The Impacts of Artificial Intelligence on Workplace Health and Safety in Aotearoa New Zealand

by

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Abstract

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. This research employs an integrative review to explore previous literature to understand what is known about artificial intelligence and workplace health and safety in Aotearoa New Zealand. The data generation, automation, detection, and the power of artificial intelligence to enhance the workplace safety culture are all opportunities that artificial intelligence technology can provide a workplace. However, there are still many challenges that come with artificial intelligence implementation. Some of these challenges include poor preparation of an organisation, cultural issues within the workplace, talent shortages, regulations, and ethics. Application of artificial intelligence technologies in New Zealand are in their infancy, some examples that have been implemented were identified and presented in this research study. This study provides insights into AI applications as well as opportunities and challenges of artificial intelligence in relation to workplace health and safety. These insights explored can also be applied to New Zealand workplaces who are looking into, or already have implemented artificial intelligence technologies.

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Introduction

Workplace Health and Safety in New Zealand

Over the last ten years Aotearoa New Zealand has been focused on improving the poor workplace health and safety (WHS) record. From the tragedy of the Pike River Mine Disaster in 2010, sprung an increased awareness about the change which needed to happen in the space of workplace health and safety in Aotearoa New Zealand (Lamm et al., 2017). The then, Minister of Labour appointed the Independent Taskforce on Workplace Health and Safety, the Independent Taskforce on Workplace Health & Safety (2013) was published and it was determined that the health and safety system in New Zealand was failing.

Following on from the taskforce report a new independent regulator, Worksafe New Zealand was introduced. Worksafe was tasked with leading the change of New Zealand's Health and safety record. The enactment of the Health and Safety at Work Act 2015 (HSWA) came into effect on 4 April 2016, the modernised legislation in the HSWA reflected the change in direction that New Zealand's WHS need to head in (Peace et al., 2019). HSWA focuses on being proactive, identifying and managing risks to ensure that all people are kept healthy and safe, rather than being reactive and addressing incidents once they have already happened.

Within the field of workplace health and safety, change is something that is extremely important and cannot be avoided. Change is crucial, whether this is legislative, structural, or attitudinal – change is fundamental in the evolution of workplace health and safety and avoiding future workplace health and safety tragedies. New Zealand is a leader on the world stage in many things, unfortunately for our workforce, workplace health and safety is not one of these things. This is something that needs to change, momentum for this change started when the new Act was introduced, however organisations and those within them need to work together and be part of these changes, prioritising the safety of workers over the profit of the business. Organisations

must keep up with legislative changes, and work with their workforce to implement the changes, updates of standards are also important to be aware of, however something new to be mindful of is technology. There are emerging technologies being released that may be able to enable organisations to enhance workplace health and safety, this is important for the changes in the workplace health and safety space, as if these technologies are implemented there may be a change in how work is done.

It is a fact that technology changes and advances rapidly. These changes are something that organisations globally, as well as in New Zealand, need to be prepared for and open to. Information technology and digitisation has been identified as an emerging risk to workplace health and safety, the European Agency of Safety and Health at Work (EU-OSHA) is currently looking into the large developments in the space of digitisation and information technology, specifically in areas such as artificial intelligence, exploring the potential of how it may impact upon workplace health and safety (WHS).

Artificial Intelligence

Artificial intelligence is rapidly becoming a tool of the future. AI has largely evolved since the 1940s when Alan Turning first explored the possibility of whether a computer was capable of imitating the brain, to think like a human (Cooper & Leeuwen, 2013). The term artificial intelligence as we know it was first coined in 1956 at an Artificial Intelligence Dartmouth Summer Research Project run by John McCarthy. McCarthy, now known as the father of AI, wanted to explore if "intelligence can in principle be so precisely described that a machine can be made to simulate it."(Andresen, 2002, p. 84).

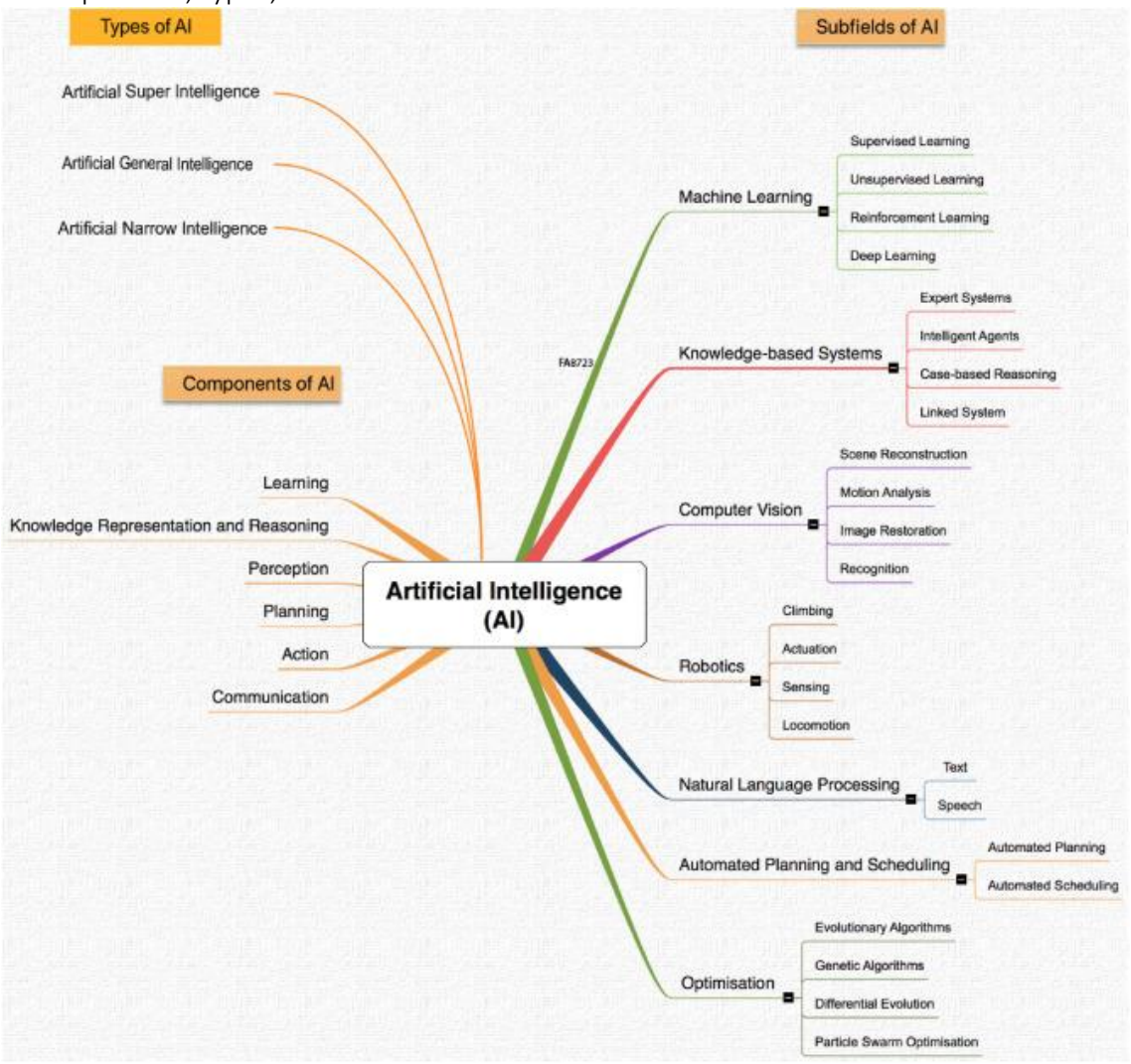
AI has now been used in many different industries and is in many people's day-to-day life. AI is being used as a problem solving tool and is in use for the likes of decision making (Habli et al., 2020), monitoring (Segal et al.), as well as increasing workplace productivity (Abuwarda et al., 2022). There are many other uses of AI and it is fast becoming a tool which is commonly used within many organisations. Jeske et al. (2021)

make the point that AI technologies are to be thought of as process and method loop, this enables the technological system to perceive the environment it is in, process what they perceive, and then from there solve a problem, make decisions, as well as learn from the result of their decisions and actions.

The evolution of AI since the 1956 research project has birthed many other sub-fields of AI. Within the general term of AI there are three types of AI; Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI) and Artificial Super Intelligence (ASI) (Baum et al., 2017), these are shown in Figure 1 – as documented by Abioye et al. (2021). Currently, what has been achieved in the space of AI development has been concentrated on ANI, ANI has been termed as weak AI, where machines are able to exhibit intelligence in specific domains. AGI is a step up from ANI, and is often called strong AI, this is artificial intelligence simulating at a level of human intelligence. AGI is an AI system which has a degree of self-understanding as well as autonomous self-control, these AI systems have more abilities such as being able to learn from tasks and solve problems which have emerged since their creation (Goertzel & Pennachin, 2007). For researchers and developers to progress to this point of AI technology there are many problems which need to be overcome, this is why the main focus of usable AI development has been on ANI (Goertzel & Wang, 2007). ASI intends to go far beyond what ANI and AGI do, hypothetically ASI will be able to outperform humans in practically every aspect, exceeding all human capabilities (Pueyo, 2018).

Figure 1.

AI components, types, and subfields



Note. This model was produced by Abioye et al. (2021), this summarises AI and its components, types and subfields. From "Artificial intelligence in the construction industry: A review of present status, opportunities and future challenges," by Abioye et al. 2021, Journal of Building Engineering, 44, 103299. CC BY 4.0.

There are six major components of AI, shown in Figure 1 – these components are: Learning, knowledge representation, perception, planning, action, and communication (Abioye et al., 2021). These components then contribute to the sub-fields of AI which lead to developers being able to create a multitude of technologies. According to Abioye et al. (2021) it is also important to outline the major sub-fields of AI, these sub-fields are the technologies powering what we know broadly as AI. The sub-fields are Machine

learning, Knowledge based systems, Computer vision, Robotics, Natural language processing, Automated planning and scheduling, and Optimisation.

Machine Learning

Machine learning (ML) is concerned with giving computers the ability to be able to learn, progressively improving upon their performance and ability to execute tasks.

Knowledge Based Systems

Knowledge based systems (KBS) is the branch which explores machines being able to make decisions based of prior knowledge. KBS are able to analyse knowledge, data and other information in order to generate further information. These systems are able to provide knowledge based information to workers at all levels of an organisation (Walczak, 2016).

Computer Vison

Computer Vision is a field of AI which involves several different disciplines. The primary focus of computer vision is to artificially simulate the human visual system. From here the goal is to enable machines to imitate human intelligence. The sub-field of computer vision seeks to process images/videos. This process occurs by using algorithms, accessing what the media is and then making an informed decision based off the image received (Abioye et al., 2021).

Robotics

Robotics, this sub-field of AI involves producing and automating machines which can carry out tasks and actions which are typically undertaken by humans. In a workplace setting robotics are currently used as a tool to assist workers in tasks, substituting the worker and protecting workers from hazardous situations or exposures (Deshpande et al., 2018). Robotics typically encompasses multiple subfields of AI such as machine

learning and computer vision, Robots generally utilise actuators and sensors to interact with their environment (Abioye et al., 2021).

Natural Language Processing

Natural Language Processing, this is an AI sub-field which allows machines to understand and process language as humans do, written or spoken. Many people around the globe are already using natural language processing in their day-today lives and an example of this are voice assistants, Siri and Alexa, the technology behind these programs is NLP (Rohan et al., 2020). Within the field of WHS, natural language processing has been used within some organisations to analyse safety reports, this has been in use since the 1990s (Garcia, 2005), utilising natural language processing in the health and safety field is logical as safety reports hold valuable information, details such as causation can be drawn out of the report, quickly linking the report to other historical reports in the database (Ganguli et al., 2021).

Automated Planning and Scheduling

Automated Planning and Scheduling, this is a sub-field of AI which is concerned with enabling AI to achieve desired objectives, to reach these objectives the technology selects, and sequences actions based on the expected or most probable outcome. Scheduling involves plans and an allocating time and resources to achieve a task or goal. Planning and scheduling involves algorithms and optimisation (Abioye et al., 2021).

Optimisation

Optimisation is a sub-field which makes decisions or choices based a set of constrains providing the best outcome. Optimisation is connected to algorithms and is concerned with outcome providing the optimal solution for the problem trying to be solved. Most AI is built around optimisation, it plays a large role within AI systems (Stray, 2020)

Rationale for this research

There are many applications where AI is being used in workplaces around the globe. Successful uses of these technologies are part of the accumulating evidence that there is high potential AI technology could be used within workplaces to detect, identify, monitor, and predict hazardous work environments or situations which involve risky behaviours. On a surface level this could be a highly beneficial tool that could benefit workplace health and safety (Pishgar et al., 2021). However, there is still a large amount unknown about AI technologies and their effects on WHS, which is why this topic has been classed as an area of interest.

The topic that this research is focused on – Artificial intelligence and its impacts on Workplace Health and Safety (WHS), has been identified as an area of interest by workplace health and safety agencies globally, including the European Agency for Safety and Health at Work (EU-OSHA). EU-OSHA has identified AI as an area which needs more research, the research is needed to understand and raise awareness on how the integration of digitisation and information technology may impact upon the health and safety of workers in organisations. Organisations need to have the information of how artificial intelligence can impact upon their organisation, including how to control the emerging challenges and risks to ensure that employees remain healthy and safe while at work. There is a gap in knowledge regarding the dynamics of AI and WHS, there is a need to know about and understand the "risks and unintended consequences" (Wilkens, 2020, p. 253) which may emerge from introducing AI into the workplace. However, it is also important to focus on what opportunities there are for introducing or using AI within organisations and what advantages there are for WHS.

EU-OSHA – European Agency for Safety and Health at Work (2021), published a policy brief which starts by outlining that AI has the potential to lead to profound changes in how work within organisations is done. The brief talks to the point that there are many opportunities in utilising AI technologies in many ways. Examples of how these AI technologies can be used include: removing workers from hazardous situations by

substituting human workers with that of a robot (Seward et al., 2007), utilising machine learning for the automation of tasks (Young et al., 2021), workers may be able to use wearable technologies as a form of PPE which will allow constant monitoring of the workers risky movements or the hazardous environment that they are working in, these technologies will then contribute to the worker receiving less exposure to tasks with a higher risk factor (Patel et al., 2022).

However, there are also risks that come along with this integration of AI. Risk factors can include a reduction in interaction with human workers which could lead to increased psychological risks, unpredictable AI in the workplace could lead to increased risk of incidents and ultimately if the organisation becomes too reliant on these new technologies it could result in the workers becoming unaware of safety risks within the workplace (EU-OSHA – European Agency for Safety and Health at Work, 2021). As this area is becoming relevant with the increasing number of technologies available, more safety agencies around the world are starting to explore the topic, Australian Institute of Health and Safety (2021) released a news article on their website which was titled "How will artificial intelligence and machine learning impact OHS?" in the article they mentioned an interview by Dr Ben Morrison, Senior Lecturer in Organisational Psychology at Macquarie University. Morrison has said that people can see that there is a benefit of AI systems on the health and safety of workers but to also expect hazards to arise from the use of these technologies – pointing to the psychosocial risks that EU-OSHA had mentioned, as well as expressing concern about increased work pace as well as other pressures within the workplace environment. Morrison concludes by mentioning the lack of consideration for WHS in the use of these technologies and how this area is an urgent problem for WHS professionals.

This researcher aims to review relevant literature to be able to give recommendations for the opportunities and challenges that may emerge when implementing or deciding to implement artificial intelligence into New Zealand

workplaces. The research question posed by this research study is, what are the opportunities and challenges of artificial intelligence on workplace health and safety in Aotearoa New Zealand? Two objectives have been set in order to answer the research question:

- What impacts do AI applications have on WHS?
- What applications of AI are being used in New Zealand organisations?

This study is an important contribution to understanding the dynamics of AI and its impact upon workplace health and safety. This study begun by providing a background of what AI is, including components and AI sub-fields. It then moves into exploring applications of AI in the workplace and the opportunities and challenges in relation to WHS. With the information generated by this research it is hoped that it will become a learning tool for organisations and their journey for controlling or implementing AI in the workplace.

Methodology

Research Question

Previous research has identified research gaps regarding the impacts of Artificial Intelligence on Workplace Health and Safety. As a result of this, the research question posed by this research study is:

- What are the opportunities and challenges of artificial intelligence on the workplace health and safety in Aotearoa New Zealand?

Research Focus

This research intends to focus on understand how AI integrated in workplaces, can impact upon the health and safety of the workers within them.

As this research intends to understand the challenges and opportunities of artificial intelligence on workplace health and safety in New Zealand, what this researcher first needs to understand is what applications of AI are being used in workplaces, as well as the impact that these applications have on the workplace health and safety of people in the organisations.

Research Design

The present study employs an integrative review methodology, the researchers' decision to employ an integrative review methodology for this topic of research, was that the area of interest is in its infancy. Torraco (2005, 2016) stated that integrative reviews are generally intended when addressing two kinds of topics – the first being a mature topic and the second a new or emerging topic. Acknowledging that AI and the impacts of this technology on WHS is very new, the researcher believed that this research methodology was a good fit.

The choice of an integrative review methodology allows this researcher to synthesise literature and identify major themes as well as key constructs in this new area of interest that is Artificial Intelligence and Occupational health and safety. As stated previously the topic of AI and its' impact on WHS is an emerging area of interest, utilising information obtained in an integrative review it allows the researcher to connect a various array of research findings to be able to create a new understanding and recommendations about AI and WHS.

An integrative review method allows the researcher to look at the phenomena of AI and WHS more broadly than other review types. It is intended that the integrative review will be broad, this is to ensure that enough information is gathered about AI in relation to occupational health and safety. As this research aims to identify the challenges and opportunities of artificial intelligence on workplace health and safety in New Zealand, what this researcher first needs to understand is what applications of AI are being used in workplaces, as well as the impact that these applications have on the workplace health and safety of people in the organisations. An integrative review allows the researcher to gather insights which include concepts, thoughts as well as experiences.

Search Strategy

The integrative review was completed with guidance from the book A step-by-step guide to conducting an integrative review (Toronto & Remington, 2020). A broad approach to searching literature was used, the initial search was conducted on the Victoria University of Wellington Te Waharoa search engine which was then extended and included Web of Science, Scopus, Science Direct and Research Gate. The searches were conducted systematically, utilising Boolean operators and advanced search techniques which features on most search engines as per guidance of Toronto and Remington (2020). The primary focus of searching databases was to identify full length, peer-reviewed articles but if any grey literature was identified in this process which was

of use this would also be used within the research study. Due to the research of AI and its link to WHS being only in its infancy and the fact that modern AI is dated back to the 1950s (Abioye et al., 2021), it was decided that no limitations be placed on the date of publication to ensure the researcher could review a broad array of literature.

A variety of concepts were identified from initial searches of the research question to identify effective search terms for this research.

Concepts: Artificial Intelligence, Health and Safety, WHS/OHS, Workplace, Machine Learning, AI Challenges, AI Opportunities, Future of work.

These concepts were then combined, and keywords were used in the searches which included combinations of “artificial intelligence”, “AI”, “health and safety”, “OHS”, “WHS” “workplace”, “future of work”, “machine learning”, “challenges”, “opportunities”.

As this research is focused on the impact of AI on WHS, the AND operator was most commonly used as a search term in order to return literature which included information on both AI and WHS. After multiple searches it was obvious that the term health was being identified in the search engines too broadly and searches were yielding results from the healthcare industry that were not relevant to this research. Even after the researcher excluded the term healthcare by utilising the NOT operator articles based in a healthcare setting were still clogging the results. The researcher then decided to analyse the results and filter by a relevant subject such as ‘Public Environmental Occupational Health’, or to included key words such as “Health and Safety” and “Artificial Intelligence”. This significantly narrowed down the number of articles and yielded more results that were of relevance to strengthen this research.

Database searches

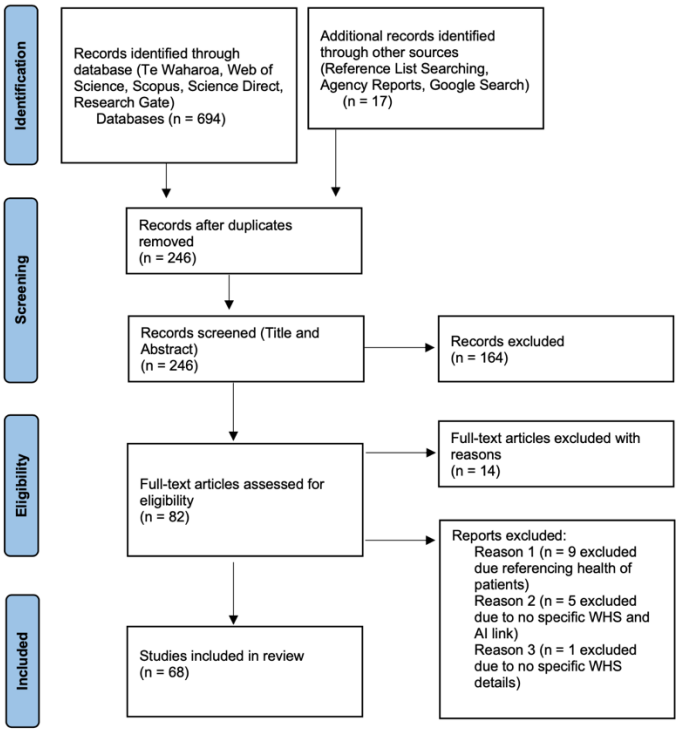
The database searches were successes in yielding many interesting articles on the topic of AI, however upon analysing the articles that were found in the Endnote software, a large number of duplicates were identified, and subsequently removed. The researcher then began reviewing titles and abstracts, it was found that there was a large number or articles published on the topic of AI but many of these articles only referred to a link to WHS and did not go into detail of the opportunities or challenges that are presented when implementing AI into an organisation, thus many articles were not included as they did not present the information needed for the review. Once the researcher had a manageable number of research articles to review, which were thought to be of relevance to this research study, the full-text articles were then assessed for suitability to be used in this review. A small number of articles were removed at this point due to the information not being suitable, the reasons can be found in the PRISMA flowchart diagram in Figure 2.

As the researcher found that there was a lack of research regarding AI and WHS based in New Zealand, the researcher utilised a search strategy in the google search engine. This search strategy was utilised as the research study needed more information on AI and WHS in New Zealand, and academic databases did not have the information which was needed. This finding was not surprising as early on in the research an article from Polak-Sopinska et al. (2019) was review and they found that only 31 articles matched their inclusion criteria. Table 1 displays the search terms that were utilised when searching on a large database such as google, this method was explained by Toronto and Remington (2020)

From here, a review of literature was conducted to identify what applications of AI are in use in organisations that provide opportunities or introduce challenges for workplace health and safety.

Figure 2.

PRISMA flowchart showing final results



Note. Source: (Toronto & Remington, 2020)

Table 1

Google Search – Search Strategy

Search	Exact Search	Results
Google search without limiters	Artificial intelligence and New Zealand workplaces	6.5 million results
Google search with limiters	(Artificial intelligence) and (New Zealand) workplaces and (file: .pdf or file: .org) and site: .edu or site: .org or site: .gov)	1,690 results – looked at first 20 results, only first 14 results had relevance.

Results and Synthesis

Applications of Artificial Intelligence

At this point in time, more organisations are exploring the possibilities of how AI technologies can help them thrive into the future. Organisations are leveraging AI technologies to help them navigate workplace risks and discover specific risks that workers are exposed to, the organisation can the use the data collected to improve the work environment to make it healthier and safer for all workers. It is well known that each workplace is different, and there are different risks present in all working environments. To mitigate these risks some workplaces have started to used key enabling technologies (KETs), KETs are able to monitor, manage and optimise the working environment, this is relevant as AI is viewed as a KET (Kress et al.).

The Health and Safety at Work Act (HSWA) 2015, section 30 management of risks, states that under the Act, there is a duty (a) to eliminate risks to health and safety, so far as reasonably practicable; and (b) if it is not reasonably practicable to eliminate risks to health and safety, to minimise those risks so far as reasonably practicable. Employers are now beginning to explore technological options that are available to keep their workers safe. Technologies have been introduced into workplaces to improve control measures already in place and even to improve the effectiveness of personal protective equipment (PPE) (Patel et al., 2022), the lowest level of the hierarchy of controls.

Schwab and Daly (2020) discuss manual handling and the risks of back sprains, workers pulling muscles, as well as injuries to the back, arms, and the spinal cord. There are many industries in which heavy manual handling tasks are a risk. Within the context of New Zealand, Worksafe New Zealand data shows that in the time between June 2021 to May 2022, the most common cause of injuries which result in more than a week away from the workplace, was muscular stress caused by lifting, carrying or putting down objects – manual handling (WorkSafe New Zealand, 2022). There are now technologies

on offer that can assist workers, to minimise the chance of being injured while performing manual handling tasks.

An example of a wearable technology in use to prevent manual handling tasks is a device that is worn on the belt of a worker. This device, from a company called Kinetic works by using AI technology to detect high risk manual handling tasks, in this example the employee had to bend and twist to place parts from a table into a machine as part of their daily workflow. The motion sensor device worn on their belt automatically detects unsafe positions and provides a light vibration to the user to alert them to the unsafe behaviour. From the data generated the organisation was able to see that sensor device detected 97 high risk movements. Other important information that is shown on the corresponding software analytic platform is the specific worker who was making these movements, what these movements were, when the worker was performing them as well as how often they were performing them. With this data the organisation can then work with the affected worker to modify or redesign the work process or the workplace, in this instance this was exactly what happened and the workers high risk movements were reduced by 64% (Kinetic, 2021). In this case, the AI technology and the data generated by this technology enabled the organisation to understand what is happening in their workplace, make the appropriate changes with the affected workers and were able to measure the impact of what these changes were, seeing a quantified difference.

Manual handling hazards are not the only hazards that are beginning to be minimised using wearable technologies. Wearable technology is useful, in the last example it shows that some wearables serve as an always on, continuous coaching tool which can improve the behaviour of the worker or alerts the worker when they should act. The technology generates real time data as well as alerting the user to risky situations (Patel et al., 2022). Another example of a wearable device, is a technology which is worn on the wrist, called Reactec it is a solution to manage exposure to hand arm vibrations. Hand arm vibrations are caused by use of power tools, those that use

power tools for long periods of time are more susceptible to hand arm vibration. The Reactec device is worn on the workers wrist and looks identical to a watch. The device has multiple sensors and has been improved to detect vibration, noise, gas, and dust. The device tracks tool use and calculates daily exposures, once exposure limits are reached or exceeded, the wearer receives an alert of the hazardous situation. This system, like Kinetic – generates reports on exposures for each of the wearers. An interesting point to this technology is that controls can be logged, and the technology can record the effectiveness by conducting risk assessments while the worker is wearing the device (Patel et al., 2022).

Sensor technology has also been implemented into many workplaces, a high-risk area in the workplace where sensors have been implemented, is around mobile equipment, this will be discussed further in the research study, but it is important to identify this technology at this point in the research also. A journal article titled "High accuracy lift-height sensor makes forklifts safer" (2005) discussed the point, that on forklifts, sensor technology had been used to optimise the forklifts speed to prevent tilt overs as well as automatically ensuring that the forklift has a load at the correct lift height. Although there have been advances in forklift technology since the release of this article, this still shows that sensor devices have been around, and in use for some time. Like forklifts, sensor devices too have advanced. Within the material handling industry sensor technologies are being used to detect row heights, pedestrians, and other moving equipment (Nkwocha, 2013).

Current safety programs in the workplace rely heavily on training, many training programs utilise resources such as videos and consultants. The outcomes provide workers with the knowledge to understand why a task should be done in a specific way or with specific tools. The workers can then modify the way that they do their work, however it is then up to the individual to sustain the learnings and any modifications of how their work is done. If used, the technologies discussed and others, can drive the

change in how workers are doing their work, aiding the worker to sustain the behaviour learnt in trainings by providing continuous feedback while completing their daily work. The technologies are able to monitor the health and safety of workers and there are a large amount of technologies which may be used to contribute to reducing risk within the workplace (Polak-Sopinska et al., 2019). Another training tool that is discussed by Nkwocha (2013), is the use of virtual reality software programs to improve the quality of workplace trainings. The example given in this article discusses a forklift training funded by the US National Institute for Occupational Safety and Health (NIOSH), the training allows the forklift operators to virtually practice several different safety challenges while in a virtual warehouse, controlling a virtual forklift with all the relevant controls.

Video analysis detection is another use of AI technology that is emerging. This works in a similar way to the wearable sensor technology discussed earlier in this section by detecting a behaviour and recording this detection data. Video analysis detection works by determining an algorithm or rule within the software managing CCTV footage of a workplace. Once the software detects a violation of this rule, a video of the event is logged in the online system to be reviewed and data of the event is logged. An example of a scenario that detects a violation is – a rule algorithm is programmed to detect human and forklift interaction; the CCTV footage captures a worker who is interacting with the path of a forklift; a violation detection is actioned within the system and this violation can then be reviewed by the appropriate person (Seedigital, 2022). This type of AI technology offers an insight into what is occurring in a workplace when key personnel are not around to see events happening. It can be used, like the sensor technology, to understand the workforce is following rules or procedures, but it can also be used as a learning tool for workers to understand what the risks were surrounding their actions. There are many other scenarios that can be programmed to be detected and this AI technologies offers an alternative way in gathering WHS data. Some workplaces, where they need move visibility than CCTV cameras can offer, have utilised drones for this same goal, the drones fly in an open space and capture photos and videos which are then

transferred through to the deep learning software, programmed with the corresponding algorithms to identify any detections (Shanti et al., 2022). The use of a drone allows the AI technology to be used in workplaces which cannot allow for CCTV installation.

The final application of AI technologies that will be discussed in this section of the research study is a concept explored by Ganguli et al. (2021), they discuss use of a smartphone-based worksite application. This application can be advantageous for WHS professionals by providing real time data for observations or incidents which occur in the workplace. An example in the article was that natural language processing was used to analyse the data from workplace observations submitted through the smartphone application. From these observations the WHS team on site were alerted to a potential hazard on the worksite as a number of workers had documented a specific practice in their observations. These observations are rich in data coming firsthand from the workers on the frontline, depending on what is documented in the observations, the WHS professionals onsite have many options of what they can do to prevent injury or ill health from occurring.

Industry 4.0

Industry 4.0 is a term that stands out in a large amount of literature. Industry 4.0 otherwise referred to as the fourth industrial revolution, is the transition into a fully digitised organisation (Badri et al., 2018). It is believed that industry 4.0 will increase productivity by promoting optimisation, digitisation, and customisation of the work process. The primary goal of the majority of organisations is to generate a profit, the promises that Industry 4.0 will increase the productivity of a workplace contributes to achieving this goal as it will be able to strengthen the value chain (Aiello et al., 2022). However with any change in a workplace, WHS needs to be considered as there is the potential for new WHS risks (Naeini & Nadeau, 2022)

With the fourth industrial revolution we are starting to see the changes within organisations structures and the roles that human play within these (Neumann et al., 2021). However, Badri et al. (2018) conclude by stating that if manufactures of technologies for industry 4.0 continue to develop these products or systems without WHS initiatives, the systems are implemented into the workplaces there will be an increase in workplace hazards and potentially incidents. They mention that it is important that these technologies and implementation methods are developed in collaboration between researchers, field experts as well as industrialists to ensure that there is a safe transition into the new industry 4.0 paradigm.

AI technologies have the power to perceive their environments, solve problems and make decisions and learn from these decisions (Jeske et al., 2021). The implementation of these technologies into the workplace changes the design of the work, affecting WHS but also providing advantages such as physical or mental relief for workers within organisations. The traditional role of the operator is starting to be re-considered and WHS is one of the factors that is driving this change (Aiello et al., 2022). Artificial intelligence tools will begin to allow workplaces to streamline the process of organising, assessing and interpreting large amounts of data, this then will result in organisations being able to address problems quickly to mitigate or minimise adverse effects on the workforce (Hull & Bowman, 2018). This is an interesting point for the field of WHS and indicates how AI can be used a tool for changing how work is done. However, it is important to consider how these changes will be perceived from the 'shop floor' level. Workers on the floor will need to buy into these changes for full effect of industry 4.0. Kelley (2022) considers this in their study, looking into employee perceptions of effective adoption of AI. Briefly, they found that if there is not full support for the adoption of AI then this may impact upon the effective adoption of AI in the workplace, this point will be explored in more depth in the challenges section of the research.

An article published in 2018 also explores employee perceptions of future workplaces. The study found that there was only little belief that AI, specifically robots and automation would take over jobs in the workplace. The study interviewed a range of people in different industries and professions from bartenders to managers, there was a common theme identified which was a level of uncertainty – it is not yet known how much workplaces or workforces will change (Brougham & Haar, 2018). In general, a large proportion of articles on AI in the workplace focus on what AI or more broadly industry 4.0 may look like in the workplace on a surface level, the jobs it may replace and how it may be implemented. Currently AI has not been deeply rooted into workplaces, and organisation only have a limited understanding of AI, the uses of AI at this stage are predominantly focused on AI being used to supplement mechanical or heavy tasks. The technology is being introduced to reduce the mundane repetitive tasks in the likes of manufacturing industries by automating tasks with machinery (Wei & Li, 2022). This is important information, however in this research study research the main focus will be on exploring the effect of these technologies on WHS, such as the risks that may emerge and how they can be controlled.

Risk management is an extremely important part of WHS, Hull and Bowman (2018) consider the need to update the risk management process, specifically risk assessment to keep up with Industry 4.0. They state that as the technology is advancing rapidly it is important that the risk management process also needs to be modernised to be able to identify and manage the risks associated with the implementation of these technologies. Further to this point, more studies are starting to look into utilising AI in the risk management process (Ayhan & Tokdemir, 2019; Azadeh et al., 2011) as well as how new hazards associated with AI should be considered in the risk assessment process framework (Anastasi et al., 2021). Linking back to industry 4.0 there is a need for an updated standard of safety and risk management as we start to look at integrating AI technologies in to the workplace. Anastasi et al. (2021, p. 342) conclude their research

paper by stating that “In future, a Risk Assessment 4.0 will be developed by considering the new technologies and the continuous monitoring and data acquisition”.

A limitation of the research on industry 4.0 is that it originated in the manufacturing industry, therefore the majority of information generated is based solely on the manufacturing industry, some of the research cannot be crossed over into other industries, however a large proportion of the research done in the topic of industry 4.0 can transfer to the majority of different industries.

Opportunities

Most organisations have realised that effective health and safety management is paramount to the success of an organisation as a whole. A large number of organisations have transitioned to a proactive approach to WHS and realise that it is crucial to understand the challenges and opportunities that affect WHS, including future technologies and its components. The early stages of WHS were extremely reliant on placing a buffer between the worker and the hazard by utilising personal protective equipment. From here the field of WHS moved toward educating the workers with the aim of reducing dangerous situations and unsafe behaviours at work. This wave saw a greater emphasis on root cause analysis with the intention to prevent incidents from reoccurring (Niu et al., 2019). Although there have been large accomplishments made in the space of WHS management, there are gaps in rational decision making and acting when dangerous situations emerge. Niu et al. (2019) continue by pointing out that they believe WHS management has stagnated, and the field is ready for the next wave. The next wave is defined by the introduction of AI technologies into the workplace, the authors do acknowledge that the developments in this space are still in their infancy and that there is more to be understood regarding this topic. This point echoed by other research as discussed earlier in this research.

Power of data

Artificial Intelligence (AI) technologies such as the wearable device discussed earlier in this research can be beneficial for the workplace, they allow the workers to see the data that they generate, allowing the workers to be in control of what they are doing and are able to see insights regarding the progress that the workers are making in the space of creating a safer, healthier workplace. Having the worker integrated in the process, and in control of their data means that workers can begin to own their safety as well as improving the overall safety of the workplace. These technologies allow the organisation to enhance their safety culture by engaging the workforce. When the sensors detect high risk tasks workers in the organisation should feel empowered to suggest solutions for how the organisation can improve the task or even the work environment. Finally, AI technologies also mean that a large amount of data is generated automatically. WHS professionals may not have to spend hours inputting data into a spreadsheet for further analysis, it gives back time to the WHS team to spend more time with the frontline workers thoroughly understanding how their work is done (Kontus & Reinhold, 2021).

Automation

In the present state of industrialisation, automation is a key talking point. Organisations are beginning to consider the role of the robot. An example of the role of the robot is autonomous warehouses, these are warehouses which have autonomous robots working, completing tasks such as loading trucks and moving product. To keep workers safe organisations started out by separating robots and humans, placing a barrier between the human worker and the robot worker, human workers would have full control, being able to immediately stop the robot if something were to go wrong. However, with technology advancing some organisations are moving toward humans and robots collaborating in the workplace. Collaborative robots provide an increase in efficiency and productivity; however, this collaborative work introduces new hazards into the workplace, one of these being the increased risk of the robot colliding with the workers (Beetz et al.). This is why it is critical that there are effective controls in place to

ensure the safe operation of the workplace robots to ensure that they cannot cause harm to the human workers (Inam et al., 2018). Sensors are commonly used in autonomous warehouses, the sensors detect and track human workers, robots then deviate from the path of the workers – a safety system known as a collision avoidance system. The safety system monitors the behaviour of the robots, the environment of which they are working in, including the presence of unexpected obstacles and human workers. The system reacts to failures, ensuring that the robot continues to operate in a safe manner. Safety sensors are sensors which comply with safety norms, pre-programed rules, these sensors have high reliability as well as very low failure and error rates (Magnanimo et al., 2016). Utilising safety sensors means that means that the workplace can identify safety zones around the robot, according to Magnanimo et al. (2016) these zones are known as safety fields and these are programmed according to the layout of the workplace the robots will be working in. The safety field is made up of two components, a protection field, and a warning field. If the sensor detects something within the protection field the robot will immediately stop. When something is detected in the space of the warning field the movement of the robot is then restricted and slowed to ensure that there is not a collision with equipment or another worker, reducing the risk of an incident

Detection

Why utilise detection? Sometimes workers may believe that the way they have always done a task is the best way that it can be done, they may not realise that the way it is performed could potentially cause an injury or worse – death. In some organisations the worker may not feel comfortable to report that there is an issue with the way that work is done, there can be many factors surrounding why this may be. The worker may not realise that the task can be done in an alternative way or that the workplace could potentially be altered in order for the worker to perform their task in a safer manner and potentially get the task completed more efficiently. Reporting generates extremely

important information for WHS professionals as well as the organisation, AI technologies can be used to help increase the levels of reporting within the workplace.

Improving Safety Culture

Workers owning their own data generated by AI technologies in the workplace build the internal safety culture within the organisation. Data generated by the AI technology aims to improve the workplace, which means we need to look into how this technology can work with WHS professionals. The literature reviewed, which has been discussed earlier in this research shows that the data will allow the WHS professionals to review tasks that are occurring on the floor and identify the gaps within the workplace, allowing controls to be put in place before an incident occurs, minimising or eliminate the risk to the worker. If the workers are able to see that the AI technology is working with them and detections are being actioned by the management team to make the workplace safer, this will be a positive driver for improving the safety culture in the workplace (Niu et al., 2019). This finding is mirrored by that of a white paper published by Kinetic (2021), who made a key point which was that technologies will allow organisations to enhance their safety culture. Niu et al. (2019) conclude their study by mentioning that to improve the safety culture in a workplace with stagnant WHS management, the path forward lies with the implementation of AI technologies.

Reporting

Near miss reports act as an early warning signal for potential incidents in the workplace. Reports of near misses can allow health and safety professionals to put controls in place before an incident does occur.

Predicting incidents is a key aspect of the safety of the workplace, Ayhan and Tokdemir (2019) noted that the workplace in their study did not have a large amount of near miss data, this workplace prioritised accident reports and root cause of these

investigations, the organisation believed that near miss reporting was not as important or significant as accidents, thus taking an 'ambulance at the bottom of the cliff approach'. Reporting of safety events and hazards in the workplace can contribute towards preventing accidents and making the workplace a safer place to be. When an incident has been reported, the organisation has the information on the event, the team can then analyse the report, identify the hazards and risks involved, they are then able to put actions in place to reduce the risk to their workers, in doing so preventing more serious incidents from occurring. With the data that AI technology generates, research points to the fact that organisations will see an increase in near miss reporting and as Ayhan and Tokdemir (2019, p. 100) write – "at risk behaviour". With these important reports being generated automatically by some AI systems the organisation can then begin to investigate the cause of the near miss incident and start communications with the affected workers to raise awareness, consult with these workers to understand why the event triggered an alert, liaising with the workers to put controls in place. These actions will potentially reduce the likelihood of the near miss escalating into an incident which could cause harm to a worker. Another benefit of these reports is that they can work as an educational tool, helping workers understand what is classed as a near miss, enhancing their knowledge of how the reports can benefit both themselves and the organisation. Workers should feel comfortable and empowered to report issues and hazards when they see or experience them in the workplace. It is hoped that with AI tools integrated in the workplace contributing to safety reporting, reporting of hazards and incidents will become normalised, workers will understand that these reports are beneficial to them as workers and to the organisation – as these reports help strengthen the WHS within the organisation.

Training

Training – AI data can help WHS training become more personalised which can be more impactful to workers. In the applications of AI section in this research, it was learnt that AI technologies can provide real-time insights which can highlight the frequency and

the context of the workplace environment. With these insights from here learnings can be presented to prevent the re-occurrence of a dangerous behaviour. Following on from the previous paragraph, successful reporting is reliant on cooperation between the management team and the workers, the workers on the frontline must be alert and understand what they should be reporting. In turn, management, must ensure that there is an environment that fosters and encourages positive reporting behaviours (Winkler et al., 2019). AI systems which automatically generate reports for incidents by detecting them can be great learning tools for workers. Workers can be trained on the reports generated by the technology, understanding what events should be reported and what behaviours could potentially be dangerous to their health and safety. As AI is becoming more popular, there is also an interest in incorporating the data generated by AI into virtual reality training programs, allowing the workforce to be virtually trained in an environment displaying all the hazards in their day-to-day role.

Return on Investment

There is a significant cost involved in implementing AI technology into a workplace, which is a barrier for organisations to make the decision to choose to start exploring these technologies. However, it is important for organisations to explore the benefits of AI technologies as the integration may provide to the organisation with a return on investment (Abioye et al., 2021). Previous research findings have predicted that there are AI technologies which can be implemented into the workplace to reduce the frequency of injuries, as well as reducing the number of lost work days due to injury for the organisation (Pereira et al., 2021). If organisations take a proactive approach to safety by implementing AI technologies in the workplace there could be a variety of benefits. These benefits may include, the company's reputation remaining intact, an increase in productivity, and prevention of the organisation from being exposed to greater issues such as legal action or fines due to an unsafe workplace (Abioye et al., 2021).

Catalyst for change

The majority of the previous information discussed points to the fact that AI technologies have the potential to create change within the workplace. AI technology has the possibility to increase the safety culture in organisations and could help organisations move away from the stereotypical idea that safety is a command and control activity based solely on compliance and adherence to procedures and rules (Sharman, 2018). Although one cannot introduce AI technologies into any workplace and expect them to be effective, there needs to be a level of understanding and respect for WHS already instilled in the organisation. While it is true that incidents in the workplace can be reduced with effective training and development of a strong safety culture, there is always going to be a chance that another incident may happen. The occurrence of incidents cannot be completely eliminated, this is due to unexpected situations or conditions such as fatigue and other distractions or sudden events within the workplace (Fang et al., 2015). This is where AI technologies can be introduced, AI systems implemented in the workplace can be used for early risk detection within the work environment. Niu et al. (2019) concluded their research stating that AI technologies will deviate from traditional safety management methods and utilising AI technologies in the workplace will help develop an effective safety culture in the workplace. As already discussed, AI technologies provide rich data and an accumulation of evidence. This data can then be used as an awareness tool to

Challenges

So far, this study has explored some of the applications and opportunities in integrating AI into the workplace. To further build the knowledge and strengthen the understanding of the effect AI has on WHS, it is important to also consider the challenges. The main challenge areas affecting WHS with the adoption of AI are discussed below.

Preparation

The introduction of AI technologies into the workplace hopes to result in decision making, which is faster and more accurate, these technologies give options for different approaches to production as well as organisation structures, the technologies allow tasks to be performed in different ways. All of these factors have the possibility to have a meaningful effect of the safety and health of workers (Polak-Sopinska et al., 2019). However, due to the rate that technology is developing, implementation into the workplace needs to be a key point of consideration. Insufficient preparation can be detrimental for any program, tools, or changes in the workplace, implementing AI technology is no different. As discussed, implementing AI technologies can be a can be a catalyst for change however the organisation needs to ensure its preparedness first, creating a culture which supports these changes. Business people, academics and scientists are all predicting that employees within the organisation view AI technology as a threat (Brougham & Haar, 2018). This means that preparing a workplace before implementing these technologies is extremely important. If an organisation is not prepared for the implementation of AI technologies in the workplace it is highly likely that they will not reap the expected benefits and will see a decline in the safety as well as the quality of their work (Ashri, 2019). There may be many reasons why organisation may not be ready for the implementation of AI technologies, this can be down to the fact that the organisations are not aware of what these technologies can offer their workplace or even that the organisations are not aware of how these technologies can be implemented into their workplace, to effectively work alongside their current solutions in place (Polak-Sopinska et al., 2019). For some organisations it may be down to the fact they are implementing the AI technologies to try and solve a problem, however more groundwork and education around what AI can offer may need to be done to improve understanding of what AI means for the workplace, this will gain trust and help push the implementation of the technologies to strengthen the health and safety in the workplace.

Cultural Issues

Workplace safety culture is an important aspect to consider with the implementation of AI, there are opportunities which have been listed above but this also comes with challenges. An organisation cannot implement AI technology into a workplace and expect the systems and tools to automatically improve safety in their workplace. Establishing a solid safety culture in the workplace based off strong, effective WHS management needs to be the primary focus of the organisation before implementing AI technology to assist with strengthening WHS in the organisation (Niu et al., 2019). Transparency is another issue associated with the implementation of AI into the workplace. Workers need to understand what is involved in the process and what the intention of the AI technology is. If an organisation were to implement AI technologies without workers understanding the intention of the technology, this again would be a large challenge and detrimental to the organisations overall goal (Jeske et al., 2021). As Patel et al. (2022) discuss, another challenge for the workforce may be accepting the data which is produced by AI technologies. It may be difficult for the workers to trust the judgements and the different scoring systems used by the technology. This point reiterates how important it is to keep communications flowing with workers during the process of implementation. The more transparent the organisation is with workers about how the AI systems work the more likely they will accept the data that the technology produces, and corrective actions will be easily implemented (Abioye et al., 2021). Another cultural problem that could have a negative effect on WHS is the reliance of AI technologies. As stated earlier, AI technologies should be implemented alongside existing, robust WHS management systems. If this is the case, there is a reduced chance that workers will become overly dependent on the AI systems in use. There will always be a risk of AI technologies failing, organisations need to ensure that they have foundation controls in place, this shows that it is critical AI technologies are implemented alongside current controls in the workplace, this is a point echoed by Niu et al. (2019).

Dehumanisation

Utilising AI technologies in the workplace could lead to dehumanisation of workers. Dehumanisation of workers in connection to AI includes the perception that workers are being forced to behave as machines. Studies point to the fact that in the long run implementing AI technology into worker management systems could lead to the workforce displaying reduced levels of thinking, decreased intellectual and cognitive abilities as well as a decrease in creative, proactive thinking. This could be detrimental to health and safety of staff within the workplace (Heaven, 2020). While this study has noted that AI technologies are able to inform the workers of risks present in the workplace environments it is worth noting that these technologies may also lead the worker to lose their ability to identify and recognise that there is a hazard in their work environment, this could be detrimental to the workers' health and well-being and lead to a work-related incident. De Stefano (2019) discuss the point that when AI technologies are introduced, the organisation may begin to view their workers as data points. This kind of dehumanisation is referred to as datafication – all though this currently happens in workplaces with the tracking of data such as run rates – it is important that organisations are aware of this risk when implementing these technologies. Knowing and understanding the challenges involved in implementing AI technologies is critical to ensure controls are in place to work around the risks for both the organisation and the workers to see maximum benefit from these technologies (EU-OSHA – European Agency for Safety and Health at Work, 2022).

Intensification of Work

One of the most recurrently reported risks which relates to the implementation of AI technologies in the workplace is the intensification of work. This risk is reported when organisation implement AI systems with the sole purpose to increase the productivity and encourage the workers to complete their work at an increased speed. This occurs when the AI technology is used to track tasks such as completion times, movements that the workers are making, mistakes in the workflow, how long workers are spending at their desks, the length of time workers are on their breaks and even how long the workers toilet breaks are (EU-OSHA – European Agency for Safety and Health at Work,

2022). This data is then used by the organisation to improve the workers efficiency in relevant areas. As stated, this can lead to an intensification of work, but it also can lead to a fear or distrust, a feeling that the workers are being undermined by the organisation. Situations such as these create problems for organisations, and the human ethics come into question, this point will be discussed further later in the research. According to research by Mulholland and Stewart (2014), in a large proportion of organisations, speed of work and lean logistics are still the main priority, speed of production comes first with health and safety a secondary thought. Following on from this, with the added pressure of AI technologies in the workplace, workers may feel obliged to speed up their work and work longer hours without breaks. This could lead to increased risk for incident, and a decrease in the workers wellbeing – affecting the health and safety of the workers.

Robotics

Autonomous robotic sensors play an important role in the WHS of the human workers who are working in the same environment as the robots. A challenge with robots and the safety sensors is that with a wide safety zone area around the robots, they will have trouble navigating narrow spaces such as isles in a warehouse. The isles will be detected in both the warning and protection fields and the robot will be forced to stop. A workaround is that the safety field can be set to small – thus the robot will be able to access these narrow areas but when it is set to a small field the robot will operate at a largely reduced speed to ensure it complies with the reduced safety zone, keeping the people around the robot safe. Haight (2020) discussed safe integration of the robot into the workplace environment needs to include provisions for the human worker that will be working with the robot. It is important that there are controls in place to keep the human worker actively engaged, and in control of the environment that they are working in. With rapid developments being made in AI technologies, there are concerns that by the time there is research on the risks around operating autonomous or semi-autonomous technologies, there will be advancements made on these technologies, research will become somewhat obsolete, and further research will not be able to keep

up with the pace of the advancements being made (Haight, 2020). Previous research by Miller and Parasuraman (2007), have suggested that it is important there is forethought into how the human workers can actively remain engaged in the operation of the machines, this contribute toward the safe integration of autonomous machines into the workplace. A final point for WHS professionals, identifying risks involved with working around collaborative robots will need to remain a key priority for WHS professionals. Task-based risk assessments have been mentioned as the preferred methodology for autonomous robots which interact with humans. Task-based risk assessments explore the hazards of the robotic system as well as the tasks performed by the human worker in relation to the robot which they are interacting with (Franklin et al., 2020).

Shortage of Talent

Another challenge that faces the implementation of AI into the workplace is the lack of AI engineers, there is a global shortage of skilled workers that are able to integrate AI technology and these developments into the workplace (Abioye et al., 2021). If we correctly understand how these technologies store their data, AI engineers will be able to build a system to effectively store data from all AI technology sources in one place, running off the same system. Currently when looking into AI technologies on offer, there are single dashboards for each of the AI technologies, having single dashboards for all AI technologies can make tracking and analysing data extremely time consuming and difficult to do. Another issue surrounding the many different technologies is that providers may choose to no longer support the technology, the programs that they run on, and as well as the services for these technologies (Patel et al., 2022). This is why there is an importance to ensure that AI engineers are able to work with Information Technology (IT) professionals to link and support these technologies in the workplace. To ensure the effectiveness this will require a large amount of upskilling in the IT field as well as working with AI engineers to seamlessly integrate the technologies to communicate within one database (Patel et al., 2022).

WHS management

WHS management tools such as risk assessment will still remain very relevant as workplaces transition into a digital era (Jeske et al., 2021). However, the need to understand the risks of AI technologies is what researchers see as the challenge. Polak-Sopinska et al. (2019) question whether the work done in WHS management in relation to preventative actions may begin to revert back to corrective actions due to the lack of knowledge, skills and competencies to predict risks of AI technologies. As touched on, AI technologies will introduce new risks into the work environment, WHS professionals will need to upskill in the area of AI technologies and the risks in which are introduced into the work environment. The more AI technology that gets introduced into the workplace, the more WHS professionals need to understand about the technology. It will become even more important that WHS professionals have the skills and knowledge of the AI technologies to ensure work is done in a healthy and safe manner (Tamers et al., 2020). AI technology will not replace the need for workers reporting issues, but it will generate a lot of rich data, WHS professionals will need the skills to know how to sort through the vast amount of data and understand how best to create learnings from the reports in a proactive, positive manner to ensure that workers continue to understand and trust the AI systems.

Regulation and Ethics

Regulation and ethics remain some of the big questions in regard to the widespread implementation of AI technologies in the workplace. Ethics come into question when AI is implemented within the organisation, most commonly ethics are questioned when the AI is monitoring the workforce. This is why it is extremely important that there is transparency and an understanding of the AI system before it is implemented into the workplace. Having an understanding of the technology and transparency from the beginning of implementation will build a level of public trust in the AI technologies within the workplace. Building a level of trust within the intelligent autonomous systems is essential. Without a level of trust from the workers, the people

who will be interacting and being monitored by the technology, the benefits of the AI systems will not be achieved (Winfield & Jirotka, 2018). As innovation in this area ramps up, new governance processes are needed. Policy makers, businesses, and innovators have begun collaborating, creating policies for AI. Schwab (2017) make the point that policy making needs to be reimagined as there is a shift into industry 4.0, the fourth revolution. This book continues by stating that there is a responsibility to ensure that there are common values established as this will drive policy choices, ensuring the correct changes are implemented, thus making the fourth revolution an opportunity for all. This is an important consideration as policies will provide guidance and keep the organisations and the workers within them accountable for how AI systems operate within the workplace. Some researchers have suggested that ethics should be programmed into the AI systems, others do not agree with this statement and believe that the approach to building ethics into the AI is wrong. In New Zealand, the AI Forum New Zealand (2018), found that 68% of their respondents had concerns about how AI could potentially make unfair, biased or inaccurate decisions. In contrast to this, they also found that only 15% of organisations who plan to utilise AI in their workplace, intend to develop any kind of AI ethics committee. Ethics of AI is not just an issue within New Zealand, it is an issue globally, without ethics and regulation around AI technologies, there is no assurance that the AI technologies will be fit for purpose or safe for use in the workplace (Winfield & Jirotka, 2018). Technology is generally trusted in the workplace if it provides benefits and is safe, regulated well, and investigated when incident occurs, again generating a level of trust toward the technology that the workforce will be interacting with and using.

AI in New Zealand

The New Zealand AI forum has now published two reports. These reports give insights and information on the impacts of AI for New Zealand. The first report was published in 2018, this report had six major findings, the most important finding was focused on developing a coordinated AI strategy for New Zealand, driving awareness

through organisations, ensuring that people understand what AI can do for both, businesses as well as the society. This initial report published by the AI Forum, touched on the point of health and safety and how important this is. Although the report did not directly focus on the impact of what AI can have on the workforce, it is a positive that the report made a start in taking into account that the aspect of WHS should be considered when incorporating AI into the workplace (AI Forum New Zealand, 2018).

A further statement from this report mentions that health and safety legislation is a driving factor as to why some organisations are choosing to adopt AI technologies. By utilising AI technologies, organisations in New Zealand are able to automate monotonous or highly risky work, however AI technologies are, at this point in time, largely focused on data management and improving the performance of the business. Interestingly, this shows that there is still a lot to be understood about what AI can do for organisation in New Zealand, this further aligns with the purpose of this research study, more focus is needed exploring the opportunities and risks for the implementation of AI into organisations in relation to WHS.

The second report published by the AI forum, outlines recommendations that there will be a need for regulation in regard to the safety of AI – how ever one standard AI safety body will not be sufficed as a model such as this will struggle to meet the expertise needed for each sector in regard to regulation (AI Forum New Zealand, 2019). The report talks to points that have been touched on in this research study. One of these points is the effects there would be if there was no AI safety policy in place. As safety professionals know, policy is an important part of any safety management system, and when including AI into a workplace, there will need to be policy created. The report also states that without safety standards for AI being regulated there is potential for harm to individuals.

The AI Forum 2019 report also investigates case studies of AI being developed in New Zealand and being used in New Zealand workplaces. Robotics Plus is based out of

Tauranga, New Zealand and they have developed and built AI systems which are able to remove workers from hazardous situations which has improved safety in workplace as well as increased productivity of the businesses transport chain (AI Forum New Zealand, 2019). Another example of AI being used within a New Zealand workplace is that of a manufacturing plant in Christchurch. The site has implemented sensor technologies on their forklifts. The reason for exploring AI technology options was that the warehouse manager had noticed that in their busy warehouse environment there was an increase in workers interacting with operating forklifts. Although the team were trained and the site management were working with the warehouse staff to improve worker behaviours, they were aware that something more needed to be done to reduce the risk of the interaction with forklifts and pedestrians.

After some research, the team found a company that offered a trial of a sensor technology for their forklifts, with this technology they could use it to track how often the issue of pedestrian interaction was occurring, as well as use the technology as a control to ensure that the environment around the forklift is kept safe and pedestrian free. If there was a violation and someone was to enter the zone around the operating forklift, an audible alarm would sound notifying the forklift driver of the presence of a pedestrian. If the pedestrian moved closer to the operational forklift the AI technology would store a photo of who made the violation and track the frequency of how often the violations were occurring. With this data, the workplace was able to consult with the workers involved and integrate them and their ideas into the solutions for making the warehousing department a safer place to work.

When this technology was first installed onto the forklifts, the team had worked with the suppliers and decided on 3 sensors on the top of the forklift, in theory, this placement of sensors would allow the technology to detect pedestrians in many areas around the operating forklift. However, once these sensors were installed and became operational, the team noticed the sensors were detecting a large number of violations,

not all of these violations were pedestrians. The sensor is able to detect a violation when it identifies a reflective strip – like the strips that are on high visibility vests – a very commonly worn piece of personal protective equipment in material handling industries. When the sensor detects the reflective strip around the hazardous zone of the forklift – an audible alarm is triggered alerting the operator, so that they are able to act on the alert. Supplementary to the alert, as mentioned above, video footage is stored, showing the cause of the alert, allowing trainings, and other learnings to be worked through with the affected worker.

The initial teething issue with the sensors on the forklift found that the sensors were alerting to an extremely high number of violations. The 3 sensors around the top of the forklift were detecting reflective sensors off trucks, bollards, and other reflective strips around the warehouse, this then constantly triggered the audible alarm which when measured was over 80db and very disruptive for the forklift operator, particularly as it was occurring regularly. Once these teething issues were mitigated, and the number of sensors reduced and repositioned, the sensors began operating effectively, and the workers have embraced the AI technology on the forklifts (Amcor Flexibles, 2022). An interesting finding from this example is that when the co-workers were aware that they may be detected by the sensors – the number of violations dramatically reduced, this a great example of the Hawthorne effect.

The Hawthorne Effect refers to the tendency of people to perform better or in the correct way as they are aware that someone is observing what they are doing. Typically, individuals change the way that they are working or their behaviours due to the attention they are receiving. This effect should be an important consideration for all WHS professionals (Sharman, 2016). Observation has a powerful influence on the behaviour of people, this is a point that workplace AI technology leverages off – the organisation is able to have eyes on their workers at all times ensuring that they remain healthy and safe while at work. Currently in the workplace WHS professionals have to rely on audits,

supervisors on the floor as well as reporting from frontline workers to assess how the workplace is performing in terms of safety. There is no constant monitoring to know where the workplace needs to make improvements. Relating back to the Hawthorne effect, the workers on the floor may see a WHS professional conducting an audit and comply with the behaviour that is expected of them, however when they are no longer present the worker may revert back to their own way of completing a task, the task in the workplace is then being done as imagined and the WHS team are not aware of the gap they currently have, as it complied during the audit processes. This is where the use of AI technologies can influence the workers behaviour, however for this to be successful it needs to be introduced correctly and transparently to be seen by the workers in a positive light.

Discussion

General Discussion

Artificial intelligence has an impact on workplace health and safety, the technologies of AI will begin to shape the future of health and safety as it is applied in workplaces. The integration of AI applications into the workplace has been dubbed as 'Industry 4.0' or the fourth industrial revolution (Schwab, 2017). And the use of AI has begun to provide great opportunities in the space of health and safety, but there are and will continue to be challenges when it comes to implementation of these technologies into the workplace.

The findings discussed in this research study report outline the applications, opportunities and the challenges drawn out from an array of literature. Previous literature solely focused on the impacts of AI on WHS are difficult to come across, the majority of literature published on the topic of AI and the workplace mainly discusses the operational benefits for the organisation, if there is mention of WHS, it is typically a paragraph stating that AI can be beneficial for the WHS of the organisation, literature lacks scope and overall perspective from a WHS view. Much more research is needed in this area, deep diving into AI and WHS.

From this research, the researcher has outlined and discussed the primary opportunities and challenges of AI on WHS, these are summarised below:

Opportunities:

- Power of the data generated by AI technologies
- Automation in the workplace
- Detection of risks
- Improving safety culture
- Reporting
- Training
- Return on Investment

- AI creating a catalyst for change

Challenges:

- Preparation
- Cultural issues
- Dehumanisation
- Intensification of work
- Robotics
- Talent Shortages
- WHS Management
- Regulation and ethics

Niu et al. (2019) considered the implementation of AI technologies into the construction industry, although their points of discussion are relevant to most, if not all industries. They talk to the point that implementation of AI technologies will not replace the WHS management methods, and the use of AI technologies will work alongside these existing methods strengthening WHS in the organisation. This finding is mirrored by that of Jeske et al. (2021), WHS management tools will continue to remain extremely important with the implementation of AI technologies into the workplace. This points to the fact that organisations must ensure that there is a strong foundation of WHS management before AI technologies are implemented to assist in managing health and safety in the workplace, this is a key take away from this research. AI needs to be considered in the broad view of WHS, to start with, it can be used as a tool within the field to reinforce health and safety in the workplace in organisations which already have a strong foundation formed in health and safety.

Fukumura et al. (2021) found that incorporating AI into a workplace is a complex task, the organisation needs to explore both advantages as well as challenges in order to gain acceptance from the workforce. This is an important point to consider as change in the workplace needs to be accepted by the frontline workers for implementation of AI

technologies to be successful. Problems with acceptance of AI technologies may arise when organisations implement AI technologies into the workplace for the wrong reasons.

The findings from this research are not directly comparable with any one other piece of literature – these findings have been drawn from an accumulation of many different types of literature from around the globe, this has allowed the researcher to gain a broad understanding of the impact of AI on WHS, in order to understand the opportunities and challenges for implementing AI into the workplace in New Zealand. The findings that have been discussed in this research study highlight the fact that the use of AI technologies in the workplace poses risks to WHS. AI systems can negatively affect workers by dehumanising them, pressuring the workers to work more intensely, reduce the control that the workers have over their role as well as lower their productivity in the workplace. These negative effect from AI implementation can also result in cultural issues and a reliance on the technology. However, there is also an array of opportunities created with the implementation of AI technologies and it is projected to make a large impact on the way that work is done within an array of industries.

This study has reviewed a large amount of research undertaken in the topic if AI and WHS. While there is still only a small amount of research that directly focuses on AI and its impact on WHS, a lot of beneficial information was able to draw out of published literature. While the majority of the published research on this topic only related to singular fields it was not difficult to understand how findings from the multitude of studies could be transferred into other industries. The most common application of AI technologies discussed in published research was the use of sensors, whether this was installed on forklifts or used in wearable device technology. Sensors are useful as they do not take up much space, they can be relatively simple to implement, and they can produce powerful data and insights into events occurring in the workplace that may give rise to WHS incidents.

Future for AI in New Zealand

The future of AI in New Zealand is vague, but research being conducted around the globe, as well as this research, is extremely relatable, transferable, and important. Although adoption of AI in New Zealand is very much in its infancy. Each year progress is being made and there are more applications being introduced into the workplace. However, the rate of implementation in New Zealand is still not comparable to other countries around the world. The fact that New Zealand is behind in the implementation of AI technologies into the workplace does produce some advantages. As discussed in the AI Forum New Zealand (2019) it allows regulation to be created and AI safety policy to be implemented before there is a large amount of AI technologies already implemented in the workplace. New Zealand is able to learn from the failures of other countries and ensure that AI technology is has been through rigorous safety assessment before integrating into the workplace. Organisations may be able to upskill their workforce, including WHS professionals in time for large developments in this space. New Zealand organisations have a chance to be at the front foot of implementation of AI technologies into the workplace, ensuring the workers are kept health and safety during the introduction and continued use of these technologies.

The AI Forum New Zealand (2019), has considered the effects on health and safety much more in their second report than their initial report. Under the heading 'safety' it states that AI technologies do pose numerous safety risks and that these risks need to be managed. Some of the risks discussed in the report, are risks which include harm that autonomous robots may pose, algorithm failures, as well as risks which may present in the long term. Long term risks include AI which takes a mind of their own ending up with goals which are not aligned with that of the organisation, and the humans within them, this could potentially emerge with the creation of artificial super intelligence (AI Forum New Zealand, 2019).

Discussed in this research, there is a general lack of understanding around AI and the potential opportunities that the technology offers. This point becomes evident when searching for literature, there next to no published research on the topic of AI and WHS that is based off a New Zealand workplace. The main source of information around AI technologies in New Zealand came from the AI Forum reports. The AI Forum is solely focused on finding ways to use AI to help New Zealand thrive into the future. The fact that there is a limited amount of information directly extracted out of New Zealand is a limitation of this study. The intention of this research was to explore the opportunities and challenges of AI on WHS in New Zealand, however due to the lack of research, findings in wider literature had to be attributed to New Zealand. Although the findings of this study can be transferred into a New Zealand workplace, the study would have been strengthened had there been an abundance of New Zealand based research available.

Conclusions

A large amount of progress has been made in the field of artificial intelligence since the term artificial intelligence was first coined in 1956, by John McCarthy. Artificial Intelligence is predicted to immensely impact on the way that work is done across all industries. Most organisations have developed proactive approaches to WHS and have comprehended that effective health and safety is paramount to the success of the organisation. However, as with anything introduced to the workplace it is crucial that opportunities and challenges are understood. There has been a large amount of literature published in the space of industry 4.0 and what AI technologies can offer to workplace, however a large amount of this research fails to discuss the impact upon WHS. AI technology has the potential to benefit an organisation. However, even with the best intentions it is still possible that AI could be damaging to the organisation's workforce, impacting negatively on the workers' health and safety. Artificial intelligence will be part of the future of work, and it will contribute to the solutions for the future of

work, therefore it is crucial that organisations complete their due diligence and create an environment where AI can be used within the workplace in a healthy, safe, transparent, and ethical way.

Future Research

As applications of AI continue to expand into various industries, there is a need for more practical research conducted within the organisations to understand all WHS aspects for implementing AI technologies into the workplace. Having research that is conducted with an organisation will be extremely valuable as it will provide rich data, with first-hand accounts of the implementation of these technologies into the workplace. Literature reviews can only cover a certain proportion of the opportunities and risks, however workers on the frontline, including WHS and management teams may be able to provide a more in depth understanding about the impact that AI has on WHS.

From a New Zealand perspective, there is still a lot unknown and a large gap in the research. Further research is needed to understand the proportion of AI implemented into workplaces, and how the AI is impacting upon WHS in New Zealand.

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