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Cover Photo

FAO/Lebanon -- The worst forms of child labor include the kinds of hazardous work found in the agriculture sector, in which most children in the Arab region work in both paid and unpaid labor. Such labor takes place mostly in rural areas, and represents a cheap workforce for small-scale farming – mostly non-mechanized labor-intensive methods of production involving high risks. Conflicts and mass displacement had a toll on agriculture and food security. Building resilient rural livelihoods is essential to child labor reduction in this sector, which generally involve high level of work-related fatalities, non-fatal accidents and occupational diseases.

Agriculture accounts for more than half of children in employment in countries such as Yemen, Sudan and Egypt. The predominance of agriculture calls for special attention since this sector is characterized by early entry into work compared to other sectors. Arab countries need to realize that child labor poses immediate and future challenges not only to the children themselves, but also to their nations and communities, as well as the broader economy.

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Perspectives on child labor in the Arab World and Lebanon!

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KEYWORDS

Child Labor
Human Rights
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ABSTRACT

In recent years, the Arab World has seen a large wave of armed conflicts and population displacement, which is thought to have resulted in an increase in child labor, the magnitude of which is still unknown. Armed conflicts have exacerbated pre-existing levels of child labor in rural and urban areas, which are typically driven by economic vulnerability, poor education, and certain social norms. Children, society's most vulnerable members, have been especially hard hit. They are increasingly drawn into the most heinous forms of child labor, where they face serious and concerning exploitation, abuse, and violations of their rights. These forms include hazardous work in agriculture, services, industry, as well as street work. Further, the Arab region has seen an alarming increase in the use of children in illicit activities, such as prostitution and armed conflicts, often under forced or bonded-labor conditions. The aim of this paper is to address child labor in the Arab World in general, and in Lebanon in particular.

1. INTRODUCTION

Globally, governments and non-governmental organizations (NGOs) are concerned about the prevalence of child labor. People all over the world are looking for the quickest and most thorough ways to protect children from the negative impact of child labor on their physical, mental, and emotional development.

1.1 What exactly is meant by the term "child labor"?

Child labor is defined by the International Labour Organization (ILO) as work that is mentally, physically, socially, or morally hazardous to children and interferes with their education by:

- depriving them of the opportunity to attend school;
- obliging them to leave school prematurely; or
- requiring them to combine school attendance with excessively long and heavy work.

The child's age, the nature of the activity, the number of hours spent on it, the working conditions, and the goals of each country all play a role in determining whether a particular type of "work" constitutes

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"child labor." The response differs from country to country, and even within a country, from industry to industry.

While it is critical to eliminate as much child labor as possible, this does not apply to all child labor. Most people believe that it is beneficial for children and teenagers who are legally allowed to work to do so in jobs that do not jeopardize their health or development, or interfere with their education. This includes helping out at the family business after school and on weekends, as well as doing extra work over the summer. Children and their families benefit from these kinds of events because they teach children important lessons about life, help them learn important skills, and prepare them for success as adults.

1.2 Inhumane methods of child labor

Some of the worst kinds of child labor are slavery, separating children from their families, putting children in danger, and leaving children alone on the streets of large cities.

While there are many different types of child labor, the worst forms, as defined in Article 3 of the International Labor Organization's (ILO) Convention No. 182, must be eliminated:

- all forms of slavery or practices similar to slavery, such as the sale and trafficking of children, debt bondage and serfdom and forced or compulsory labour, including forced or compulsory recruitment of children for use in armed conflict;
- the use, procuring, or offering of a child for prostitution, for the production of pornography, or for pornographic performances;
- the use, procuring, or offering of a child for illicit activities, in particular for the production and trafficking of drugs, as defined in the relevant international treaties;
- work that, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety, or morals of children.

1.3 The perils of child labor

According to the ILO and the United Nations Development Programme (UNDP):

- 152 million children worldwide are victims of child labor; 88 million are boys and 64 million are girls (ILO, 2017).
- Girls are more likely than boys to shoulder responsibility for household chores, a type of work not considered in child labor estimates (ILO, 2017).
- Girls are more likely than boys to drop out of school early to take care of chores at home. Boys, on the other hand, are more likely to drop out of school early to go to work (ILO, 2017).
- Children aged 5 to 11 make up 48% of all child labor victims (ILO, 2017).
- Nearly half of the people who work as child laborers (73 million) do dangerous work, and children under 12 do more than a quarter of the dangerous work (19 million) (ILO, 2017).
- 71 percent of child labor takes place in agriculture, which includes fishing, forestry, livestock herding, and aquaculture (ILO, 2017).
- 19 percent of child labor victims live in low-income countries; 2 million victims live in high-income countries (ILO, 2017).

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- There is a strong correlation between child labor and situations of conflict and disaster. The incidence of child labor in countries affected by armed conflict is 77 percent higher than the global average; the incidence of hazardous work is 50 percent higher (ILO, 2017).
- The illegal profits from forced labor are thought to be around $150 billion a year (UNDP, 2015).
- More than two-thirds of all children in child labor (69.1 percent) work as laborers on family farms and in family businesses (ILO, 2017).
- Children who have to leave school before they turn 15 because of problems at home or other things are less likely to ever get a job (ILO, 2015).
- Former child laborers are much more likely to have only a primary education or less (ILO, 2015).
- Young people who work as child laborers (up to the age of 15) are more likely to be in low-paying jobs (ILO, 2015).
- Almost half of child laborers are in Africa (72.1 million), and 41 percent (62.1 million) are in Asia and the Pacific (ILO, 2017).

1.4 ILO Conventions on child labor

The two ILO Conventions on Child Labor are Convention No. 138 on the Minimum Age and Convention No. 182 on the Worst Forms of Child Labor. These Conventions are "fundamental" Conventions. This means that, under the ILO Declaration on Fundamental Principles and Rights at Work, all ILO member states have an obligation to respect, promote, and realize the abolition of child labor, even if they have not ratified the Conventions in question.

These conventions and recommendations are alluded to in the following: (ILO Conventions on child labor, n.d.):

ILO Minimum Age Convention, 1973 (No. 138) and its Recommendation No. 146

One of the most effective methods of ensuring that children do not start working too young is to set the age at which children can legally be employed or otherwise work. The aim of ILO Convention No. 138 on the minimum age is the effective abolition of child labor by requiring countries to establish a minimum age for entry into work or employment, and establish national policies for the elimination of child labor.

Recommendation No. 146

The Recommendation No. 146, which accompanies Convention No. 138, stresses that national policies and plans should provide for: poverty alleviation and the promotion of decent jobs for adults, so that parents do not need to resort to child labor; free and compulsory education and the provision of vocational training; the extension of social security and systems for birth registration; and appropriate facilities for the protection of children and adolescents who work. To achieve the elimination of child labor, laws setting the minimum age for work should be embedded in such comprehensive policy responses.

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ILO Worst Forms of Child Labor Convention, 1999 (No. 182) and its Recommendation No. 190

> *Child labor, as the statistics clearly demonstrate, is a problem of immense global proportions. Following its comprehensive research into the issue, the ILO concluded that it was necessary to strengthen existing conventions on child labor. Convention No. 182 helped to focus the international spotlight on the urgency of action to eliminate, as a priority, the worst forms of child labor without losing sight of the long-term goal of the effective elimination of all child labor. Convention No. 182 requires countries to take immediate, effective, and time-bound measures to eliminate the worst forms of child labor.*

Recommendation No. 190

> *The Recommendation No. 190, which accompanies Convention No. 182, recommends that any definition of "hazardous work" include: work that exposes children to physical, psychological, or sexual abuse; work underground, underwater, at dangerous heights, or in confined spaces; work with dangerous machinery, equipment, or tools, or carrying heavy loads; exposure to hazardous substances, agents, or processes, or to temperatures, noise levels, or vibrations that are damaging to health; and work for long hours, night work, and unreasonable confinement to the premises of the employer.*

2. INTERNATIONAL LEGAL PRINCIPLES

Several international and regional laws and agreements, as well as United Nations (UN) programs, have talked about the issue of child labor. These laws, agreements, and UN programs were all meant to protect children from economic and social exploitation.

The UN General Assembly of 1959 proclaimed the Declaration of the Rights of the Child to the end that he may have a happy childhood and enjoy, for his own good and for the good of society, the rights and freedoms set forth, and called upon parents, upon men and women as individuals, and upon voluntary organizations, local authorities, and national governments to recognize these rights and strive for their observance by legislative and other measures, progressively taken in accordance with Principle 9 of the Declaration that states the following (University of Minnesota: Human Rights Library, n.d.):

> *The child shall be protected against all forms of neglect, cruelty, and exploitation. He shall not be the subject of traffic, in any form.*
>
> *The child shall not be admitted to employment before an appropriate minimum age; he shall in no case be caused or permitted to engage in any occupation or employment that would prejudice his health or education, or interfere with his physical, mental, or moral development.*

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3. ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT CONVENTIONS

The International Labor Organization (ILO) has worked since its inception in 1919 to develop conventions and recommendations that regulate child labor and protect children from all forms of exploitation. This was long before the adoption of the Universal Declaration of the Rights of the Child and the Convention on the Rights of the Child. Some of these agreements specified the minimum age for a child to legally work in certain fields.

The United Nations adopted General Convention No. 138, which established the minimum age, in 1973. To accomplish this goal, it proposed making the legal working age the same as that considered to be an adult in most countries; in most, this age is set at fifteen. Furthermore, it prohibited the employment of minors under the age of 18 "in jobs likely to endanger their health, safety, or morality due to the nature or working conditions." The convention required nations that approved it to develop national policies prohibiting the use of children as laborers.

However, prior to the adoption of Convention No. 138, the ILO had produced several conventions that established the age at which children could no longer be employed in specific occupations (Morcos, 2014). The first of these, Convention No. 5 (1919), established 14 as the minimum age for industry work; this was later raised to 15 by means of Convention (Revised) No. 59 (1937). In 1920, the ILO established 14 as the minimum age for sea employment, by means of Convention No. 7. The minimum age was set at 15 in 1936, by Convention (Revised) No. 58. In 1921, Convention No. 10 established a 14-year-old age limit for agricultural work. Convention No. 15 of 1921 established 18 as the minimum age for trimmers and stokers. In 1932, Convention No. 33, concerning the minimum age in non-industrial employment, set the age at 14; Convention (Revised) No. 60 of 1937, raised the age to 15. The minimum age for fishermen was set at fifteen by means of Convention No. 112 (1959). The minimum age for underground work was set at 16 by means of Convention No. 123 (1965).

Night work by young people under the age of eighteen in industry is prohibited under Convention No. 6 of 1919. In Convention (Revised) No. 90 (1948), regarding the night work of young persons, the modifications did not affect the age requirement that had previously been suggested. Convention No. 79 of 1946 banned night work for young persons under 14 years of age in non-industrial occupations, in order to protect their bodily integrity. Convention No. 16 of 1921 established the compulsory medical examination of young persons (at sea); Convention No. 124 of 1965 established the medical examination of young persons in underground work; Convention No. 77 of 1946 established the medical examination of young persons in industrial work; and Convention No. 78 of 1946 established the medical examination of young persons in non-industrial work. The latter two conventions required medical examinations for anyone under the age of 18 in industrial and non-industrial work unless a medical examination proved that they were fit to carry out such work. They further stipulated that minors under 18 years of age who carry out hazardous work must undergo periodic medical examinations.

In 1998, the ILO came out with a broader statement of basic rights and principles (ILO, 1998). In the second part of the declaration, it was stated that "all Members, even if they have not ratified the Conventions in question, have an obligation, arising from the very fact of membership in the Organization, to respect, to promote, and to realize, in good faith and in accordance with the Constitution, the principles concerning the fundamental rights which are the subject of those Conventions, namely:

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- freedom of association and the effective recognition of the right to collective bargaining;
- the elimination of all forms of forced or compulsory labor;
- the effective abolition of child labor;
- the elimination of discrimination in respect of employment and occupation; and
- a safe and healthy working environment."

As for the practical steps, the International Program for The Elimination of Child Labor (IPEC) was launched in 1992 with the aim of eliminating child labor by supporting the capacities of states and promoting a global anti-child labor movement. This program, carried out in partnership with the International Labour Organization and the World Health Organization, aimed to support and sensitize countries to develop plans and programs to eliminate child labor and keep children away from hazardous work.

4. THE ARAB LABOR AGREEMENTS

The Arab Labour Organization (ALO) includes in its membership all 22 Arab countries (Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, the United Arab Emirates, and Yemen) and is the only Arab regional organization with tripartite representation. Founded in 1965, its aims consist of the following (UNESCWA, Arab Labour Organization, n.d.):

- coordinate efforts in the field of labor and workers on the Arab and international levels;
- develop and maintain union rights and freedoms;
- provide technical assistance in the labor domain to the three parties of production in member states;
- improve labor laws in member states and work on unifying them;
- improve the circumstances and conditions of work in member states;
- Develop Arab human resources so that they can reach their full economic and social potential;
- Develop the Arab labor force and enhance its productivity;
- Prepare a manual and lay the foundation for occupational classification and qualification;
- Translate labor and vocational training terminology to Arabic.

Countries in the Arab World have been working hard to eliminate (or reduce) child labor. However, recent unprecedented and tumultuous events, such as armed conflicts, economic shocks, and the COVID-19 pandemic, have presented policymakers with enormous challenges related to child labor. It is estimated that 13.4 million, or 15%, of children in the Arab World, are working. Many experts have raised concerns about the harsh realities of life for these child workers, particularly those in informal sectors such as seasonal agriculture, street labor, and domestic labor, which frequently go unmeasured by authorities. The problem is exacerbated during times of armed conflict and political unrest, when millions of people may be displaced and, as a result, families may resort to child labor to supplement lost earnings. Furthermore, the COVID-19 pandemic, spiraling job losses, and falling incomes have all contributed to the increased prevalence of child labor. The work that children are forced to do is frequently abusive and dangerous, leaving them permanently afflicted, overwhelmed, and distressed; further, it restricts their access to quality education and health care, both of which are regarded as critical pillars for charting a positive future course. Children are forced to work for a variety of reasons. Poverty-stricken families and those without social protection safety nets are particularly vulnerable to economic shocks that affect employment and income. As a result, families are increasingly forcing their children to work in order to survive. This has been evident during several economic crises in

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which the countries' progress on reducing child labor and improving school attendance has been reversed (Al-Mulla, 2012; Morcos, 2014; ILO, Child labor in Arab States, n.d.).

4.1 General trends and characteristics

The poorest countries in the Arab World show the highest rates of child employment; this reflects a global trend verified by the latest ILO Global Estimates (ILO, 2017). The general trends of child employment in the region can be summarized as follows (League of Arab States, n.d.):

- child employment increases with age, with higher employment rates in the 15–17 age group than the 5–14 age group. Particular attention should be paid to the fact that 15–17-year-olds do a lot of dangerous work.
- child employment rates are higher among boys. However, it should be noted that surveys might fail to capture hidden forms of child labor among girls, such as domestic work and unpaid household services, which merit further research and inquiry.
- child employment rates are generally higher in rural areas than in urban areas.

The most important things to know about children working in the Arab region are:

- unpaid family work is more common among children ages 5 to 14, girls, and people who live in rural areas. Paid non-family work is more common among children ages 15 to 17, boys, and people who live in cities.
- children aged 15–17, particularly males, tend to work longer hours than their respective counterparts. On the other hand, working children who attend school tend to work less than those who do not go to school.
- children in urban areas tend to work longer hours than rural children. But it should be noted that agricultural work is highly labor-intensive, but seasonal.

4.2 Trends and working conditions by sector

- child labor in the Arab region is mostly found in agriculture, followed by services and industry. Country-level data also point to the following trends:
- children ages 5–14 are more likely to work in agriculture, while 15–17-year-olds are more likely to work in services and industries.
- the sectoral distribution of girls' activities varies a lot from country to country, depending on the nature of the local economy. Keep in mind that household surveys often can't find some of the hidden work that girls do.

4.3 Agriculture: Small-scale farming

The majority of children in the agricultural sector are unpaid family workers, especially children aged 5–14. Child labor in agriculture is mainly related to small-scale farming, where cheap intensive labor is in high demand, especially on family farms that depend on the contribution of children. A closer look at child labor in agriculture in Lebanon, Morocco, Egypt, and Yemen highlights the following push factors: household poverty, low parental education, certain social norms, lack of access to education or lack of enforcement of compulsory education, lack of access to water and electricity networks, and lack of social security.

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Agriculture was found to be one of the most hazardous sectors of activity. Children working in this sector are at risk of being exposed to the following hazards, which vary in degree and combination, depending on the activity: exposure to chemicals, pesticides, dust, and smoke; carrying heavy loads; working long hours; repeatedly bending and standing; working at heights; working in isolation; long hours of exposure to the sun and other climatic conditions; and working with dangerous tools and farm machinery, often with a lack of protective gear or access to first aid.

Children working on family farms often lack social and legal protections. Countries can choose to apply certain exemptions allowed under Article 5 of the Minimum Age Convention, 1973 (No. 138), and exclude some children from the legal provisions on the minimum age for work. It should be noted, however, that such exemptions do not apply to any form of hazardous work. In remote rural areas, there are further issues regarding the limited capacity of labor inspectors and the lack of geographical coverage, often leaving rural child labor outside the purview of government oversight.

4.4 Industry and Services: The Informal Sector

Child labor in the secondary and tertiary sectors is generally informal work, which is particularly prone to child labor since, by definition, it escapes regulatory and inspection oversight. In the industrial sector, paid, non-family work is the most common type of child labor. In the services sector, where jobs are more varied, paid, non-family work is the most common type of job.

A closer look at children in informal employment in some Arab countries highlights the following determinants of child labor:

- poverty such that the household relies on the additional income generated by sending children to work, especially among refugees and internally displaced persons (IDPs);
- education is considered of limited value in the absence of future prospects for decent work;
- limited labor inspection capacity; and
- from an employer's perspective, children represent low-cost labor and are easier to manage.

Children working informally face various hazards depending on the type of activity, such as long hours of work, dust and pollution hazards, injury and security risks, carrying heavy loads, and working without protective clothing. Based on the country studies presented here, the majority of children working informally in industry and services do not attend school.

As for young girls (under the age of 16) found in domestic work, they face a disconcerting situation due to the risks of seclusion, the lack of school attendance, and the potential for their rights as children to be violated. In Tunisia, girls were found to be subject to strenuous working conditions and physical abuse from employers. They were also isolated from their families and friends, and poorly paid. The ILO has highlighted the need to improve data collection in order to measure the extent and nature of children's involvement in domestic work across the Arab region, and has called for a strategic policy response to address such child labor.

4.5 Child labor in armed conflict

Children are often the main victims of armed conflicts and population displacement in the region. Child labor is on the rise among refugees and internally displaced populations, as well as among host communities in Lebanon, Jordan, and Iraq. Refugee and displaced children can be found working in a

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number of sectors of activity, with a notable rise in street work, bonded labor, early marriage, and commercial sexual exploitation. Child labor among refugee and displaced children is mainly a financial coping mechanism for families who face extreme poverty or where adults are unemployed. Refugee and displaced children also work longer hours for lower pay than local children (Mekay, n.d.).

The UN Secretary-General has reported a rise in the recruitment and use of children by armed groups, among both local and refugee populations. This is certainly the case in Yemen, Syria, and Iraq, where the majority of recruited children are generally boys. However, there is an emerging tendency to recruit more girls, as well as children below the age of 15. Hundreds of children across the Arab region are also held in detention – and even tortured – on the grounds of being involved in armed groups. According to the Secretary-General's report, the factors contributing to such child recruitment are relatively attractive salaries, religious and ideological influences, propaganda, and sometimes pressure and coercion by their communities. Enlistment is not always voluntary, and there is an increasing trend toward forced or deceitful recruitment. Another major concern is the vulnerability of girls to forced marriage, trafficking, and sexual abuse.

Moreover, children living in conflict zones are the greatest victims of the humanitarian crisis. In addition to the extreme conditions of poverty, health and security threats, and the damage to their education, these children are being forced into the kinds of activities associated with armed conflict situations, such as smuggling goods across borders or between fighting zones, collecting oil waste, performing funerary work (collecting body parts for burial), household work, and fetching water or collecting food from fields and landfills, which are even more dangerous in cases of violent conflict.

5. CHILD LABOR IN LEBANON

Action against child labor in Lebanon effectively began in the early 2000s when the Government of Lebanon ratified ILO Conventions No. 182 and No. 138 and signed a Memorandum of Understanding with IPEC as part of a technical cooperation programme agreed upon and implemented in partnership with the ILO Regional Office for the Arab States. This marked the beginning of a series of projects that have been implemented during the last ten years in collaboration with the Ministry of Labor, employers' and workers' organizations, and other national stakeholders. These projects primarily supported the implementation of policy and normative measures accompanied by grassroots activities to combat child labor, with particular attention to its worst forms (Osseiran, 2012; Bureau of International Labor Affairs, 2021).

During the third and final phase of this technical cooperation program (2009–2011), with the financial support of the Italian Government, IPEC reviewed and analyzed national legislation, plans, and strategies related to child labor in Lebanon. This document is the result of this initiative. The overview presented in this study aims to facilitate future efforts to mainstream child labor concerns, especially in the context of national policies and laws. This is vital to sustaining and coordinating efforts to combat child labor using government resources and authority in a manner that is comprehensive, coherent, and sustainable. Moving towards the elimination of child labor in Lebanon requires policy-level dialogue to integrate child labor issues within national development priorities, anti-poverty initiatives, and robust employment generation schemes for adults combined with equal access to quality education (Osseiran, 2012; Bureau of International Labor Affairs, 2021).

In 2021, Lebanon made little progress toward eliminating the most heinous forms of child labor. A UNICEF-funded project trained police officers in Tripoli, Lebanon's northernmost city, to identify child labor and refer children to social services. On the other hand, children in Lebanon are subjected to the worst kinds of child labor, including drug production and trafficking, sometimes as a result of

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human trafficking, and forced agricultural labor. Children also work as child laborers in the potato and tobacco industries. Furthermore, government officials have stated time and again that funding is insufficient to carry out their duties. Moreover, labor inspectors can only inspect in formal workplaces, where child labor is almost nonexistent, and social programs aimed at addressing child labor have remained insufficient to fully address the scope of the problem (Bureau of International Labor Affairs, 2021).

Several crises have converged on Lebanon, increasing the rate of child labor, including a national economic crisis that started in 2019 and has since worsened, the continued presence of Syrian refugees, and the COVID-19 pandemic, which has created new barriers to education and accelerated economic decline. The multidimensional poverty rate in Lebanon has risen from 42% in 2019 to 82% in 2021, including nearly all of the country's refugee population. UNICEF reported an increase in child labor from 2.6 percent to 4.4 percent as a result of worsening conditions, with agriculture and street work accounting for the majority of the increase. Furthermore, 12% of families report sending at least one child to work, and Lebanese households have 7 times as many working children as in previous years.

A review of available data on child labor, according to sector and activity, reveals the following (Table 1):

Table 1. Child labor, according to sector and activity

Sector/Industry	Activity
Agriculture	• Farming, including the production of potatoes, olives, beans, figs, grapes, eggplants, and cannabis. • Production of tobacco. • Fishing, activities unknown.
Industry	• Construction, including carpentry, tiling, and welding. • Making handicrafts. • Working in aluminum factories. • Working in slaughterhouses and butcheries.
Services	• Street work, including begging, street vending, portering, washing cars, scavenging garbage, and shining shoes. • Maintenance and repair of motor vehicles, and painting. • Domestic work. • Cleaning sewage and collecting waste materials, including scrap metal. • Food service, including working as waiters. • Working in small shops and groceries.
Categorical Worst Forms of Child Labor	• Used in illegal activities such as drug production and trafficking, as well as arms dealing. • Forced begging. • Commercial sexual exploitation, sometimes as a result of human trafficking. • Forced labor in agriculture.

5.1 Child labor legislation and regulations

Child labor legislation and regulations have been enacted by the Lebanese government. However, gaps in Lebanon's legal framework exist that prevent children from being subjected to the most heinous forms of child labor, such as the prohibition of commercial sexual exploitation of children. Because they are not performed in industrial, trading, or agricultural enterprises, domestic work and non-

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industrial, non-trade agriculture are not covered by the Labor Code. This is contrary to international standards, which require that all children be protected by a minimum working age. In Lebanon, basic education is required. The majority of children complete elementary school by the age of 15. Children may drop out before completing compulsory education because the minimum age for work is lower than the compulsory education age, as shown in Table 2:

Table 2. Child labor legislation and regulations

Standard	Meets International Standards	Age	Legislation
Minimum Age for Work	No	14	Article 22 of the Labor Code
Minimum Age for Hazardous Work	Yes	18	Articles 1-2 and Annex 2 of Decree No. 8987
Identification of Hazardous Occupations or Activities Prohibited for Children	Yes		Annex 1 of Decree No. 8987
Prohibition of Forced Labor	Yes		Article 8 of Decree No. 3855; Articles 569 and 586.1 of the Penal Code
Prohibition of Child Trafficking	Yes		Articles 586.1 and 586.5 of the Penal Code
Prohibition of Commercial Sexual Exploitation of Children	Yes		Articles 506, 523, 525–527, 586.1, and 586.5 of the Penal Code; Decree No. 8987
Prohibition of Using Children in Illicit Activities	Yes		Articles 586.1, 586.5, and 618 of the Penal Code; Article 13 of the Law on Drugs
Minimum Age for Voluntary State Military Recruitment	Yes	18	Article 30 of the National Defense Law
Prohibition of Compulsory Recruitment of Children by (State) Military	N/A*		
Prohibition of Military Recruitment by Non-state Armed Groups	Yes		Article 586.1 of the Penal Code; Annex 1 of Decree No. 8987
Compulsory Education Age	Yes	15	Article 49 of the Education Law
Free Public Education	Yes		Article 49 of the Education Law

Inspections of child labor at informal work sites are permitted only if a complaint is filed and the accused fails to respond to a summons issued by the Child Labor Unit (CLU). There is no mechanism in place to investigate complaints of child domestic labor because social workers—the only officials permitted to enter a private home—can only assess the overall well-being of the family, not the working conditions. According to a limited number of sources, the penalties for violating child labor and other related laws are insufficient to address the issue.

5.2 Agencies Responsible for Child Labor Law Enforcement

The government of Lebanon has set up institutions to make sure that laws and rules against child labor, even in its worst forms, are followed (Table 3).

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Table 3. Agencies responsible for child labor law enforcement

Organization/Agency	Role
Ministry of Labor	Enforces child labor laws through desk reviews and workplace inspections. The Ministry's Child Labor Unit acts as the government's focal point for child labor issues and raises public awareness about child labor and the right to education. Receives complaints of child labor violations on its Child Labor Unit hotline.
Internal Security Forces (ISF)	Enforces laws regarding child labor through the Anti-Human Trafficking and Moral Crimes Unit.
Ministry of Justice	Prosecutes violations of the Penal Code in coordination with the ISF. Maintains general data and statistics on criminal violations involving child labor. Refers at-risk children to shelters and protection services. Coordinates, through signed agreements, with civil society organizations to provide social workers who oversee court proceedings involving juveniles and deliver services to them, including children engaged in begging.
Directorate of General Security	Focuses on immigration and border protection. Works with the farmers' union to address child labor in agriculture.

5.3 Coordination of Government Efforts on Child Labor

Lebanon's government has put in place mechanisms to coordinate its efforts to combat child labor, including its most heinous forms (Table 4).

Table 4. Coordination of government efforts on child labor

Coordinating Body	Role & Description
National Steering Committee on Child Labor	Raises awareness; coordinates efforts among government agencies; establishes standard practices; develops, enforces, and recommends changes; and ensures that government agencies comply with the law. Led by the Minister of Labor, the delegation includes representatives from six other ministries, other institutions, and international organizations.
National Steering Committee on Trafficking in Persons	Coordinates efforts against human trafficking, including child trafficking. It is based at the Ministry of Labor and meets on a monthly basis.
UNICEF and UNHCR	Coordinate efforts to address the needs of children affected by the Syrian refugee crisis in Lebanon. UN representatives identify crucial concerns, including factors that make children vulnerable to child labor. Make recommendations to the government on the use of resources, including referral services. UN agencies and international and local NGOs coordinate child protection efforts through Child Protection Working Groups.

5.4 Government policies on child labor

The government has enacted policies concerning child labor (Table 5). However, policy gaps, including a lack of implementation, impede efforts to address child labor.

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Table 5. Policies related to child labor

Policy	Description
National Action Plan on the Elimination of the Worst Forms of Child Labor (2013–2016)	Establishes strategies for addressing the worst forms of child labor. Includes a National Awareness Strategy to be carried out by the ILO. Full funding for the $23 million implementation budget has not been secured.
National Social Development Strategy	Establishes a plan for a comprehensive social, health, and educational program. Includes the protection of working children and the implementation of HCC's strategy to address the needs of street children.
Ministry of Economy's (MOEs) Education Sector Development Plan	Aims to improve retention and educational achievement in areas with high dropout rates. Funded by the EU.
Ministry of Social Affairs' (MOSA's) Higher Council for Childhood (HCC)	Implements children's rights policies, including combating child labor.

5.5 Social Programs to Address Child Labor

In 2013, the government of Lebanon paid for and took part in programs that aimed to end or stop even the worst kinds of child labor (Table 6).

Table 6. Social programs to address child labor

Program	Description
Child Protection Program	Joint program by UNICEF and the Ministry of Social Affairs. Addresses child labor through interventions, including a non-formal education program for children, child protection services, skills development, and social assistance.
Reaching All Children	A donor-funded, 5-year project, implemented by the Ministry of Education and Higher Education and partners, aims to ensure quality educational opportunities for children ages 3 to 18, regardless of nationality, through holistic interventions that address the demand for and availability of quality public education, including non-formal education.
National Poverty Alleviation Program	Funded by the government and foreign donors, this program, housed at the Prime Minister's Office and Ministry of Social Affairs, provided WFP food vouchers ($27 per month) for each member of poor families. It also provided school tuition and book costs for secondary school students from 43,000 poor families.

Although Lebanon has programs to address child labor, the scope of these programs is insufficient to fully address the extent of the problem, including forced child labor in agriculture. Furthermore, due to a lack of adequate social services, some officials are hesitant to remove children trafficked by their families.

The prevalence of the phenomenon of child labor is not related to the insufficiency of texts, in terms of international agreements and legislative texts in this area, but the problem is mainly related to the lack of internal policies aimed at enshrining these rights and developing appropriate plans for their enforcement, as well as the effectiveness of the application, where the incubating environment of this phenomenon must be eliminated through a well-developed plan and an effective socio-economic policy strategy. It should be noted that Lebanon has played a positive role in this regard through its determination to put an end to this scourge by harmonizing its legislation with international agreements

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and the practical steps that it has taken and continues to take toward strengthening the fight against child labor. A good step, but not enough in the absence of a well-defined plan.

6. CONCLUSION

Sustainable and systematic solutions must be at the heart of child labor strategies. Central governments must invest in data systems that track child labor rates across different age groups, income levels, and geographies, as well as the types of work they do, to better understand regional vulnerabilities and the root causes that exacerbate the trend. The implementation of comprehensive birth registration systems that aid in the tracking of children is deemed necessary. Policymakers should constantly develop job-creation policies to assist in providing fair and adequate opportunities for families to break the cycle of poverty. Authorities should also conduct regular workplace inspections to identify instances of child labor. At the same time, solid social protection schemes for families, such as housing assistance, school tuition, healthcare services, and childcare, as well as cash payments, are needed to offset the need to rely on child labor to improve livelihoods.

Parenting education programs can help people learn about the dangers of child labor and question social norms that may support it unintentionally. Child labor should be identified and reported by community advocates as well. In tandem, national legislation must be enacted to protect children's fundamental rights to education, healthcare, well-being, and safety. Suggested actions to advance the elimination of child labor in the Arab World in general and Lebanon in particular are presented below (Table 7).

Table 7. Suggested actions to eliminate child labor

Area	Suggested Action
Legal Framework	Raise the minimum age for work to the age at which education is compulsory.
	Make sure that the minimum age to work applies to all children, including those who work informally, in homes, or on farms.
Enforcement	Make sure there is a good way to receive complaints about child labor, write them down, and send them to an investigation.
	Track and publish information on labor law enforcement.
	Authorize the labor inspectorate to assess penalties.
	Provide the Ministry of Labor’s inspectors with proper funding and resources.
	Increase the number of labor inspectors to meet the ILO's technical advice.
	Publish information on the criminal enforcement of child labor laws.
	Make sure that criminal law enforcement agencies, like the Internal Security Forces' anti-human trafficking unit, have the money and people they need to investigate and prosecute cases of child labor that break the law.
Government Policies	Ensure that the Work Plan to Prevent and Respond to the Association of Children with Armed Violence in Lebanon is implemented, and that children previously associated with armed conflict receive social and rehabilitation services.
	Make sure that key policies about child labor are put into action during the reporting period and that information about these activities is made public.
	Adopt a new action plan to address the worst forms of child labor.
Social Programs	Collect and share information about how much and what kind of child labor there is so that policies and programs can be made.
	Make sure that all children, including refugees, can go to public school by improving transportation, dealing with bullying and harassment, taking care of students with disabilities, and improving facilities.
	Expand programs, such as those that offer social services to people who have been victims of human trafficking, to deal with the full extent of child labor, including forced labor in agriculture and construction.

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Noteworthy is that more than half of the 22 Arab countries, with a population of 420 million people, are currently affected by conflicts or inflows of refugees and internally displaced persons. These include: Iraq, Jordan, Lebanon, Libya, Somalia, Sudan, Syria, Tunisia, Egypt, and Yemen. As is the case across the globe, conflict has hit women and children disproportionately hard in the region. In consequence, child labor has emerged as perhaps the most critical child-protection issue in the region, requiring our urgent attention and action. The effects of recent economic shocks, political turmoil, conflict, and war have worsened pre-existing levels of child labor and also reversed much of the progress Arab countries had made in combating child labor through policy development and practical measures. On the other hand, Arab governments have generally worked to combat child labor through legislation but have often failed to rein in abuse because of the spread of corruption, a lack of oversight, and their own contribution to political instability. Some countries have even restricted the work of some NGOs whose activities include combating child labor (Mekay, n.d.).

The International Rescue Committee's project in Lebanon, which the EU's Civil Protection and Humanitarian Aid funded, came to the following conclusions (IRC and LPC, 2021):

- An increased use of child labor as a negative coping mechanism is due to food insecurity and deteriorating nutrition practices. The inability to provide food is one of the main triggers for parents to send their children to work, and the primary use of children's income is for food.
- Children are increasingly reporting becoming the main breadwinners for their families. However, even when they are working, the children and their families suffer acutely from food insecurity and resort to food-based coping mechanisms; 84% of the working children surveyed have been worried that their household would not have enough to eat, and 56% of the working children surveyed reported going to bed hungry.
- Food insecure working children are more likely to face short- and long-term consequences: 50% of the surveyed children had wounds. Children report suffering from tiredness (24% of the communities surveyed by LPC), body pain (19%), exposure to verbal and physical abuse (13%), and psychological distress (12%). The children are very likely to have some form of micronutrient deficiency and stunted growth. Their well-being and mental health are dramatically impacted. There is a concern over the possible increased risk of child marriage.

It is clear from the above that there is a strong correlation between child labor and food insecurity; the inability to provide food is one of the main triggers for parents to send their children to work, and the primary use of children's income is for food; children in Lebanon are increasingly reporting becoming the main breadwinners for their families. Since 2019, Lebanon has been dealing with an unprecedented number of crises that have brought the country to its knees. The country's resources, health system, and businesses have been strained as a result of the financial and socioeconomic crisis, as well as COVID-19 and the Beirut Blast of 2020. Over half of Lebanon's population lives in poverty (World Bank, 2020), and 9 out of 10 refugees (UNHCR, 2020) live in extreme poverty. Unemployment has risen in the last couple of years (Commerce du Levant, 2020; UNOCHA, 2020), affecting both Lebanese and Syrian workers. Thus, it is of utmost importance to mainstream child labor efforts into inter-sector priorities and programming. Also, there is an immediate need for food security and basic assistance programs for working children and their families that include nutrition and case management. There is also a need for programs that deal with child labor over a longer period of time and that combine food security and nutrition.

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Millions of people in Lebanon have been forced into poverty and have reduced their food consumption. Three years into the economic crisis, the government has not acted adequately, and the existing system reaches a tiny share of those with low incomes, leaving the majority completely unprotected. Rising unemployment, a weakening local currency, skyrocketing inflation, and the elimination of medicine and fuel subsidies have made it difficult for many people to meet their basic needs. Nearly four out of every five households had a wage earner who had lost their job since the crisis began in 2019, with about 15% still unemployed. Households with an unemployed member were more likely to struggle to make ends meet (Human Rights Watch, 2022). Existing social assistance programs, which are partially funded by the World Bank, have limited coverage and target households in extreme poverty, leaving large segments of the population vulnerable to hunger, unable to obtain medicines, and subject to other deprivations that undermine their rights, such as the right to food and health. The government has not yet come up with a national plan for social security that protects everyone's right to it.

According to Human Rights Watch (2022), the severity of the current economic crisis highlights the urgent need for a universal, rights-based social protection system that leaves no one behind, fulfilling everyone's right to an adequate standard of living and to social security that fulfills this right. Donors and governments should recognize widespread suffering and devise a system to provide basic social security guarantees, such as child, disability, and unemployment benefits, as well as old-age pensions, in which the state is responsible for ensuring that everyone has access to food and income security. Both the Universal Declaration of Human Rights (UDHR) and the International Covenant on Economic, Social, and Cultural Rights recognize the right to social security. Article 25 of the UN's Universal Declaration of Human Rights says, "Everyone has the right to a standard of living adequate for the health and well-being of himself and his family, including food, clothing, housing, medical care, and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age, or other circumstances that leave him without a way to make a living."

Lebanon's population is approximately 6.7 million people. The United Nations estimated in late 2021 that nearly half of Lebanon's population, or 3.28 million people, had fallen into poverty since the country's economic crisis began in 2019 (Human Rights Watch, 2022). Others who were already struggling to fulfill their basic economic rights, such as food, education, or health care, saw their situation deteriorate. More adults skipped meals or were unable to afford medicines, and more children were forced to work to support their families. To make matters worse, the ongoing conflict in Ukraine has increased the cost of staple foods and energy.

For years, the political establishment was aware of the impending disaster, but did little to prevent it. A legal vacuum allowed capital to flow out of the country, allowing well-connected individuals to move their money out of the country. As a matter of human rights, truth and accountability must be sought. Political leaders in Lebanon are completely disconnected from reality, including the desperation they have created by destroying people's lives. Lebanon is also one of the most unequal countries in the world, and the country's leadership appears to be unaware of this at best, and complicit in it at worst.

In conclusion, if hope for a better future is to be restored in Lebanon, future governments must strengthen the Central Inspection, remove potential political interference from the National Anti-Corruption Commission, and incorporate accountability and transparency into recovery plans. The governments must also commit to improving human rights records in all areas, including reducing inequality, combating corruption and impunity, constructing strong and resilient social protection, education and healthcare systems, and prioritizing public interests over private profits. By any means, the destructive actions of Lebanon's political and financial leaders are to blame for most of the country's people living in poverty, which is against international human rights law.

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REFERENCES

Al-Mulla, S. (2022, June 12). *Ending child labor in the region must be a priority*. Arab News. Available from: https://www.arabnews.com/node/2101941

Bureau of International Labor Affairs - U.S. Department of Labor (2021). *Findings on the Worst Forms of Child Labor: Lebanon*. Available from: https://www.dol.gov/sites/dolgov/files/ILAB/child_labor_reports/tda2020/Lebanon.pdf

Commerce du Levant (July 2020). Le taux de chômage au Liban a triplé depuis début 2019, selon Infopro. https:// www.lecommercedulevant.com/article/29889-le-taux-de-chomage-au-liban-a-triple-depuis-debut-2019-seloninfopro

ESCWA - Arab Labour Organization (n.d.). Cairo, Egypt. Available from: https://www.unescwa.org/sd-glossary/arab-labour-organization-alo

Human Rights Watch (2022, December 12). *Lebanon: Rising Poverty, Hunger Amid Economic Crisis - Government and World Bank Should Invest in Rights-Based Social Protection*. Available from: https://www.hrw.org/news/2022/12/12/lebanon-rising-poverty-hunger-amid-economic-crisis

ILO (2017). *Global Estimates of Child Labour: Results and Trends, 2012-2016*. International Labour Office, Geneva, Switzerland. Available from: https://www.ilo.org/global/publications/books/WCMS_575499/lang--en/index.htm

ILO (2015). *World report on child labour 2015: Paving the way to decent work for young people*. International Labour Office, Geneva: Switzerland. Available from: https://www.ilo.org/ipec/Informationresources/WCMS_358969/lang--en/index.htm

ILO (1998). *ILO Declaration on Fundamental Principles and Rights at Work*. International Labour Office, Geneva, Switzerland. Retrieved from: https://www.ilo.org/declaration/thedeclaration/textdeclaration/lang--en/index.htm

ILO (n.d.). *Conventions on child labour*. International Labour Office, Geneva, Switzerland. Available from: https://www.ilo.org/ipec/facts/ILOconventionsonchildlabour/lang--en/index.htm

ILO (n.d.). *Hazardous child labour: What is hazardous child labour or hazardous work?* International Labour Office, Geneva, Switzerland. Available from: https://www.ilo.org/ipec/facts/WorstFormsofChildLabour/Hazardouschildlabour/lang--en/index.htm

ILO (n.d.). *Child labour in Arab States*. International Labour Office, Geneva, Switzerland. Available from: https://www.ilo.org/ipec/Regionsandcountries/arab-states/lang--en/index.htm

International Rescue Committee (IRC) and the Lebanon Protection Consortium (LPC) - which includes Action Against Hunger (ACF), Gruppo di Volontariato Civile (GVC) and the Norwegian Refugee Council (NRC) (2021, February). *Working children in crisis-hit Lebanon: exploring the linkages between food insecurity and child labour.*

League of Arab States, International Labour Organization, Food and Agriculture Organization of the United Nations, Arab Labour Organization and Arab Council for Childhood and Development (2019). *Child labour in the arab region a quantitative and qualitative analysis*. Available from: https://www.ilo.org/beirut/publications/WCMS_675262/lang--en/index.htm

Mekay, E. (n.d.). *Middle East: Child labour on the rise as conflicts and tensions grow*. International Bar Association, London, UK. Available from: https://www.ibanet.org/article/6EE5DBD3-FEEF-4400-B4FC-B1CC9F4ECBE6

Morcos, P. (2014, January). Child labour: international law and Lebanese legislation. Human & Health magazine. Syndicate of Hospitals in Lebanon, No. 26, pp. 20-24. Available from: https://www.syndicateofhospitals.org.lb/Content/uploads/SyndicateMagazinePdfs/5006_20-25ar.pdf

Osseiran, H. (2012). *Action against child labour in Lebanon A mapping of policy and normative initiatives*. International Labour Office, Geneva, Switzerland. Available from: https://www.ilo.org/wcmsp5/groups/public/---arabstates/---ro-beirut/documents/genericdocument/wcms_210577.pdf

University of Minnesota: Human Rights Library (n.d.). Available from: http://hrlibrary.umn.edu/instree/k1drc.htm#:~:text=Principle%209&text=The%20child%20shall%20not%20be,physical%2C%20mental%20or%20moral%20development.

UNDP (2015). *Human Development Report 2015*. Available from: https://www.undp.org/publications/human-development-report-2015 Work for Human Development.

United Nations High Commissioner for Refugees (UNHCR), United Nations Children's Fund (UNICEF), World Food Program (WFP), and Inter-Agency Coordination (2020). *Vulnerability Assessment of Syrian Refugee in Lebanon (VASyR)*

United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) (August 2020): *Lebanon Flash Appeal.*

World Bank (WB) (October 2020). *Lebanon Economic Update*. https://www.worldbank.org/en/country/lebanon/ publication/economic-update-october-2020

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The experiences of mineworkers interacting with driverless trucks: risks, trust and teamwork

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KEYWORDS

Haul truck automation
Automation hazards
Mineworkers
Human-machine interface
Trust and Teamwork

ABSTRACT

Driverless haul trucks represent a significant transformation for the mine site workers in the Western Australian (WA) Mining Industry. Research within the industry is yet to explore the experiences of frontline workers who are mining with this new technology. The aim was to investigate the practical experiences of miners working with driverless trucks in a broader evaluation of safety incidents. A stratified sample of workers, from a WA mine site, were interviewed face-to-face using a mixture of open and close-ended questions. A convergent parallel design developed a comprehensive understanding of various risk perspectives. Interpretive data collected from multiple cases were analysed thematically through cross-case displays. The results indicate new hazards and risks are introduced through automation. Despite this, miners developed high levels of trust for technology through predicted pathways, adherence to instructions and exercising diligence when stopping for objects. The driverless trucks were perceived to play their part; however, technology does not assist others and engage in team play. Therefore, the worker perspectives highlight the introduction of new risks, high levels of trust and the narrow focus of driverless technology.
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1. INTRODUCTION

Driverless haul trucks have been involved in several mine site incidents since 2013 (Department of Mines and Petroleum, 2014). This kind of events are unconventional and are new to the Western Australian (WA) Mining Industry (Department of Mines and Petroleum, 2015a). Although they account for a small number of total incidents across the industry, the plans to expand the technology across Australia could see those numbers increase. The expansion is not only the case in the Mining Industry; with driverless vehicles being involved in public road incidents across the United States (National Transportation Safety Board, 2017; 2018). Despite recent reports of incidents involving driverless haul trucks, they provide little insight into the experiences of mineworkers who are now working with this technology. The experiences of people interfacing with automated systems across high-risk industries appear to be well known in aviation (Billings, 2018), maritime (de Vries, 2017), manufacturing (Frohm et al., 2006) and railroad (Gschwandtner et al., 2010). Experiences reported through the interactions with automated equipment include automation surprises (De Boer & Dekker, 2017), machine literalism (Billings, 2018) and opacity (Wessel et al., 2019) to name a few.

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What is most concerning, however, is the fact that automated systems are often evaluated on what they have been programmed to do, not what they should have been programmed to do (McKinnon, 2019). Such inward thinking will hinder the improvement cycle of human-machine systems, leaving the frontline to continue to make local improvisations to soothe the practical constraints of pre-programmed machines.

Open-cut mining represents a unique and high-risk environment, with mine workers performing various tasks with a variety of tools and equipment. Moving haul trucks creates a particular risk, due to the mobility, size and speed of the machine. In addition to this, mining companies are now replacing their truck drivers with automated systems. This substitution represents a transformation in the nature of tasks completed on mine sites, and associated risks, with the integration of human and machine activities. Moreover, there are also specific risks associated with computer interfaces, which are linked to feedback loops and system warnings (Dixon et al., 2007; Parasuraman & Manzey, 2010). Lastly, supervisors and users of automated technology are often the last lines of defence, applying local adaptions to avoid incidents and recover systems from failure (Reason, 1990).

Several studies have made connections to the nature and causes of human-machine breakdowns, which attempt to investigate the effects of automation on human performances. There have been reports that automation can be challenging to track and linked opaque interfaces to its contribution (Sarter & Woods, 1992). More recent studies have explored the effects of the unawareness of machine modes and associated features (Björklund et al., 2006; Feldhütter et al., 2019, August 26-30). Specifically, a lack of mode awareness emerging from an overreliance on automation than visual attention. Mode awareness has been argued to be a more complex phenomenon than merely eye-tracking. In addition, there are also links to the level of trust that is extended to automated systems and the reliance that is placed upon them (Botsman, 2017; Körber et al., 2018; Lee & See, 2004).

Despite the extensive amount of human factors research conducted in the Aviation Industry, there has been little research undertaken in the WA Mining Industry. A Code of Practice (COP) by the Department of Mines and Petroleum (2015a) indicated that there are unique risks associated with automating mobile equipment. However, there is no mention of trust or reliance issues that have been linked to automation (Hoff & Bashir, 2015). Although the COP does, however, note the risk of human intervention, system overriding, survey mismatches and mode switching. Research examining the attentional demands of automation suggests that monitoring automation can create out-of-the-loop problems for humans (Endsley, 2017). Moreover, a study in automated driving identified that individual trust levels influence how humans monitored the surrounding environment (Körber et al., 2018). Therefore, there is a real need to determine the trust levels of miners and whether attentional demands are leading to out-of-the-loop problems (Department of Mines and Petroleum, 2015b).

There is a significant body of knowledge that evaluates whether automated systems are team players. Team players have been defined as agents that cooperate (sharing, observable, directable) and participate (fluent, coordination) in team play (Christoffersen & Woods, 2002). Within the Aviation Industry, there is a powerful link between new surprising problems and human-machine breakdowns; for instance, how automated systems managed to get into a particular mode (Sarter & Woods, 1995). The characteristics of a team player are that humans must be able to cooperate with driverless trucks and share similar priorities. If the automated system is to be redirected, relative to operational demands, it can be achieved quite fluently. Finally, the effectiveness of feedback and awareness improves team play and minimises the significant problems with human-machine interactions (Sarter & Woods, 1997). The high-risk environment of driving trucks suggests that improving team play is equally important in mining. However, there is still no research conducted on how driverless trucks can become better team players.

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The research aimed to explore the practical experiences of mining personnel working with a driverless haulage system. This aim was achieved by facilitating face-to-face interviews with workers using semi-structured questions. The technique enabled the researchers to gather quantitative and qualitative data on the perspectives and lived experiences of worker interactions. Data that was transcribed was analysed using a pattern matching technique, identifying the themes across the sample group to represent the experiences of workers.

2. METHOD

2.1. Design

A simplified haulage system represents a number of components that work seamlessly together to load, haul and dump. Reductionism distinguishes between what the system has and what it does, achieving simplicity through what it excludes. The practice also distinguishes between what humans and machines undertake as well (Dekker, 2014). The simplification of haulage systems rests on the belief that components operate independently, without non-linear interactions disrupting the flow of the cycle. This is achieved by breaking down the system into its most basic parts, re-allocating tasks to either human or machine (Pritchett et al., 2013). The system is then put back together again, with isolated components that operate independently. This enables engineering to contain incidents and serious breakdowns in the design of the haulage cycle.

The reductionist approach aims to understand each components of the cycle individually within the system (Hamada & Saito, 2018). A simplified system improves upon knowing the behaviours of the constituent parts and being able to lock-in the productive methodologies for automation. It removes the variability and increases the predictability in what the system will perform. Haul trucks in a simplified system will therefore appear to be foreseeable and controlled in the way they execute the tasks. Therefore, trucks working within the design parameters will ultimately improve workplace safety and haul truck productivity. This constitutes the set of appearances that sit behind a much simpler haulage system.

2.2. Participants

The population of the study involved employees and contractors who work with driverless haul trucks. The size of the population was approximately 450 people who performed specific functions and characteristics pertinent to the research. A single-stage sampling procedure provided the investigation with direct access to the participants and the population under study (Teddlie & Tashakkori, 2009). The characteristics of the population were understood to enable stratification to occur. Therefore, the following roles and features identified: control room operators who monitor the performance of the trucks and make decisions via computer interfaces; pit technicians who attend to truck recoveries and system builders who build and verify the virtual mine model; ancillary and haul class operators manually controlling equipment; supervisors of system-based roles and auxiliary equipment operators who check and inspect work; and the professionals who include the designers and specialist in the function and pre-programming of the trucks. Specific characteristics targeted by random selection may not represent the entire population (Creswell, 2014a). There was saturation by recruiting 25 participants, which represented 5.5% of the operation when validating results.

2.3 Data collection

Semi-structured interviews were digitally recorded and took appropriately 45 minutes to 1.5 hours to complete. Participants were interviewed one-on-one between January 2018 and February 2019. The

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interviews were conducted on the research site and held in a quiet room. Every meeting was digitally recorded and was transcribed by one of the researchers verbatims.

During face-to-face interviews, participants were asked whether automating the haul trucks introduced new hazards and risks. Participants that believed new dangers and risks emerged were offered to elaborate on what they were and what contributed to them. Secondly, participants were asked to provide a trust level rating and what underpinned their level of trust. Thirdly, whether the interviewees observed driverless perform something that they did not anticipate. Did their trust level reduce after facing an incident or unanticipated situation? Fourth, did the system inform them adequately of what mode and function the truck is performing. Lastly, are driverless trucks team players, and whether they had ever instructed a truck to do something, yet it undertook something different. The set of questions (Table 1) remained consistent for all participants across the stratified sample.

Table 1: Interview questions specific to risk, trust and teamwork when working with driverless haul trucks

Topic	Question
Risk	– Do you believe new hazards and risks have been introduced through haul truck automation? – What do you think is contributing to incidents involving driverless haul trucks?
Trust	– What rating out of 10 would you say your trust level was towards the driverless trucks? – Have you observed a driverless truck perform something that you did not anticipate? – Did your trust level change after an incident or unanticipated situation? – How confident are you in redirecting or overriding obstacle detections?
Teamwork	– Does the system inform you adequately of what mode or function the driverless truck is performing? – Have you instructed a driverless truck to do one thing, yet it performed something different? – If the driverless trucks were team players, how would you describe them?

2.4 Data analysis

Interview data was uploaded and transcribed into an online database. Interpretive data collected from multiple cases analysed through a cross-case display. The display compared the interview responses for patterns and themes when coding abductively (Tashakkori & Teddlie, 2010). A mixed-method analysis provided statistical and analytical generalisations about the phenomenon (Creswell et al., 2011). Descriptive analysis organised and summarised the responses to enhance understanding of worker experiences. The technique was applied to represent natural clusters, grouping and dimensions (Onwuegbuzie & Combs, 2010). Statistical results were, therefore justified rather than predicted, comparing different perspectives drawn from qualitative and quantitative data (Creswell, 2014b).

Participants rated their understanding of the systems' modes and features, comparing their reasons why with responses that may have been higher. An inclusive design framework calculated statistics from data themes. Therefore, the numerical properties of the results stemmed from the stratified sample taken in the population (Onwuegbuzie & Combs, 2010). Cross-case analysis facilitated the simultaneous facilitated the analysis of multiple perspectives to avoid being bound by individual

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contributing factors (Onwuegbuzie & Combs, 2010). Raw data were sorted into groups and did not distinguish between independent and dependent variables (Miles & Huberman, 1994).

Furthermore, to enhance the investigation, this approach enabled the researcher to identify patterns and variables. The variables compared against the participants' perspectives working with driverless haul trucks (Wainer, 2005). A graphical analysis reported the results and highlight how they relate to the questions, which assisting in presenting the statistical information in visual form. Bar graphs developed for the visualisation of practical significance and trends in the worker experiences.

2.5 Ethical considerations

The research was approved by the University Research Ethics Committee (HRE2017-0844). The participants were provided with written information about the study. The researcher undertaking the interviews was an employee on the mine site. Therefore, the researcher informed participants of the researcher's role before commencing discussions. Participants provided written consent to participate in the research and were given to opportunity to choose the interview location. The interviewees were assured that interviewed records were kept confidential, with the participants allowed to cease the interview at any time.

3. RESULTS

The findings of miners' experiences working driverless trucks were synthesised into three themes. Those three themes include; the introduction of new hazards and risks, higher levels of trust for haul trucks and the narrow focus of driverless technology. The headings describe the workers' primary response to the question of their thoughts and personnel experiences.

3.1 New hazards and risks introduction through automation

3.1.1 Hazards and risks

A majority of participants reported that new hazards and risks had been introduced through automation. Participants explained how it used to be enough to train people how to drive haul trucks. However, since the replacement of truck drivers, coordinating the truck fleet is much more complicated. Driverless trucks were said to perform everything that is instructed, yet they will not perform tasks humans do not ask. New hazards, such as complacency, were reported to have emerged in anticipation of a trucks' next move. An expectation that the trucks will repeat the exact performances every single time. However, it was explained that there are factors outside the design parameters that can influence the trucks' performances. For example, truck settings and speed zones can be applied to change the truck's response to a situation. Local adaptions are required since the technology expects a particular operating environment; requiring roads to be dry and survey information to be accurate. When there is a distinction between the virtual and physical environment, the driverless system is restricted in how it can respond. As a result, without speed restrictions and accurate survey information in place, trucks' can drive full speed in wet weather and reverse beyond windrow boundaries. Therefore, humans must be a step ahead of the system to put controls in place to avoid incidents.

A humans' complacency towards driverless trucks was raised as a particularly significant hazard. Since automated trucks were considered so 'predictable', the frontline workers had developed a high level of trust. In particular, when participants compared their experiences in manual truck operations. Despite this, high levels of trust drove practices that were not observed in a manual environment. For example, graders working head on to an oncoming haul trucks until they stopped, pulling away at the last minute.

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These practices place a high dependence on the trucks' lasers, sensors and GPS systems to work:

> *You still have to respect the blue light. They are a big machine, no one in them, could be doing 60 km/h. They are not just going to stop on a dime [abruptly].* *[P23*]

If a vehicle turns in front of a travelling haul truck, it was reported that a driverless truck could not stop in time. The eyes and ears of truck drivers are said to be far different from the lasers and sensors that substitute them. Personnel now monitors a 3D world through a 2D display, which requires a high frequency of verifications to validate the virtual model. Participants raised the importance of checks to avoid truck backing through windrows. Virtual mine models must be 'real' to prevent penetrating the boundary:

> *Had a truck back through a windrow to get to another windrow behind that, because someone had not surveyed it in. A grade operator has come up and said, 'no, it's all clear'.* *[P21]*

Now that mine controllers supervise multiple trucks; it was noted that an enormous amount of responsibility had been placed on a single person to manage numerous trucks. Since there is no longer direct communication with a haul truck, mine controllers rely on computer interfaces. Controllers set goals for the shift, allocate trucks and redirect the fleet where they are needed. When it comes to manually operated equipment, the machines must be connected to the network to be visible in the system. Vehicles without communications are escorted through the mine, which has created escort splits and unintended interactions in the past. Furthermore, participants reported that personnel rely heavily on this technology to recognise their vehicle and rarely observe in-cab displays. In addition, their reliance drove new methods of managing the truck operation:

> *[Driverless] truck breaks down on a ramp. Truck stops. We put a virtual zone around it…. In the manned world, if that had have happened. Someone would have to stay in the [manual] truck; we would put a barrier behind the truck, we would put cones there, we would probably put a lighting plant there to shine on the truck... We are comfortable with virtual controls, as opposed to hard controls.* *[P15]*

There were situations reported where personnel were unable to create a dump plan without turning off all the exclusion zones. An exclusion zone prevents driverless trucks from driving into that area. The problem with zones in dump plans, however, is that some people were not turning them back on. Personnel tend to rely on sensors that do not always recognise objects. Moreover, it was noted that people are still learning how to interact with the trucks properly:

> *In general, I think it is safer, but it's that learning around working with the system properly. I guess, what it does and what it doesn't do.* *[P25]*

While ever people are interacting with a 400-tonne truck, participants noted that there will always be associated with risks. For example, there are people still on the ground refuelling and mode changing driverless trucks. If the mode changing process is not followed, there was said to be a chance that a driverless truck could drive away while someone is nearby. However, when comparing hazards to manual truck operations, participants maintained that the risks had been reduced.

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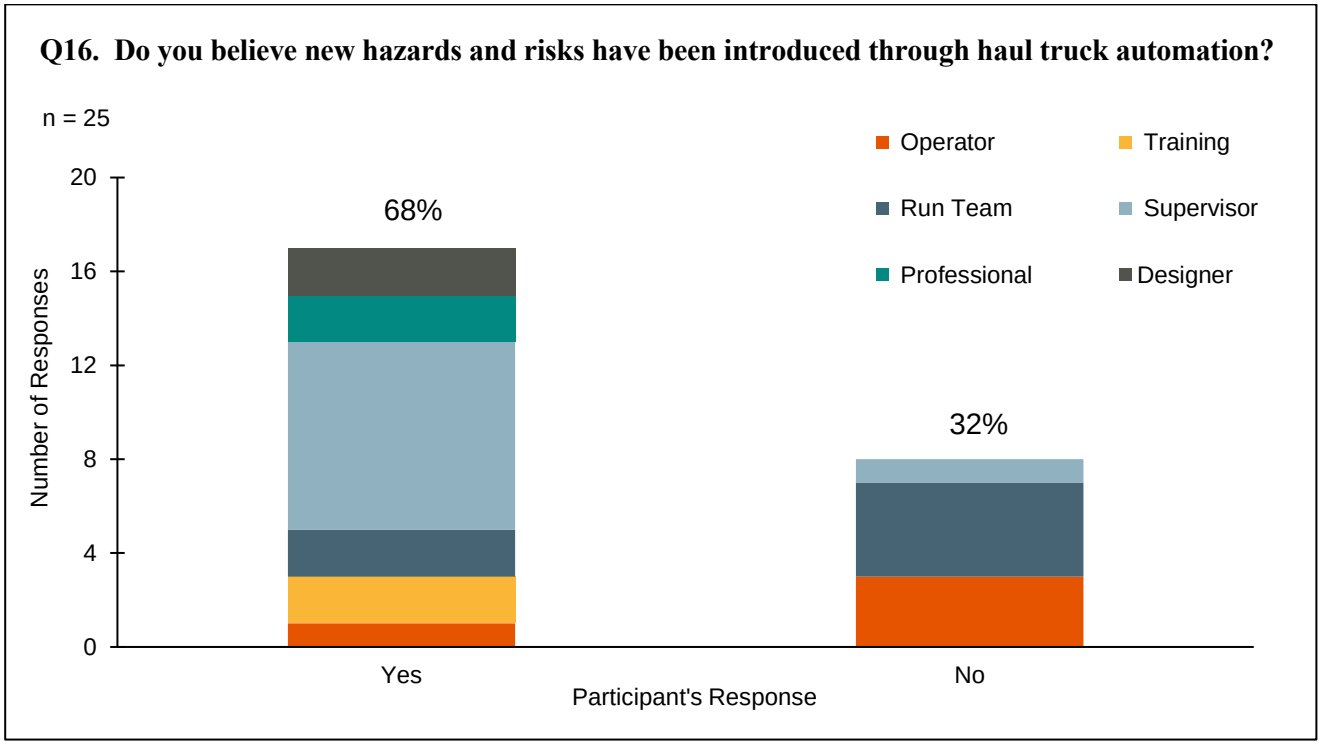

Figure 1. Responses to question whether new hazards and risks have been introduced through haul truck automation. Data collected through one-on-one interviews

Participants reinforced that the positives of driverless technology far outweigh new hazards and risks. Where priority rules breaches used to be the most common risk, a now reported to be virtually non-existent. Therefore, replacing the truck driver removed some of the typical event types:

> *The amount of incidents we used to have with priority rules breaches with truck on truck. Things like that, that's just disappeared. We don't have it. Pos comms (positive communication) breaches as well.* *[P18]*

Despite most participants reporting that there are new hazards, there was a much small number of participants that stated there were no new hazards. Those participants claim that removing people simply left nothing to worry about:

> *I think it's a much safer environment to drive around in, than if there were humans driving around in the trucks. Because you can see exactly where they're going, and you just stay out of their way, basically.* *[P5]*

Driverless operations were reported to be a lot safer than manual, which was referenced by the improvements in recordable injuries. Participants recalled the hazards and risks that observed in the driverless operations. The hazardous conditions had elements of human and technology. The primary concerns were the difference in the virtual and physical world, complacency and limited experience with automation:

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> *And then this comes back to knowledge of people in the pit… grader operator didn't look for that windrow being surveyed in and all that sort of stuff. Where if he had a bit more knowledge before that event, he would have known… that windrow is not surveyed in, don't back that truck in there.* *[P21]*

3.1.2 Humans are contributing to driverless incidents

When asked what is contributing to incidents involving driverless trucks, a majority of participants (n = 16) reported that it was 'humans'. The events were argued to be a perfect representation of the mining culture embedded in the WA Mining Industry. Participants claim that people who are so focused on the dirt can quickly look past things. There is much more detail now required to run a truck operation. Moreover, it was argued that people are not verifying situations in enough depth:

> *Especially with the truck going through the bund, everyone assumes when that occurred, it was just a little rock that was there that the truck had seen. They didn't go into the in-depth detail to look at it a little bit further and actually really check. [P2]*

Participants explained that when a truck identifies a reverse object, rather than just looking for a physical object. People must compare what they are observing to the virtual mine model. When detected objects are cleared from a distance, there is no way to identify whether there are objects behind the truck. Personnel need to make themselves aware of their surroundings, including communicating with others to verify and explain what is being observed. The trust extended to the system is very high, with an expectation that the truck will not do anything outside of its design parameters. When people perceive that they are being rushed, it was reported that they perform tasks outside of the procedure. The low operating discipline on behalf of the human is claimed to lead to the frontline not following standards and avoiding ownership. As a result, people have more faith in computer literalism than human cognition, with the belief that the system is perfect:

> *What I believe is that the system is perfect. We are the ones that slow it down or make it fault. So, human error…* *[P18]*

Participants reported that personnel become comfortable with what driverless trucks can perform. If people do not look at their in-cab displays, they will not observe truck assignments. When people are not concentrating, it was reported that people rush into tasks and create incidents. These conditions include lapses in judgement or not focusing on the things around them. The inexperience of working with driverless systems has led to actions that conflict with the situation. Moreover, as the operation has expanded, it was reported that more people were brought over from the manual truck operation with less experience:

> *It's just the skill set of operators. A lot of operators have moved around; we are bringing in a lot of other operators at this point in time. They're experienced operators, but not all have autonomy experience.* *[P22]*

Surveys that do not match the physical mine leave virtual distinctions that the trucks accept as an accurate representation. When people do not respond quick enough to downpours of rain, trucks can be left operating at full capacity without speed or traction controls (Jamasmie, 2019). Moreover, water cart operators have applied too much water on the road, creating slippery conditions for a driverless truck. The lack of knowledge with truck capability has led to people removing controls while believing other functions were in place.

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It is essential to know how to read and use the information outputted by the system correctly. Some conditions were considered to be influencing people's actions, mainly manually operated equipment interacting with the trucks. Without physical demarcation, it is challenging to identify an intersection that exists in the virtual mine model. Unless in-cab displays are observed, there is nothing to indicate intersections exist. Participants explained can be confused when a truck stops for no physical obstruction in the truck's lane.

Participants reported that workers could become comfortable with driverless technology, regardless of what it does. Participants noted that the people assume driverless trucks will always identify them. This assumption drives relaxed behaviours when in the field. Moreover, in the beginning, the operation did not have all their systems and processes to support people. As the technology was evolving and people were learning, those processes were just being developed. Therefore, the operation relied heavily on the manufacturer to coach them on how to interact with the driverless fleet.

3.2 High levels of trust developed with driverless technology

3.2.1 Participant trust levels

Participants reported a high level of trust towards the driverless fleet (median = 9), claiming that if a truck drove somewhere that it did not instruct it to, then it is a person's fault. For example, driverless trucks that park too far away from the excavator have had the loading point placed there by the operator. Furthermore, it was explained that driverless trucks could reverse over rocks or up the dig face when instructed. Driverless trucks were claimed to be reasonably accurate, which resulted in high levels of trust. Particularly when compared to a manual truck environment, with one participant adding that they would rate humans low on a good day. With 12-hour shifts, driverless trucks are reported to perform safely for 12 hours, where truck drivers did not:

> *A man truck might be spot on after his smoko [cigarette break] and his coffee, but 5 hours down the track, he could be thinking about fishing or something like that. An autonomous truck is not thinking about that.* *[P10]*

Trust increased through the introduction of in-cab displays which highlight haul truck travel paths. In addition, the frontline could control driverless trucks from their light vehicle. Moreover, driverless trucks were claimed to not drive out of their assigned lane like a manual truck driver. As a result, with blue paths indicating where trucks are travelling, participants trust that the truck is going to go straight and not veering off in front of them. As time went on, people's trust level had increased, with a realisation they were not going to hurt them. The truck will just stop. Despite the potential for truck slides, interviewees reported that driverless haul trucks losing control turn their wheels to the outside windrow to avoid oncoming traffic. It is these sorts of practices and observed vigilance that increased trust:

> *When you watch them give way to a cow on a haul road… Come to a stop in a space that no way a human could pull a truck up in, safely. And a cow walks across the road in front of it, and the truck drives off in the end. And you go, wow.* *[P4]*

Driverless trucks are usually attempting to correct themselves and avoid oncoming traffic. It is these responses that participants observed in the mine. It was also noted that through virtual playbacks, when participants watched truck movements, the machines were never found performing something unsafe. Although personnel may question why a truck is driving from one location to another, one participant claimed that they never observed a truck do something unpredictable:

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> *I've never seen a truck do anything in an unsafe manner that I couldn't say wasn't predictable… But I've never seen it do something unpredictable. There's always been a reason why it has always done what it has done.* *[P3]*

It was argued that there is always a reason why a truck performs something or is redirected. Participants have observed trucks waiting in the queue and suddenly execute a U-turn to travel to another loading source. It was noted that people might find this action unpredicted. Yet it was suggested that this might be unexpected, but not unpredictable. The assignment engine can simply re-assign a truck elsewhere, with the U-turn lanes already available for the trucks. The more participants observed trucks performances and understood the assignment engine, the more they trusted the system.

Participants reported that trust is built through learning what the trucks will and will not perform. Understanding the controls and the systems that are in place, particularly how driverless trucks respond to situations. Recognising that it is an algorithm, participants reported that trucks would simply repeat the observable functions. This function is underpinned by in-cab displays that highlight the intended travel path, which is non-existent in a manual truck operation. Moreover, it was reported that participants have the sense that trucks will remain in their lane. If a truck touches or slightly breaches the path, it will stop. A manual truck is reported to have less certainty:

> *You don't have the uncertainty of a manned driver, that can go off over windrows, can go bush, can go anywhere, if they wanted to… You know a truck is going to stay in its lane, and it's going to travel that path, and if deviates slightly, it's going to stop.* *[P19]*

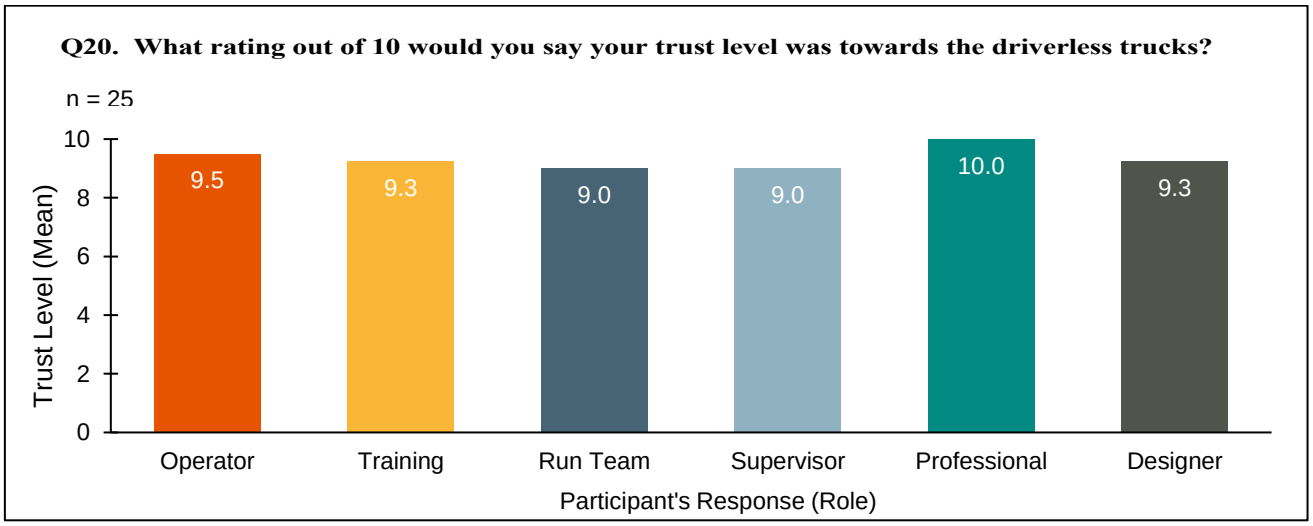

Figure 2. Median trust level out of 10 towards the driverless trucks by role. Data collected through one-on-one interviews with personnel on mine site

Driverless trucks had built trust by stopping when they lose communication. The fact that the system stops when the situation is 'not right', made participants feel like safety was taken seriously. Moreover, manually operated equipment that lose communication generates an exclusion bubble, which expands a zone that stops trucks until the vehicle has found a safe location. The safety mechanisms and their effectiveness underline the high level of trust was realised. In addition, the trucks are reported to behave the way a truck is supposed to, responding to situations similar to a truck driver, if not better. Driverless trucks travel to where they are supposed to and park where loading units wants them.

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The human factor was argued to have been removed, with priority rules and communication breaches no longer a risk. One of the significant dangers reported was fatigue, where truck indicators were never trusted. Participants noted that they would never drive out, claiming that it was unknown whether the driver was paying attention. In comparison, the technology had introduced layers of controls to maintain a safe distance between people and haul trucks, including avoidance boundaries and emergency stop devices. However, the participants did note that they would never walk out in front of a truck. With an understanding of what a truck is capable of performing, the only trust issues were highlighted in wet weather:

> *But, road conditions, weather permitting and all that stuff. Where a dump truck could potentially slide down a ramp into an LV or a car or something, yeah, that's a bit of a different question… If we don't put a zone lock on in time, then stuff can get pretty hairy."* *[P12]*

3.2.2 Driverless trucks performed unanticipated tasks

Driverless haul trucks were observed by participants to perform tasks that were not expected. A driverless truck 'wobbling' aggressively side-to-side was one example. Although it can now be explained that is was a steering fault, at the time, participants were left confused. Driverless trucks can also drive away without explaining its intentions to manually operated equipment. This reinforces the point made earlier by a participant who noted that manual machines could no longer make direct contact with a haul truck driver. On the pit floor, driverless trucks are given the flexibility to generate their pathway to being loaded. For a dozer operator, they can be surprised when a truck arrives behind them without notice:

> *All of a sudden, the digger moved to a certain spot and the trucks had to come back in behind me, and I didn't realise… I came out, and this blinkin' thing is right behind me on the dozer, going 'barrrrrrrrrp' (sound of the truck horn).* *[P5]*

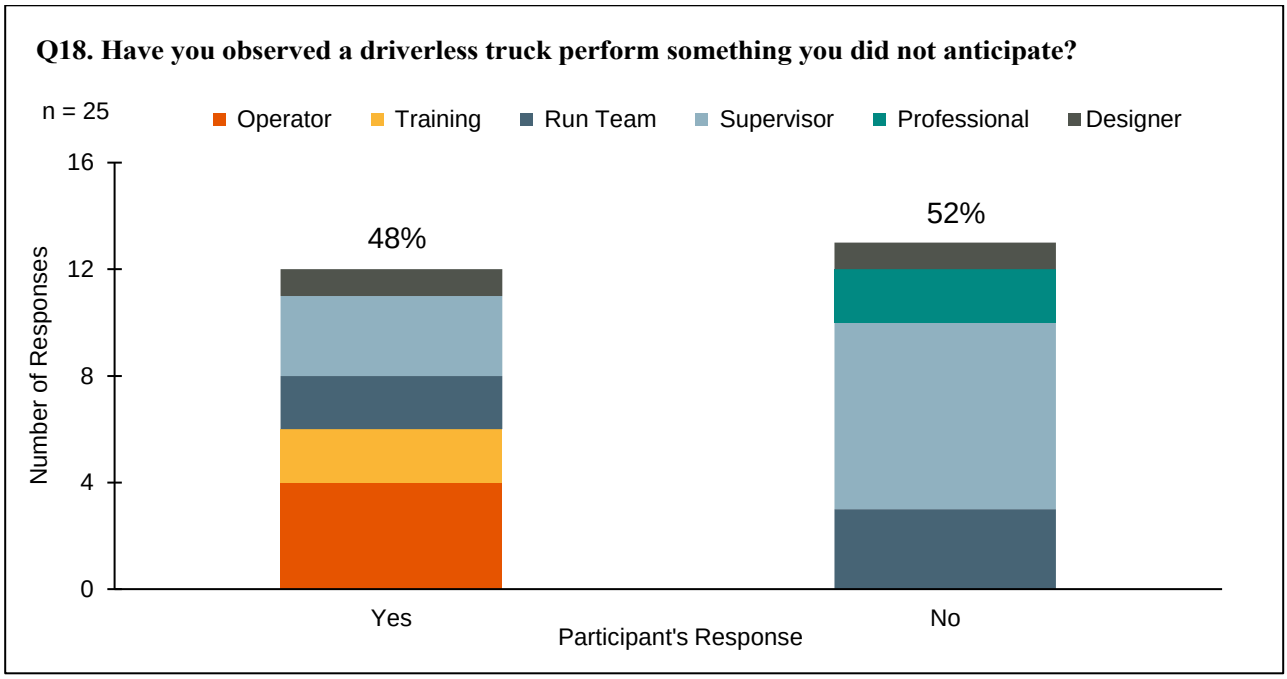

Figure 3. Responses to question whether participants had observed a driverless truck perform something that they did not anticipate. Data collected through one-on-one interviews

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Participants reported that driverless trucks could be found driving the longest haul route to the crusher. Several in-cycle delays on the haul route changed the average time taken, resulting in the trucks making a different way. However, at the time, the mine controller did not understand why this was being performed. Excavator operators have observed empty trucks driving off before loaded trucks as well. It was later found that the empty truck was higher up in the queue. Therefore, the system assigned the empty truck away, despite the other truck being loaded. Driverless trucks have also been observed travelling back to the loading unit with its tray in the air. Without a dump script in place, driverless trucks can drive away without being instructed to lower its tray.

Observing in-cab displays enables the frontline to be more informed of truck performances. The information highlights what a driverless truck is performing and what it is likely to do next. However, some functions are not described unless the designer previously explained it—for example, trucks driving through dust with its horn sounding. Although the algorithms are not visible, the data logs highlight a person's input or mechanical failure. With an explanation, participants explained how it could answer the uncertainty. Yet, not every role is provided with this level of information. Participants without this level of information learn through observing machine actions:

> *So, you learn how to interact with them… Figure out where the dump spots are, where the digger is loading from, and you just watch your screen to make sure they are going in the path, and you can move out of their way.* *[P12]*

Most of the truck activities were reported to be fairly structured. As a result, the trucks would not do much other than what was instructed. It was reported that there are always human decisions underlying why driverless truck do what they do. There are also different reasons why trucks slide out of their lane. Participants identified that birds were being detected as objects, which was leading trucks engaging the emergency brake. What was also surprising to participants, were driverless trucks trying to correct themselves. When faced with a wet road, driverless trucks will make every effort to remain on the centre line. The permission-based control system also enables two trucks to use an interaction at a time, which was never permitted in a manual operation. Despite participants observing practices that they had never seen before, once they had learned the parameters of the system, it had answered a lot of unanticipated situations.

3.2.3 Trust levels did not waver after incidents or unanticipated situations

Trust towards driverless trucks never wavered for the majority of participants. The participants reflected on incidents involving driverless trucks and explained how humans had instructed trucks to perform those tasks. Since the truck was only performing what was instructed, participants noted that their trust did not waver after such situations. What was even more profound, was that fact that some participants had increased their level of trust upon having the situation being explained:

> *When I found out it wasn't the truck's fault… it wasn't technology's fault, it was human error. So that just reiterated to me that I still had full trust in the system.*
> *[P23]*

The trucks only perform what has been instructed; therefore, the logic appears to be relieved of the consequences. As a result, with a person identified as the fault, participants found themselves comfortable with the actions of the computer. However, there were reports of participants becoming warier after being involved in an incident. Not necessarily with the system itself, more towards the clearing of objects and questioning the virtual representation. By developing a basic understanding of the safety features, participants were able to build a level of respect for the system. The experience of

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working long enough with the system establishes a level of knowledge for what a truck will and will not perform. For some participants, it has been a journey of watching the technology evolve overtime and ultimately improve.

Trust for a driverless system is reinforced when compared to manual truck operations. Participants reported truck drivers turning in front of them in a light vehicle in manual trucks operations. With people sitting in a truck for long periods, the risk is considered a lot higher:

> *I've always felt comfortable with them. Because I've had issues where people and trucks have pulled out on me when you least expect it. Because of the predictability of the AHT's, I've never really had those moments.* *[P15]*

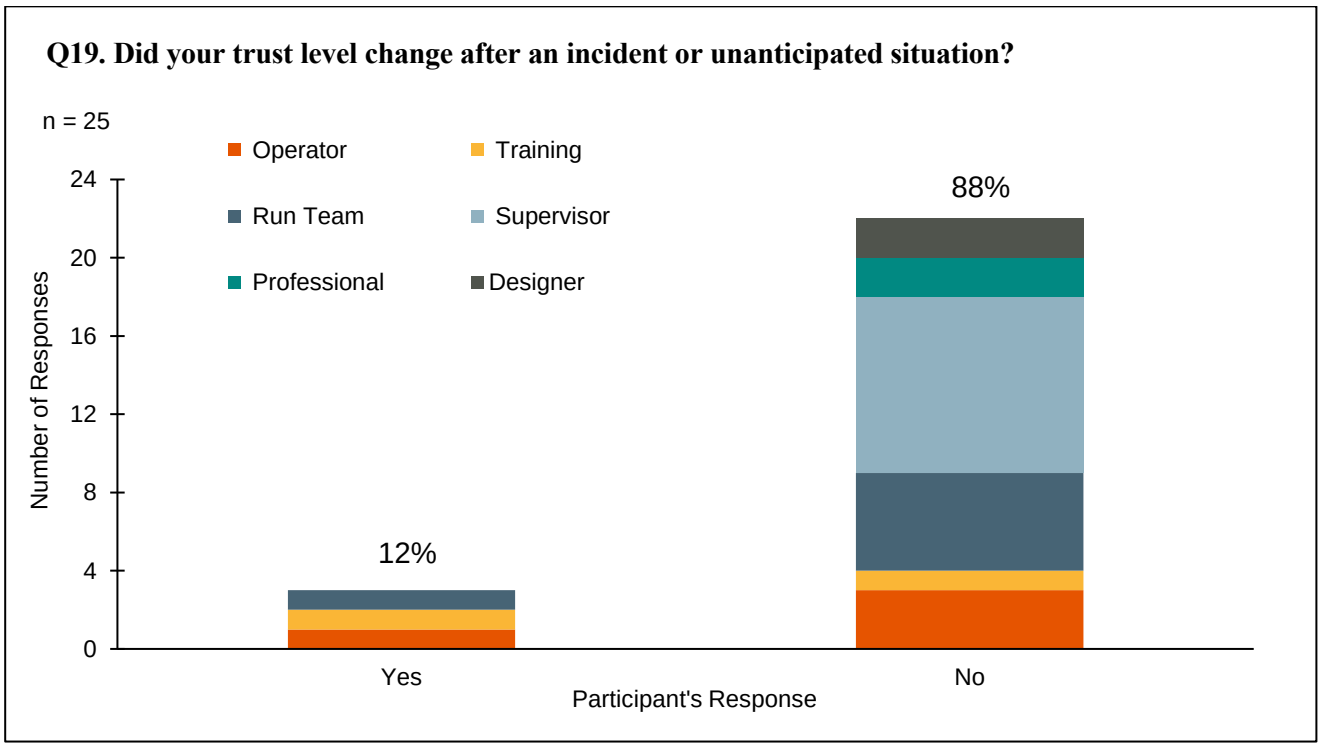

Figure 4. Responses to question whether participants' trust level changed after an incident or unanticipated situation. Data collected through one-on-one interviews

Providing an allocated pathway in the system has meant that participants avoided similar experiences in manual. For example, when approaching an intersection, the in-cab display indicates the intended path with blue coloured lane. This predictability results in people building trusting the trucks knowing what direction the truck is travelling. Some participants admit extending too much trust to the system. It is generally believed that the truck is built to keep people safe, with experiences reported that they had never faced a situation where a driverless truck has performed something they did not anticipate.

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3.2.4 Informing personnel of what mode or function trucks are performing

When asked when the systems inform personnel of what mode or function trucks are performing, the participants responded favourably (n = 24). Blue lanes on in-cab displays were reported to indicate that trucks travelling in autonomous mode and their direction. When approaching a driverless truck, the mode lights located on the side of the truck indicate the machine's mode. Combining the visual reference with the virtual mine model, participants noted that personnel could identify what is around the truck and foresee potential interactions. More in-depth screen displays provide supervisors and run team members with diagnostics details and the performance of the fleet. When mode changing trucks, the lights change colour and flash to indicate the change in modes. Additional real-time information on in-cab displays highlights scripts and zones that can influence the function of the truck. It is in dumping and loading (dynamic) areas where participants experience surprises:

> *Sometimes they drive off by themselves. The controller didn't know what was happening. We put in a delay to have a clean-up, and it just backed itself up the ramp and took off.* *[P5]*

A dynamic area allows the trucks to utilise the space to reverse into the loading bay. On haul roads, participants reported that determining what the truck is performing is relatively clear. The blue light indicates the driverless mode and the blue lane identifies where it is heading. However, when in manual mode, a predicted pathway is not provided, requiring personnel to switch back to conventional priority rules. It was noted that at times mode lights could be challenging to change, which was described as a communication issue that can difficult to switch between functions. However, when asked whether the system informs personnel, one participant put simply:

> *It's blue, flashing blue, it's in autonomous mode. It's lifting its tray, it's dumping, it's backing under the digger, and it's going to get loaded.* *[P15]*

There was only a single participant who reported that the system does not adequately inform them. In contrast to observing mode lights or learning the repetitive elements of the haul cycle, it appeared the operator expected some level of feedback on what trucks are performing. The level of detail displayed on in-cab displays is dependent on the role, which manual haul class and ancillary equipment do not have. Despite this, there was personnel who considered the information adequate. For run team members, the status page provides additional functional information:

> *It tells you exactly what state the trucks in. Whether its travelling loaded, travelling empty, dumping… spotting at a dump, spotting at a digger, queuing… it tells you exactly what it is doing all the time."* *[P24]*

There are truck tiles that are coloured green, yellow or red, which indicate the health of the machine. Since the system was reported to log everything, system-based roles can see real-time modes of the entire fleet. The system is said to highlight what needs to be address and what is happening in the system. However, this is providing that personnel understand what they are looking to obtain.

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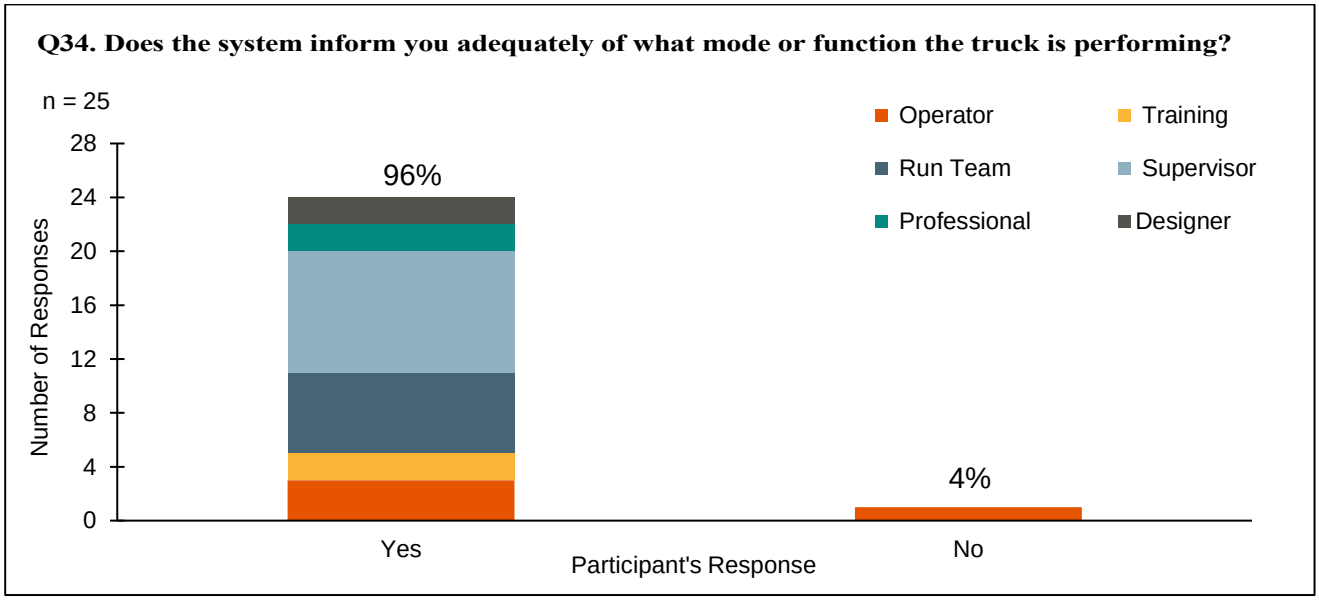

Figure 5. Responses to question whether the system informs participants of what mode or function a driverless truck is performing. Data collected through one-on-one interviews

The mode lights provide additional meaning, including communication losses that result in mode lights turning green. With the added benefit of a status page, participants reported that they are informed of what part of the cycle each truck is performing. Whether it be travelling empty, loading at source or dumping at the crusher, the information is available. Moreover, if a truck is facing issues such as wheel slippage, the system will highlight that this is occurring. In addition, the system is reported to display mechanical problems and increases in the truck's tyre temperature. When the truck is on delay, the truck icons turn grey to highlights that production is suspended. It was noted that a truck could only be in one of the five aspects of a cycle, which makes it easier to determine what the truck is performing:

> *... yeah because it's in, like travelling, spotting, loading, dumping, you know it's a cycle that it's in. It's only them five or six cycles that it can be in. So, you know which states it's in, and whether its autonomous or in manual mode." [P23]*

The data that indicates how many tonnes are on a truck, informing personnel whether the machine has been loaded. The real risk, however, was whether there was too much information for people to process to remain in-the-loop.

3.2.5 Driverless trucks may perform tasks that were not instructed

Participants reported that trucks had performed tasks that were not anticipated:

> *Yes, go the other way, without me seeing. Take a load of waste to the longest waste dump because of me not closing a particular dump off or taking a different route that I didn't want it to. [P8]*

They reported that if a truck is instructed to do something, it will just go ahead and do it. Rarely, that group argued, has a truck ever performed something that was not expected. A truck was more likely to do nothing than do something that was not instructed. To some participants, driverless trucks are the perfect truck driver:

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> *To me, they are the perfect trucky… If it went there, but it was supposed to go there, but I assigned it to go there. It's not the truck's fault; the truck's only doing what it got told to do.* *[P13]*

In the participants' experience, if a truck is instructed to do something, it will go ahead and do it. A participant experienced a situation where a truck breached a windrow. It was noted that this occurs when the windrow is detected as an object. To the person clearing that object, there appears to be no obstruction to get to the windrow. However, since reverse locations can be mistakenly placed behind windrows, and if cleared, the truck will attempt to reverse over the windrow. There were also other examples experienced in the excavator, where pressing the incorrect button led to trucks parking out on the pit floor. The automated system can be re-assigned to perform a task numerous times; however, if old assignments exist, driverless trucks can difficult to direct:

> *We sent it out of the fuel bay. We sent it to go to park up in one of the park up bays. Done another loop again, come back around and parked up on the other side and sat there looking at us… It's done it three times before we got it to where we wanted it to go…* *[P4]*

The participant explained that it was later identified that personnel had previously attempted to instruct a truck to the fuel bay. As a result, old assignments existed in the background and were being executed before performing the new instructions. In addition, trucks may hang onto scripts when the crusher light turns red as the truck is reversing into the bay. Trucks have then tipped shortly after being instructed to move forward away from the crusher bay. Participants reported that unanticipated situations could be glitches, rather than a truck performing different tasks. In contrast, trucks that take longer routes for no apparent reason are said to be recalculated routes after multiple stoppages, which increase the average travel time on main thoroughfares. More often than not, however, participants noted that a driverless truck is likely to remain stationary than perform something different.

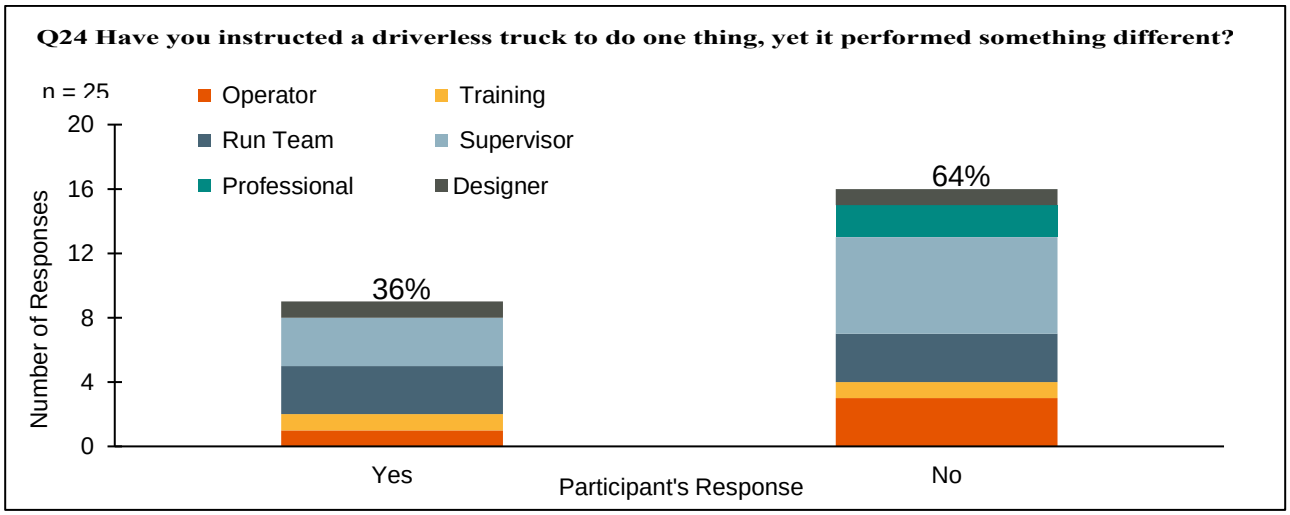

Figure 6. Responses to question whether participants have instructed a truck to do one thing, yet it had performed something different. Data collected through one-on-one interviews

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3.3 Driverless trucks player their role, yet are not necessarily team players

3.3.1 Team play

Driverless trucks were described as the workhorse of the operation. To be a team player, however, participants noted that the correct goals and inputs must be provided to enable the system to succeed. These reports highlight how reliant the system currently is on human contributions. When describing whether the trucks are team players, participants explained how much harder they work than truck drivers. Driverless trucks perform what personnel want when they want it. Despite various responses, a majority were positive in how the fleet act as a unit. Yet, it was expressed that it would be nice if the trucks helped each other out. For example, if an object was already cleared for one truck, that information is not passed on. Therefore, the system does not learn from its experiences like truck drivers. Although participants described them as hard-working, the system also showed signs of independence, described them as being 'tonne hungry'. Driverless trucks were reported to drive as fast as they could and move as much material as possible:

> *There are no toilet breaks, no meals breaks, no hot seating, no crib breaks. They come in for a bit of fuel once a day, and away they go… They just do what I asked them to do, and they don't talk back.* *[P11]*

Driverless trucks were also described as performing tasks relatively the same. For example, if a speed or traction zone were put in place, every truck passing that zone would reduce their speed. Given their discipline to controls and instructions, participants highly regard their ability to play as team players. Participants noted that the trucks follow through with instructions when given to them, grinding away as their key player.

Despite the positives, there were, however, situations where participants observed literalism from the system. Driverless trucks may work hard, yet they focus on moving the dirt. Therefore, despite what is on the daily plan, trucks drive to loading units moving the most material. The driverless system is said to be geared towards utilising the most productive machines. If trucks are not overseen, the system only focuses on moving tons:

> *Like I said, if you give it the options, or if you know how to control the options you give it properly, it will play your game. But, if you let it do whatever it wants it to do, it will play its own game, and it's a production game.* *[P20]*

Although driverless trucks can move material quickly, some participants highlighted that they have to reign them in. Otherwise, the system will transfer material that personnel do not want to move. The control room is aiming to move material as per the plan; this can be at odds with how trucks are designed. It was argued that personnel need space to move the fleet freely between sources and destinations. Although they are primarily considered team players, they were not necessarily viewed as the captain. Instead, they fulfil the role of a half back, who would remain present before and after the game. As personnel learn to work them, participants noted that the relationship was improving. With the intricacies and complexities of such a system, a participant argued that it is bound not to work. If driverless trucks do not receive the right inputs, participants noted that driverless technology could not be expected to perform:

> *Well, it's not the system that changes, there's inputs… If there's a change in the priority, someone has to input that into the system, that's just basic. It's not artificial intelligence, it's just a system that we tell what to do…* *[P15]*

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3.3.2 Participants are confident in redirecting or overriding obstacle detections

Depending on the participants' role, various experiences were shared with redirecting and overriding obstacles. Supervisors and designers were the most confident, given that they both have high levels of knowledge and information. Knowledge is coupled with field time, validating the virtual mine model with what is being observed. Participants reported that specific training is required to direct truck, which also comes technical in-cab displays. When it comes to clearing objects, every person was suggested to be capable of performing this. Despite this, some participant experiences tested their level of confidence:

> *The truck picked up the windrow, come up with an obstacle, I cleared the obstacle, and then the truck climbed over the windrow to get to where it was going. [P23]*

Although there was a high level of confidence across the participants, intervening is highly dependent on whether the foundations are in place—for example, the physical world matching the virtual system. Upon experiencing a situation where a truck breaches the boundary, it appears that participants were far more cautious in their approach. Despite this, participants still recorded a high level of confidence. The main reason for this was the driverless systems' adherence to instructions:

> *Well, they just do what I ask them to do mate, and they don't talk back, so yeah. [P11]*

Since the truck is only performing the instructions given, participants maintained that the trucks were not at fault. The reason why the professionals' confidence level was much lower was purely from a frequency perspective. With the majority of the participants' confidence levels being so high, it could be argued that their trust levels were also high. Given the participants' experiences in some incidents, it was noted that the task must also be performed within strict guidelines. Otherwise, personnel could find themselves experiencing unintended situations.

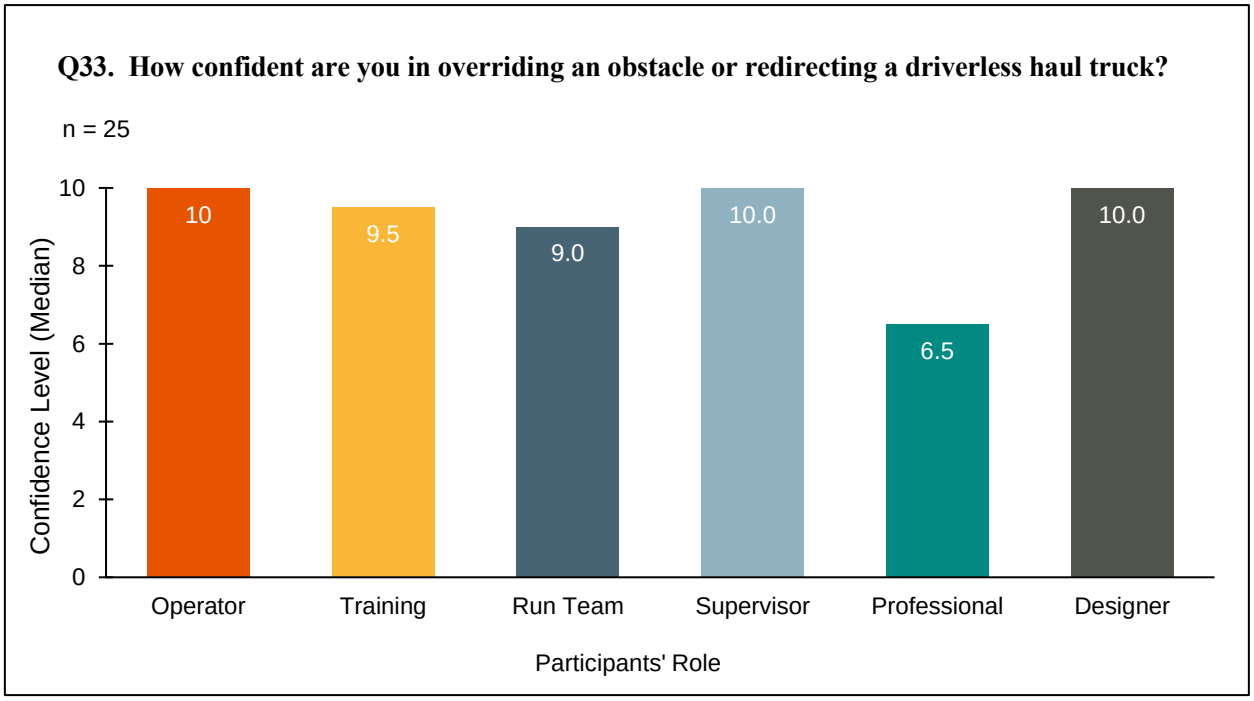

Figure 7. Median confidence level out of 10 towards the driverless trucks by role. Data collected through one-on-one interviews with personnel on mine site

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4. DISCUSSION

The study reflects similar experiences of humans interfacing with automated systems in high-risk industries (Billings, 2018; de Vries, 2017; Frohm et al., 2006). Study participants noted that new hazards and risks were presented through the introduction of driverless trucks. Despite this, participants developed a higher level of trust through observing predicted travel, diligent truck reactions and compliance to instructions. However, the high levels of confidence could be linked to the complacency contributing to driverless incidents.

New hazards and risks associated with driverless haul trucks were reported in the interviews. Driverless trucks require communications to operate; however, if those communications are lost, the sudden braking that occurs can cause trucks to slide. Moreover, the mismatches between the virtual model and the real mine resulted in trucks breaching windrows after objects were cleared. This experience reflects the literalism and opacity that comes with automation (Billings, 2018; Wessel et al., 2019). When it came to who was responsible for incidents, participants reported that humans were making the main contributions. The main reason was that the system was considered to be performing what it was instructed to do. A truck reversing over a windrow, it was noted could be cleared by a human to achieve a dump location place behind the windrow. However, the feedback loops and the transparency of the system need to be considered (Dixon et al., 2007; Parasuraman & Manzey, 2010). When verifying reverse objects in the field, there can appear to be no obstruction between the truck and the windrow. Yet, it is the windrow that is identified as the object. As a result, the object is cleared, and the truck passes through the windrow. In this scenario, humans are required to check the physical location against the mine model. Since a high level of trust that has developed, it appears humans do not anticipate that a truck would reverse over a windrow, even if there were potential mismatches.

A high level of trust had been developed towards driverless trucks by them only performing what was instructed. However, this trust could also be leading to a reliance on automated systems (Parasuraman & Riley, 1997). This comparison was made to the manual environment, where it was difficult to determine where a truck driver was heading. When it came to driverless trucks, the intended pathway on in-cab displays provided a level of transparency on the trucks' intentions. Predicted pathways removed a lot of anxiety for smaller equipment operators with manual trucks frequently turning in front of them, which increased their level of confidence. In addition, when dump or load location is set, driverless trucks reversed to that exact location. Manual trucks, in this instance, were reported to present a higher risk of reversing into excavators. More importantly, the additional concentration requirements to drive a truck for 12-hour shift. Despite being involved incidents and unanticipated situations with driverless trucks, a majority of participants' trust level did not waver. Therefore, the findings highlight that high levels of trust could be maintained if it can be demonstrated that driverless trucks performed what was programmed.

There were driverless observed performing tasks that were not anticipated. However, this was highly dependent on the persons' role and experience, which was realised in the operators' response. An operator has less detailed information on their screen interfaces, whereas supervisors, run team members and professionals had access to diagnostic and the assignment engine pages. These roles have the option and time to analyse the background information relating to performance. Therefore, the performance is matched to the mode or script at the time and increased human awareness of automated features (Björklund et al., 2006; Feldhütter et al., 2019, August 26-30). There were, however, participants in those roles that were surprised automation. Predominately, this experience was to do with algorithms and fleet management, which has featured in the surprises in the past (De Boer & Dekker, 2017). These results highlight that in-cab display information for operators could be improved, with additional explanations and training in the algorithms influencing the assignment engine.

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Participants reported that the system informs personnel of what mode or function a truck is performing, which is in stark contrast to other industry experiences (Feldhütter et al., 2019; Sarter & Woods, 1995) More specifically, the participants alluded to the mode lights located on the side of the truck. In addition, the blue lanes highlighted the truck's intended haul route reinforced that the truck is in an automated mode. Despite haul routes, there were operators surprised by the movements of driverless trucks in the loading area. Automation enables the trucks to generate a path, which can shift from one side to the other, depending on the location of the excavator. This situation had resulted in increased proximity detections due to operators being surprised by the trucks' presents. Operators are driven to observe their in-cab display more frequently to monitor the truck lane generation. This practice was a learned skill that was developed to avoid interactions and remain in-the-loop.

Driverless trucks were reported to perform something that had not been instructed rarely. Participants argued that the trucks are likely to do nothing than follow instructions. This response also underpins why a high level of trust has been extended to the system. In addition, there is no debate on whether the decision is an appropriate one, merely performing the task anyway. Participants reported that although trucks may deliver something that was not instructed, there are usually additional assignments or algorithms influencing in the background. This was highlighted in the fuel bay and more extended haul route examples when participants elaborated on what they had observed. Since driverless trucks were considered the workhorses and mostly team players, the trucks performed instructions when personnel wanted it, when they wanted it. Yet, when participants reflected on whether the trucks were team players, it was noted that they do not assist others in performing their tasks. In particular, when one truck had an object cleared safely, 5 minutes later, another truck could identify the same object. Although the trucks play their role and work hard, the experience reveals the narrow focus on automation to perform nothing else (Christoffersen & Woods, 2002; Klein et al., 2004). There was confidence in redirecting or overriding obstacles detected by driverless trucks. In particular, participants knew that despite what they performed; the trucks would only work within the confines of their parameters. Despite the belief that the trucks would never do something unsafe, the fact virtual and physical distinctions exist presented actual risks that any instruction could be taken literally (Billings, 2018). The difference means that although a person physically observes the edge of the windrow, the virtual system reference point may be further back. Therefore, the truck could perform activities based on the virtual mine model, not the physical representation, resulting in unintended consequences.

5. CONCLUSIONS

The research highlights the perspectives of mineworkers surrounding risk, trust and teamwork. New hazards and risk were introduced through automation, including virtual-physical world distinctions, communication losses and operator complacency. Humans were considered to be contributing to workplace incidents, which was explained by the belief that driverless trucks only perform what has been instructed. Therefore, despite the introduction of new hazards and risks, a high level of trust developed with driverless technology. High confidence was underpinned by predictable haul routes, adherence to instructions and diligence for stopping for small objects. More importantly, the trust did not waiver after participants had been involved in a driverless truck incident. The driverless trucks were considered team players concerning the execution of their role. However, when it came to assisting other teammates, the participants reported that the technology simply remains focused on its purpose. As a result, the system does not engage in team play to work as a team to resolve localised problems. The localised problems created situations where personnel needed to override or redirect the driverless fleet. Despite the confidence of participants in executing those adapting, human intervention has contributed to incidents involving driverless haul trucks. The response did not intend to result in

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unintended situations; however, the experiences have highlighted the consequences of introducing automation. Mineworkers experiences demonstrate the presents of new hazards and risks, as the dynamic of the human-machine relationship unfolds in trust and teamwork.

REFERENCES

Billings, C. E. (2018). *Aviation Automation: The Search for a Human-Centered Approach*. Retrieved from https://play.google.com/store/books/details/Charles_E_Billings_Aviation_Automation?id=wS9KDwAAQBAJ

Björklund, C. M., Alfredson, J., & Dekker, S. W. A. (2006). Mode Monitoring and Call-Outs: An Eye-Tracking Study of Two-Crew Automated Flight Deck Operations. *The Internationa Journal of Aviation Psychology, 16*(3), 257-269. http://10.1207/s15327108ijap1603_2

Christoffersen, K., & Woods, D. D. (2002). How to Make Automated Systems Team Players. In Salas, E. (Ed.), *Advances in Human Performance and Cognitive Engineering Research* (Vol. 2, pp. 1-12): Emerald Group Publishing Limited. Retrieved from http://csel.eng.ohio-state.edu/productions/xcta/downloads/automation_team_players.pdf

Creswell, J. W. (2014a). *A concise introduction to mixed methods research*. Thousand Oaks, CA.: SAGE Publications.

Creswell, J. W. (2014b). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: SAGE Publications.

Creswell, J. W., & Clark, V. L. P. (2011). *Designing and Conducting Mixed Methods Research*. Thousan Oak, CA: SAGE Publications.

Creswell, J. W., Klassen, A., Plano Clark, V. L., & Smith, C. C. (2011). *Best practices for mixed methods research in the health sciences*. https://obssr.od.nih.gov/wp-content/uploads/2016/02/Best_Practices_for_Mixed_Methods_Research.pdf

Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry and research design: Choosing among five approaches*. California: SAGE publications.

De Boer, R., & Dekker, S. W. A. (2017). Models of Automation Surprise: Results of a Field Survey in Aviation. *Safety, 3*(3). http://10.3390/safety3030020

de Vries, L. (2017). Work as Done? Understanding the Practice of Sociotechnical Work in the Maritime Domain. *Journal of Cognitive Engineering and Decision Making, 11*(3), 270-295. http://10.1177/1555343417707664

Dixon, S. R., Wickens, C. D., & McCarley, J. S. (2007). On the independence of compliance and reliance: are automation false alarms worse than misses? *Hum Factors, 49*(4), 564-572. http://10.1518/001872007X215656 https://www.ncbi.nlm.nih.gov/pubmed/17702209

Feldhütter, A., Härtwig, N., Kurpiers, C., Hernandez, J. M., & Bengler, K. (2019, August 26-30). Effect on Mode Awareness When Changing from Conditionally to Partially Automated Driving. In Bagnara, S., Tartaglia, R., Albolino, S., Alexander, T., & Fujita, Y. (Eds.), *Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018)* (pp. 314-324).

Frohm, J., Lindström, V., Winroth, M., & Stahre, J. (2006). The Industry's View on Automation in Manufacturing. *IFAC Proceedings Volumes, 39*(4), 453-458. http://10.3182/20060522-3-fr-2904.00073

Klein, G., Woods, D. D., Bradshaw, J. M., Hoffman, R. R., & Feltovich, P. J. (2004). Ten challenges for making automation a 'team player' in the joint human-agent activity. *IEEE Intelligent Systems, 19*(6), 91-95. http://doi.org/10.1109/MIS.2004.74

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: A methods sourcebook* (Vol. 4). California, United States: SAGE publications.

Miller, W. L., & Crabtree, B. F. (2005). Clinical research. In Denzin, N. & Lincoln, Y. (Eds.), *The SAGE handbook of qualitative research* (Vol. 3rd ed., pp. 605-639). California: SAGE publications.

Onwuegbuzie, A. J., & Combs, J. P. (2010). Emergent data analysis techniques in mixed methods research: A synthesis. In Tashakkori, A. & Teddlie, C. (Eds.), *SAGE handbook of mixed methods in social and behavioural research* (Vol. 2, pp. 387-430). California, United States: SAGE publications.

Parasuraman, R., & Manzey, D. H. (2010). Complacency and Bias in Human Use of Automation: Attentional Integration. *Human Factors*, *52*(3), 381-410. http://10.1177/0018720810376055

Parasuraman, R., & Riley, V. (1997). Humans and Automation: Use, Misuse, Disuse, Abuse. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, , *39*(2), 230–253. http://10.1518/001872097778543886

Sarter, N. B., & Woods, D. D. (1995). How in the World Did We Ever Get into That Mode? Mode Error and Awareness in Supervisory Control. *Human Factors*, *37*(1), 5-19. http://10.1518/001872095779049516 http://journals.sagepub.com.dbgw.lis.curtin.edu.au/doi/pdf/10.1518/001872095779049516

Tashakkori, A., & Teddlie, C. (2010). *Handbook of mixed methods in social & behavioral research*. Thousand Oaks, CA: SAGE Publications.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioural sciences*. California, USA: SAGE publications.

Wainer, H. (2005). *Graphic discovery: A trout in the milk and other visual adventures*. Oxfordshire, United Kingdom: Princeton University Press.

Wessel, G., Altendorf, E., Schreck, C., Canpolat, Y., & Flemisch, F. (2019). Cooperation and the Role of Autonomy in Automated Driving. In *Control Strategies for Advanced Driver Assistance Systems and Autonomous Driving Functions* (pp. 1-27).

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Safety Training in Construction: Do Toolbox Trainings Work?

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KEYWORDS

Safety
Toolbox talk
Knowledge retention
Construction
Training

ABSTRACT

Toolbox training has become common practice in the construction industry. With the continued high numbers of fatalities and injuries plaguing the construction industry, the investigative team designed a quasi-experimental pilot study to evaluate the effectiveness of toolbox training. The study took place in Butte, MT with a small, heavy civil construction company. The lead investigator conducted six weeks of toolbox training sessions. A 23-question pre-test examination was administered to establish the baseline knowledge. At the end of the six training sessions, participants were reevaluated with a final post-test to determine if the information was retained. Statistically significant (p = .009) gains in performance were observed suggesting that toolbox trainings did have a positive impact on worker knowledge retention. The study has a number of limitations discussed in the article that influence inferences.
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1. INTRODUCTION

The construction industry will persist in society whether focused on new projects, remodels, clean-ups, or scheduled improvements. Safety is typically a high-priority a priority on the civil construction worksite. A positive company safety record is a competitive edge when bidding for projects against companies that do not prioritize safety. Technological advances are continuously evolving and have reduced some hazards and risks associated with construction methods, work practices, and environments however, significant hazards and associated risks persist. The Occupational Safety and Health Administration (OSHA) and the Mining Safety and Health Administration (MSHA) mandate that employees receive training prior to beginning work on construction sites as well as refresher training on an annual basis. Safety training is not only a requirement but also a major factor in promoting a positive work climate and safe work practices. Training may take many forms including traditional classroom presentations, onsite toolbox talks, to newer micro training using mobile technology. Toolbox or training is a common practice but their remains a paucity of research on its effectiveness. Investigators designed a quasi-experimental study in heavy civil construction to evaluate effectiveness of tailgate trainings over a six-week period.

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2. THE EXTENT OF THE PROBLEM

The U.S. Bureau of Labor Statistics (2020) reported the number of fatal work injuries in the construction industry continued to surpass all other sectors. While the rate of nonfatal injuries has dropped nearly 57% from 2003 to 2019, the injury rate remained significantly higher than all other industries combined ("Nonfatal injury," 2021). Research by Wilkins (2011) revealed that poor training and retention of relevant knowledge are two possible factors responsible for this high incidence of injury. The 2019 injury rates among construction employers with 11 to 49 employees were five times higher than those employers with 1,000 or more employees ("Nonfatal Injury," 2021). Just over 80% of construction companies have fewer than 10 employees (Dong, Wang, and Katz, 2018). The U.S. Small Business Administration (2021) defines organizational size for construction by the sum of annual receipts the business generates. A company may appear to be large based by this definition but the actual number of employees may influence whether or not a company allocates reserves for human resource and/or safety professionals. Safety training is likely to be overlooked or pushed onto unqualified or less qualified employees. Limited human and economic resources, up-to-date technology, equipment, industry best practices, and training capabilities become major factors in effective risk management (Hasle & Limborg, 2006; Masi & Cagno, 2014).

3. SAFETY TRAINING

Training on various construction sites presents unique sets of challenges because a dynamic and rapidly changing nature of the work. A common practice among construction companies, for compliance measures, is yearly training in which employees receive all of their training in one organized session, typically lasting the course of an entire workday. While this may satisfy requirements set by OSHA and MSHA, it does not assess whether the information and the delivery methods were effective for improving safe work behaviors, choices, and accomplishing knowledge gains. Long-term memory could be better accessed through more frequent training. A learning technique, referred to as spaced learning, has shown to help facilitate the storage of information in long-term memory (Noor et al., 2021). Spaced learning techniques refer to revisiting information in repeated separate time periods (Noor et al., 2021).

The most common training methods found by Hallowell (2012) were orientation, toolbox talks, informal safety communication among workers, and formal presentations by safety managers. Toolbox talks have also been referred to as tailgate meetings, safety moments, safety minutes, safety shares, microtrainings, and other terms. The primary focus is its short-delivered nature, usually lasting 15 minutes or less. It is a unique training technique that aids in the development of increased knowledge and skills which helps foster and reinforce safe behaviors and choices. This style of training provides exposure to small amounts of material delivered in short timeframes which can improve active learning and help increase knowledge retention capacities (Stober & Putter, 2013). Other benefits of repeated training include the ease of fitting training into the busy work schedule and supporting the spaced learning techniques (Stober & Putter, 2013). Toolbox talks can be given at any time but are commonly administered at the beginning of the work shift, week, or before a new phase of a project begins. Occupational safety and health (OSH) knowledge can be increased through the use of toolbox trainings (Olson et al., 2016).

A literature review was conducted and revealed several other toolbox training retention studies were conducted using surveys as a way to evaluate worker preference of training style, interest in the material, and safety climate (Eggerth et al., 2018; Freschet, 2018; Kaskutas et al., 2016). While toolbox talks tend to be delivered verbally, combining training delivery with visual information could lead to a

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better understanding and retention of the material (Mehany et al., 2021). In a study conducted by Olson et al. (2016), nine articles were reviewed related to perceived importance, effectiveness, and current quality of toolbox talks. It was concluded that there is evidence showing toolbox talks as an effective component of safety programs in construction but visual aids were either lacking or not effective (Olson et al., 2016). The study conducted by Olsen et al. (2016) focused primarily on the development and evaluation of visual toolbox talks related to fatal construction incidents.

The goal of a toolbox talk training is to repeatedly deliver a specified dose of safety information effectively to the workers frequently enough so that they remember it subconsciously and manifest the desired behavior. However, the increased safety knowledge and improvements highly depend on the willingness of the workforce to engage in the trainings (Wilson, 1989). The "one size fits all" approach to training is not practical in any industry. This pilot project was designed to gather short-term retention outcomes of the participant's pre-and post-training safety knowledge. The objective of this research was to explore whether weekly toolbox training sessions had an effect on safety knowledge retention.

4. MATERIALS AND METHODS

4.1 Study Location

This research was conducted at a waste mine removal project located in the Northwest United States. One of the construction company's managing personnel provided written approval for the research project to be conducted on this site. All toolbox trainings were conducted outside, the first workday of the week (typically Monday's), beginning at 7:00 am.

4.2 Participants

The majority of the participants for this study were employees from one small heavy civil construction company. Other onsite personnel present during the weekly toolbox talks were also invited to participate. The additional personnel consisted of professional engineers, soil samplers, and environmental specialists. All of the participants were informed of the main objective of the project and participated voluntarily. Due to the company having several worksites, there was a fluctuating number of personnel at the study site each week. In total, twenty-five workers participated in toolbox training sessions and assessments with approximately 60% attending all sessions. All participants were required to hold current HAZWOPER training certifications due to the nature of the project being performed at the construction site. The construction crew had completed their 8-hour HAZWOPER, MSHA, and first aid/CPR refresher trainings at the end of February 2021, which was approximately five months prior to beginning the project at the end of July 2021.

4.3 Materials and Experimental Design

The time frame for this study was primarily focused on short-term outcomes measured with repeated testing. Training using mobile technology with cell phones was determined to not be completely achievable with this group of participants due to technology limitations. There was also no reasonable way to use training technology such as PowerPoint or videos to administer this training. Formatted paper tests, quizzes, and pamphlets were developed due to the lack of available training technology. Questions were developed and administered through tests and quizzes in order to have a quantitative means of evaluating baseline knowledge and subsequent knowledge retention. The questions and visual materials were adapted from several online sources that included: The Center for Construction Research and Training (CPWR), the Occupational Safety and Health Administration (OSHA), the American Red Cross Association, and the National Institute for Occupational Safety and Health

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(NIOSH). A pre-test with 23 questions was developed and administered to the participants to establish a baseline of knowledge. Pretests were not coded to match individual performance for comparison to post-tests. Pre- and post-test results were aggregated to evaluate performance of the entire group rather than individuals.

In this study, performance results relate only to the first and last 23-question tests. Weekly pre-and-post two to four question quizzes were administered but data were not collected or analyzed. The 23-question tests or weekly quizzes were not coded to match individuals. The 23-question pre-and-post tests are located in Appendix A. The weekly quiz examples are located in Appendix B. These safety questions primarily focused on first aid/CPR, HAZWOPER, and construction safety. There were six questions related to first aid, ten questions related to HAZWOPER, four questions related to construction, and three questions related to general safety. Quiz questions were grouped so the training session could easily cover the material in the allotted fifteen minutes. Figure 1 displays the toolbox talks training session layout. Most of the questions were multiple choice with four response options.

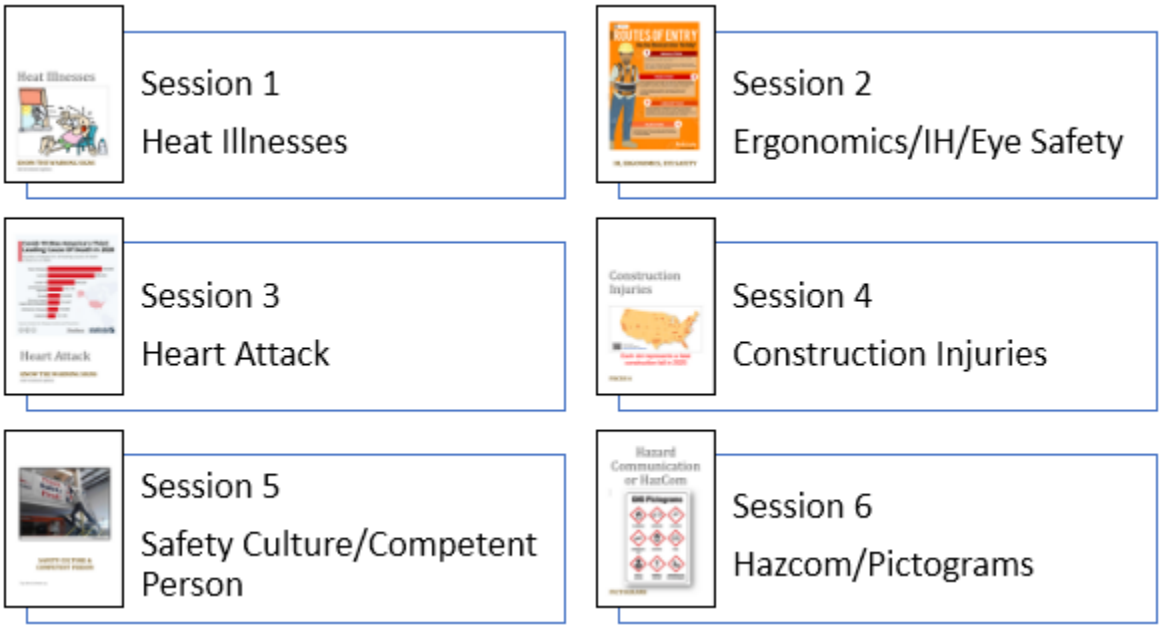

Figure 1. Weekly toolbox training topics

Each week the construction crew, plus additional site personnel, would gather outside for the weekly toolbox training. The first toolbox training session began the week following the initial 23 question pre-test. A visual timeline of the project administration by date is shown in Figure 2. At the start of training session one, participants were first provided with a paper format pre-quiz prior to receiving the training. In the subsequent weeks following the first training session, a post-quiz was added but not linked to the individual workers. The post-quiz tested the knowledge retention from the previous week's toolbox training content. Participants continued to complete both quizzes prior to beginning the training session.

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Figure 2. Timeline of project administration to participants

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No names were written on any testing documents, no codes were used to identify individuals, keeping the study completely anonymous. The protocol was approved by the Institutional Review Board (IRB) at the university. As each participant completed and handed their quizzes back to the trainer, they received a folded one-sheet pamphlet with the day's training topic. The training pamphlets for all six training sessions are located in Appendix C. The pamphlet design approach used strategically placed bold and italic fonts, colored lettering, training content-related images, and bullet-pointed lists to reaffirm important points. The training would begin by discussing the pre-quiz questions and answers. Then training continued using the pamphlets as a guide and visual tool. The trainer overlooked discussing the post-quiz question and answers with the participants for the first two training sessions. The decision was made to continue not discussing the post-quiz questions and answers to maintain training consistency throughout the project.

4.4 Data Collection

The 23-question pre- and post-test and weekly quiz results were entered into an excel spreadsheet and organized by question and date of administration. Answers were coded as either correct or incorrect and were worth one point each except for one question. One question required the participants to circle the four correct answers making this question worth four points. This brought the maximum possible points to 26. Some participants would circle multiple answers demonstrating uncertainty in their answer selection. Even if one of the multiple circled answers was a correct answer, the determination was made to mark the question as wrong due to the overall uncertainty of the participant's answers indicating they did not know the correct answer.

4.5 Statistical Analysis

Data analysis was completed using MiniTab© statistical software 20.4 (Minitab, 2021) to evaluate the potential effects of the toolbox training sessions on the entire group for retention of safety knowledge. Basic descriptives and frequencies were computed. Differences between pre- and post- scores were evaluated for the group using the Mann-Whitney test statistic. Individual responses were not coded and could not be matched for final analysis to test individual knowledge gains. The participant's completed their tests and quizzes without any form of tracking added for comparisons. Data were non-normal with unequal variances. The nonparametric Mann-Whitney test was chosen for data analysis for these reasons.

5. RESULTS

Of the 23 questions, number nine, 12, and 20 were the only three that the group did not demonstrate improvement during the week-to-week quiz completion. Figure 3 displays the group pre- and post-quiz questions as a side-by-side comparison. Questions two and six showed the greatest increase of group knowledge retention at a 75% and 62% increase respectively. Questions 18 through 23 represent the pre- and post-quiz questions from training session six, Hazcom and pictograms. The overall group results for those questions suggested that the participants possessed a high level of understanding regarding the pictogram meanings from the Hazcom standard prior to the training session.

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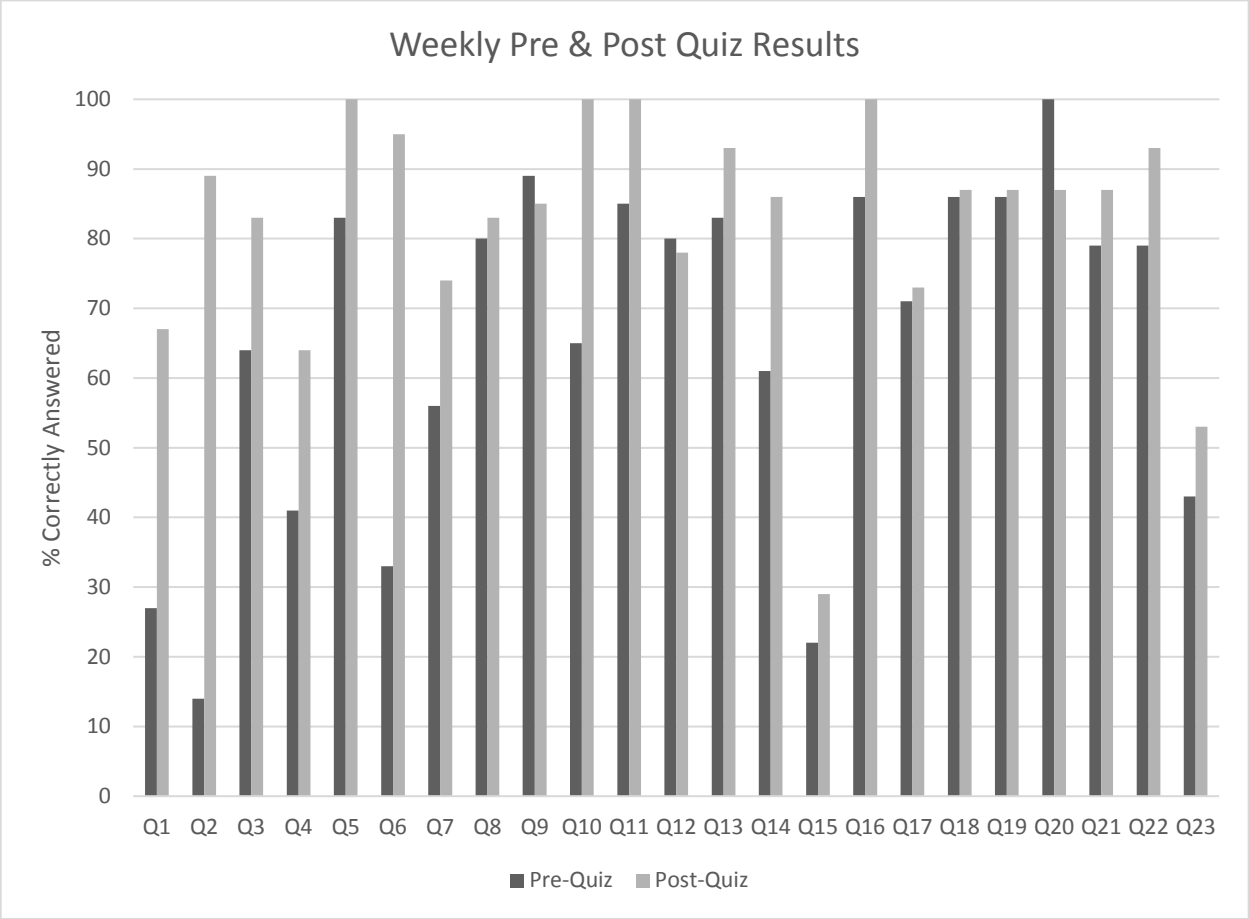

Figure 3. Weekly pre- and post-quiz comparisons

Test question groups are categorized by session in Table 1. The percent correct were recorded for each pre-test and post-test and aggregated for quizzes as well as for full 23-question test results. The pre- and post-quiz results for each weekly session all showed increased knowledge retention improvements for the group. By comparing the baseline with the post-test results, all six sessions display positive knowledge retention results for the group with session two having the greatest increase of 30%.

The aggregated group post-test results were higher than the initial aggregated group baseline scores as presented in Figure 4. The group baseline and pre-quiz results are very similar for all six training sessions, suggesting that the participants were not purposely trying to answer the questions incorrectly to skew the results. Session six showed very little increase in possible knowledge retention between the baseline and post-test. Results were similar indicating more uniform knowledge levels among the group at the end of the six trainings.

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Table 1. Test question groupings

Training Session	N	% Correct
Pre-Test (Questions 1-4)	20	34%
Session 1 Pre-Quiz (Pre-Training)	22	36%
Session 1 Post-Quiz (Post-Training)	18	75%
Post-Test (Questions 1-4)	16	48%
Pre-Test (Questions 5-7)	20	58%
Session 2 Pre-Quiz (Pre-Training)	18	57%
Session 2 Post-Quiz (Post-Training)	19	89%
Post-Test (Questions 5-7)	16	88%
Pre-Test (Questions 8-9)	20	78%
Session 3 Pre-Quiz (Pre-Training)	19	82%
Session 3 Post-Quiz (Post-Training)	20	83%
Post-Test(Questions 8-9)	16	89%
Pre-Test (Questions 10-12)	20	78%
Session 4 Pre-Quiz (Pre-Training)	20	77%
Session 4 Post-Quiz (Post-Training)	18	93%
Post-Test (Questions 10-12)	16	90%
Pre-Test (Questions 13-15)	20	58%
Session 5 Pre-Quiz (Pre-Training)	18	56%
Session 5 Post-Quiz (Post-Training)	14	69%
Post-Test (Questions 13-15)	16	73%
Pre-Test (Questions 16-23)	20	71%
Session 6 Pre-Quiz (Pre-Training)	14	79%
Session 6 Post-Quiz (Post-Training)	15	83%
Post-Test Questions 16-23)	16	73%

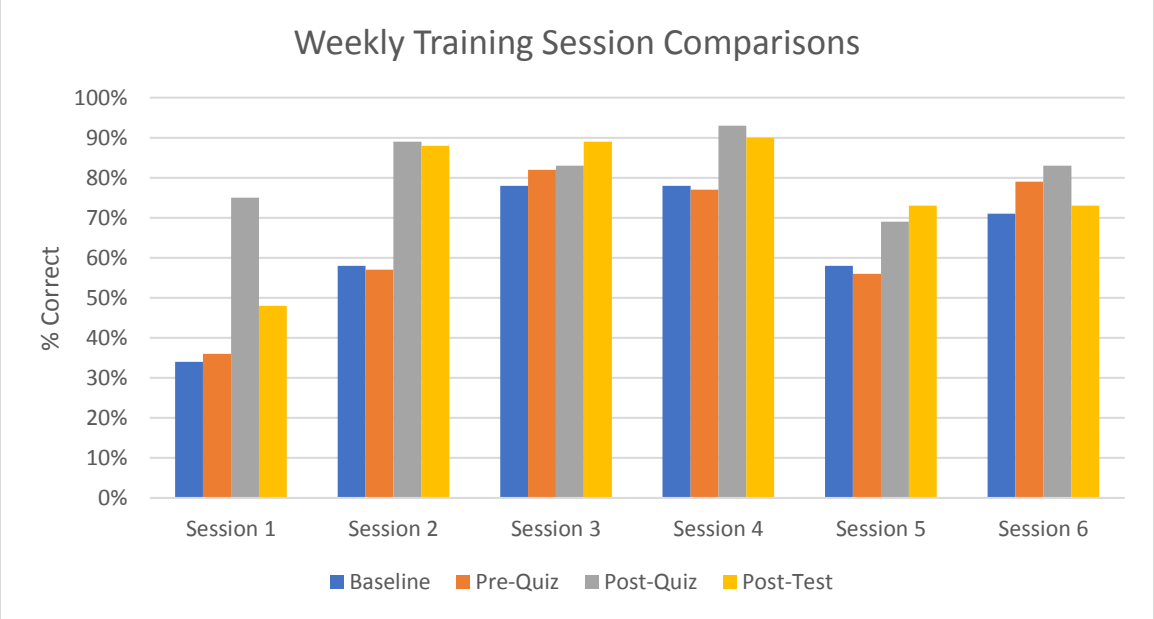

Figure 4. Training session testing comparisons

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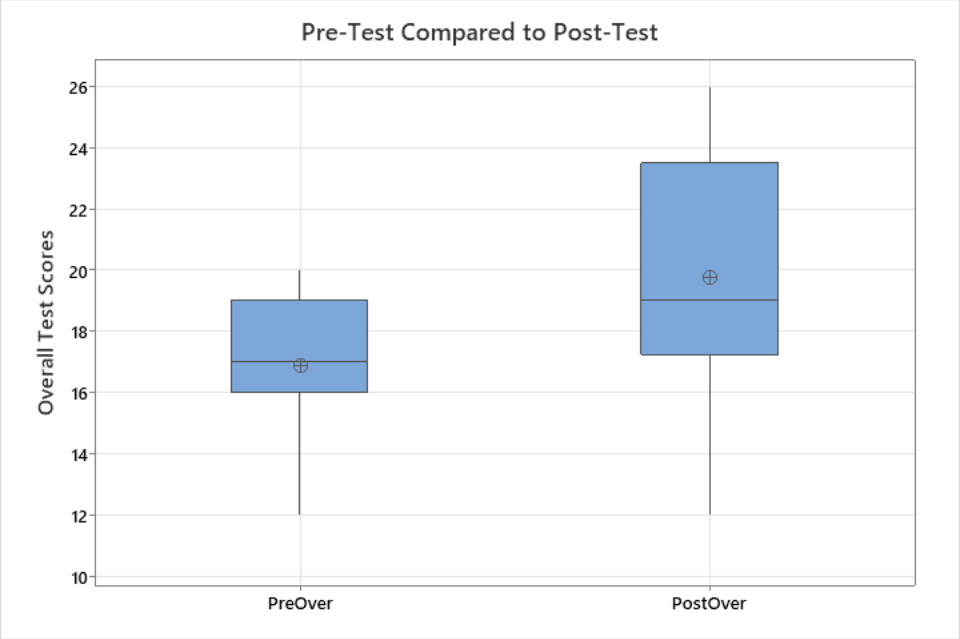
The overall group test scores of the 23 question pre- and post-tests revealed significant differences between the groups, p-value of 0.009. Figure 5 shows the pre-test population median compared to the post-test population median.



***Pre-test vs post-test results, p-value 0.009**

Figure 5. Pre-test compared to post-test

6. DISCUSSION

This pilot research project revealed statistically significant gains in knowledge retention when comparing aggregated group scores from pre- to post-test results. Our results suggest that short-term safety knowledge and retention gains are possible using toolbox training methods. We acknowledge that only 60% of the study participants completed all trainings. This raises concerns about the confidence of our assertion. While our raw group scores were significantly improved, p-value 0.009, it could be due to other factors as well. We were not able to extract the subgroup of the 60% that attended all six toolbox sessions for a more rigorous matched comparison. We do not know the background of those onsite workers that by happenstance were invited to participate in the trainings and tests. Many may have been professional engineers, soil samplers, environmental specialists, or other workers who had significant safety training in their past. If these types of participants were not assessed early in the study but came along later in the study, their test results would have driven up the final group scores.

One other similarly designed toolbox training retention study (Mehany et al., 2021) was found in our literature review. However, this study conducted only one training session with the baseline testing being conducted immediately before and follow-up testing immediately after the training. The training environment for this study characterized a typical outdoor construction setting in that there was limited indoor or formal training space. These conditions are exactly the dilemma facing the larger overall construction industry. Training needs to become more versatile and adaptive so that it can be conducted in any worksite setting.

Some training needs are appropriate for the classroom setting and can be conducted over a longer time frame. The 40-hour HAZWOPER course and first aid courses are designed with this intention. Traditional classroom training approaches are becoming a training method of the past as we transition

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to virtual and other technology-based training (Barrett, 2010). Additional on-site job training should be conducted so that the safety regulations are more immediately applicable (Wilkins, 2011). The practical applications of frequent repeated trainings are positive reinforcement of day-to-day safety issues, attention to new safety updates, improved awareness of workplace hazards, and reinforcement of relevant job information such as HAZWOPER material. Toolbox trainings can be delivered daily, weekly, biweekly, or even monthly. If documented properly, the majority of the annual training requirements for HAZWOPER and MSHA can be met through toolbox training sessions. An important consideration to examine is whether or not the training practically applies to the construction workers' day-to-day jobs. It is difficult to conduct group training that applies to the whole group. For example, excavator operators do not have the same safety risks as haul truck operators and so forth.

Some limitations of this study included fluctuating workforce participation, and quizzes potentially given to participants who had not received the previous week's training. The lead investigator estimated that approximately 60% of those trained were present for all sessions. The fact that tests and quizzes were not coded for matching was a design flaw. Had investigators coded quizzes and tests for a matched comparison using the paired t-test or repeated measures analysis, the results would be more meaningful and provide a stronger inference. This was a quasi-experimental design without a control group. The participants were meant to be their own controls. Future investigations should look at the performance of individuals as well as the group.

Another study limitation was the recruiting from one construction company rather than many. This was a convenience sample. The small civil construction company used in this study may be different than other companies and results should not be externalized to other small heavy civil companies. The company workers may have been safer than the average company doing the same type of work. On the other hand, if the workers were less aware of safety and safe work practices, this could also bias the results.

Some of the participants would often try to converse with each other to discuss what the correct answers may be during the quiz time. The last few weeks of training and quiz taking were done in near-dark conditions. This posed a new problem for the participants being able to see while taking their quizzes and during the training with the pamphlets. Some factors hindered training such as lack of interest among the group, potential literacy, comprehension issues, and topic relevance for each participant. These factors would have likely biased the result toward the null hypothesis.

7. CONCLUSION

Future research should repeat this study with random selection of small civil construction companies. It could be beneficial to further space the time gaps between training sessions to help avoid testing fatigue. It is also clear that coding each respondent's test and quiz is important for a rigorous matched analysis to determine knowledge gains week to week and from the beginning to the end. Larger time gaps should be used between the initial pre-test and future post-tests. Testing retention immediately after training, one week later, or six weeks as in this study, is not as revealing at 90- or 180-days post training. Long term knowledge assessment could further investigate whether or not toolbox training information is being retained and if work safe practices have been adopted.

It would also be beneficial to discuss the post-quiz questions and answers each week to reinforce the correct answers and provide feedback. There cannot be too much OSH knowledge in the workplace. The more often safety is discussed, trained, and reinforced, the more it is likely to become a subconscious part of workers everyday actions and translate to safe work practices with reduced injuries and fatalities. The realistic hope for continuous training is to aid workers in those moments

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when an internal negotiation has to be made between timely completion of a task and completing the task safely. No worker should ever have to choose between putting themselves at risk and making money for a company. Continuous education is vital in the workforce. The only thing that stays the same is nothing at all.

REFERENCES

Al-Shabbani, Z., Sturgill, R. & Dadi, G. (2020). Evaluating the effectiveness of toolbox talks on safety awareness among highway maintenance crews. ASCE Construction Research Congress [Conference]. Retrieved October 12, 2021, from, ascelibrary.org

American Red Cross. (2016). *First aid/CPR/AED: Participant's manual*. Staywell.

Barrett, B. (2010). Virtual teaching and strategies: Transitioning from teaching traditional classes to online classes. *Contemporary Issues in Education Research (CIER), 3*(12), 17-20

Basaga, H.B., Temel, B.A., Atasoy, M., & Yildirim, I. (2018). A study on the effectiveness of occupational health and safety trainings of construction workers in Turkey. *Safety Science, 110*, 344-354. https://doi.org/10.1016/j.ssci.2018.09.002

Bureau of Labor Statistics. (2020, December 16). *National census of fatal occupational injuries in 2019* [News Release]. https://www.bls.gov/news.release/pdf/cfoi.pdf

Burke, M.J., Sarpy, S.A., Smith-Crowe, K., Chan-Serafin, S., Salvador, R.O., & Islam, G. (2006). Relative effectiveness of worker safety and health training methods. *American Journal of Public Health, 96*(2), 315-324. https://doi.org/10.2105/AJPH.2004.059840

Demirkesen, S. & Arditi, D. (2015). Construction safety personnel's perceptions of safety training practices. *International Journal of Project Management, 33*, 1160-1169. http://dx.doi.org/10.1016/j.ijproman.2015.01.007

Dong, X., Wang, X., & Katz, R. (2018). *The construction chart book – The U.S. construction industry and its workers* (6th ed.). The Center for Construction Research and Training. Retrieved on October 7, 2021, from https://www.cpwr.com/wp-content/uploads/publications/The_6th_Edition_Construction_eChart_Book.pdf

Eggerth, D.E., Keller, B.M., Cunningham, T.R., & Flynn, M.A. (2018). Evaluation of toolbox safety training in construction: The impact of narratives. *American Journal of Industrial Medicine, 61*(12), 997-1004. https://doi.org/10.1002/ajim.22919

Freschet, J.M. (2018). *Case study: The implementation of tool box talks at a steel subcontracting shop.* [Unpublished manuscript]. Department of Construction Management, California Polytechnic University. https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1230&context=cmsp

Gillen, M., Goldenhar, L.M., Hecker, S., & Schneider, S. (2013, June 12). *Safety culture and climate in construction: Bridging the gap between research and practice* [workshop repot]. The Center for Construction Research and Training. https://www.cpwr.com/wp-content/uploads/publications/CPWR_Safety_Culture_Final_Report_0.pdf

Hallowell, M.R. (2012). Safety-knowledge management in American construction organizations. *Journal of Management in Engineering, 28*(2), 203-211. DOI: 10.1061/(ASCE)ME.1943-5479.0000067

Hasle, P. & Limborg, H.J. (2006). A review of the literature on preventive occupational health and safety activities in small enterprises. *Industrial Health, 44*(1), 6-12. https://doi.org/10.2486/indhealth.44.6

Masi, D. & Cagno, E. (2015). Barriers to OHS interventions in small and medium-sized enterprises. *Safety Science, 71*, 226-241. http://dx.doi.org/10.1016/j.ssci.2014.05.020

Noor, N., Yunus, K., Yusoff, A.M.H., Nasir, N.A.M., & Yaacob, N.H. (2021) Spaced learning: A review on the use of spaced learning in language teaching and learning. Journal of Language and Linguistic Studies, 17(2), 1023-1031. Doi: 10.52462/jlls.71

Jeschke, K.C., Kines, P., Rasmussen, L., Andersen, L.P.S., Dyreborg, J., Ajslev, J., Kabel, A., Jensen, E., & Andersen, L.L. (2017). Process evaluation of a toolbox-training program for construction foremen in Denmark. *Safety Science, 94*, 152-160. http://dx.doi.org/10.1016/j.ssci.2017.01.010

Kaskutas, V., Jaegers, L., Dale, A.M., & Evanoff, B. (2016). Toolbox talks: insights for improvements. Professional Safety, 61, 33-37. Retrieved October 13, 2021, from https://digitalcommons.wustl.edu/cgi/viewcontent.cgi?article=1082&context=ohs_facpubs

Kenner, C. & Weinerman, J. (2011). Adult learning theory: Applications to non-traditional college students. *Journal of College Reading and Learning, 41*(2), 87-96. https://doi.org/10.1080/10790105.2011.10850344

Klimova, E.V., Semeykin, A.Y., & Nosatova, E.A. (2020). Prospects for the introduction of micro training in the occupational safety management system. *IOP Conference Series: Materials Science and Engineering.* Doi: 10.1088/1757-899X/753/7/072009

Masi, D. & Cagno, E. (2015). Barriers to OHS interventions in small and medium-sized enterprises. *Safety Science, 71*, 226-241. http://dx.doi.org/10.1016/j.ssci.2014.05.020

McCall, J.R. & Pruchnicki, S. (2017). Just culture: A case study of accountability relationship boundaries infuence on safety in HIGH-consequence industries. *Safety Science, 94*, 143-151. http://dx.doi.org/10.1016/j.ssci.2017.01.008

Mehany, M.S.H.M., Killingsworth, J. & Shah, S. (2021). An evaluation of training delivery methods' effects on construction safety training and knowledge retention - a foundational study. *International Journal of Construction Education and Research, 17*, 18-36. https://doi.org/10.1080/15578771.2019.1640319

Minitab. (8 September 2021). *Minitab Statistical Software© 20.4.* Minitab: State College, PA, USA, 2021.

Nonfatal injury rate in construction decreases, but still outpaces all other industries. (2021, February 9). *Safety & Health*. Retrieved September 30, 2021, from https://www.safetyandhealthmagazine.com/articles/20817-nonfatal-injury-rate-in-construction-decreases-but-still-outpaces-all-other-industries

Occupational Safety and Health Administration. (n.d.). *Training and reference materials library*. https://www.osha.gov/training/library/materials

Ojha, A., Seagers, J., Shayesteh, S., Habibnexhad, M., & Jebelli, H. (2020, December 8). Construction safety training methods and their evaluation approaches: A systematic literature review. [Conference session]. The 8th International Conference on Construction Engineering and Project Management, Hong Kong SAR.

Olsen, R., Varga, A., Cannon, A., Jones, J., Gilbert-Jones, I., & Zoller, E. (2016). Toolbox talks to prevent construction fatalities: Empirical development and evaluation. *Safety Science, 86*, 122-131. http://dx.doi.org/10.1016/j.scci.2016.02.009

Ozmec, M.N., Karlsen, I.L., Kines, P., Andersen, L.P.S., & Nielsen, K.J. (2015). Negotiating safety practice in small construction companies. *Safety Science, 71*, 275-281. http://dx.doi.org/10.1016/j.ssci.2014.03.016

Ricci, F., Chiesi, A., Bisio, C., Panari, C., & Pelosi, A. (2016). Effectiveness of occupational health and safety training: A systematic review with meta-analysis. *Journal of Workplace Learning, 28*(6), 355-377. DOI 10.1108/JWL-11-2015-0087

Robson, L., Stephenson, C., Schulte, P., Amick, B., Chan, S., Bielecky, A., Wang, A., Heidotting, T., Irvin, E., Eggerth, D., Peters, R., Clark, J., Cullen, K., Boldt, L., Rotunda, C., & Grubb, P. (2010). *A systematic review of the effectiveness of training & education for the protection of workers.*

Schwatka, N.V., Goldenhar, L.M., & Johnson, S.K. (2020). Change in frontline supervisor's safety leadership practices after participating in a leadership training program: Does company size matter? *Journal of Safety Research, 74*, 199-205. https://doi.org/10.1016/j.jsr.2020.06.012

Stober, D.R. & Putter, S. (2013). Going mobile & micro: The new frontier of safety training. *Professional Safety, 58*(2), 41-43. Retrieved on September 30, 2021, from https://www.proquest.com/docview/1287597479/fulltextPDF/4E2E3C615E954BC5PQ/1?accountid=28080

The Center for Construction Research and Training. (n.d.). *Training and awareness programs and research.* CPWR. https://www.cpwr.com/research/training-and-awareness-programs-from-research/

The National Institute for Occuaptional Safety and Health. (n.d.). *All workplace safety & health topics.* NIOSH. https://www.cdc.gov/niosh/topics/default.htm

Torghabeh, Z.J., & Hosseinian, S.S. (2012). Designing for construction worker's safety. *International Journal of Advances in Engineering & Technology, 4*(2), 373-382. ISSN: 2231-1963

United States Small Business Administration. (n.d.). *Size standards*. Retrieved October 18, 2021, from https://www.sba.gov/federal-contracting/contracting-guide/size-standards

Walters, J. (2016). Safety training: the case for a more logical practice. *Professional Safety, 61*(11), 33-39. Retrieved October 12, 2021, from https://aeasseincludes.assp.org/professionalsafety/pastissues/061/11/F2_1116.pdf?_ga=2.136457333.498507751.1573481692-1583741738.1561580933

Wilkins, J.R. (2011). Construction worker's perceptions of health and safety training programmes. *Construction Management and Economics, 29*(10), 1017-1026. https://doi.org/10.1080/01446193.2011.33538

Wilson, H.A. (1989). Organizational behavior and safety management in the construction business. *Construction Management and Economics, 7*(4), 303-320. https://doi.org/10.1080/01446198900000030

APPENDIX A: 23-QUESTION PRE- AND POST-TEST

1. **Which of the following could indicate that someone is having a heart attack? (only 4 correct answers)**
   a. sweating
   b. hunger
   c. pain in arms
   d. loss of vision
   e. breathlessness
   f. nausea
   g. itchy skin

2. **Which of following causes the most construction site fatalities?**
   a. Electrocution
   b. Trench collapses
   c. Falls
   d. Contact with chemicals

3. **How can someone tell if a pair of glasses are safety-approved?**
   a. They have "safety glasses" stamped on them
   b. By the brand
   c. They were bought at a safety store such as A&M Fire and Safety
   d. They have "Z87" stamped on them

4. **A safety culture is:**
   a. The common and generally accepted way people behave in the workplace as it relates to safe practices.
   b. Defined by printed safety rules and posted signs.
   c. Described in negotiated agreements between unionized workers and management.
   d. Determined by the attitude that workers display each day.

5. **If a person is suffering from heatstroke, which symptoms would they least likely experience?**
    a. Severe headache
    b. Profuse sweating and cool moist skin
    c. Loss of consciousness
    d. Rapid temperature-rise and hot dry skin

6. **How many points of contact should you have when getting on and off of equipment?**
    a. One
    b. Two
    c. Three
    d. Four

7. **The correct treatment for heat stroke is:**
    h. Have the worker chug a bottle of ice-cold water
    i. Have the worker eat a banana
    j. Cover the worker with ice bags
    k. All of the above

8. **There are four major routes in which chemicals can enter your body. Which is the most common?**
    a. Injection
    b. Absorption
    c. Ingestion
    d. Inhalation

9. **Which of the following is not important to the development of an effective safety culture?**
    a. Safety managers must directly control worker behavior.
    b. Front-line supervisors initiate corrective measures for unsafe behaviors.
    c. Employees desire to be safe and work as a team.
    d. Unions take responsibility for ensuring safety as part of their role in protecting members.

10. **The best drink(s) to give someone experiencing heat cramps or heat exhaustion are:**
    a. Coffee with creamer or iced latte
    b. Caffeine free soda
    c. commercial sports drink, coconut water or milk
    d. Water

11. **Which of the following describes a competent person?**
    a. A person assigned by an employer to perform specific duties or to be at a specific location on a jobsite
    b. A person who by education or experience has successfully demonstrated the ability to solve or resolve problems related to a particular work or subject matter.
    c. A person who is capable of identifying existing and predictable hazards in the working conditions which are unsanitary, hazardous, or dangerous to employees and who has the authority to take corrective measures to eliminate them.
    d. A person who has passed a certification exam from an accredited organization.

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12. Which of these is not one of the Fatal Four - OSHA's term for the four deadliest construction site hazards?

a. caught between objects
b. silica
c. struck by object
d. falls

13. In order from least to most severe, the heat-related illnesses are heat exhaustion, heat cramps, and heat stroke.

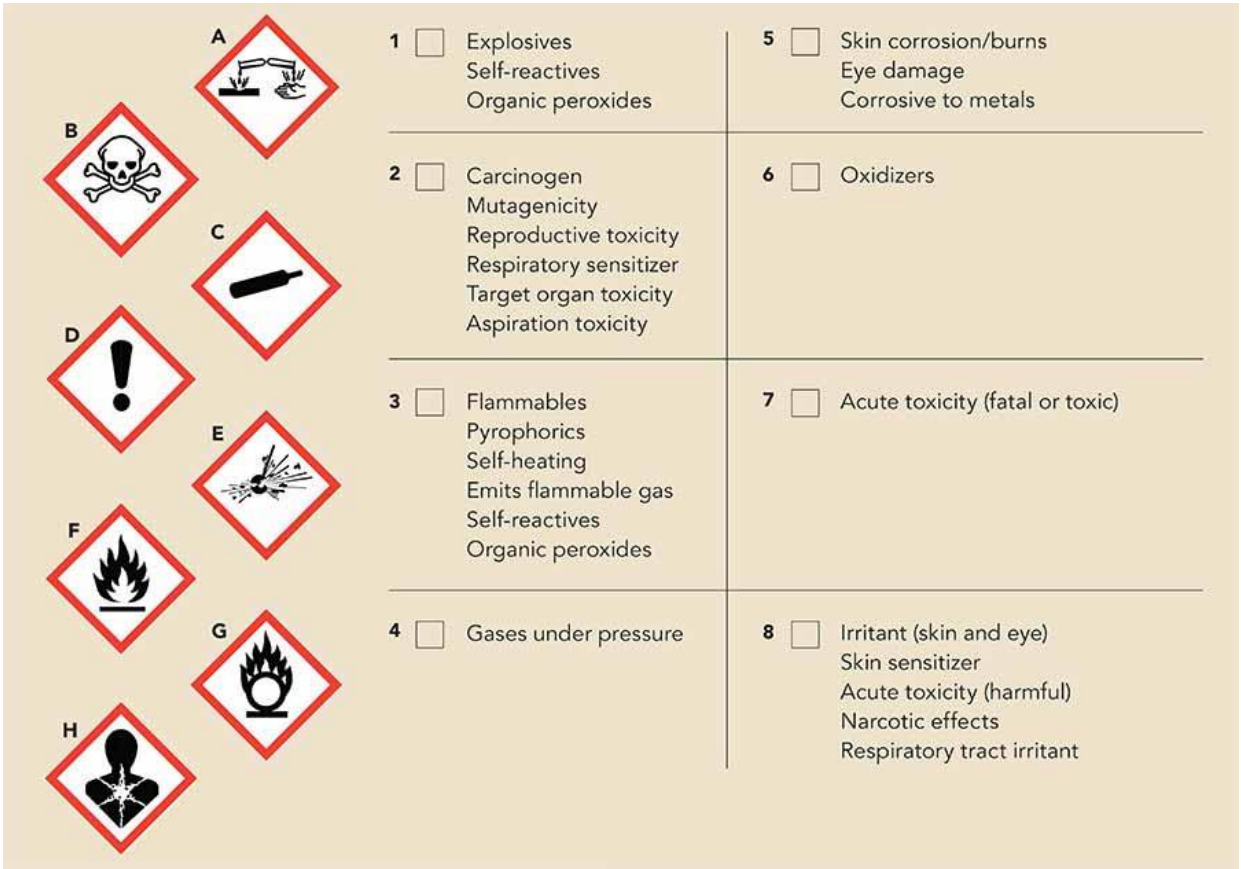
a. True
b. False

14. Where is the power zone?

a. From the ground to about the top of the thighs
b. From about mid-thigh to about mid-chest
c. From the knees to the neck
d. From the ankles to the collarbone

15. Dale is showing classic signs of a heart attack. Mike makes Dale sit down while Logan calls 911. What is the next best lifesaving step to take?

a. Give Dale some ice-cold water
b. Have Dale chew a 325mg aspirin
c. Have Dale eat something sugary
d. Have Dale take a short nap



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APPENDIX B: QUIZ QUESTIONS BY TRAINING SESSION

Training Session 1:

1. **In order from *least to most* severe, the heat-related illnesses are heat exhaustion, heat cramps, and heat stroke.**
    a. True
    b. False

2. **The *best* drink(s) to give someone experiencing heat cramps or heat exhaustion are:**
    a. Coffee with creamer or iced latte
    b. Caffeine free soda
    c. Commercial sports drink, coconut water or milk
    d. Water

3. **If a person is suffering from heatstroke, which symptoms would they *least* likely experience?**
    a. Severe headache
    b. Profuse sweating and cool moist skin
    c. Loss of consciousness
    d. Rapid temperature-rise and hot dry skin

4. **The correct treatment for heat stroke is:**
    a. Have the worker chug a bottle of ice-cold water
    b. Have the worker eat a banana
    c. Cover the worker with ice bags
    d. All of the above

Training Session 2:

1. **How can someone tell if a pair of glasses are safety-approved?**
    a. They have “safety glasses” stamped on them
    b. By the brand
    c. They were bought at a safety store such as A & M Fire and Safety
    d. They have “Z87” stamped on them

2. **Where is the power zone?**
    a. From the ground to about the top of the thighs
    b. From about mid-thigh to about mid-chest
    c. From the knees to the neck
    d. From the ankles to the collarbone

3. **There are four major routes in which chemicals can enter your body. Which is the *most* common?**
    a. Injection
    b. Absorption
    c. Ingestion
    d. Inhalation

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Training Session 3:

1. **Which of the following could indicate that someone is having a heart attack?**
   (only 4 correct answers)
   - **a.** Sweating
   - **b.** Hunger
   - **c.** Pain in arms
   - **d.** Loss of vision
   - **e.** Breathlessness
   - **f.** Nausea
   - **g.** Itchy skin

2. **Dale is showing classic signs of a heart attack. Mike makes Dale sit down while Logan calls 911. What is the next *best* lifesaving step to take?**
   - **a.** Give Dale some ice-cold water
   - **b.** Have Dale chew a 325mg aspirin
   - **c.** Have Dale eat something sugary
   - **d.** Have Dale take a short nap

Training Session 4:

1. **Which of the following causes the *most* construction site fatalities?**
   - **a.** Electrocution
   - **b.** Trench collapses
   - **c.** Falls
   - **d.** Contact with chemicals

2. **How many points of contact should you have when getting on and off of equipment?**
   - **a.** One
   - **b.** Two
   - **c.** Three
   - **d.** Four

3. **Which of these is *not* one of the Fatal Four – OSHA's term for the four deadliest construction site hazards?**
   - **a.** Caught between objects
   - **b.** Silica
   - **c.** Struck by object
   - **d.** Falls

Training Session 5:

1. **A safety culture is:**
   - a. The common and generally accepted way people behave in the workplace as it relates to safe practices.
   - b. Defined by printed safety rules and posted signs.
   - c. Described in negotiated agreements between unionized workers and management.
   - d. Determined by the attitude that workers display each day.

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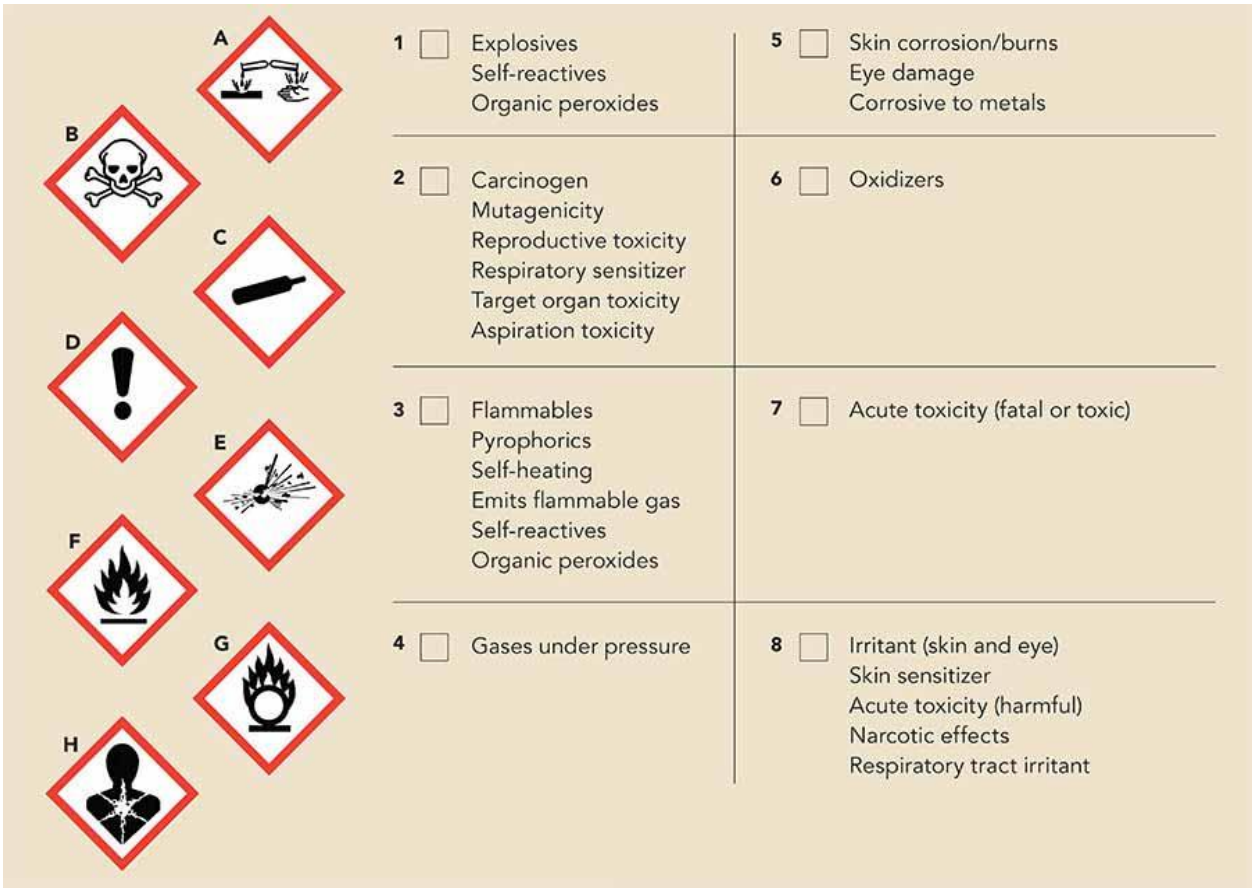
2. **Which of the following describes a competent person?**
    e. A person assigned by an employer to perform specific duties or to be at a specific location on a jobsite
    f. A person who by education or experience has successfully demonstrated the ability to solve or resolve problems related to a particular work or subject matter.
    g. A person who is capable of identifying existing and predictable hazards in the working conditions which are unsanitary, hazardous, or dangerous to employees and who has the authority to take corrective measures to eliminate them.
    h. A person who has passed a certification exam from an accredited organization.

3. **Which of the following is not important to the development of an effective safety culture?**
    e. Safety managers must directly control worker behavior.
    f. Front-line supervisors initiate corrective measures for unsafe behaviors.
    g. Employees desire to be safe and work as a team.
    h. Unions take responsibility for ensuring safety as part of their role in protecting members.

Training Session 6:



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APPENDIX C: TRAINING PAMPHLETS

Heat Illnesses

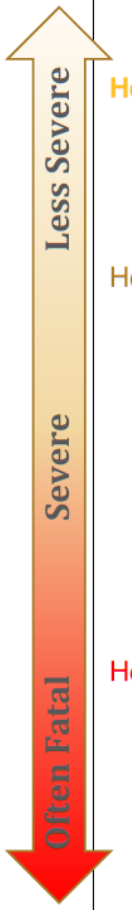
KNOW THE WARNING SIGNS

And treatment options

Know the warning signs
[Street Address]
[City, ST ZIP Code]

Take care of yourself & your coworkers

- ✓ Take regular breaks out of the sun
- ✓ Stay hydrated – don't wait until your thirsty
- ✓ Wear lighter colored clothing
- ✓ Wear loose-fitting, lightweight clothing



What are the major heat illnesses?

- Heat cramps
- Heat exhaustion
- Heat stroke

What are the signs & symptoms?

Heat cramps

- ✓ Muscle cramps, pain, or spasms in the abdomen, arms, or legs

Heat exhaustion

- ✓ Headache
- ✓ Nausea
- ✓ Dizziness, weakness
- ✓ Irritability
- ✓ Thirst, heavy sweating
- ✓ Elevated body temperature
- ✓ Decreased urine output

Heat stroke

- ✓ Confusion, altered mental state, slurred speech
- ✓ Loss of consciousness
- ✓ Profuse sweating or red hot dry skin
- ✓ Seizures
- ✓ Very high body temperature

FIRST AID – Cooling is Key

Heat Cramps

- ✓ Drink fluids every 15 to 20 minutes
- ✓ Eat a snack
- ✓ Avoid salt tablets

Note: If cramps continue over an hour, get further help.

Heat Exhaustion

- ✓ Leave hot area and drink fluids
- ✓ Remove unnecessary clothing, including shoes and socks
- ✓ Cool with water, cold compresses and/or fans
- ✓ Drink frequent sips of cool water or other appropriate fluids

Heat Stroke

- ✓ **This is an emergency**. Get emergency care immediately.
- ✓ Move worker to a cool area and remove outer clothing
- ✓ Circulate air around worker
- ✓ Place cold, wet cloths or ice on head, neck, armpits, and groin

Note: Symptoms can occur in any order. For example, a person will not always experience heat cramps before they suffer from heat exhaustion.

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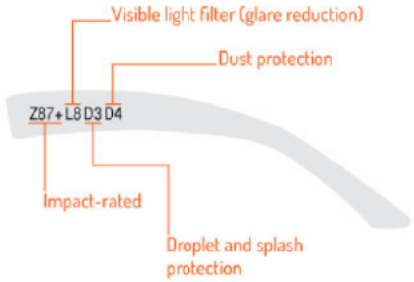
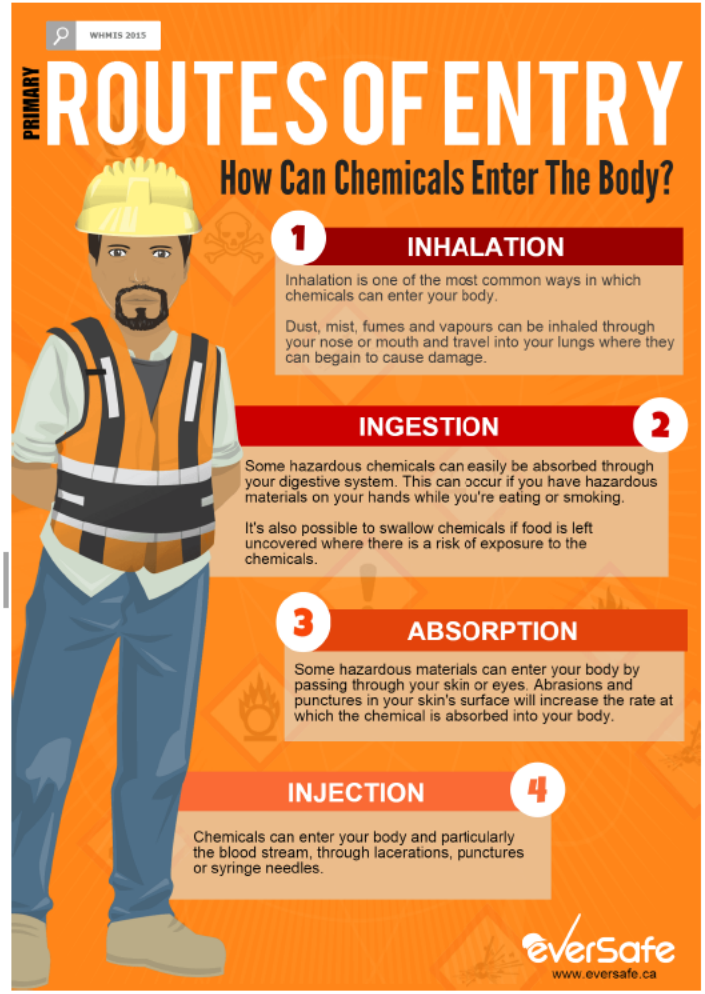
Power Zone

- ✓ Close to the body, between mid-thigh and mid-chest
- ✓ Whenever possible, work in your power zone
- ✓ This is where the arms and back can lift with the least amount of effort

Safety Glasses or Goggles

- ➢ Must meet the Z87.1-2010 ANSI standard
  - ANSI stands for American National Standards Institute
- ➢ Eye PPE must be worn when hazards such as flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors or potentially injurious light radiation are present.
- ➢ The permanent marking of "Z87" on eye protectors means the basic Z87 standard has been passed
- ➢ "Z87+" means the eyewear meets a higher impact standard





IH, ERGONOMICS, EYE SAFETY

https://doi.org/10.5281/zenodo.7498370

What are the four major routes in which chemicals can enter your body?

Inhalation Ingestion

Absorption Injection

Inhalation

- ✓ *Most common route of entry*
- ✓ Chemical and/or particle is either exhaled or deposited in the respiratory tract

Absorption

- ✓ Can occur through skin or eyes
- ✓ Some chemicals can pass through the skin and get into the blood stream

Ingestion

- ✓ Chemicals can get into the mouth and be swallowed
- ✓ Can be absorbed through the gastrointestinal tract and enter the blood stream

Injection

- ✓ Not as common
- ✓ Can occur from contaminated sharp object

The dose makes the poison.

Ergonomics

- ➢ The study of work and the relationship of work to the physical and cognitive capabilities of people

Cumulative Trauma Disorders (CTD's)

- ➢ Tennis Elbow
- ➢ Carpal Tunnel Syndrome
- ➢ Raynaud's Phenomenon (white finger syndrome)

Strains / Sprains

- ➢ Caused by a single forceful event such as lifting heavy objects in an awkward position
- ➢ Back, legs and shoulders are the most common

If you lift don't twist!!

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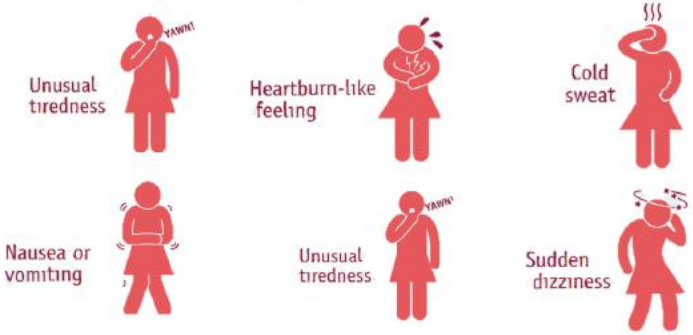
Fact

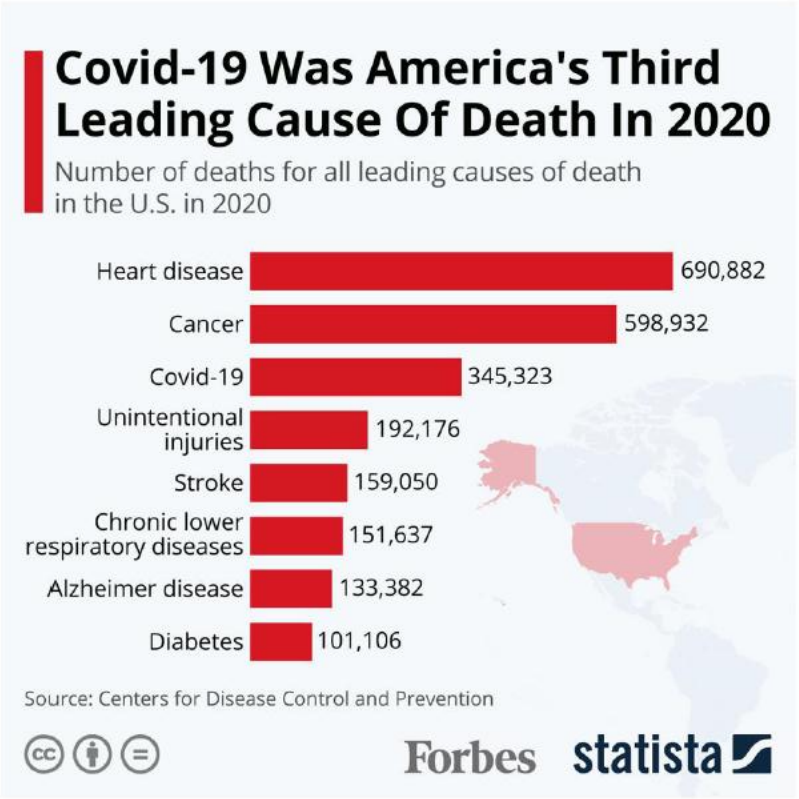
- ✓ The average person waits 3 hours before seeking help for symptoms of a heart attack.
- ✓ Chewing aspirin helps get the medication into the blood stream faster

Most Common

Women have also reported



- ✓ Hands-only CPR can be as effective as CPR with breaths.
- ✓ You can double or even triple a person's chance of survival
- ✓ **Remember:**
  - ***Ah. ha. ha. ha. stavin' alive. stavin' alive***



Heart Attack

KNOW THE WARNING SIGNS

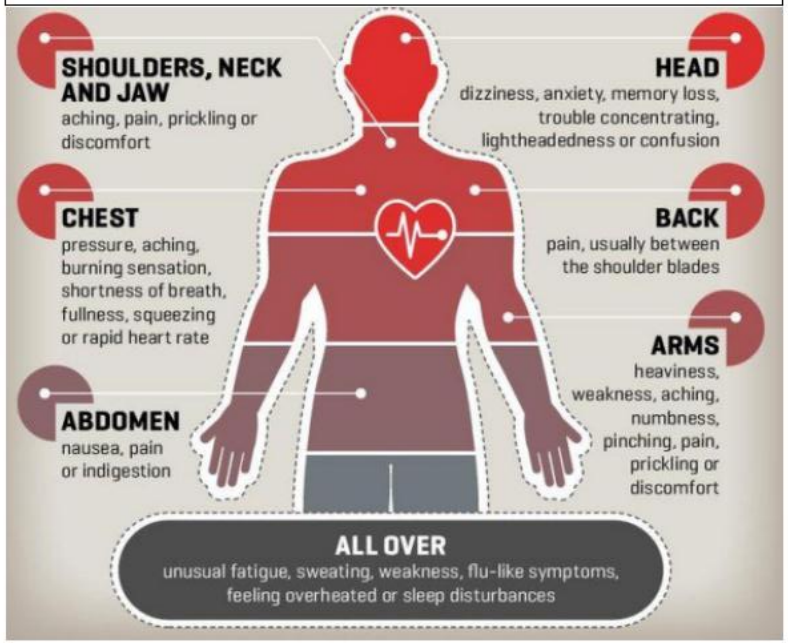
And treatment options

https://doi.org/10.5281/zenodo.7498370

What is the difference between a heart attack and cardiac arrest?

- Heart Attack
  - Blood flow to the heart is blocked
  - Circulation problem
  - *Aspirin and possibly CPR is the best treatment*

- Cardiac Arrest
  - The heart malfunctions and suddenly stops beating
  - Electrical problem
  - *CPR & AED is the best treatment*



FIRST AID – Call 911 immediately

- ✓ Have the person rest in a comfortable position to reduce the heart's need for oxygen.
  - Many people find it easier to breathe while sitting.
- ✓ Loosen any tight or uncomfortable clothing

- ✓ If the person has a history of heart disease and takes a prescribed medication such as nitroglycerin, offer to get it and help the person take it
- ✓ If the person is responsive, able to chew and swallow, offer two lose dose (81mg) or one regular strength (325mg) aspirin

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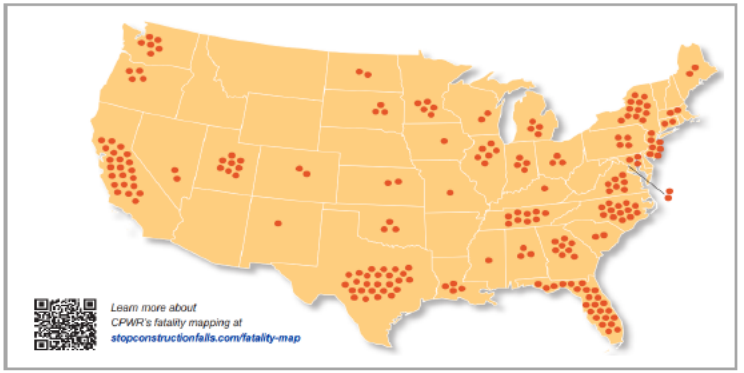
When climbing on/off equipment

- ✓ Use hand and step holds – keep one foot and two hands, or both feet and one hand, in contact with equipment at all times.
- ✓ Avoid carrying materials and tools when climbing on or off.
- ✓ Keep step and hand holds clear of mud, snow, grease and other fluids
- ✓ Do not jump off

Construction Injuries



Each dot represents a fatal construction fall in 2020

FOCUS 4

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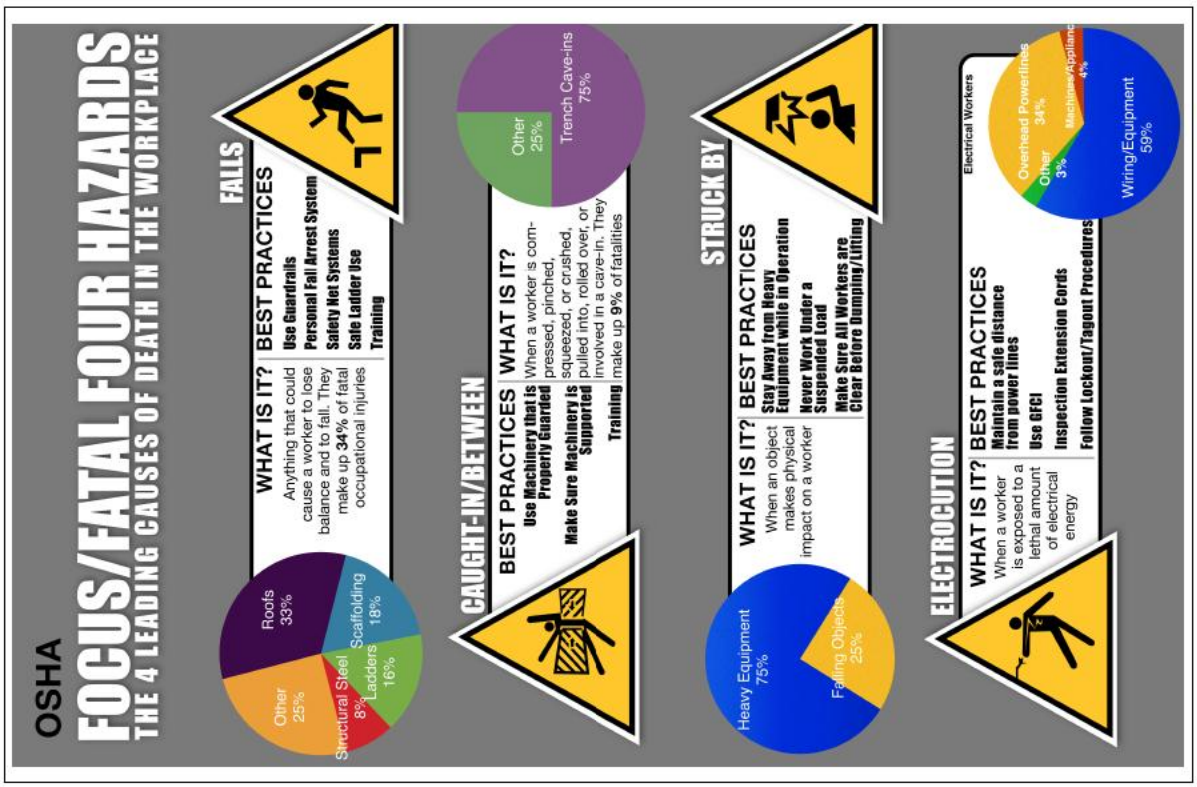

OSHA's Fatal Four Campaign

Falls

- ✓ Falls from heights are the leading cause of fatalities in construction
- ✓ Falls on the same level are one of the leading causes of injuries
- ✓ Fall protection is required when working 6 feet or more above a lower level

Struck By

- ✓ Contact with objects and equipment to include being caught in or between objects/equipment.
- ✓ Most common hazards include: flying objects, falling objects, swinging objects, and rolling objects (vehicles/heavy equipment).

Caught-In or Between

- ✓ A struck-by injury is when the injury is a result of crushing injuries rather than the initial impact.
- ✓ Common causes include: unprotected trenches and excavations, heavy equipment, getting caught in moving parts of machinery and power tools.

Electrical

- ✓ Electrocution occurs when a person is exposed to a lethal amount of electrical energy.
- ✓ Common causes include: improper extension cord use, contact with energized sources, and contact with live overhead power lines.

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Qualified vs. certified vs. authorized

- ***Qualified*** – A person who – by education or experience – has successfully demonstrated the ability to solve or resolve problems related to a particular work or subject matter. ***Example*** – journeyman electricians
- ***Certified*** – An employee who has passed a certification exam from an accredited organization. ***Example*** - A certified safety professional (CSP) or a professional engineer (PE).
- ***Authorized person*** – A person assigned by an employer to perform specific duties or to be at a specific location on a jobsite.

A person can be considered the competent person through training and/or experience.

SAFETY CULTURE & COMPETENT PERSON

Top down, bottom up

https://doi.org/10.5281/zenodo.7498370

Safety Culture

- The common and generally accepted way people behave in the workplace as it relates to safe practices.

Key Aspects of an effective culture

Management commitment
Value safety and health at least as much as productivity

Visible management
Lead by example

Good communications between all levels of employees
Safety is a part of everyday work conversations and planning

Benefits

- ✓ *Morale is high*
- ✓ *Higher productivity*
- ✓ *Low insurance costs*
- ✓ *Good company reputation*
- ✓ *Low employee turn-over & absenteeism*
- ✓ *Fewer injuries*

Competent Person

What does competent mean?

- "Having suitable or sufficient skill, knowledge, experience, etc. for some purpose; properly qualified"
- Workers may only perform tasks which they are competent to perform safely.

OSHA's Competent Person Definition

- "One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who ***has the authorization to take prompt corrective measures to eliminate them***."

What would an inspector look for on a job site?

- Do the employees appear to have been trained properly?
- Do the employees know who the competent person is?
- What does the culture, attitude, and behavior of the employees look like?

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Environment

- Aquatic toxicity
- Not regulated by OSHA

Facts

- ✓ Sugar dust is explosive in the right conditions
- ✓ Chloramine gas is produced when mixing bleach and ammonia (diaper pails; litter boxes)
- ✓ Chlorine gas is produced when mixing bleach and an acid (vinegar; drain cleaners)

Pictograms
[Street Address]
[City, ST ZIP Code]

Hazard Communication or HazCom

PICTOGRAMS

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World Safety Journal

A peer-reviewed journal,
published by the World Safety Organization

Journal Homepage:
https://worldsafety.org/wso-world-safety-journal/

Analysis of Australian Coronial Inquest and Non-Inquest findings of heavy vehicle fatal crashes reveals shortcomings in investigations!

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KEYWORDS

Heavy Vehicle
Train
Investigation
Level Crossing
Crash
Human Factors

ABSTRACT

Heavy vehicle crashes occur daily where drivers, occupants and other road users are either killed or seriously injured. Investigations are conducted by regulatory authorities of these crashes and reports are submitted to the Coroner to determine the cause of death, make findings regarding the cause of the crash and then make recommendations to improve safety and mitigate the risk of a crash occurring. The Coroner plays a critical role in examining the cause of these crashes; however, this research has identified there are a number of substandard investigative practices where the investigations have not obtained the level of detail that would assist the Coroner in making appropriate findings. This study has also identified that this sub-optimal practice has been ongoing for a considerable period of time with a number of Coroners expressing their concerns. This study has reviewed a total of 34 publicly available Coronial Inquest and Non-Inquest findings. The review has identified there are inconsistencies in the quality of the investigations. A fatal crash investigation properly conducted can be a valuable tool in identify why a crash has occurred and greatly assist the Coroner the opportunity to make recommendations from the findings to improve heavy vehicle transport safety.

1. INTRODUCTION

Coroners plays a critical role in examining the underlying causes of the deaths and have the opportunity to make recommendations from findings to improve safety (Brodie et al., 2010). Coroners however rely on the information presented to them from the fatal crash investigation report or from the information presented during an Inquest if one is held. The quality of that investigation or the Inquest is dependent on the experiences, competencies and knowledge of the investigator and the type of investigative methodology being used, if any (Cikara et al., 2020).

A fatal crash investigation, properly conducted, can be a valuable tool in identifying the underlying causes and contributory factors of a crash, why a crash has occurred and suggesting recommendations for future prevention (Brodie et al., 2010; Klockner & Toft, 2014; Dell, 2015; Dell, 2019). In most instances the heavy vehicle fatal crash investigation is conducted on behalf of Coroners by the police. As stated by various Coroners, police may not have the knowledge, skills, competencies and resources

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to understand and navigate the complexities of the heavy vehicle transport industry socio-technical system and in some instances do not know what is needed to investigate a heavy vehicle crash to identify the underlying causes (Productivity Commission, 2020).

The role of police is diverse, as well as complex, with competing priorities. In most instances police investigate matters for prosecution purposes or for identifying liability (Selk & Benner, 2019; Doecke et al., 2020; Productivity Commission, 2020) and their investigative training is not specific to the heavy vehicle transport industry (Productivity Commission, 2020), with most investigators either learning their skills on the job or bringing those skills acquired elsewhere with them which may not be conducive to the regulatory setting they are working within.

2. CORONERS

A Coroner's primary role is to establish the cause and circumstances of a sudden or unexplained death. The role of a Coroner is fact finding, inquisitorial rather than fault finding, adversarial (Burns, 2014). Deputy Coroner Loch of the Office of the State Coroner Queensland (2014) in a Finding of Inquest (File 2012/334) stated *'An Inquest is not a trial between opposing parties but an inquiry into the death. The focus is on discovering what happened, not on ascribing guilt, attributing blame or apportioning liability'* (p. 2). Chief Justice Neal Maclean described New Zealand's coronial process as speaking *'truth to power'* and the New Zealand Coroners website explains that a '*Coroner speaks for the dead to protect the living* (Burns, 2014). The Western Australian State Coroner has stated that: *'It is said that the role of the Coroner's Court is to speak for the dead and to protect the living. This two-fold role is a vital component of a civil society'* (Fogliani, 2017, p. 5).

Information drawn from a Coronial Inquest is vital to facilitate risk identification and strengthen countermeasures (Brodie et al., 2009). The significance of Coroners' recommendations and comments is their ability to advocate for change and potential wide-ranging impact (Brodie et al., 2010). In a study to quantify Coroners' recommendations and examine the nature of those recommendations according to public health principles of injury causation and prevention, Bugeja et al. (2012) stated that 'exploring the characteristics of recommendations generated from medicolegal death investigations is an important step towards improving their contribution to injury prevention' (p. 326).

Throughout Australia, Coroners' courts are state based jurisdictions where it is a legislated requirement that all deaths, including heavy vehicle fatal crashes must be reported to the Coroner in the State or Territory in which that fatal crash occurs. Generally speaking, any unexpected, unnatural or violent death must be reported. Internationally, within the Commonwealth, the requirement is not too dissimilar. In fact, throughout the United Kingdom and countries of the British Commonwealth there is much in common (Studdert & Cordner, 2010).

Coroners undertake Inquests based on the information gathered by police during the investigative process. Studdert and Cordner (2010) identified that a Coroner's role in establishing cause of deaths is especially valuable for fatalities in which the fundamental cause is obscure, or first impressions are misleading, which can be the case in heavy vehicle crashes. However, it was found that Coroners have limited resources where accurately identifying causes of deaths requires prudent efforts and directions towards investigations (Studdert & Cordner, 2010). Studdert and Cordner (2010) identified that coronial investigations in Australia changed basic presumptions about how deaths occur only in a small number of cases. This is concerning considering the findings of previous research that expressed concerns at the lack of quality of investigations of heavy vehicle crash fatalities (Victorian Parliament Law Reform Committee Review, 2006; Brodie et al., 2009; Brodie et al., 2010). This is made even more complicated where there has been a continuous effort to apportion blame for crashes on those directly involved such as the driver of a vehicle and then taking legal action against them (Dell, 2015).

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3. AIM

The aim of this research project was to analyse the findings of Coronial Inquests and Non-Inquests to identify whether investigations of heavy vehicle fatal crashes by police provided sufficient evidence of crash causation for Coroners to make informed decisions and recommendations to improve safety in the heavy vehicle transport industry.

4. METHOD

A search was conducted of each Australian State and Territory-based Coroner's office website. Publicly available coronial reports were searched to identify those reports that included a crash involving a heavy vehicle. The search was conducted for the years between 2005 and 2020. The reports were either those arising from an Inquest as well as findings from a Non-Inquest. In total 34 reports were selected. Each report was downloaded and read to ensure the report fell within the date range and included a crash involving a heavy vehicle. The reports selected came from the Coroners Courts in the states of New South Wales, Tasmanian, Victorian, South Australian, Queensland and Western Australian.

The analysis identified the type of crash, i.e., truck vs car, the type of report, i.e., Inquest or Non-Inquest, the findings and recommendations, the number of recommendations and types of recommendations. The reports were further analysed to identify:

- If the crash was considered a workplace crash or not;
- The type of investigative methodology used by investigators;
- If comments were made by the Coroner with regards to the quality of the investigation and information provided;
- Who was involved in the investigation process i.e., Police, Worksafe, National Heavy Vehicle Regulator, Office of Transport Safety Investigations, Office National Rail Safety Regulator or others.

5. CRASH TYPE

The search results identified 34 Coroners reports comprising of 13 x truck vs car, 11 x truck rollover; 2 x truck vs cyclist, 1 x lost load from truck vs car, 1 x truck trailer vs car, 1 x truck vs tree, 1 x truck vs building, 1 x truck vs motorcycle, 1 x truck vs pedestrian, 1 x bus vs pedestrian; and 1 x truck vs train.

6. CRASH TYPE AND WITH RECOMMENDATIONS

Recommendations arising from the coronial Inquests and Non-Inquest findings included:

1. Truck vs train:

This was a workplace incident. The heavy vehicle driver was charged with criminal offences however was found not guilty at trial. Two recommendations arose from the Non-Inquest. Both recommendations related to the locomotive crashworthiness and structural integrity of the locomotive driver's cabin. The Office of Transport Safety Regulator was involved in a parallel investigation providing information to the Coroner. WorkSafe was not involved in the investigation process.

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2. **A heavy articulated vehicle collided with a car:**

Eight recommendations were submitted by the Coroner. These recommendations included imposing speed restrictions for the articulated vehicle, install internal speed limiters to be set at 60kph or at 80 kph if electronic stability control was fitted, driver must undertake practical and theoretical assessments, amend the articulated code of practice to include guidance on handling characteristics.

3. **Truck vs car:**

The heavy vehicle rolled over rounding a bend, toppling over onto a car. Recommendations included government to investigate stability control systems for heavy vehicles and for the Queensland Department of Transport to appoint a coronial officer as well as mandate the attendance of a transport inspector to the scene of fatal crashes involving heavy vehicles.

4. **Truck vs. pedestrian:**

This Inquest took into account five separate fatalities and recommended *the Vehicle Standards Australian Design Rules 42/04- General Safety Requirements 2005* be amended to require front warning sensors be installed during manufacture of all cab over heavy vehicles.

5. **Oversized escorts Inquests:**

There were two Inquests that analysed three fatal crashes. In total 12 recommendations were made. These included only granting permits for loads that are indivisible, not granting permits for loads if they can me made smaller, night-time escorts to be limited to dual carriageways and metropolitan areas, Police review the use of motorcycles as escort vehicles, oversized load activity must be well managed, the National Heavy Vehicle Regulator regard the evidence of the Inquest to develop regulations and guidelines for arrangements of oversized loads, ensuring the wording for oversized loads are more effectively communicated, public awareness campaigns ensuring public are aware of their obligations, traffic management plans must be developed and distributed to all escort parties for the escort, procedures and permit conditions to be more explicit when describing risks of transporting a wide load, using more information signs for very wide loads, more attention be given to the spacing of the escorts and the oversized load, must include this in the training for the Police officers escorting oversized loads, lighting of oversized loads to be review.

6. **Unstable trailer towed by truck colliding with a vehicle:**

Recommendations included Government request training providers review content of training and assessment for license holders, whether competence for loading and towing trailers should be included in the training, government consider whether medium rigid licence holders ought to be permitted to tow trailers behind medium rigid trucks, government to raise this issue with other government agencies for consideration.

7. **Car struck by heavy log falling from a truck:**

Coroner recommended that WorkSafe review its industry standards and guidelines to address aspects of the standards that were shown and conceded to be deficient during the Inquest.

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8. **Truck colliding with a push cycle:**

It was recommended that Government immediately prohibit cyclists from using the highway, government engage with stakeholders to deal with safety concerns and provide an alternative route, signage should be erected on onramps to warn cyclists that the roadway was dangerous.

9. **Truck vs car, double fatality:**

It was recommended that government and Police maintain their awareness campaigns of the risks of using mobile phones whilst driving and ongoing attention be given to detecting those who breach the rules and consideration be given to the level of penalty applicable to such offences.

10. **Truck vs tree:**

It was recommended the shire conduct a risk assessment of the road with a view to placing signage at the beginning of the road to forewarn road users of the road's curves and undulations and the dangers within.

11. **Truck colliding with a push cyclist:**

Seven recommendations were made. Some included the routine and mandatory electronic recording of witness statements, government to regulate that vehicle stop one vehicle behind the bike box which enables drivers to see the bike. Targeted and education program to alert motorists of the risk of placing themselves immediately in front of a heavy vehicle, make such actions an offence, conventional shaped heavy vehicle should be fitted with technologies to warn drivers of obstacles and other road users in the driver's blind spot, educate all motorists about blind spots in front of a conventional heavy vehicle.

12. **Bus hitting a pedestrian:**

It was recommended that government urgently review the operations of the traffic and pedestrian crossings at intersections.

13. **Truck vs car:**

The Coroner recommended that Government proceed with the design and construction of a channelised right turn at the intersection with priority.

14. **Truck vs tree:**

It was recommended that the government consider enhanced education and awareness to ensure employees performing inspection of heavy vehicle are of the risks involved in not having clean components to inspect, and that government review the current memorandum of understanding between Police and Worksafe that includes a process for the notification of a heavy vehicle incident to the national heavy vehicle regulator.

15. **i) Truck vs. car & ii) truck vs pedestrian:**

One Inquest was held for two separate fatalities occurring at the same location. 17 recommendations were made (South Australian Government 2015). These included:

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- Drivers who don't use a safety ramp when their truck is out of control face harsher punishments, up to and including jail time. Truck drivers are automatically charged with dangerous driving if they go over the speed limit of 60 kph on the downhill stretch of the freeway. Owners or companies that hire drivers pay victims and their families for accidents involving heavy vehicles. Truck drivers are required to take classes on how to drive downhill and how to use an arrester bed.
- Trainee drivers should undergo specific tuition in relation to the required manner of driving on the downhill of the South Eastern Freeway; a truck driver must be supervised when driving down the South Eastern Freeway for the first time, and the accompanying driver must have demonstrated experience and competence on that downhill; no heavy vehicle license of any kind should be issued to any person in Australia unless they have demonstrated competence in the safe negotiation of the downhill on the South Eastern Freeway.
- Speed limits for heavy vehicles are reduced to 40 km/h on the down track; improved signage, including informing drivers that heavy penalties apply if trucks and buses do not use low gear; promotion of arrester bed use; roadworthiness and maintenance be brought within the chain of responsibility regime with the *Heavy Vehicle National Law (South Australia) Act 2013* and be undertaken nationally; all heavy vehicles be subjected to a periodic and frequent inspection regime; investigating the capability of technology to detect the speed of a heavy vehicle and tell a driver that their speed is excessive and they need to use a safety ramp.
- Consider creating a zone between the Heysen Tunnels and the second arrester bed for the mandatory stopping of all heavy vehicles, with the additional requirement that if the vehicle is unable to stop in that zone, the driver must use the second safety ramp (Marcus, 2015).

However, in this Inquest the Government of the day stated it would only support 13 of the 17 recommendations (MacLennan, 2015).

16. Truck rollover:

No recommendations were made however a number of points were raised. Company did not do any act or omission to contribute to the crash. Driver not wearing seatbelt. Delays in completing investigation, investigation not completed to a required standard. Workplace incident, WorkSafe not involved.

7. FINDINGS

Over the 15-year period this study identified a total of 34 publicly available Coronial Inquest and Non-Inquest reports. In those 34 reports a total of 60 recommendations were made with five Inquests providing 43 recommendations and the remaining 29 Inquest and Non-Inquest findings providing 17 recommendations. This study supports the findings of a previous study conducted by Brodie et al. (2010) in which it was identified that Coroners recommendations from fatal crashes were infrequent. The Inquests where multiple recommendations were made came about where Coronial Inquests were combined and heard as one because the fatalities occurred at the same location or were similar types. i.e., fatal crash occurring during the escort of an oversized load.

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There was one Inquest that investigated two incidents because the fatalities that occurred were the result of the same type of incident, this being a collision occurring as a result of escorting oversized loads. From these two fatalities there were seven recommendations. There was a second Inquest that also involved an oversized escort from which there were five recommendations.

There was one Inquest that had a total of eight recommendations, one Inquest had six recommendations. Twenty of the Coroners' reports focused on the heavy vehicle driver behaviours. In seven of the reports, it was noted the driver was criminally charged however the driver was found not guilty in four of the crashes. In another crash the driver pleaded guilty, despite there being evidence to suggest other contributing factors. In another crash the driver was convicted of the offences and in another crash the charges were downgraded to lessor charges to which the driver pleaded guilty.

Thirty-three of the crashes involved a workplace incident as the heavy vehicle driver was working at that time. Only one of the 33 crashes that were workplace incidents was investigated by WorkSafe.

The types and focus of recommendations made were varied. Most were directed towards the management of driver behaviour such as imposing speed restrictions, driver training, installing speed limiters in heavy vehicles, better risk management of oversized escorts, employees performing inspection of vehicles and increased penalties for drivers who do not travel at restricted speeds. There were recommendations that included increased penalties for breaching the laws, installing in-vehicle technologies such as stability control and front warning sensors and other recommendations were aimed at improving the manner in which investigations are conducted. For example, in one Inquest it was recommended that there be routine and mandatory electronic recording of interviews, another recommended the mandatory attendance of a transport inspector at the scene of a fatal crash and in another that government review its current memorandum of understanding between police and WorkSafe. Support, by way of applying a consistent investigative methodology as well as providing training to investigators on the heavy vehicle transport system, is needed. This will enable the collection of evidence and information to identify and analyse the underlying causes for targeted prevention. As stated by Brodie et al. (2009) 'Increased recognition of heavy vehicle safety beyond individual driver responsibility is needed' (p.563). In support Newnam et al. (2017) identified that a comprehensive investigative process is likely to identify interventions that have contributed to a crash all the way up to the level of regulatory bodies and Government agencies

More importantly, in 22 of the Coronial reports, it was identified that the heavy vehicle driver behaviour, actions or omissions had in some part contributed to the crash. For example, in one Inquest it was identified the driver had no experience driving a heavy vehicle and, in another Inquest, it was found the driver was significantly fatigued as a result of being under too much pressure to meet a deadline to deliver their load. However, the Inquest did not delve more deeply into the safety management system to identify 1. If the driver's employer had checked the drivers were competent and experienced to drive a heavy vehicle 2. whether the scheduling and risk management processes permitted a driver to drive a heavy vehicle to meet unrealistic deadlines causing them to become fatigued.

In addition, the role and importance of systemic investigations was recognised. In an Inquest where separate investigations had been conducted by police and the Queensland Office of Transport Safety Investigations, the Coroner noted that police were statutorily prohibited from relying on the investigation reports from another agency for prosecution purposes and that police had to independently gather and analyse the evidence using their own expertise and resources. The Coroner went on to further state that the other agency involved in the investigation was focused on identifying contributory factors for the purpose of identifying opportunities to improve safety and health (Queensland Coroners Court 2008/392 & 2008/393, p. 4).

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8. DISCUSSION

8.1 Quality of crash investigations

A review of the Inquest and Non-Inquest findings suggests that systemic investigations are not being undertake. This is supported by comments made by Coroners. This study found there were a number of comments made by Coroners regarding the quality of crash investigations. This has been consistent since 2001 where Coroners around Australia have made similar findings and expressed their concerns. For example, in a Victorian Coronial Inquest (1114/2001), the Coroner recommended that police consider developing a basic investigation standard for fatal and serious crashes. This recommendation came about due to a number of serious deficiencies identified by the Coroner of an investigation conducted by the police of a fatal crash. Additionally, the Victorian Parliament Law Reform Committee Review (2006) conducted a review of the Victorian *Coroners Act 1985* and reported that the limitations of Coroner's investigations related to transport collision had been raised in a number of forums over the previous past five years. The review identified that:

1. Coroners did not have legal control over the death investigation process nor any power to direct the investigation, and
2. There was an absence of comprehensive guidelines for Coroners conducting death investigations as well as widespread discrepancy between the standard of Coroners' investigations in Melbourne and those in rural areas.

In a Coronial Inquest regarding a vehicle colliding with an escorted oversized load, killing the car driver (Queensland Coroners Court 2199/05(0)), the family of the deceased were dissatisfied with the evidence submitted to the Coroner by the police. The family of the deceased had taken it upon themselves to assemble a substantial body of material regarding the conditions and events prior to the collision and provided that information to the Coroner. That material was subsequently forwarded by the Coroner to the police for further investigation who were then able to obtain further evidence for the Coroner. Although not criticising the investigation, the Coroner found (Queensland Coroners Court, 2199/05(0), p. 28) that a Coronial Inquest is better informed when evidence is available from all perspectives.

In another Findings of Inquest, (Queensland 2011/1631 & 2010/4091) a police officer riding a motorcycle and escorting an oversized load was struck and killed by a heavy vehicle travelling in the opposite direction. The heavy vehicle driver was charged with driving without due care and attention, however, after a three-day trial, the heavy vehicle driver was found not guilty (p. 11). In the subsequent Inquest, the deceased's wife made a submission to the Coroner to consider flaws in the way the investigation was undertaken and managed (p. 12). During the Coronial Inquest the Coroner identified a number of 'sub-optimal practices' (p.12) that included:

- Conversations with witness at the crash scene were not tape recorded.
- Detailed accounts were not taken from any witnesses on the morning of the crash.
- Police did not have witnesses adopt any notes taken of the conversations.
- Key witnesses were allowed to confer at the scene and then leave on the understanding they could attend to a Police Station at a time and place convenient to them to provide a statement.
- The defendant was spoken to by four officers on the day of the crash, but none took detailed statement or questioned the defendant closely as should have been in such circumstances.
- One officer was notionally put in charge, but other officers gave directions about aspects of the investigation without consulting with the person in charge and did not ensure the person in charge was advised of the outcomes.

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- Other officers who were tasked with various inquiries or to obtain statements were inadequately briefed regarding the issues under investigation as well as the versions provided by other witnesses meaning they could contribute little to the investigation.
- The expert investigators from the Fatal Crash Unit did not arrive until two days after the crash.
- Significant delays occurred during the investigation as the supervisors allowed significant delays to occur.

> *The Coroner noted that 'Whilst these criticisms have some force, as a result of reviewing the investigations of numerous traffic fatalities I am aware that similar practices are common' (p. 13).*

The Coroner went on to further identify a number of key points in relation to the quality of the investigation. These included the investigating police officer worked in a very busy station, the officer had very limited crash investigation training and experience, there was no specialist support, experts undertook discreet parallel investigations or reviews, there was limited coordination of the number of investigations being conducted at the same time. The Coroner noted that:

> *'(name redacted) was the officer in charge of a very busy division with limited crash investigation training and experience. Nonetheless, in the normal course he would investigate fatal road crashes in that division, there being at the time no specialist FCU in central region. However, in this case he was left to undertake a criminal and coronial investigation of a particularly sensitive matter, while other experts undertook discreet investigations or reviews of aspects of the incident. There was limited coordination of the four inquiries and less supervision of (name redacted).*

In conclusion, the Coroner stated that '[t]he outcome was less than perfect, but probably no worse than many investigations regularly undertaken throughout the state' (p.13).

These comments raise a number of concerns at the lack of quality of investigations that are conducted of fatal crashes. The Coroner's comments suggest that sub-optimal practices in investigations are common place and the quality of heavy vehicle fatal crash investigations are not to a suitable standard.

The Coroner's comments were consistent with the findings from research conducted by the authors of this paper where a number of participants were interviewed to identify why heavy vehicle drivers were blamed for crashes. The participants in the interviews, many being either police officers or former police officers, stated that police officers, themselves included, were required to conduct heavy vehicle fatal crash investigations whilst working under strenuous circumstances, without support, in busy police stations with limited or no training or crash investigation experiences. This may, to some extent, explain the sub-standard quality of investigations being conducted resulting in deficient investigation reports being submitted to Coroners.

Research by Brodie et al. (2010) found there was no systematic approach to Coroners' investigations of heavy vehicle fatalities. The research identified that police crash expert investigators are not involved in the investigation of all fatal heavy vehicle crashes, especially those that are single heavy vehicle crashes. Generally, these investigations are conducted by general duties police often with less experience and expertise that those within the specialised crash investigation squads.

In another Non-Inquest of a single heavy vehicle rollover fatal crash killing the driver (Magistrates Court of Tasmania 2020), the Coroner found the police officer allocated to the investigation was not a qualified investigator and was attached to a police station with a very heavy workload. The Coroner concluded that it was understandable the police officer was unable to complete the investigation to a required standard and in a timely manner (Magistrates Court of Tasmania 2020, p. 7). These comments are consistent with the research findings by the authors of this paper who conducted a number of semi-structured interviews with a participant who had investigation experiences. The participants stated that

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when working in busy police stations, particularly those police stations in country areas, they did not have the support or resources to properly complete a heavy vehicle fatal crash investigation, nor did they have the training, competencies or experiences to conduct those investigations.

In an Inquest finding of a fatality caused by an incorrectly loaded trailer causing it to lose balance leading to a crash, the Coroner became aware of a number of systemic failings identified during the investigation. The Coroner suggested that 'where systemic flaws in the system are disclosed, they should be addressed with urgency and careful attention' (Coroner's report 2013/298913, p. 11). Later in the report, the Coroner stated in relation to the circumstance surrounding the death that:

> *Coroners have no professional expertise in relation to these questions. I have therefore framed the recommendations not in rigidly prescriptive terms but putting the serious issues (name redacted) death raises before the experts in the field for them to consider and resolve (p. 13).*

However, the substandard quality of investigations is not just specific to police. In another example of an Inquest, the Coroner expressed concerns regarding an improperly conducted investigation by another government agency. The Coroner commented on the substandard quality of a tape-recorded interview, noting that:

> *The tape recording of the interview reveals a rather shambolic, rambling and unstructured interchange. The panel chair stated at the Inquest he had taken some comfort from knowing that a coronial investigation was to follow. However, subsequent events have revealed this to be illusory. While there is no doubt the panel members had high level content knowledge, it might be desirable in future to include a person with forensic expertise (Queensland Coroners Court 2009, p. 3).*

The research suggests there are sub-standard and sub-optimal investigation practices that have been evident for a considerable period of time. Driscoll (2003) identified that limited investigative resources and a lack of standard investigation approaches were likely to impede the information and investigative process. Bohensky et al. (2005) identified that if the process for investigating deaths were standardised, these deaths would be more easily and efficiently investigated. Bugeja et al. (2007) concluded there were recognised limitations associated with the coronial investigations of heavy vehicle crashes and the lack of an existing systematic approach affecting investigation outcomes.

A review conducted by the Government of Western Australia Department of Treasury (2018) to improve the efficacy of coronial investigations recommended a number of efficiency and effectiveness reforms, three of which focused the lens on the quality and output of investigations. These recommendations included enhancing the powers of Coroners to obtain information outside of an Inquest, improving consistency of regional investigations and updating guidelines to police and modifying performance measures reflecting the integrated components of coronial investigations. The recommendations highlight the need for police to conduct consistent investigations.

This is not new as previous studies by Brodie et al. (2009) posited that opportunities remain through learnings from fatal crash investigations and the systematic analysis of contributing factors. In that study it was concluded that a standardised approach to heavy vehicle fatal crash investigations will support Coroners and research efforts to increase knowledge. In a subsequent study by Brodie et al. (2010) into recommendations following fatal heavy vehicle crash investigations, it was identified that investigation standards were lacking. This included a need for a minimum crash investigation standard, improved investigative practices and increased resources for data collection to enable proactive measures by investigative authorities (p. 140).

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9. CONCLUSION

The analysis of the coronial Inquests and Non-Inquest findings identified that crash investigations differed in quality and complexity. This study identified there have been historical concerns raised by Coroners over the substandard quality of investigations arising from reviews and Coroners' findings. This study has revealed a number of comments from Coroners who have continued to voice their concerns of the quality of investigations and that it suggested that sub optimal practices are commonplace. The investigations were all conducted by the Police for the Coroner from differing states. The thematic analysis identified there were differing quality of investigation, some of which were criticised by the Coroner.

A review of the coronial Inquests and Non-Inquest findings revealed that there did not appear to be a standardised approach to the investigations. There were varying degrees of quality and detail as evidenced by Coroners' remarks and the investigations did not identify contributory factors across the levels of the socio-technical system. Most factors identified in the coronial Inquests would more than likely be limited in scope because the investigations did not appear to adopt a systematic approach. It is also highly likely that other systems factors at the upper levels of the socio-technical system were present however not identified nor investigated due to the investigator's lack of understanding and knowledge of effective investigation practices.

REFERENCES

Bohensky, M., Ibrahim, J.E., O'Brien, A.L., Emmett, S.L., Newman, E., Charles, A., & Young, C. (2005). World without borders. Integrating clinical perspectives into coronial jurisdiction in Victoria, Australia. *Journal of Medicine and Law*, *25*(1), 13-29.

Brodie, L., Bugeja, L., & Ibrahim, J.E. (2009). Heavy vehicle driver fatalities: Learnings from fatal road crash investigations in Victoria. *Journal of Accident Analysis and Prevention*, *41*, 557-564. DOI: 10.1016/j.aap.2009.02.005.

Brodie, L., Bugeja, L., & Ibrahim, J.E. (2010). Coroner's recommendations following fatal heavy vehicle crash investigations. *Australian and New Zealand Journal of Public Health*, *34*(2), 136-141. DOI: 10.1111/j.1753-6405.2010.00497.x.

Bugeja, L., Symmons, M., Brodie, L., Osborne, N., & Ibrahim, J.E. (2007). *Development of a specialist investigation standard for heavy vehicle fatal collisions in Victoria*. *In P. Schofield (Ed.): Conference Proceedings of the 2007 Australasian Road Safety Research, Policing and Education Conference.* Melbourne Victoria Australia: The Meeting Planners, 1-10.

Bugeja, L., Ibrahim, J.E., Ozanne-Smith, J., Brodie, L.R., & McClure, R.J. (2012). Application of a public health framework to examine the characteristics of coroner's recommendations for injury prevention. *Journal of Injury Prevention*, *18*, 326-333. DOI: http://dx.doi.org/10.1136/injuryprev-2011-040146

Burns, B. (2014). Lessons learned from the Coroner's court. *Kai Tiaki Nursing New Zealand*, *20*(8), 21-23.

Cikara, I., Dell, G., Toft, Y., Dell, S., & Skrizovska, M. (2020). The need for enhanced heavy vehicle crash investigations: Beyond 'blame the driver'. *Transactions of the VSB - Technical University of Ostrava, Safety Engineering Series*, *15*(1), 60-72, (ISSN: 1805-3238). DOI: 10.35182/tses-2020-0007.

Dell, G. (2015). Foreword, in Viner D, *Occupational risk control: Predicting and preventing the unwanted.* Gower Publishing, Farnham.

Dell, G. (2019). *The lessons from 15 years of airline corporate governance roles (and 40 years of air safety investigations)*. Presentation at the Australia and New Zealand Societies of Air Safety Investigation, Wellington, New Zealand.

Doecke, S., Thompson, J., & Stokes, C. (2020). How do we prevent and mitigate crashes? Evidence from Australian at-scene in-depth crash investigations. *Journal of Safety Research*, *1*(2), 35- 43.

Driscoll, T. (2003). Traumatic work-related deaths and Australian Coroners. A thesis for preventions. *The Journal of the Australasian Coroners Society Inc*, Issue 2.

Fogliani, R. (2017). *Office of the state Coroner for Western Australia. Annual Report 2016-2017*. https://www.coronerscourt.wa.gov.au/_files/Annual_Report_2016_17.pdf

Government of Western Australia, Department of Treasury. (2018). Improving the efficiency of coronial investigations, 90 day regulatory mapping and reform project series report no 4.

Heavy Vehicle National Law (South Australia) Act 2012.

Klockner, K., & Toft, Y. (2014). *Accident modelling using social network analysis for complex socio technical systems*. Australian Safety System Conference (ASSC 2014), Melbourne, Victoria, Australia.

Marcus, C. (2015). *Coroner recommends national training for truck drivers on the South Eastern Freeway into Adelaide*. *ABC News* [online]. https://www.abc.net.au/news/2015-01-12/Coroner recommends national training for truck drivers on the South Eastern Freeway/6012304. [Accessed 23 June 2021].

MacLennan, L. (2015). *Truck drivers could be jailed if low gear not used on South Eastern Freeway decent in Adelaide Hills. Truck drivers who fail to engage low gear when descending the South Eastern Freeway in the Adelaide Hills could be jailed under legislation the South Australian Government is drafting*, Sydney.

Magistrates Court of Tasmanian. (28 October 2020). *Record of investigation into death (without Inquest), James William Espie.*

Productivity Commission. (2020). *National Transport Regulatory Reform, Inquiry report: Overview and recommendations.* Australian Government, report no. 94, Canberra. ISSN 1447-1329-1447-1337.

Newnam, S., Goode, N., Salmon, P., & Stevenson, M. (2017). 'Reforming the road freight transportation system using systems thinking: An investigation of coronial Inquests in Australia. *Journal of Accident Analysis & Prevention*, *101*, 28-36. DOI: http://dx.doi.org.exyproxy.lib.monash.edu.au/10.1016/j.aap.2017.01.016

Queensland Courts, Office of the State Coroner. (22 December 2008). Findings of Inquest, Innisfail Coroners Court, file number 2199/05(0).

Queensland Court, Office of the State Coroner. (23 December 2009). Findings of Inquest, Brisbane Coroners Court, file number COR868-870/06.

Queensland Courts, Office of the State Coroner. (15 March 2013). Findings of Inquest, Brisbane Coroners Court, file number 2011/1631 & 2010/4091.

Queensland Courts, Office of the State Coroner (5 June 2014). Findings of Inquest, Toowoomba Coroners Court, file number 2012/334.

Queensland Courts, Office of the State Coroner. (27 March 2018). Findings of Inquest, Toowoomba Coroners Court, file number 2014/3137.

Queensland Coroners Court, Office of the State Coroner, Findings of Investigation: Non-Inquest findings into the deaths of Michael Smithers and Richard Wetherell, 2008/392 & 2008/393, Cairns, Australia.

Selk, S., & Benner, L. (2019). Accident investigation challenges for process safety practitioners. *Journal of Process Safety Progress*, *28*(4), 1-9.

South Australian Government. (2015). Response to the deputy State Coroner's recommendations of January 2015, following the death of Mr James William Venning on the South Eastern Freeway, September 2015.

State Coroners Court. (13 June 2016). New South Wales, Findings from Inquest, 2013/298913.

Studdert, D.M., & Cordner, S.M. (2010). Impact of coronial investigations on manner and cause of death determinations in Australia, 2000 – 2007. *Medical Journal of Australia*, *192*(8), 444-447. DOI:10.5694/j.1326-5377.2010.tb03582.x

The Coroners Act 1985 (Victoria).

Vehicle Standards Australian Design Rules 42/04- General Safety Requirements 2005.

Victorian Coroners Court. (2001). Case number 1114/2001.

Victorian Parliament Law Reform Committee. (2006). *Inquiry into the review of the Coroners Act 1985*. Parliamentary Paper No. 229 of Session 2003-06. ISBN-0-9757984-1-3, Melbourne Victoria.

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A glimpse of optimism for Lebanon's public (rail) transport: donation of 50 buses by France!

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KEYWORDS

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ABSTRACT

Lebanon is currently experiencing a manifold of crises, the worst since the Civil War (1975-1990) that crippled the country and its people, among them a suffocating financial crisis – the worst economic and financial crisis that the world has seen since 1850, according to the World Bank. It is destroying the livelihoods and lives of the people of Lebanon, and also affects whatever public transport there is in this country – it is virtually non-existent. With respect to the latter, on 23 May 2022, a slight glimmer of hope appeared on the horizon, when a ship arrived at the Port of Beirut, carrying a first batch of the 50 buses that have been donated by France. This paper addresses this issue and looks at the challenges and opportunities for Lebanon's road transport sector.

1. INTRODUCTION

The UN Habitat for Humanity published a report on Transport and Mobility in 2021, stating that the transport sector in Lebanon is one of the most unsustainable in the Middle East region, owing to weak governance structures and regulatory frameworks, the lack of a modern and reliable public transportation system, and a car-friendly culture dominated by large, old-model polluting cars. Further, the report concluded that Lebanon lacks a comprehensive and inclusive transportation system, with mostly informal public transportation and very limited infrastructure for alternative modes of transportation (UN-Habitat, 2021a).

In 2017, the United Nations Human Settlements Programme in Lebanon launched the National Urban Policy (NUP) program to assist in the management of the country's rapid urbanization, capitalizing on opportunities and addressing stresses. Lebanon's program, which is part of a regional program that also includes Jordan, Tunisia, and Sudan, reached a significant milestone in 2018 with the publication of a diagnosis report (UN-Habitat Lebanon, 2018). This included completing the diagnosis phase of a five-phase NUP process (Figure 1) that concentrated on feasibility, diagnosis, formulation, implementation, monitoring and evaluation. Consultations with relevant stakeholders following the publication of the diagnosis report identified transportation as one of two sectors, along with housing, that are particularly important for the country's sustainable urban development.

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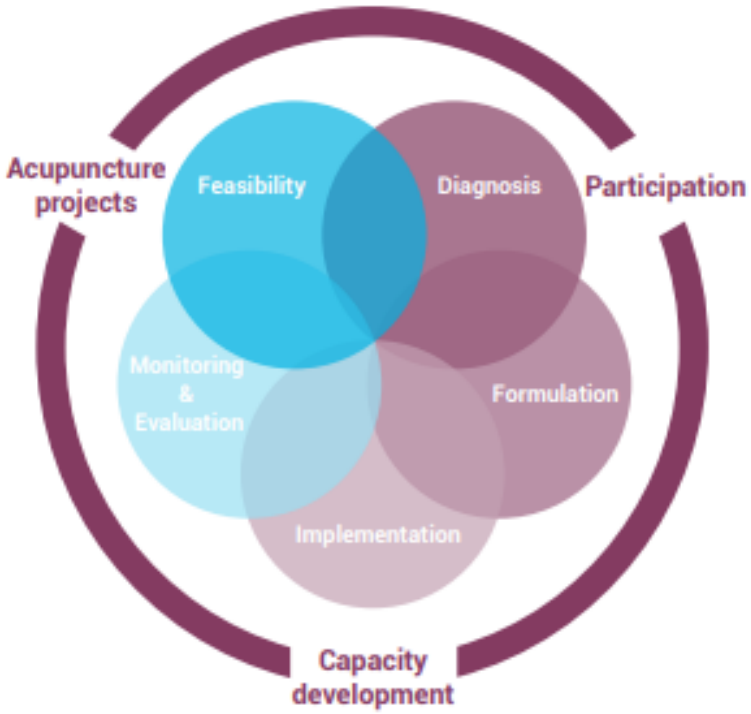

Figure 1. The NUP process

2. MEMORANDUM OF UNDERSTANDING

As noted earlier, Lebanon lacks an integrated and inclusive transportation system, with most public transportation being informal and very limited infrastructure for alternative modes of transportation such as walking and cycling. As a result, mobility is concentrated on car use on congested highways, with high consumption of polluting fossil fuels, making Lebanon's road transport sector the second largest energy consumer and having long-term effects on human health and the environment. Furthermore, the authorities in charge of managing the sector have unclear responsibilities and limited resources, limiting the sector's potential for proper development toward greater accessibility, efficiency, and effectiveness.

The establishment of a NUP for Lebanon may thus provide an opportunity to improve the planning, implementation, and integration of new transportation infrastructure, technologies, and service models into appropriate urban forms, allowing people easy access to a variety of transportation modes. This will allow urban residents to reach more destinations, opportunities, and amenities in a safe, convenient, and cost-effective manner, potentially improving living quality in Lebanese cities. This can also contribute to economic prosperity and growth by attracting new businesses and investments.

2.1 Donation of 50 buses by France

On 11 March 2022, as part of an integrated transportation plan, the French government signed a Memorandum of Understanding (MoU) with Lebanon, under which France would donate 50 public transport buses to Lebanon, in order to modernize the Lebanese public transport network, and also to supplement the some 40 buses that are currently circulating the roads (Figure 2) (The Daily Star, 2022]. On 23 May 2022, the first shipment of buses arrived at the Port of Beirut (Figure 3).

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The MoU signed between France and Lebanon also entails that France would provide "technical assistance and expertise" and "in-depth reflection on the organization and structuring of urban transport in Lebanon." Thus, the donation of the 50 buses is part of a bigger initiative to improve Lebanon's transportation sector. According to the MoU, Lebanese authorities are to establish a fund, financed by donations that are to be obtained from other countries, in order to financially assist passengers in paying their fares.

About one-third of the donated buses are to serve the Greater Beirut Area (GBA), and the remainder is destined for operation in the Beqaa Valley, and North and South Lebanon. Each of the donated single-deck buses could offer space for up to 92 passengers, a big improvement as compared to the 24-seater buses that are currently in operation. It is expected, that once financial support is in place, the donated buses could somewhat alleviate the dire public transport system in Lebanon, but they are insufficient to solve the entire problem. The construction of railway lines and/or a SkyWay system is also of paramount importance.

Figure 2. Signing of Memorandum of Understanding (MoU) on 11 March 2022
– involving France's donation of 50 buses –
by the French Transport Minister Delegate, Mr. Jean-Baptiste Djebbari (left)
and the Lebanese Minister of Public Works & Transport, Mr. Ali Hamieh (right),
with the (now caretaker Lebanese Prime Minister, Mr. Najib Mikati, looking on (centre)

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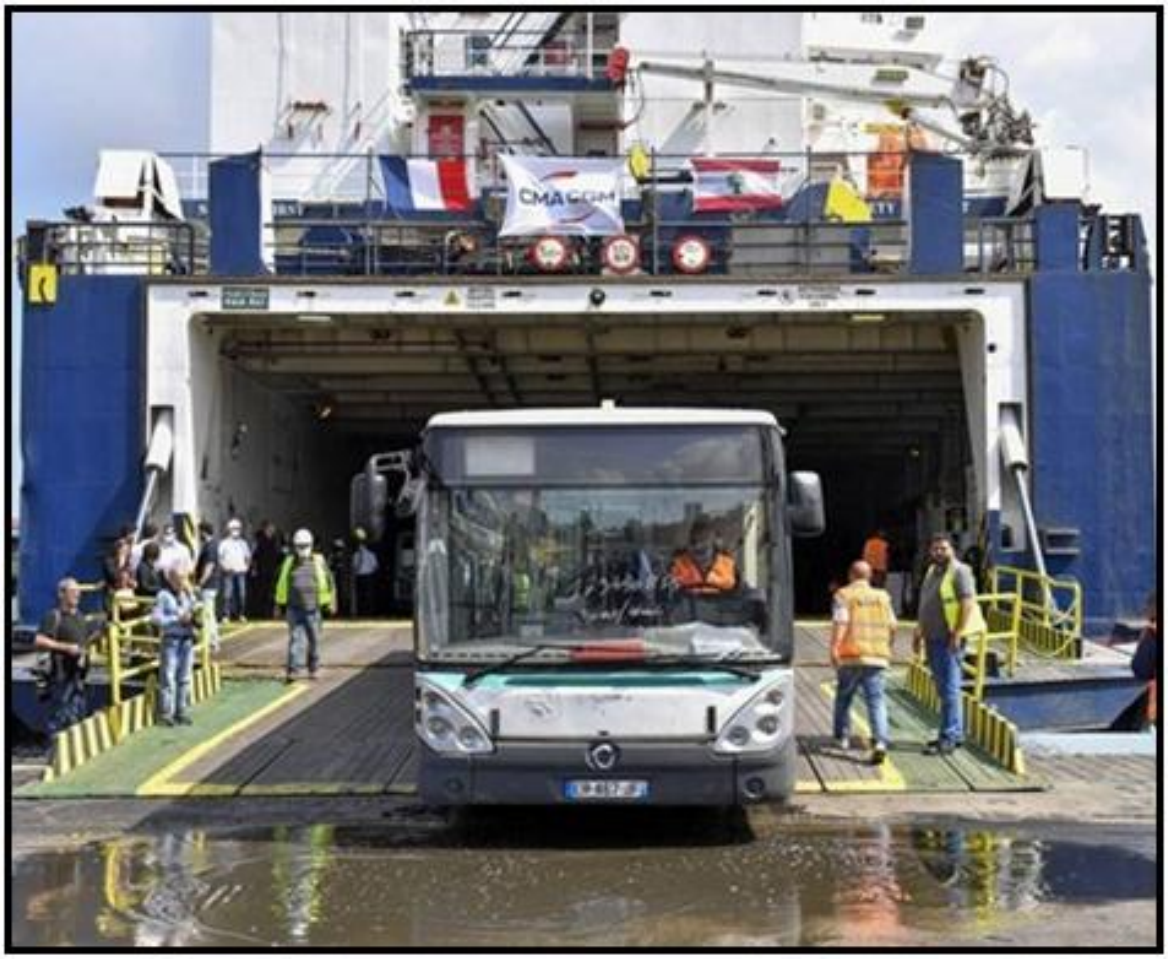

Figure 3. Arrival of the first batch of donated buses at the Port of Beirut

3. OVERVIEW OF CHALLENGES AND OPPORTUNITIES FOR LEBANON'S ROAD TRANSPORT SECTOR

Road transport activity in Lebanon has grown rapidly and steadily over the last two decades, in tandem with population and economic growth, until the onset of the 2019 economic crisis and the outbreak of the COVID-19 pandemic in 2020. However, the increase in travel activity has not been matched by the development of the necessary infrastructure and services. In fact, no progress on public transportation has been made by government authorities or the private sector since the end of Lebanon's 15-year civil war in 1990, and there have been no major initiatives to promote and enable alternatives to motorized transport in cities or across the country in general. This has contributed to severe traffic congestion in cities and across the country, making Lebanon's transportation sector one of the least sustainable in the Middle East (Haddad et al., 2015). The challenges of road passenger transport in Lebanon, as well as the opportunities for improvement, are described in the following subsections through a plethora of observations and data.

3.1 High rates of motorization and severe traffic congestion

Mobility in Lebanon is almost entirely dependent on motorized transport, with approximately 1.49 million cars for passenger travel, over 150,000 light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs) for passenger and freight movement, including buses for public transportation and trucks for goods movement, and over 100,000 motorcycles, for a total of approximately 1.75 million registered

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vehicles (MoIM, 2015). This corresponds to a distribution of approximately 85% for passenger cars, 0.9% for buses, 7.9% for LDVs and HDVs, and 6.2% for motorcycles (Figure 4). With a 2015 population of approximately 5.5 million (excluding Syrian refugees in border areas), this translates into a share of more than 270 cars per 1,000 people, or approximately 1 passenger car for every 3.7 people, placing Lebanon among the most motorized countries in the Middle East. This is largely due to a lack of alternatives to car use on the one hand, and the availability of financial facilities in the form of low-interest car loans by banks and financing institutions on the other (until the beginning of the ongoing financial crisis). These are aided by the government's economic policy of pegging the local currency to the US dollar at a fixed exchange rate for the past three decades (until currency exchange fluctuations began in late 2019 and eventually led to de-pegging), making passenger car purchases less affordable.

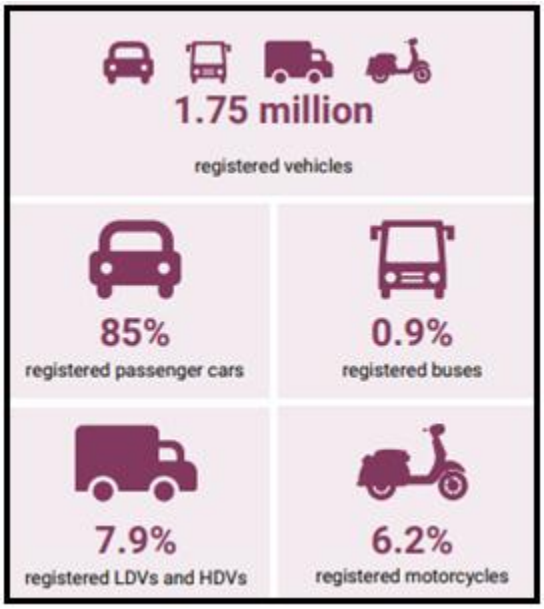

Figure 4. Registered vehicles in Lebanon (MoE, UNDP and GEF, 2016)

3.2 Main challenges facing the urban planning system

According to the UN-Habitat diagnosis report that provided a context analysis for Lebanon from social, economic, and political perspectives, using three key thematic areas: urban legislation, urban economy, and urban planning and design, the main challenges facing the urban planning system in Lebanon were identified as follows (UN-Habitat Lebanon, 2018):

- Lack of communication and inconsistency between the national and local levels.
- Absence of integrated planning in the urban management system.
- Centralized and hierarchical administrative system of Lebanon.
- Poor appreciation of the concerns and interests of stakeholders, beneficiaries, and related end users.
- Lack of public participation in urban planning.
- Inefficiency of some urban planning laws, rules, and regulations.
- Lack of inter-organizational relationships.
- Expansion of urban areas, as well as issues related to urban sprawl and informal settlements.

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3.3 Lebanon's transport challenges

Lebanon lacks an integrated and inclusive transportation system, with mostly informal public transportation and very limited infrastructure for alternative modes of transportation like walking and cycling. Thus, mobility is concentrated on car use on congested highways, with high consumption of polluting fossil fuels, making Lebanon's road transport sector the second largest consumer of energy and having long-term effects on human health and the environment. Furthermore, the national and local government authorities in charge of managing the sector have unclear responsibilities and limited resources, limiting the sector's potential for proper development toward greater accessibility, efficiency, and effectiveness.

3.4 Energy, environmental and health impacts

The rise in demand for motorized mobility translates into increased energy consumption in road transport, which in Lebanon is overwhelmingly powered by fossil fuels, with gasoline and diesel accounting for about 99% of CO emissions (Figure 5). Consumption levels rise even more in gridlocked traffic, not only because a trip takes longer to complete, but also because of slower driving speeds and longer idling periods, both of which result in the inefficient operation of conventional internal combustion engines (ICEs). Furthermore, because of the inefficiency of their outdated engine technologies, older vehicle models, which dominate the Lebanese vehicle fleet, with over 70% of cars older than 10 years, are responsible for higher energy consumption. Larger vehicle types, which account for more than 60% of the Lebanese passenger car fleet, also contribute to an increase in energy consumption due to their large (over 2.0 liters) gas-guzzling engines (MoE, URC and GEF, 2012). As a result of these factors, road passenger transportation in Lebanon has a high energy demand per capita, estimated in 2007 at 15.06 GJ per capita, which exceeds the global average. And, as more fuel is consumed, more emissions are released into the atmosphere, including greenhouse gas (GHG) emissions (primarily carbon dioxide [CO_2]), which are a major contributor to global warming and climate change, as well as pollutant emissions, which have a negative impact on human health. Indeed, the transportation sector in Lebanon is the second largest source of total GHG emissions, accounting for more than 23% of total annual GHG emissions, and is a major polluter, accounting for 95% of total carbon monoxide (CO), 60% of total nitrogen oxide (NOx), and 57% of total non-methane volatile organic compounds (NMVOCs) (MoE, UNDP and GEF, 2016).

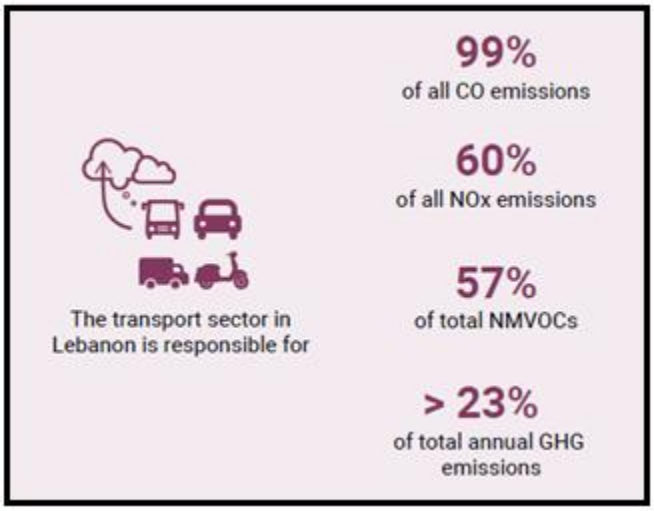

Figure 5. Transport sector emissions (MoE, UNDP and GEF, 2016)

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The issues are particularly acute in dense urban areas with slow-moving traffic on typically narrow streets, as well as suburban areas adjacent to major highways, where mobility has become synonymous with noxious fumes and a primary cause of respiratory and other diseases, as well as a source of stress, loss of productivity, and waste of disposable income. Despite the dire environmental consequences, there is hope for progress thanks to the country's commitment to reduce emissions under the 2016 Paris Agreement signed by parties to the United Nations Framework Convention on Climate Change (UNFCCC). Indeed, Lebanon has committed to reducing its GHG emissions by at least 15% by 2030 compared to 2010. (MoE, 2015). This will be accomplished by providing incentives to renew the vehicle fleet with fuel-efficient vehicles (FEVs) and hybrid electric vehicles (HEVs) in order to achieve a market share of 35% and 10%, respectively, by 2040, and by revitalizing the public transportation system in order to increase its share of passenger kilometers (pass-km) travelled by bus by 15%.

3.5 Inadequate bus system and absence of rail

Lebanon's public transportation system was largely destroyed during the country's civil war, which lasted from 1975 to 1990. As a result, the railway system, which consists of approximately 400 kilometers of installed rail and nearly 30 stations serving four rail lines along Beirut-Damascus, Naqoura-Tripoli, Tripoli-Homs, and Rayak-Aleppo, became completely inoperative, and all attempts to revive it have failed. Similarly, a single attempt in the late 1990s to revitalize the public bus system with the purchase of 200 newer-model buses was short-lived, and the public bus system has been reduced to less than 40 old-model buses operating on nine lines to serve a population of more than 2 million people in the GBA and surrounding areas (Baaj, 2002). There are no other public transportation options in Lebanon, such as a marine ferry or internal aviation flights. To date, exclusive-use taxis and shared-ride taxis (known as "service taxis"), as well as newer ride hailing providers such as Uber and Careem, account for the majority of mass transportation in Lebanon, with a low vehicle occupancy rate of 1.2 passengers per vehicle (Figure 6). Private minivans and buses account for the remaining market share, with estimated occupancies of 6 and 12 people per van and bus, respectively. These operate ad hoc, with no fixed routes, schedules, stops, or stations, no coordination or central management, and only basic information provided by third parties in the form of paper maps and non-real-time mobile applications. There are also no measures, equipment, or infrastructure in place to make public transportation accessible to the elderly, people with disabilities, or other vulnerable groups.

Figure 6. Vehicle occupancy rates for mass transport in Lebanon (MoE, URC and GEF, 2012).

As a result, by international standards, public transportation in Lebanon is considered unreliable, uncomfortable, and unsafe, limiting ridership and forcing commuters to continue relying on private automobiles. This is a major contributor to the country's unsustainable land transport sector, as illustrated in Figure 5, which compares cities around the world based on the modal share of private cars versus GDP per capita. This places Beirut alongside car-dependent cities with the highest rates of urban sprawl, such as some cities in North America and Australia. However, what makes Beirut's position even more untenable is the lack of viable alternatives offered by American and Australian cities, such as buses and rail, as well as the lack of necessary resources for long-term system improvement, as is the

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case in Riyadh, where major public transportation projects, such as buses, metros, and monorails, are underway.

This unsustainable reality is due, in large part, to a lack of vision and strategy required for proper city planning and development in Lebanon, as well as administrative mismanagement of the public transportation system. This has hampered all CSO and international agency modernization efforts, leaving the market to be dominated by private operators, many of whom operate without a proper license. Unofficial figures show that 33% of taxi licenses (known as "red plates") are illegal, resulting in anti-competitive practices among operators. Furthermore, Lebanon's public transportation system remains unregulated, which leads to chaotic operations and contributes to traffic jams rather than alleviating congestion —an unusual role due to the lack of dedicated lanes and irregular pick-up and drop-off patterns that increase traffic collision risks and casualties.

3.6 Lack of walking, bicycling spaces, traffic calming measures, and poor road safety

The majority of Lebanon's cities have become unfriendly to cyclists and pedestrians. The most notable is Beirut, where ad hoc and unchecked urbanization has occurred (UN-Habitat Lebanon, 2021b), making it difficult to commute by any mode of transportation, particularly walking and cycling. Some of the primary causes of these difficulties are:

- There is no use of zoning or land-use planning in Lebanon to encourage walking and cycling. As a result, there are few pedestrian-only zones in the GBA and other cities, with only a few car-free days in select areas.
- A lack of sidewalks alongside most roadways, as well as a poor state of use for the majority of those that do exist, in addition to common infringement by cars parked over most sidewalks and random obstructions, such as unofficial signposts and barriers, for illegally reserving curbside parking spots in front of residential buildings and commercial establishments.
- A lack of clearly marked pedestrian crosswalks at intersections, as well as pedestrian walkways, bridges, tunnels, and other structures to allow for safe pedestrian crossing of roadways.
- There are few parks and public squares for walking, bicycling, and scootering, and the few that do exist have become inaccessible to the public due to security measures.
- There are no dedicated bike lanes in or around the GBA, only temporary bike trails in limited areas are made available for biking on occasion. A 3-kilometer bike lane with traffic (separated only by roadway markings) was installed in the city of Tripoli to the north of Beirut in 2016, and a dedicated bike trail was installed in the city of Byblos to the north of Beirut in 2019.
- Only one operational bike-sharing system was installed in Byblos, to the north of Beirut, in 2017, with only a handful of bikes available. A few similar bike-sharing systems were installed in the GBA in 2018, but have yet to be operational; some have even been removed in recent months due to political and economic instability.
- Dominance of highways and roadways over urban space, which cut off the residential areas of parts of Beirut from each other and the city center.
- Some traffic-calming measures, particularly speed bumps on internal roads to slow traffic in residential and commercial areas, are widely used in Lebanon. However, these measures almost never include urban land-use planning and regulations, which are most effective for calming traffic and reducing car dependence—for example, changing street design standards to create pedestrian-only spaces with services such as shopping and recreational activities. At the same time, the chronic lack of enforcement of traffic laws encourages motorists to drive recklessly and at high speeds, endangering cyclists and pedestrians and discouraging alternative modes of transportation.

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3.7 Expensive mobility and a lack of innovative mobility options

In 2015, the cost of motorized mobility in Lebanon was estimated to range between USD 0.43 and USD 0.64 per vehicle-kilometer traveled for small-size vehicle categories, and USD 0.64 for large-engine sport utility vehicles (SUVs). Given that the average regular commuter in Lebanon drives 12,000 km per year, or approximately 33 km per day, the daily cost of mobility would be LBP 21,000 (at the current official exchange rate of USD 1 = LBP 1,500). As a result, mobility in Lebanon can be viewed as a significant financial burden on commuters.

However, with the significant and ongoing depreciation of the Lebanese Pound since 2019, which has increased all vehicle-related costs by multiple orders of magnitude, in line with the rate of unofficial trading of the US dollar in the market, it has become quite clear that motorized mobility is becoming completely unsustainable.

Most of these major cost components can be mitigated, at least in large part, by proper urban and transport planning policies and strategies aimed at reducing motorized vehicle trips and commuting distances. Such measures would directly lower travel time, congestion, fuel consumption, and emissions, and indirectly lower the risk of accidents. Therefore, there is an urgent need to find new solutions for affordable, reliable, and safe mobility in the country, especially since the transport sector is the backbone of the Lebanese economy—for touristic, industrial, and/or agricultural activities.

3.8 Fragmented institutional and regulatory framework

In Lebanon, several governmental institutions have different types of authority over the transport sector, including the authority to regulate, implement, operate, manage, and oversee various parts of the sector. The main entities and their agencies are (Figure 7):

- **Ministry of Public Works and Transport (MoPWT)**, namely the following directorates:
    - **The Directorate General of Land and Maritime Transport (DGLMT)** is responsible for the organization, administration, and oversight of the entire land transport sector and its proper development, as well as oversight of public transport services.
    - **The RPTA (also known as Office des Chemins de Fer et des Transports en Commun or OCFTC)** is part of the MoPWT but operates as an independent body in charge of managing and operating the railway and public bus networks.
    - **The Directorate General of Roads and Buildings (DGRB)** is responsible for the construction, rehabilitation, and maintenance of the public roadway network.
    - **The Directorate General of Urban Planning (DGUP)** is mandated to develop and review national urban master plans and regulations for urban planning. It presides over the Higher Council of Urban Planning (HCUP), which is a coordination mechanism between concerned ministries and agencies.
- **Ministry of Interior and Municipalities (MoIM)**, namely the following organizations:
    - **The Traffic Management Organization (TMO)** is in charge of developing traffic and parking operating plans and overseeing the implementation of traffic laws.

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- **The Traffic and Vehicle Management Authority (TAVMA)**, which is included in the TMO, is in charge of vehicle registration and inspection, driver licensing, and traffic code implementation.
- **The Council for Development and Reconstruction (CDR)** reports directly to the Council of Ministers and receives funds separately from donors. It is responsible for roadway planning and project implementation. It is also mandated to develop master plans for urban planning.
- **Municipalities** are in charge of roads within their municipal jurisdiction and the associated regulation of traffic. The different institutions and their associated responsibilities were outlined in detail during the diagnosis phase of Lebanon's NUP (UN-Habitat Lebanon, 2018).

- **The Ministry of Finance (MoF)** is responsible for the allocation and disbursement of funds for the implementation of the majority of transport projects by ministries and municipalities.

As illustrated in Figure 7, there is no centralized authority in charge of the land transportation system, which is the primary reason for the lack of a comprehensive national transportation strategy or a road map for sustainable mobility. The distribution of responsibilities among various stakeholders, sometimes with overlapping mandates, results in conflicting plans and decisions, delays in action implementation, and ultimately gridlocked outcomes. Furthermore, there is a lack of coordination between agencies, even within the same ministry; a lack of integration of project activities across different ministries' funding, implementing, and operating agencies; and a complete lack of comprehensive urban transportation and land-use planning. For example, different institutions may carry out various aspects of the same project without detailed coordination or clear communication with the public.

4. AN EFFICIENT AND MODERN PUBLIC TRANSPORT SYSTEM

Building more roads, demolishing buildings to make space for more cars, and adding more parking spaces will only exacerbate the road traffic congestion problems in Beirut. Anyway, in the case of Beirut, decreasing road traffic congestion by developing more roads is not a viable option, because of its urban density and terrain, with the mountains to one side, the sea to another, and a narrow coastal strip in-between. Any road development project would require either the expropriation of land, or the construction of tunnels in mountains or highways over the sea, all of which would be costly options. This leaves the development of an efficient and modern public transport system as the only and most favorable option.

As noted in numerous articles (e.g., Choueiri, 2014; Choueiri, 2018; Choueiri, 2020; Choueiri, 2021), studies to implement an efficient and modern public transport system to alleviate road traffic congestion in the Greater Beirut Area (GBA) have been underway for several years now, but are struggling to make much progress due to the various political, economic, financial, and other crises Lebanon is currently plagued with. Among these studies are railways, such as revitalizing railway services (using existing rights-of-way) on the following routes:

- Beirut - Jounieh - Tabarja-Maameltein (- Tripoli); and
- Tripoli - Abboudiyeh.

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Model/ function/ process	Roads	Traffic management	Parking	Public transport	Paratransit	Freight	Accidents	Urban transport	Vehicle registration	Rail transport
Policy	DGRB	TAVMA DGRB		DGLMT	DGLMT			DGLMT		DGLMT
Regulation	DGRB	TAVMA DGRB	DGU	DGLMT	DGLMT	DGLMT	DGRB		MoIM TAVMA	RPTA
Planning	DGRB CDR		TAVMA	RPTA						
Financing	MoF CDR	MoF CDR		RPTA MoF			MoF CDR			
Project preparation & implementation	DGRB CDR Municipalities						DGRB CDR Municipalities			RPTA
Operation management		Municipalities	MoIM TAVMA	RPTA			DGRB Municipalities			
Maintenance management	DGRB	Municipalities	MoIM TAVMA	RPTA			DGRB Municipalities			
User information		MoIM TAVMA	MoIM TAVMA				MoIM TAVMA		MoIM TAVMA	

Figure 7. Government functional responsibilities for land transport (MoE, UNDP and GEF, 2016)

Another option to consider is an elevated SkyWay system between Beirut Rafic Hariri International Airport and Casino du Liban (Jounieh) with intermediate stations at key locations. Such a system could alleviate the serious road traffic congestion situation near the airport and, thus, provide an efficient and reliable transport alternative for people travelling to/from the airport, as well as other destinations served by this route.

For any of the aforementioned to become a reality, it would take quite some time. However, the dire road traffic congestion situation needs to be alleviated much sooner—a temporary solution could come in the form of the Greater Beirut Urban Transport (GBUT) project. GBUT entails the establishment of appropriate institutional entities for the management, operation, and maintenance of the BRT system. Once implemented, it would become Lebanon's first modern public transport system in decades. France's donation of 50 buses is seen as a first tentative step toward getting the GBUT system up and

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running. Without a dedicated BRT corridor, buses would be trapped in mixed traffic, with no dedicated stations for passengers or regulated timetables. Finally, it is expected that there will be no improvement in the level of service provided by a public transportation system, with negative consequences for quality of life and the environment. As an alternative to ground-level structures, BRT corridors running through the median highway can be built on separate elevated roads or underground viaducts. Because of the complexity of the underground system and the archaeological potential in Lebanon, an elevated system must be considered as a potential alternative to the current project.

5. FUNDING NEEDED

With the financial and economic situation in Lebanon being very much in a dilapidated state, the country is very much in need of financial support for—actually—everything, including projects to alleviate its road traffic congestion situation. In March 2018, the World Bank approved a USD 295 million financial package to allow the alleviation of some of the imminent problems facing the road transport sector in Lebanon, and, at a later stage, it extended a preliminary agreement to institutionally and financially support the aforementioned Greater Beirut Urban Transport (GBUT) project (World Bank, 2018). However, due to the ongoing economic collapse of the country, which started in October 2019, the project, once hailed to be the country's "first modern transportation system" in decades, has not yet materialized!

6. CONCLUDING REMARKS

As noted earlier, the USD 295 million financial package for the road transport sector, approved by the World Bank, was never disbursed, because it was tied to the government demonstrating progress in implementing economic reforms, including improving fiscal management. Of course, any donor would want to see a genuine and lasting commitment to seeing reforms through in Lebanon. That means setting up a credible and transparent follow-up mechanism to monitor progress, not just government pledges of improved management, given Lebanon's poor record in terms of fiscal responsibility and capital investment, as well as the country's poor infrastructure. Donors and investors will need to be convinced that Lebanon is really in a position to implement infrastructure projects in an effective manner as, in the past, weak governance standards have allowed sectarian and elite interests too much influence in the awarding of public contracts. So, it is really up to the political leaders of Lebanon to capitalize on the goodwill of the international community that is willing to offer financial support, but only when requested reforms are in place and protected.

However, at the time of writing this article, there has been no government in place in Lebanon since the parliamentary elections held in May 2022. There is only a caretaker government, which, although very much attempting to do what it can, is very much restricted in its actions. To further exacerbate the situation, as of 1 November 2022, Lebanon does not have a president, as Members of Parliament (MPs) have not been able/willing to agree on a successor to the previous one. Both are needed to take the country further on its long journey to implement the reforms necessary to unlock funding from external bodies [e.g., the World Bank, the European Union (EU), the European Investment Bank (EIB), and the United Nations' Development Programme (UNDP)], so that the various (public) transport projects can finally go ahead.

REFERENCES

Choueiri E.M. (2014). *Alleviating traffic congestion by implementing LRT: studies underway for Beirut*. REI, Number 4, p. 9.

Choueiri E.M. (2018). *Revitalising public transport in Lebanon – a matter of urgency: steps that are being undertaken towards making it a reality (Part 1 of 2)*. REI, Number 3, pp. 14-16.

https://doi.org/10.5281/zenodo.7498407

Choueiri E.M. (2020). *An efficient public transport system could combat the serious road traffic congestion situation in Beirut, Lebanon – a country that is currently facing a dire economic crisis*. REI, Number 3, pp. 4-7.

Choueiri E.M. (2021). *SkyWay: a possible solution proposed to alleviate the very dire road traffic congestion and air pollution situation in the Greater Beirut Area (GBA), Lebanon*. REI, Number 4, pp. 12-14.

The Daily Star (2022, March 11). *France to donate buses to Lebanon as part of Integrated Transport Plan*. Beirut, Lebanon.

Haddad, M., Mansour, C. and Stephan, J. (2015). *Unsustainability in Emergent Systems: A Case Study of Road Transport in the Greater Beirut Area*. Proceedings of the 2015 International Conference on Industrial Engineering and Operations Management, pp. 1-10. Dubai, United Arab Emirates. Available from: https://ieeexplore.ieee.org/abstract/document/7093899

Ministry of Environment, UNDP and Global Environment Facility (2016). *Lebanon's Third National Communication to the UNFCCC*. Beirut, Lebanon. Available from: https://unfccc.int/sites/default/files/resource/lbnnc3.pdf

Ministry of Environment, URC and Global Environment Facility (2012). *Lebanon: Technology Needs Assessment for Climate Change*. Beirut, Lebanon. Available from: https://climatechange.moe.gov.lb/viewfile.aspx?id=150

The World Bank (2018, March 15). *World Bank supports Lebanon's Public Transport to improve mobility, spur growth*. Beirut, Lebanon.

UN-Habitat on Transport & Mobility (2021a). *Guide for mainstreaming transport and mobility in Lebanon's national urban policy*. Beirut, Lebanon. Available from: https://unhabitat.org/guide-for-mainstreaming-transport-and-mobility-in-lebanons-national-urban-policy

UN-Habitat Lebanon (2021b). *Beirut City Profile 2021*. Beirut, Lebanon. Available from: https://unhabitat.org/es/node/160483

UN-Habitat Lebanon (2018). *National urban policies programme in Lebanon*: *Diagnosis Report 2018*. Beirut, Lebanon. Available from: https://unhabitat.org/national-urbanpolicies-programme-in-lebanon-diagnosis-report

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Last Name/Family Name

First Name/Given Name | Initial | ❑ M ❑ F (Gender)

Birthdate MM / DD / YYYY *(Application must include exact birthdate with year to be processed.)*

Current Street Address ❑ On Campus ❑ Off Campus *(Attach separate sheet if you need more room for your address.)*

City | State/Province | Country

Zip/Postal Code | Telephone Number (including area code) | ❑ Landline ❑ Mobile (Type)

Permanent Street Address

City | State/Province | Country

Zip/Postal Code | Telephone Number (including area code) | ❑ Landline ❑ Mobile (Type)

Send mail to: ❑ Current Address ❑ Permanent Address

Email Address(es)

COLLEGE/UNIVERSITY STUDENT

Category: ❑ Undergraduate ❑ Graduate/Post-Graduate

Degree(s) Sought/Obtained

Name of College/University | Campus

MIDDLE / HIGH SCHOOL STUDENT

❑ I am a Middle Schooler in: ❑ 6th Grade ❑ 7th Grade ❑ 8th Grade

❑ I am a High School: ❑ Freshman ❑ Sophomore ❑ Junior ❑ Senior

Name of School

Approximate Date of Graduation (MM / YYYY)
(For High School and College/University students, application must include approximate date of graduation to be processed.)

If you were referred by someone, please list name(s), chapter, division, etc.:

WSO Member: _____

WSO Chapter/National Office: _____

WSO Division/Committee: _____

Other: _____

What Interests You?

Please specify your area(s) of interest. These areas of interest will allow you to connect with others who share similar interests throughout the world.

[ ] Occupational Safety and Health (OS&H)
[ ] Environmental Safety and Health (EH&S)
[ ] Fire Safety/Science (FS&S)
[ ] Safety/Loss Control Science (S&LC)
[ ] Public Safety/Health (PS&H)
[ ] Construction Safety (CS)
[ ] Transportation Safety (TS)
[ ] Industrial Hygiene (IH)
[ ] Product Safety (PRO)
[ ] Risk Management (RM)
[ ] Hazardous (Toxic) Materials Management (HAZ)
[ ] Nuclear Safety (NS)
[ ] Aviation Safety (AS)
[ ] Ergonomics (ERG)
[ ] Petroleum (PS)
[ ] Oil Wells (OW)
[ ] Other: _____

Required Signatures & Permissions

I subscribe to the above record and when approved will be governed by the Constitution and By-Laws of WSO and its Code of Ethics as I continue as a member. I furthermore agree to promote the objectives of the WSO wherever and whenever possible.

X _____ Applicant Signature | Date

***FOR MID/HIGH SCHOOLERS ONY**: WSO subscribes to the Family Educational Rights and Privacy Act (FERPA) philosophy in protecting student privacy and information. WSO may disclose "directory" information such as a student's name, WSO Student Chapter affiliation, name of school, grade in school, etc., along with group or individual photos in WSO NewsLetters, NewsFlashes, eNews, on WSO website, and on WSO's social media accounts.*

❑ My student has permission to participate as outlined above.

❑ My student has permission to participate with exclusions:

_____

X _____ Parent/Guardian Signature (Mid/High Student) | Date

X _____ WSO Student Chapter Mentor Signature **[IF APPLICABALE]** | Date

WSO – National Offices

WSO National Office for Algeria
c/o Institut des Sciences et de la Technologie (I.S.T.)
attn.: Mr. Ferhat Mohia, Director
contact: ferhatmohia@yahoo.fr

WSO National Office for Australia
c/o Curtin University of Technology
attn.: Dr. Janis Jansz, Director
contact: j.jansz@curtin.edu.au

WSO National Office for Austria
c/o Payesh System Mehr Engineering Company
attn.: Dr. Majid Alizadeh, Director
contact: majidealizadeh@gmail.com

WSO National Office for Cameroon
c/o Cameroon Safety Services
attn: Mr. Clement B. Nyong, Director
contact: ny.clement@yahoo.com

WSO National Office for Canada
c/o Apex One Management Group
attn.: Mr. Michael Brown, Director
contact: michael.brown@worldsafetycanada.ca | mike@apexone.com
website: worldsafetycanada.ca

WSO National Office for Ghana
c/o Ghana National Fire Service
attn.: Mr. Peter Oko Ahunarh, Director
contact: pahunarh23@gmail.com

WSO National Office for India
c/o Indian Society of Safety Engineers (I.S.S.E)
attn.: Mr. T. Shankar, Director
contact: support@worldsafety.org.in

WSO National Office for Indonesia
c/o Prosafe Institute
attn.: Mr. Soehatman Ramli, Director
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WSO National Office for Iran
c/o Payesh System Mehr Engineering Company
attn.: Mrs. Fatemeh Gilani, Director
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WSO National Office for Iraq
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WSO National Office for Nigeria
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contact: info@worldsafety.org.ng
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c/o Greenwich Training & Consulting
attn.: Mr. Tayyeb Shah, Director
contact: doctimes@gmail.com

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attn.: Engr Alfredo A. De La Rosa Jr., Director
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c/o The Academy of Sciences for Medical Education
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contact: info@aos-ksa.com | binuya.rocky@gmail.com
website: https://aos-ksa.com/en

WSO National Office for United Arab Emirates (UAE)
c/o Tatweer Industrial Inspection & Training Services LLC
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contact**:** info@tiits.ae

WSO National Office for Vietnam
c/o Safety Training & Consulting Limited
attn.: Mr. Binh Pham, WSO-CSI(ML), Director
contact**:** binh.pt@worldsafety.org.vn
binh.pt@safety.edu.vn
website: worldsafety.org.vn

World Safety Organization

Code of Ethics

Members of the WSO,
by virtue of their acceptance of membership
into the WSO,
are bound to the following Code of Ethics
regarding their activities associated with the WSO:

Members must be responsible for
ethical and professional conduct in relationships
with clients, employers, associates, and the public.

Members must be responsible for professional competence in
performance of all their professional activities.

Members must be responsible
for the protection of professional interest, reputation, and
good name of any deserving WSO member
or member of other professional organization involved in
safety or associate disciplines.

Members must be dedicated to professional development of new
members in the safety profession
and associated disciplines.

Members must be responsible
for their complete sincerity in professional service to the
world.

Members must be responsible for continuing improvement and
development of professional competencies
in safety and associated disciplines.

Members must be responsible
for their professional efforts to support the WSO motto:

"Making Safety a Way of Life…Worldwide."

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