypothesis, that supports There are many risks related to occupational safety and health in the Egyptian work environment., **Accordingly, this results supports acceptance of the third study hypothesis (H3).**

H4: There is a possibility to employ applications of artificial intelligence applications in monitoring and analyzing risks related to safety and health in Egyptian Electricity Holding Company.

Table (12): Results of One Sample T-test for H4:

	Items	Mean	Significance level
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N			Std. Deviation	T-test	P- value	Sig
1	Artificial intelligence is a recent and powerful technology that can transform industry and create new opportunities and challenges for occupational safety and health management.	4.41	0.629	16.458	0.000	sig
2	The use of artificial intelligence applications in the field of occupational safety and health reflects the interest of the system and the company's senior management in occupational safety and health.	4.43	0.704	15.121	0.000	sig
3	Artificial intelligence can help occupational safety and health professionals in Egyptian Electricity Holding Company through using Smart sensors that can monitor environmental conditions, equipment performance, and worker health.	4.46	0.619	17.643	0.000	sig
4	Artificial intelligence applications can monitor violations and unsafe behaviors related to occupational safety and health.	4.33	0.672	14.247	0.000	sig
5	Artificial intelligence can help occupational safety and health professionals in Egyptian Electricity Holding Company through using Chatbots that can provide information,	4.38	0.639	15.741	0.000	sig

	guidance, and support to workers and managers.					
6	Artificial intelligence can help occupational safety and health professionals in Egyptian Electricity Holding Company through using Virtual reality and augmented reality that can simulate realistic scenarios for training and education for workers.	4.42	0.629	16.458	0.000	sig
7	Occupational safety and health professionals at Egyptian Electricity Holding Company must keep up with the latest developments and trends in artificial intelligence and how they impact the management of risks related to occupational safety and health in the electricity sector.	4.44	0.618	17.370	0.000	sig
8	Occupational safety and health specialists at Egyptian Electricity Holding Company must communicate with various stakeholders, such as officials and managers, to understand their needs, concerns, and expectations regarding the use of artificial intelligence and its applications in managing risks related to occupational safety and health.	4.54	0.604	19.383	0.000	sig
9	Occupational safety and health professionals in Egyptian Electricity Holding Company should evaluate and monitor the performance and impact of	4.45	0.649	16.695	0.000	sig

	Artificial intelligence on occupational safety and health outcomes. They should also identify any gaps or issues that need to be addressed or improved.					
10	Occupational safety and health professionals in Egyptian Electricity Holding Company should seek to improve the design of Artificial intelligence applications by providing feedback and recommendations to the relevant parties.	4.46	0.588	18.588	0.000	sig
11	While Artificial intelligence can offer many benefits for occupational safety and health, but Artificial intelligence is still a developing field that faces many technical, ethical, social, and legal issues.	4.36	0.732	13.467	0.000	sig

From the above table (4) it can be concluded that: there is agreement of the study sample about that There is a possibility to employ applications of artificial intelligence applications in monitoring and analyzing risks related to safety and health in Egyptian Electricity Holding Company., with a T-test (P-Value less than 0.05), indicating the rejection of null hypothesis and the acceptance of alternative hypothesis, that supports There is a possibility to employ applications of artificial intelligence applications in monitoring and analyzing risks related to safety and health in Egyptian Electricity Holding Company, **Accordingly, this results supports acceptance of the fourth study hypothesis (H4).**

4.3 To what extent do the respondents' opinions vary on the study's themes according to their personal and job variables:

Differences according to Gender variable:

Table (13): Results of One-Way ANOVA test to demographic characteristics (Gender)

Questionnaire Axes		Sum of Squares	df	Mean Square	F	Sig.
First Axis	Between Groups	.000	1	.000	.001	.975
	Within Groups	25.672	104	.247		
	Total	25.673	105			
Second Axis	Between Groups	.464	1	.464	2.149	.146
	Within Groups	22.456	104	.216		
	Total	22.920	105			
Third Axis	Between Groups	.094	1	.094	.360	.550
	Within Groups	27.158	104	.261		
	Total	27.252	105			

Based on the provided table, it can be inferred that there are no significant differences in the respondents' agreement of the Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health among various **gender**, as the ANOVA test's significance level is higher than (0.05) for all questionnaire axes.

Differences according to Age variable:

Table (14): Results of One-Way ANOVA test to demographic characteristics (Age)

Questionnaire Axes		Sum of Squares	df	Mean Square	F	Sig.
First Axis	Between Groups	.354	4	.088	.353	.842
	Within Groups	25.319	101	.251		
	Total	25.673	105			
Second Axis	Between Groups	.253	4	.063	.281	.889

	Within Groups	22.667	101	.224		
	Total	22.920	105			
Third Axis	Between Groups	.676	4	.169	.642	.634
	Within Groups	26.576	101	.263		
	Total	27.252	105			

Based on the provided table, it can be inferred that there are no significant differences in the respondents' agreement of the Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health among various **age**, as the ANOVA test's significance level is higher than (0.05) for all questionnaire axes.

Differences according to Level of Education variable:

Table (15): Results of One-Way ANOVA test to demographic characteristics (Level of Education)

Questionnaire Axes		Sum of Squares	df	Mean Square	F	Sig.
First Axis	Between Groups	.363	2	.181	.738	.481
	Within Groups	25.310	103	.246		
	Total	25.673	105			
Second Axis	Between Groups	.269	2	.134	.611	.545
	Within Groups	22.651	103	.220		
	Total	22.920	105			
Third Axis	Between Groups	.401	2	.200	.769	.466
	Within Groups	26.851	103	.261		
	Total	27.252	105			

Based on the provided table, it can be inferred that there is no significant differences in the respondents' agreement of the Employing Artificial Intelligence Applications to Monitor and

Analyze Risks Related to Occupational Safety and health among various **Level of Education**, as the ANOVA test's significance level is higher than (0.05) for all questionnaire axes.

Differences according to Marital Status variable:

Table (16): Results of One-Way ANOVA test to demographic characteristics (Marital Status)

Questionnaire Axes		Sum of Squares	df	Mean Square	F	Sig.
First Axis	Between Groups	.448	2	.224	.915	.404
	Within Groups	25.224	103	.245		
	Total	25.673	105			
Second Axis	Between Groups	.317	2	.158	.722	.488
	Within Groups	22.603	103	.219		
	Total	22.920	105			
Third Axis	Between Groups	.106	2	.053	.201	.818
	Within Groups	27.146	103	.264		
	Total	27.252	105			

Based on the provided table, it can be inferred that there is no significant differences in the respondents' agreement of the Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health among various **Marital Status**, as the ANOVA test's significance level is higher than (0.05) for all questionnaire axes.

Differences according to Professional Experience variable:

Table (17): Results of One-Way ANOVA test to demographic characteristics (Professional Experience)

Questionnaire Axes		Sum of Squares	df	Mean Square	F	Sig.
First Axis	Between Groups	1.926	4	.481	2.048	.093
	Within Groups	23.747	101	.235		
	Total	25.673	105			
Second Axis	Between Groups	.880	4	.220	1.008	.407
	Within Groups	22.040	101	.218		
	Total	22.920	105			
Third Axis	Between Groups	1.193	4	.298	1.156	.335
	Within Groups	26.059	101	.258		
	Total	27.252	105			

Based on the provided table, it can be inferred that there is no significant differences in the respondents' agreement of the Employing Artificial Intelligence Applications to Monitor and Analyze Risks Related to Occupational Safety and health among various **Professional Experience**, as the ANOVA test's significance level is higher than (0.05) for all questionnaire axes.

4.4 Descriptive Statistics of Open-Ended Question:

In your opinion, what are the proposed areas in which artificial intelligence applications can be employed for occupational health and safety purposes in Egyptian Electricity Holding Company?

Table (18): descriptive statistics of Open-ended Question

Categories	Frequencies	Percentages
Monitoring industrial processes and analyzing data for hazardous sites such as power plants and transportation stations.	40	37.7%
The field of meter reading and also following up on the contractor's work to avoid any delay in implementation	14	13.2%
Fields of operation and maintenance of the electrical power system	19	18%
The security gate uses artificial intelligence to identify employees and allow entry and exit to prohibited areas	17	16%
Detecting materials that have an impact on the environment and reducing their danger	16	15.1%
Total	106	100%

Table (18) shows that the respondents believe that one of the most important areas in which artificial intelligence applications can be employed for occupational health and safety purposes in the Egyptian Electricity Holding Company is: Monitoring industrial processes and analyzing data for hazardous sites such as power plants and transportation stations, Fields of operation and maintenance of the electrical power system, and The security gate uses artificial intelligence to identify employees and allow entry and exit to prohibited areas.

Chapter 5:

Results and Recommendations

5.1 Conclusion:

The field of artificial intelligence (AI) is rapidly expanding, with many applications seen routinely in health care, industry, and education, and increasingly in workplaces. Although there is growing evidence of applications of AI in workplaces across all industries to simplify and/or automate tasks there is a limited understanding of the role that AI contributes in addressing occupational safety and health (OSH) concerns.

Artificial intelligence is an example of the great importance of scientific and technological advances in a global society. Artificial intelligence is having an increasing impact on employee health and safety. Artificial intelligence can fundamentally impact work management, even to the point where it can not only aid the work process but also manage it autonomously by making autonomous decisions based on the data collected. In such a situation, there is a new, hitherto unknown relationship between the employee and AI. Artificial intelligence can also be used directly to improve employee health. Wearing exoskeletons can improve workers' productivity and promote health protection. An exoskeleton is a robot that a human wear in the form of a suit, constructed with an appropriate structure that improves the dynamics of the user's limbs and joints.

Artificial intelligence (AI) offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process data through algorithms, leading to widespread and profound changes in how work is done. AI is used in a range of applications and tools for assisted work and data analytics, allowing the automation

of increasingly complex tasks, as well as automated or semi-automated workplace decision-making and management. The applications of AI in working processes range from cobots, wearable technologies and assistive tablets on production assembly lines, chatbots in factories, warehouses and call centers, and smart personal protective equipment (PPE), to algorithmic processes in human resource (HR) applications such as people analytics and ‘gamification’. AI may create opportunities but also new challenges for occupational safety and health (OSH), its management and regulation.

Artificial intelligence (AI) has the potential to either reduce or exacerbate occupational safety and health (OSH) inequities in the workplace, and its impact will be mediated by numerous factors. This paper anticipates challenges to ensuring that the OSH benefits of technological advances are equitably distributed among social groups, industries, job arrangements, and geographical regions. A scoping review was completed to summarize the recent literature on AI’s role in promoting OSH equity. The scoping review was designed around three concepts: artificial intelligence, OSH, and health equity.

5.2 Results:

- Artificial Intelligence or AI in short, simply means the intelligence of machines and the branch of computer science that aims to create it. It is the area of computer science focusing on creating machines that can engage on behaviors that humans consider intelligent.
- OHS is often referred to as an important resource for companies in their ambition to create a good working environment. Health and Safety in the workplace is very important to ensure that an organization provides a safe working environment for its employees and to minimize the risk of accidents and injuries.
- Artificial intelligence has facilitated the emergence of new forms of worker management, as digital technologies based on artificial intelligence allow workers to be monitored and managed based on the collection of large amounts of data in a timely manner for decision-making. Artificial intelligence has facilitated the emergence of new forms of worker management, as digital technologies based on artificial intelligence allow workers to be

monitored and managed based on the collection of large amounts of data in a timely manner for decision-making.

- Artificial intelligence can help occupational safety and health professionals through using Virtual reality and augmented reality that can simulate realistic scenarios for training and education for workers.
- Artificial Intelligence (AI) has the potential to significantly reduce risks caused by human factors in various domains:
- Artificial intelligence is a recent and powerful technology that can transform industry and create new opportunities and challenges for occupational safety and health management.
- The use of artificial intelligence applications in the field of occupational safety and health reflects the interest of the system and the company's senior management in occupational safety and health.
- Artificial intelligence applications can monitor violations and unsafe behaviors related to occupational safety and health.
- Occupational safety and health professionals should evaluate and monitor the performance and impact of Artificial intelligence on occupational safety and health outcomes. They should also identify any gaps or issues that need to be addressed or improved.
- The Saudi Data and Artificial Intelligence Authority plays an important role in setting guidelines related to the ethics of artificial intelligence.
- There are many occupational hazards associated with the workplace, and lung diseases associated with exposure to hazardous chemical substances such as lead, beryllium, etc. remain among the most frequently diagnosed work-related conditions.

5.3 Recommendations:

- Occupational safety and health professionals must keep up with the latest developments and trends in artificial intelligence and how they impact the management of risks related to occupational safety and health.
- Occupational safety and health specialists must communicate with various stakeholders, such as officials and managers, to understand their needs, concerns, and expectations

regarding the use of artificial intelligence and its applications in managing risks related to occupational safety and health.

- Occupational safety and health professionals should evaluate and monitor the performance and impact of Artificial intelligence on occupational safety and health outcomes. They should also identify any gaps or issues that need to be addressed or improved.
- Occupational safety and health professionals should seek to improve the design of Artificial intelligence applications by providing feedback and recommendations to the relevant parties.
- Health promotion is a central element of occupational health practice. Efforts must be made to enhance workers' physical, mental and social well-being.
- Education and training are vital components of safe, healthy working environments. Workers and employers must be made aware of the importance and the means of establishing safe working procedures. Trainers must be trained in areas of special relevance to different industries, which have specific OHS concerns.
- There is no replacement to Saudi stakeholder capacity and engagement in developing comprehensive, occupational, workplace health and safety. Saudi stakeholder should embark on introducing a number of new modern regulations to develop a national occupational health service, involving investors, employers, government and health services.
- The work safety and health in Saudi Arabia should have many organization and groups cooperate among them to accomplish three main different objectives: a) the protection and promotion of workers' health and working capability; b) the enhancement of working environment and work to become more safe and healthy; c) Create work groups and working traditions to ensure the safety at workplace. All of this will help develop a new and encouraging social environment which eventually will increase the efficiency of the Saudi workforce.
- Other companies should also be examined, along with a campaign to ensure that employers are involved in planning for occupational health and workplace safety services.

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Appendix:

Questionnaire:

Employing artificial intelligence applications in the process of monitoring and analyzing risks related to occupational safety and health: An applied study in the Saudi Electricity Company

Dear respondents:

We would like to thank you in advance for your time and cooperation in filling out this questionnaire. We are currently conducting research on Employing artificial intelligence applications in the process of monitoring and analyzing risks related to occupational safety and health. It is believed that your genuine answers to the questions will help the researchers to pinpoint potential opportunities that contribute to use Artificial Intelligence Applications in monitoring and analyzing risks related to safety and health in the Saudi Electricity Company.

General Profile of Respondents:

1) Gender

☐ Male ☐ Female

2) Age

☐	18 – 25 Year	☐	35 – 40 Year
☐	25 – 30 Year	☐	More than 40 Year
☐	30 – 35 Year		

3) Level of Education

☐	Pre-secondary education
☐	Secondary
☐	University
☐	Postgraduate

4) Marital Status☐

Single

☐

Married

☐

Divorced

☐

Widow

5) Professional Experience:☐

Less than 5 years

☐

5-10 years

☐

10-15 years

☐

15-20 years

☐

More than 20 years

No	Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
THE FIRST AXIS: ARTIFICIAL INTELLIGENCE						
1	Artificial intelligence is systems that demonstrate intelligent behavior by analyzing their environment and autonomously executing actions to achieve certain goals					
2	Artificial intelligence is making a machine behave in ways that would be considered intelligent if a human were doing so.					
3	Artificial intelligence is currently part of everyday life for a large proportion of people around the globe.					
4	Artificial Intelligence (AI) has the potential to significantly reduce risks caused by human factors in various domains.					
5	Artificial intelligence (AI) offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process					

No	Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	data through algorithms, leading to widespread and profound changes in how work is done.					
6	Artificial intelligence has facilitated the emergence of new forms of worker management, as digital technologies based on artificial intelligence allow workers to be monitored and managed based on the collection of large amounts of data in a timely manner for decision-making.					
7	The Saudi Data and Artificial Intelligence Authority plays an important role in setting guidelines related to the ethics of artificial intelligence.					

THE SECOND AXIS: OCCUPATIONAL SAFETY AND HEALTH RISKS

8	Occupational health and safety focus on protecting individuals and ensuring a safe working environment.					
9	Occupational safety and health in the workplace are routinely evaluated to ensure the safety of workers and the safe use of equipment and tools.					
10	Occupational health and safety relate to the field of public health, focusing on analyzing and monitoring patterns of illness and injury that occur within the workplace.					
11	The necessary technical capabilities must be provided to implement occupational safety and health procedures and regulations.					
12	There are many occupational hazards associated with the workplace, and lung diseases associated with exposure to hazardous chemical					

No	Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	substances such as lead, beryllium, etc. remain among the most frequently diagnosed work-related conditions.					
13	Safety-leading indicators are a way to flag sites with higher risks. However, there is a lack of validated leading indicators to classify sites reliably according to safety risk levels.					
14	The Saudi Vision 2030 help in developing the national policy for occupational safety and health.					

THE THIRD AXIS: EMPLOYING ARTIFICIAL INTELLIGENCE APPLICATIONS TO MONITOR AND ANALYZE RISKS RELATED TO OCCUPATIONAL SAFETY AND HEALTH

15	Artificial intelligence is a recent and powerful technology that can transform industry and create new opportunities and challenges for occupational safety and health management.					
16	The use of artificial intelligence applications in the field of occupational safety and health reflects the interest of the system and the company's senior management in occupational safety and health.					
17	Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Smart sensors that can monitor environmental conditions, equipment performance, and worker health.					
18	Artificial intelligence applications can monitor violations and unsafe behaviors related to occupational safety and health.					

No	Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
19	Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Chatbots that can provide information, guidance, and support to workers and managers.					
20	Artificial intelligence can help occupational safety and health professionals in the Saudi Electricity Company through using Virtual reality and augmented reality that can simulate realistic scenarios for training and education for workers.					
21	Occupational safety and health professionals at the Saudi Electricity Company must keep up with the latest developments and trends in artificial intelligence and how they impact the management of risks related to occupational safety and health in the electricity sector.					
22	Occupational safety and health specialists at the Saudi Electricity Company must communicate with various stakeholders, such as officials and managers, to understand their needs, concerns, and expectations regarding the use of artificial intelligence and its applications in managing risks related to occupational safety and health.					
23	Occupational safety and health professionals in the Saudi Electricity Company should evaluate and monitor the performance and impact of Artificial intelligence on occupational safety and health outcomes. They should also identify any gaps or issues that need to be addressed or improved.					

No	Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
24	Occupational safety and health professionals in the Saudi Electricity Company should seek to improve the design of Artificial intelligence applications by providing feedback and recommendations to the relevant parties.					
25	While Artificial intelligence can offer many benefits for occupational safety and health, but Artificial intelligence is still a developing field that faces many technical, ethical, social, and legal issues.					

Open-ended Question: In your opinion, what are the proposed areas in which artificial intelligence applications can be employed for occupational health and safety purposes in the Saudi Electricity Company?

.....

Thank you ,,,

Statistical Results:

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	81	76.4	76.4	76.4
	Female	25	23.6	23.6	100.0
	Total	106	100.0	100.0	

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18 – 25 Year	12	11.3	11.3	11.3
	25 – 30 Year	12	11.3	11.3	22.6
	30 – 35 Year	26	24.5	24.5	47.2
	35 – 40 Year	25	23.6	23.6	70.8
	More than 40 Year	31	29.2	29.2	100.0
	Total	106	100.0	100.0	

Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Secondary	11	10.4	10.4	10.4
	University	79	74.5	74.5	84.9
	Postgraduate	16	15.1	15.1	100.0
	Total	106	100.0	100.0	

Marital_Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single	26	24.5	24.5	24.5
	Married	77	72.6	72.6	97.2
	Divorced	3	2.8	2.8	100.0
	Total	106	100.0	100.0	

Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 5 years	18	17.0	17.0	17.0
	5-10 years	18	17.0	17.0	34.0
	10-15 years	28	26.4	26.4	60.4
	15-20 years	15	14.2	14.2	74.5
	More than 20 years	27	25.5	25.5	100.0
	Total	106	100.0	100.0	

Reliability Statistics

Cronbach's Alpha	N of Items
.821	7

Reliability Statistics

Cronbach's Alpha	N of Items
.843	7

Reliability Statistics

Cronbach's Alpha	N of Items
.939	11

Reliability Statistics

Cronbach's Alpha	N of Items
.945	25

Descriptive Statistics of the First Axis

	N	Minimum	Maximum	Mean	Std. Deviation
X1	106	2.0	5.0	4.349	.7438
X2	106	2.0	5.0	4.340	.6745
X3	106	1.0	5.0	4.142	.9405
X4	106	1.0	5.0	4.142	.8557
X5	106	3.0	5.0	4.406	.5981
X6	106	3.0	5.0	4.292	.6469
X7	106	3.0	5.0	4.349	.6767
XX	106	3.00	5.00	4.288 4	.49447
Valid N (listwise)	106				

Descriptive Statistics of The Second Axis

	N	Minimum	Maximum	Mean	Std. Deviation
B1	106	2.0	5.0	4.623	.6087
B2	106	3.0	5.0	4.566	.5858
B3	106	2.0	5.0	4.387	.6410
B4	106	2.0	5.0	4.594	.5819
B5	106	2.0	5.0	4.340	.7418
B6	106	2.0	5.0	4.208	.7894
B7	106	2.0	5.0	4.557	.6630
BB	106	3.00	5.00	4.467	.46721
				7	
Valid N (listwise)	106				

Descriptive Statistics of The Third Axis

	N	Minimum	Maximum	Mean	Std. Deviation
C1	106	3.0	5.0	4.406	.6291
C2	106	2.0	5.0	4.434	.7040
C3	106	3.0	5.0	4.462	.6199
C4	106	3.0	5.0	4.330	.6722
C5	106	3.0	5.0	4.377	.6392
C6	106	3.0	5.0	4.406	.6291
C7	106	3.0	5.0	4.443	.6184
C8	106	3.0	5.0	4.538	.6043
C9	106	3.0	5.0	4.453	.6493
C10	106	3.0	5.0	4.462	.5884
C11	106	3.0	5.0	4.358	.7328
CC	106	3.00	5.00	4.424	.50945
				5	
Valid N (listwise)	106				

Correlations

	XX	X1	X2	X3	X4	X5	X6	X7
XX Pearson Correlation	1	.689**	.658**	.637**	.649**	.714**	.716**	.680**
Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000
N	106	106	106	106	106	106	106	106
X1 Pearson Correlation	.689**	1	.464**	.337**	.311**	.449**	.380**	.342**
Sig. (2-tailed)	.000		.000	.000	.001	.000	.000	.000
N	106	106	106	106	106	106	106	106
X2 Pearson Correlation	.658**	.464**	1	.299**	.279**	.482**	.360**	.322**
Sig. (2-tailed)	.000	.000		.002	.004	.000	.000	.001
N	106	106	106	106	106	106	106	106
X3 Pearson Correlation	.637**	.337**	.299**	1	.330**	.236*	.370**	.221*
Sig. (2-tailed)	.000	.000	.002		.001	.015	.000	.023
N	106	106	106	106	106	106	106	106
X4 Pearson Correlation	.649**	.311**	.279**	.330**	1	.352**	.269**	.407**
Sig. (2-tailed)	.000	.001	.004	.001		.000	.005	.000
N	106	106	106	106	106	106	106	106
X5 Pearson Correlation	.714**	.449**	.482**	.236*	.352**	1	.577**	.470**

Sig. (2-tailed)		.000	.000	.000	.015	.000	.000	.000
N		106	106	106	106	106	106	106
X6 Pearson Correlation		.716**	.380**	.360**	.370**	.269**	.577**	1
Sig. (2-tailed)		.000	.000	.000	.000	.005	.000	.000
N		106	106	106	106	106	106	106
X7 Pearson Correlation		.680**	.342**	.322**	.221*	.407**	.470**	.570**
Sig. (2-tailed)		.000	.000	.001	.023	.000	.000	.000
N		106	106	106	106	106	106	106

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Correlations

	BB	B1	B2	B3	B4	B5	B6	B7
BB Pearson Correlation	1	.674**	.768**	.749**	.654**	.621**	.775**	.720**
Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000
N	106	106	106	106	106	106	106	106
B1 Pearson Correlation	.674**	1	.605**	.353**	.397**	.181	.402**	.502**
Sig. (2-tailed)	.000		.000	.000	.000	.063	.000	.000
N	106	106	106	106	106	106	106	106
B2 Pearson Correlation	.768**	.605**	1	.502**	.484**	.299**	.423**	.603**

	Sig. (2-tailed)	.000	.000	.000	.000	.002	.000	.000
	N	106	106	106	106	106	106	106
B3	Pearson Correlation	.749**	.353**	.502**	1	.399**	.462**	.363**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000
	N	106	106	106	106	106	106	106
B4	Pearson Correlation	.654**	.397**	.484**	.399**	1	.366**	.319**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.001
	N	106	106	106	106	106	106	106
B5	Pearson Correlation	.621**	.181	.299**	.462**	.366**	1	.270**
	Sig. (2-tailed)	.000	.063	.002	.000	.000		.005
	N	106	106	106	106	106	106	106
B6	Pearson Correlation	.775**	.402**	.423**	.612**	.372**	.399**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
	N	106	106	106	106	106	106	106
B7	Pearson Correlation	.720**	.502**	.603**	.363**	.319**	.270**	.523**
	Sig. (2-tailed)	.000	.000	.000	.000	.001	.005	
	N	106	106	106	106	106	106	106

** . Correlation is significant at the 0.01 level (2-tailed).

Correlations

	C C	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C 10	C 11
CC Pearson												
Correlat ion	1	.806**	.783**	.793**	.775**	.790**	.797**	.840**	.787**	.803**	.876**	.676**
Sig. (2- tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
N	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06
C1 Pearson												
Correlat ion	.806**	1	.588**	.662**	.604**	.681**	.495**	.586**	.623**	.688**	.646**	.467**
Sig. (2- tailed)	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
N	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06
C2 Pearson												
Correlat ion	.783**	.588**	1	.714**	.580**	.585**	.566**	.735**	.588**	.504**	.569**	.379**
Sig. (2- tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000
N	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06
C3 Pearson												
Correlat ion	.793**	.662**	.714**	1	.636**	.637**	.516**	.628**	.525**	.587**	.662**	.366**
Sig. (2- tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000
N	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06

C4	Pearson Correlat ion	. 775**	. 604**	. 580**	. 636**	1	. 638**	. 626**	. 584**	. 497**	. 614**	. 646**	. 337**
	Sig(2- tailed)	. 000	. 000	. 000	. 000		. 000	. 000	. 000	. 000	. 000	. 000	. 000
	N	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06
C5	Pearson Correlat ion	. 790**	. 681**	. 585**	. 637**	. 638**	1	. 634**	. 560**	. 480**	. 548**	. 621**	. 501**
	Sig. (2- tailed)	. 000	. 000	. 000	. 000	. 000		. 000	. 000	. 000	. 000	. 000	. 000
	N	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06
C6	Pearson Correlat ion	. 797**	. 495**	. 566**	. 516**	. 626**	. 634**	1	. 684**	. 573**	. 619**	. 698**	. 549**
	Sig. (2- tailed)	. 000	. 000	. 000	. 000	. 000	. 000		. 000	. 000	. 000	. 000	. 000
	N	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06
7	(Pearson Correlat ion	. 840**	. 586**	. 735**	. 628**	. 584**	. 560**	. 684**	1	. 681**	. 634**	. 714**	. 529**
	Sig (2- tailed)	. 000	. 000	. 000	. 000	. 000	. 000	. 000		. 000	. 000	. 000	. 000
	N	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06	1 06
C8	Pearson Correlat ion	. 787**	. 623**	. 588**	. 525**	. 497**	. 480**	. 573**	. 681**	1	. 636**	. 714**	. 571**

	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	106	106	106	106	106	106	106	106	106	106	106
C9	Pearson Correlation	.803**	.688**	.504**	.587**	.614**	.548**	.619**	.634**	.636**	.1718**	.476**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	106	106	106	106	106	106	106	106	106	106	106
C10	Pearson Correlation	.876**	.646**	.569**	.662**	.646**	.621**	.698**	.714**	.714**	.1718**	.672**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	106	106	106	106	106	106	106	106	106	106	106
C11	Pearson Correlation	.676**	.467**	.379**	.366**	.337**	.501**	.549**	.529**	.571**	.476**	.672**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	106	106	106	106	106	106	106	106	106	106	106

** . Correlation is significant at the 0.01 level (2-tailed).

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
C1	106	4.406	.6291	.0611
C2	106	4.434	.7040	.0684
C3	106	4.462	.6199	.0602
C4	106	4.330	.6722	.0653
C5	106	4.377	.6392	.0621
C6	106	4.406	.6291	.0611
C7	106	4.443	.6184	.0601
C8	106	4.538	.6043	.0587
C9	106	4.453	.6493	.0631
C10	106	4.462	.5884	.0571
C11	106	4.358	.7328	.0712
CC	106	4.424	.50945	.04948
	5			

One-Sample Test

	Test Value = 3.40					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
C1	16.458	105	.000	1.0057	.885	1.127
C2	15.121	105	.000	1.0340	.898	1.170
C3	17.643	105	.000	1.0623	.943	1.182
C4	14.247	105	.000	.9302	.801	1.060
C5	15.741	105	.000	.9774	.854	1.100
C6	16.458	105	.000	1.0057	.885	1.127

C7	17.370	105	.000	1.0434	.924	1.163
C8	19.383	105	.000	1.1377	1.021	1.254
C9	16.695	105	.000	1.0528	.928	1.178
C10	18.588	105	.000	1.0623	.949	1.176
C11	13.467	105	.000	.9585	.817	1.100
CC	20.705	105	.000	1.02453	.9264	1.1226

ANOVA Gender

		Sum of Squares	df	Mean Square	F	Sig.
XX	Between Groups	.000	1	.000	.001	.975
	Within Groups	25.672	104	.247		
	Total	25.673	105			
BB	Between Groups	.464	1	.464	2.149	.146
	Within Groups	22.456	104	.216		
	Total	22.920	105			
CC	Between Groups	.094	1	.094	.360	.550
	Within Groups	27.158	104	.261		
	Total	27.252	105			

ANOVA Age

		Sum of Squares	df	Mean Square	F	Sig.
XX	Between Groups	.354	4	.088	.353	.842
	Within Groups	25.319	101	.251		
	Total	25.673	105			
BB	Between Groups	.253	4	.063	.281	.889

	Within Groups	22.667	101	.224		
	Total	22.920	105			
CC	Between Groups	.676	4	.169	.642	.634
	Within Groups	26.576	101	.263		
	Total	27.252	105			

ANOVA Education

		Sum of Squares	df	Mean Square	F	Sig.
XX	Between Groups	.363	2	.181	.738	.481
	Within Groups	25.310	103	.246		
	Total	25.673	105			
BB	Between Groups	.269	2	.134	.611	.545
	Within Groups	22.651	103	.220		
	Total	22.920	105			
CC	Between Groups	.401	2	.200	.769	.466
	Within Groups	26.851	103	.261		
	Total	27.252	105			

ANOVA Marital_Status

		Sum of Squares	df	Mean Square	F	Sig.
XX	Between Groups	.448	2	.224	.915	.404
	Within Groups	25.224	103	.245		
	Total	25.673	105			
BB	Between Groups	.317	2	.158	.722	.488
	Within Groups	22.603	103	.219		
	Total	22.920	105			
CC	Between Groups	.106	2	.053	.201	.818
	Within Groups	27.146	103	.264		
	Total	27.252	105			

ANOVA Experience:

		Sum of Squares	df	Mean Square	F	Sig.
XX	Between Groups	1.926	4	.481	2.048	.093
	Within Groups	23.747	101	.235		
	Total	25.673	105			
BB	Between Groups	.880	4	.220	1.008	.407
	Within Groups	22.040	101	.218		
	Total	22.920	105			
CC	Between Groups	1.193	4	.298	1.156	.335
	Within Groups	26.059	101	.258		
	Total	27.252	105			

first study hypothesis (H1).

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
X1	106	4.349	.7438	.0722
X2	106	4.340	.6745	.0655
X3	106	4.142	.9405	.0913
X4	106	4.142	.8557	.0831
X7	106	4.349	.6767	.0657

One-Sample Test

	Test Value = 3.40					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
X1	13.137	105	.000	.9491	.806	1.092
X2	14.342	105	.000	.9396	.810	1.070
X3	8.117	105	.000	.7415	.560	.923
X4	8.922	105	.000	.7415	.577	.906
X7	14.439	105	.000	.9491	.819	1.079

second study hypothesis (H2).

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
X5	106	4.406	.5981	.0581
X6	106	4.292	.6469	.0628

One-Sample Test

	Test Value = 3.40					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
X5	17.312	105	.000	1.0057	.890	1.121
X6	14.205	105	.000	.8925	.768	1.017

Third study hypothesis (H3).

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
B1	106	4.623	.6087	.0591
B2	106	4.566	.5858	.0569
B3	106	4.387	.6410	.0623
B4	106	4.594	.5819	.0565
B5	106	4.340	.7418	.0720
B6	106	4.208	.7894	.0767
B7	106	4.557	.6630	.0644

One-Sample Test

	Test Value = 3.40					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
B1	20.680	105	.000	1.2226	1.105	1.340
B2	20.492	105	.000	1.1660	1.053	1.279
B3	15.850	105	.000	.9868	.863	1.110
B4	21.131	105	.000	1.1943	1.082	1.306
B5	13.042	105	.000	.9396	.797	1.082
B6	10.532	105	.000	.8075	.656	.960
B7	17.960	105	.000	1.1566	1.029	1.284

fourth study hypothesis (H4).

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
C1	106	4.406	.6291	.0611
C2	106	4.434	.7040	.0684
C3	106	4.462	.6199	.0602
C4	106	4.330	.6722	.0653
C5	106	4.377	.6392	.0621
C6	106	4.406	.6291	.0611
C7	106	4.443	.6184	.0601
C8	106	4.538	.6043	.0587
C9	106	4.453	.6493	.0631
C10	106	4.462	.5884	.0571
C11	106	4.358	.7328	.0712

One-Sample Test

	Test Value = 3.40					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
C1	16.458	105	.000	1.0057	.885	1.127
C2	15.121	105	.000	1.0340	.898	1.170
C3	17.643	105	.000	1.0623	.943	1.182
C4	14.247	105	.000	.9302	.801	1.060
C5	15.741	105	.000	.9774	.854	1.100
C6	16.458	105	.000	1.0057	.885	1.127
C7	17.370	105	.000	1.0434	.924	1.163
C8	19.383	105	.000	1.1377	1.021	1.254
C9	16.695	105	.000	1.0528	.928	1.178
C10	18.588	105	.000	1.0623	.949	1.176
C11	13.467	105	.000	.9585	.817	1.100

بحث بعنوان

توظيف تطبيقات الذكاء الاصطناعي في عملية رصد وتحليل المخاطر المتعلقة بالسلامة والصحة المهنية:
دراسة تطبيقية في الشركة السعودية للكهرباء

مشروع بحثي مقدم استكمالاً لنيل درجة الماجستير في تخصص الإدارة

إعداد

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تحت إشراف مشرف المقرر

د. وليد سليمان

٢٠٢٤

مستخلص:

يهدف هذا البحث إلى دراسة توظيف تطبيقات الذكاء الاصطناعي في عملية مراقبة وتحليل المخاطر المتعلقة بالسلامة والصحة المهنية وتطبيقها على الشركة السعودية للكهرباء. تعتمد الدراسة على المنهج الوصفي الذي يعتبر الأنسب للبحث في العلوم الإنسانية والاجتماعية. يقوم على وصف الظواهر وجمع البيانات وتحليلها ومناقشتها بهدف التطوير. واعتمدت الدراسة على استخدام استبانة لموظفي الشركة السعودية للكهرباء (١٠٦ أشخاص) كعينة استطلاعية للتحقق من أداة الدراسة. وأظهرت النتائج أن الذكاء الاصطناعي هو تقنية حديثة وقوية يمكنها تحويل الصناعة وخلق فرص وتحديات جديدة لإدارة السلامة والصحة المهنية. يمكن للذكاء الاصطناعي أن يساعد العاملين في مجال السلامة والصحة المهنية من خلال استخدام العديد من التطبيقات مثل الواقع الافتراضي والواقع المعزز الذي يمكنه محاكاة سيناريوهات واقعية لتدريب وتعليم العاملين. واقترحت الدراسة أن يقوم متخصصو السلامة والصحة المهنية في الشركة السعودية للكهرباء بتقييم ومراقبة أداء وتأثير الذكاء الاصطناعي على نتائج السلامة والصحة المهنية. وينبغي عليهم أيضًا تحديد أي ثغرات أو مشكلات تحتاج إلى المعالجة أو التحسين.