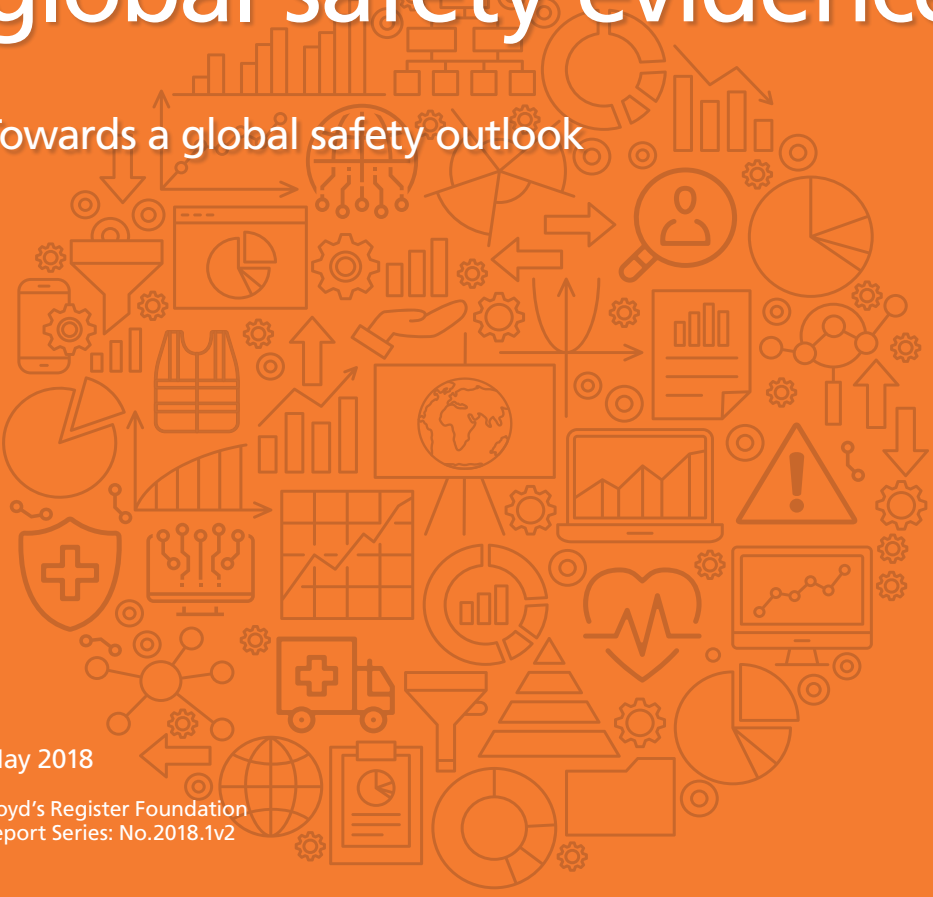
Lloyd's Register Foundation

Foresight review on global safety evidence

Towards a global safety outlook



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About the Lloyd's Register Foundation

Our vision

Our vision is to be known worldwide as a leading supporter of engineering-related research, training and education, which makes a real difference in improving the safety of the critical infrastructure on which modern society relies. In support of this, we promote scientific excellence and act as a catalyst working with others to achieve maximum impact.

The Lloyd's Register Foundation charitable mission

- To secure for the benefit of the community high technical standards of design, manufacture, construction, maintenance, operation and performance for the purpose of enhancing the safety of life and property at sea, on land and in the air.
- The advancement of public education including within the transportation industries and any other engineering and technological disciplines.

About the Lloyd's Register Foundation Report Series

The aim of this Report Series is to openly disseminate information about the work that is being supported by the Lloyd's Register Foundation. It is hoped that these reports will provide insights for the research community and also inform wider debate in society about the engineering safety-related challenges being investigated by the Foundation.

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Executive summary

This foresight review will further Lloyd's Register Foundation's goal to establish a global safety evidence base to support decision making leading to enhanced safety of life and property. It draws on interviews and desk studies with an international range of experts from many sectors and with different perspectives.

This foresight review will further Lloyd's Register Foundation's goal to establish a global safety evidence base to support decision making leading to enhanced safety of life and property.

The review gives example case studies of global datasets and how they are currently used. It considers where there are gaps and shortcomings in such data and highlights strengths and weaknesses in different approaches. Key learning points from the case studies include:

- Wide ranging variations in data quality and in the reliability of systems generating data at government, sector and company level exist, with some countries lacking any functioning systems for health and safety data collection and disclosure.
- Non-safety specific datasets can provide a critical context for safety, such as GDP, existence of regulatory and enforcement frameworks, transparency and the rigour of notification systems, investments in education, and health outcomes.
- Industry best practice approaches use both lagging and leading indicators of health and safety performance, and improved data collection.
- Data on health and how health is managed is currently a focus for many businesses seeking to understand and track leading indicators of safety.
- There is a need to capture and understand data from weak signals, near misses and emerging patterns related to safety performance as well as intelligence from a smaller number of high impact, high profile catastrophes.
- There is value in using unstructured data and new analytical techniques to identify a range of health and safety performance indicators.
- Subject matter experts are important in interrogating and giving meaning to this increasingly rich and complex data landscape and the insights to be revealed about the safety of the world and the cultural contexts and drivers shaping safety outcomes.

The review provides insights from experts into how data systems and their uptake may evolve in the future. Key themes include:

- The varying quality and many different quantitative and qualitative approaches to data collection around the world – both in relation to traditional approaches of data collection as well as new analytics and big data approaches.
- Increased attention to leading indicators of safety performance and safety culture.
- Better understanding of health considerations. How they influence safety outcomes and how they can be managed in the workplace in particular.
- Concerns regarding the widely acknowledged gap in data and understanding of the link between chronic diseases and workplace exposure.
- Challenges presented by new business and employment models and more flexible and casual workforces in many countries. These can lead to compromised health and safety and makes it hard to collect performance data through traditional mechanisms.
- The lack of data in some emerging economies and the changing health and safety landscape. Initiatives are being undertaken by a range of civil society, institutional and corporate initiatives to raise standards across global supply chains, build local inspection and insurance capabilities, and to access intelligence from unstructured data.
- The wide-ranging impacts of new technology and analytics, including opportunities for the generation of new products, new sources of data and new forms of analysis, all of which simultaneously present new issues to do with privacy, regulation and where accountability for safety lies.

Finally, the review offers recommendations to the Foundation on how it might make a distinctive difference in developing a 'global safety outlook' that will improve safety outcomes for all. Lloyd's Register Foundation can:

- Convene leaders who contributed to this research and those developing new approaches to understanding global safety data and performance.
- Use existing data sources to identify and communicate global safety priorities.
- Identify opportunities to continuously improve and enrich available safety data and intelligence.
- Identify which evidence-based interventions and research can be made by Lloyd's Register Foundation, in collaboration with others, to improve world safety outcomes.
- Make global safety analysis and data accessible for public use.
- Scope education and development programmes for the global community.

Foreword

Lloyd's Register's origins lie in the publication of global safety evidence. The register of shipping was trusted public information on which many stakeholders could make decisions. Decisions that led to the enhanced safety of life and property.

Over 260 years later we live in an age of global data. Yet despite advances in data collection, reporting and analysis there are still large gaps in our knowledge. We are still unsure where and why harm is occurring, and we still lack basic information to inform important safety decisions, with some of the largest data gaps seen in the poorest parts of the world. We need improved data to make better decisions and target valuable resources where they are most needed. Indeed, the UK's Health and Safety Executive has a long history of using data to provide an evidence based approach to both its policy and regulatory activities.

Coupled with these data gaps is the changing nature of the world we live in. Supply chains are increasingly complex and international. Workers move between sectors and countries and a 'job for life' is a thing of the past. Technology increasingly enables different ways of working and will be used more and more to replace workers in hazardous environments. Innovative data collection methods and analytical techniques provide new opportunities for safety and risk insights to help us understand, monitor and prevent harm.

When we set out to examine the current global safety evidence base we anticipated a complex and varied data landscape. However this foresight review points beyond the data to the changing way in which decisions are made, the needs of the community for predictive indicators to prevent harm and not just record it, the maturing understanding and impetus to improve health outcomes alongside safety, and the opportunities new technologies bring. The review provides Lloyd's Register Foundation with the starting point in developing a resource for all: a global safety outlook for a safer future.

Professor Richard Clegg
Foundation Chief Executive
Lloyd's Register Foundation

Professor Andrew Curran
Chief Scientific Adviser and
Director of Research for the
Health and Safety Executive, HMG


INDIAN
OCEAN

Background

This report is one in a series of foresight reviews commissioned by Lloyd's Register Foundation. It examines global safety knowledge, analytics and data, the availability of such data, and the ways in which these are used. It summarises trends in such data collection, analysis and use with a view to making recommendations to the Foundation on how it can make a distinctive difference.

This review examines global safety knowledge, analytics and data, the availability of such data, and the ways in which these are used.

It furthers the Foundation's strategic goal to promote safety and public understanding of risk and supports a goal set out in the Foundation's five year plan to develop a global evidence base for safety.

Lloyd's Register Foundation is a charity and owner of Lloyd's Register Group Limited (LR). LR is a 258-year old organisation providing independent assurance and expert advice to companies operating high-risk, capitally intensive assets primarily in the energy, maritime and transportation sectors. It also serves a wide range of sectors with distributed assets and complex supply chains such as the food, healthcare, automotive and manufacturing sectors.

Building on the findings of this review, the Foundation will establish a capability to serve society's changing needs for safety evidence. It will convene and support shared learning among international partners and foster innovation in data sourcing and analysis.

The Foundation is a charity with a global role. Reflecting this the review drew on expert opinion from an international group of data experts, statisticians and end users.

Contributors

Lead contributors

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Interviewees

We are grateful to the following individuals who shared their experience and insight as part of the research process. Interviews were conducted under Chatham House rules and so while a spectrum of opinions is reflected within the report, none are directly attributable.

Isidora Díaz Heredia
Group Head of Health & Safety
Management Systems, LafargeHolcim

John Elkington
Chair and Founder
SustainAbility and Volans Ventures

Laura Espinach
Standards Manager
Global Reporting Initiative

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Labour Inspection and Occupational
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UK Health and Safety Executive

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Review workshop

The following participated in a workshop to review the findings of the research.

Ruth Boumphrey
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Lloyd's Register Foundation

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Lloyd's Register Foundation

Yasmin Crowther
Head of Strategic Research
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Michelle Davies
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James Lawn
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Nial McCollam
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James Pomeroy
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Jan Przydatek
Associate Director of Programmes
Lloyd's Register Foundation

Steven Reece
The Alan Turing Institute and Oxford
University

Michael Wetherell
Director of Operations
Lloyd's Register Foundation

Introduction, objectives and approach

At an individual level nothing is more important or emotive than our safety; our ability to keep ourselves and our loved ones well and out of harms way.

We need good data and intelligence on what causes harm, at a global, national, community, industry and individual level, to learn from safety failures and improve in the future. Excellent data is essential to continuous improvement as each instance of safety failure is an opportunity for maximum learning to prevent future harm.

In the future there will be many new sources and forms of data, and technology's ability to interrogate and visualise that data to find meaning in the noise will also be greater than ever before. This will enable better and more timely decisions, interventions and investments. It will put more accessible and holistic data about safety performance, safety risk and safety accountabilities in the hands of citizens and communities, employers and employees, regulators and governments globally.

New forms of artificial intelligence and natural language processing will be able to analyse perceptions of safety concerns at scale and identify safety performance drivers and data. This will help enhance communication, education, policy development, decision-making and regulation, and improve safety.

At an individual level nothing is more important or emotive than our safety; our ability to keep ourselves and our loved ones well and out of harms way.

Objectives

Lloyd's Register Foundation set a goal to establish a global safety evidence base (box 1 overleaf) founded on a review of existing global safety knowledge, analytics and data. The review is intended to identify both trusted safety data sources as well as gaps in data availability. This review of knowledge, data and intelligence regarding global safety will inform Lloyd's Register Foundation's next steps towards a global safety evidence base.

In considering global safety, the starting point for this review was safety in the workplace.

The approach

The research for this foresight review followed a phased approach, illustrated in figure 1.

- Phase 0: The starting intent of the review was to identify available safety data but recognising that data underpins decisions it was decided to extend the work to:
  (i) understand the wider context of how safety data is currently used and its limitations when it comes to appraising global safety;
  (ii) establish the ways in which rapid advances in new technology are changing the availability of safety data; and,
  (iii) assess the opportunities and challenges in establishing a global safety outlook.
- Phase 1: A variety of different stakeholders were identified, including data holders, safety practitioners and users of safety data, as well as technology providers seeking to develop new approaches to safety intelligence.
- Phase 2: Interviews were undertaken alongside wide-ranging desk research on current and emerging approaches to providing data on global safety.
- Phase 3: An unstructured data safety prototype was developed to test what types of insight into global safety could be revealed from unstructured data, to appraise strengths and limitations compared to traditional approaches.
- Phase 4: The results were synthesised into case studies, interview insights and preliminary conclusions and recommendations.
- Phase 5: The initial draft review was tested through consultation and with Lloyd's Register Foundation.

The review

The following chapters present the finding in two distinctive parts.

The first gives examples of existing global datasets and how they are used. It considers gaps in current data provision, the strengths and weaknesses of a range of datasets and considers how such gaps could be filled.

The second provides insights looking ahead to how data systems and the way they are used may evolve in the future.

Finally the review makes recommendations to the Foundation about how it can play a distinctive role in moving towards this future, supporting the collection and use of meaningful data towards a safer world.

Goal 1 Global safety evidence base

We will undertake and publish a foresight review on global safety knowledge, analytics and data, aimed at identifying where trusted safety data is available around the world and where there are gaps to be filled.

We anticipate a need for a global analytics capability. This will explore, compile and publish the authoritative independent evidence base underpinning global understanding of risks and safety in the sectors we serve. It will identify patterns and trends analysed in different ways such as by sector, technology and geography.

We envisage the output will be used worldwide by industry, governments, policy makers, researchers and the financial, insurance and risk industries. By 2021 we will have defined and established this capability and produced initial datasets to underpin the Foundation's own decisions and support the activities of others seeking to improve safety of life and property.

Box 1: Extract from Lloyd's Register Foundation: Five Year Plan (2016-2021)[1]

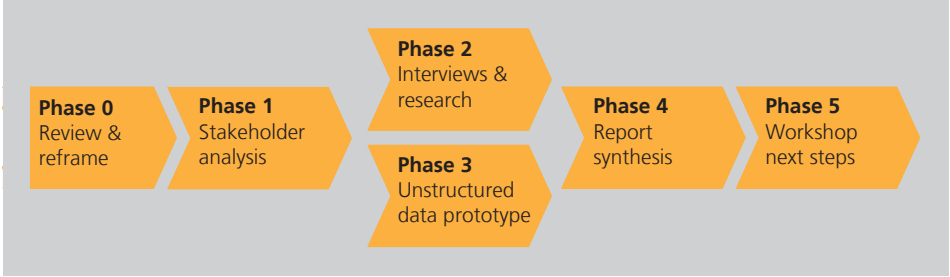


Figure 1: Approach to research

Safety data in practice: case studies

This section looks at a selection of data-based approaches to mapping and understanding aspects of global safety that emerged from the research.

Regulators, institutions, labour bodies, insurers, underwriters, businesses, standards setters and data analytics firms all have different needs and approaches. There are a wide range of challenges to reporting health and safety performance at company, sector, country, demographic and global level.

A reinsurer's perspective

Swiss Re's online data visualisation tool, Sigma[2], provides access to data on global trends regarding insured and uninsured losses arising from man-made and natural catastrophes that lead to loss of property and life. Such models are used to determine or validate occurrences of disaster and help inform pricing for reinsurance policies.

Swiss Re is one of the world's largest reinsurers. Its online 'catastrophe database', Sigma, provides data on a subset of catastrophes comprised of the 20 largest events for each year as defined by the number of victims, value of insured losses or total losses. The results provide a useful indicator of global trends over time.

Figures 2-4 are visualisations taken from Sigma in August 2017. Overall, the visualisations tell us that from 1970 to 2016:

- natural disasters have outpaced man-made disasters since 2010 (figure 2); see box 2 overleaf for how Sigma defines man-made and natural catastrophes.
- the worst natural disasters create many more victims than man-made disasters (figure 3), and
- the costs (insured and uninsured) of natural disasters far outstrip those that are man-made (figure 4). However man-made factors such as building design and emergency response play a part in mitigating the impact of a natural catastrophe.

Sigma is powerful in providing insight to trends based on this subset but it does not give a complete picture. The frequency, distribution and impact of many smaller scale catastrophes or near-misses may yield different valuable insights to sectors and countries that are not available in the publicly available Sigma data.

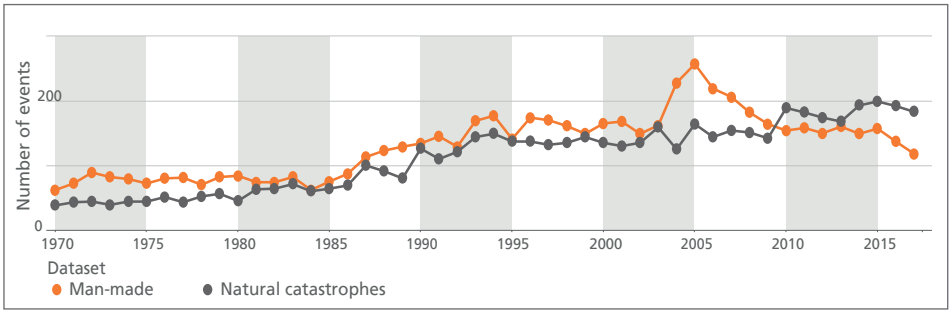


Figure 2: Sigma - Number of man-made and natural catastrophe events (1970-2016)*

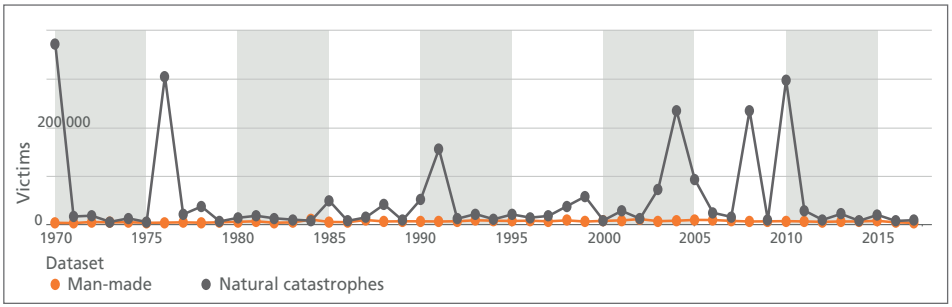


Figure 3: Sigma - Number of victims of man-made and natural catastrophe events (1970-2016)*

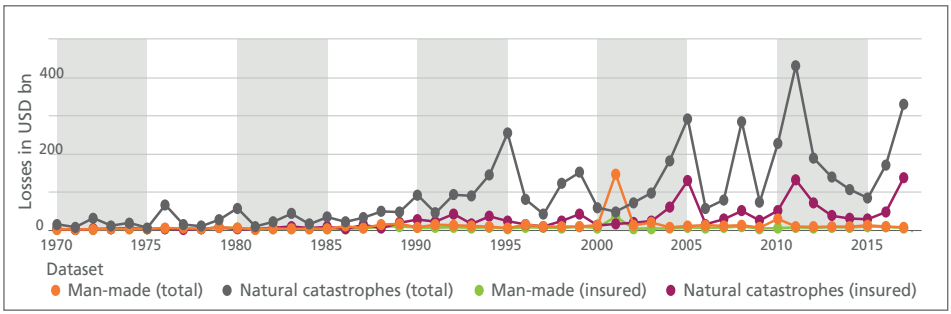


Figure 4: Sigma - Total v insured losses arising from man-made and natural catastrophe events (1970-2016) *Source: Swiss Re Institute

- Man-made disasters: Major events associated with human activities are categorised as 'man-made' or 'technical' disasters. Generally, a large object in a very limited space is affected, which is covered by a small number of insurance policies. War, civil war, and war-like events are excluded. Sigma subdivides man-made disasters into the following categories: major fires and explosions, aviation and space disasters, shipping disasters, rail disasters, mining accidents, collapse of buildings/bridges, and miscellaneous (including terrorism).
- Natural catastrophes: The term 'natural catastrophe' refers to an event caused by natural forces. Such an event generally results in a large number of individual losses involving many insurance policies. The scale of the losses resulting from a catastrophe depends not only on the severity of the natural forces concerned, but also on man-made factors, such as building design or the efficiency of disaster control in the afflicted region. In Sigma, natural catastrophes are subdivided into the following categories: floods, storms, earthquakes, droughts/forest fires/heat waves, cold waves/frost, hail, tsunamis, and other natural catastrophes.

Box 2: Sigma definition of man-made and natural catastrophes

United Nation's perspectives

UN agencies like the World Health Organization and International Labour Organization collect and publish data on numbers and causes of death and injury globally. Such statistics have long been a key measure by which the world has understood health and safety – in other words, how good or bad are we at keeping people alive and well, in different parts of the world.

The ILO and WHO compile data from diverse sources, much of it submitted to them by governments and national statistics offices.

The World Health Organization

World Health Organization (WHO) databases include:

- The Global Health Observatory[3] is WHO's portal providing access to data and analyses for monitoring global health. It provides key data and analyses for over 30 health themes ranging from health systems to specific diseases. It also gives access to its full database.
- Global Health Estimates[4] provides a comprehensive and comparable assessment of mortality and loss of health due to diseases, injuries and risk factors. It provides global, regional and country estimates for all causes of mortality, and deaths and disability adjusted life years by age, sex and cause.
- The WHO Mortality Database[5] holds annual death registration data on causes of death by age and sex as reported from civil registration systems in over 100 member states.

In 2015[6], WHO estimated there were 56.4 million deaths worldwide. WHO attributes one in four of these deaths to living or working in an unhealthy environment[7]. Pollution, chemical exposures, climate change and ultra-violet radiation reportedly contribute to over 100 types of disease and injury. Non-communicable diseases like stroke, heart disease, cancers and chronic respiratory disease account for nearly two-thirds of deaths due to unhealthy environments. However infectious diseases like diarrhoea and malaria are declining as access to safe water, sanitation and immunisation improves. Unintentional injuries such as road traffic accidents and intentional injuries like suicide account for around 2 million deaths

each year. In 2015, road injuries claimed 1.3 million lives, 76% of victims being men or boys. When this data is reflected in a WHO map in terms of implications for life expectancy, the divide between the developed world and emerging economies is clear, (see figure 5[8]) .

A second WHO map (figure 6[9]) reveals the challenges regarding the completeness of data available on life expectancy and causes of death in many parts of the world. As the map shows, India, China, Asia, much of the Middle East and Africa have very incomplete civil registration of causes of death, which raises questions about how data from those countries informs understanding of life expectancy.

WHO provides periodic wide-ranging data on the diseases, injuries, loss of health and causes of death globally, along with assessments of the availability of such data in different parts of the world. It provides high level insights but does not typically link deaths or diseases to specific sectors or workplaces.

Interviewees for this report discussed the challenges of linking illness and death, particularly due to chronic diseases, to workplace exposure earlier on in life and many consider this to be an under-reported area. Other interviewees pointed to potential 'big data analytics' solutions, such as the ability to survey obituaries at scale for both causes of death and previous employment history.

The International Labour Organization

International Labour Organization (ILO) databases include:

- ILOSTAT[10] which provides recent labour data for over 165 indicators in over 100 economies.
- Labour Force Surveys[11] comprises links to websites with data from national statistical agencies all around the world.

The ILO[12] publishes a wide range of statistics (see box 3 overleaf) on the vulnerability of workers around the world to illness, injury or death due to poor safety at work, for example as a result of accidents and workplace exposures as well as forced labour, child labour and modern slavery.

The ILO brings together government, employers and worker representatives from 187 member states to set labour standards, develop policies and devise programmes to promote decent work for all women and men. It has collected statistics on occupational injuries for

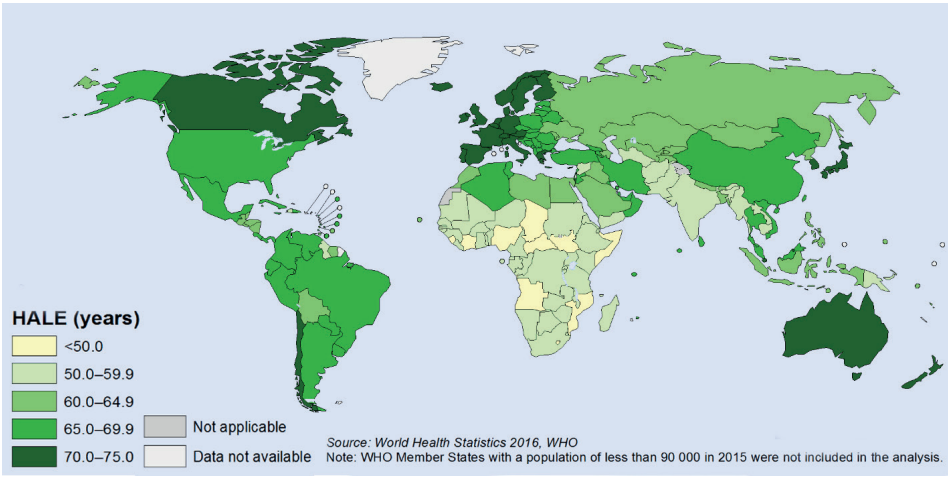


Figure 5: WHO healthy life expectancy at birth (2015)[8] (Copyright WHO 2016)

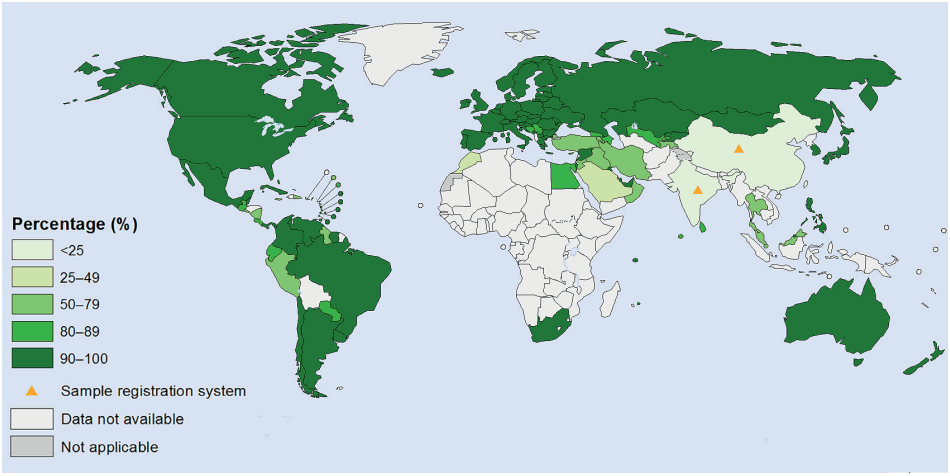


Figure 6: Civil registration coverage of causes of death (%) (2005-11)[9] (Copyright WHO 2016)

publication in the Yearbook of Labour Statistics since 1941, requesting countries to provide data in accordance with the most recent international recommendations on the subject[13].

Its recent estimates are that over 2.3 million deaths each year are caused by occupational accidents or work-related diseases, with around 2 million being associated with health issues as opposed to injury, all of which impose a total annual economic burden of some 4% of global GDP[14]. This excludes the 12,000 or more children who are estimated to die each year working in hazardous conditions. UNICEF estimates that 150 million children worldwide are engaged in child labour, with 1 in 4 engaged in work that is harmful to their health in the world's poorest countries[15].

- Every 15 seconds, 153 workers have a work-related accident and a worker dies from a work-related accident or disease.
- Every day, 6,300 people die as a result of occupational accidents or work-related diseases: more than 2.3 million deaths per year.
- 317 million accidents occur on the job annually, many leading to extended absence.
- The majority of fatalities – some 2 million – are associated with health issues, as opposed to injuries.
- The Institute of Occupational Safety and Health (IOSH) estimates that the biggest killer is cancer, with 742,000 deaths a year related to workplace exposures[16] (estimated by the ILO to cause over 30% of deaths in 2000) followed by circulatory diseases, then accidents (19%) and communicable diseases (17%). Asbestos alone takes over 100,000 lives annually.
- Agriculture, in which more than half of the world's workers are employed, claims more than 50% of occupational fatalities, injuries and diseases.
- A particularly heavy toll of dead and injured occurs in developing countries where large numbers of workers are concentrated in primary and extraction activities such as agriculture, logging, fishing and mining – some of the world's most hazardous industries.
- The human cost is vast and the economic burden is estimated at 4% of global GDP each year.
- 12,000 or more children die each year working in hazardous conditions.

Box 3: ILO statistics on workplace fatalities, illness and injury[17]

In summary, ILO provides comprehensive data on workplace health and safety collated from countries around the world and linked to sectors. Its prime focus is lagging indicators of death and injury, published periodically, although it is collaborating widely on the thinking and development of leading indicators. ILO is dependent on governments to submit relevant data and so has a close interest in the quality of the notification and recording systems of different countries and has encouraged a 'confidence-led' key performance indicator (KPI), that will require countries to provide a measure of their confidence in their data collection and results, as part of the UN Sustainable Development Goal linked to labour standards.

Country analysis: the UL Safety Index

The UL Safety Index[18] is published online and is interrogated via an interactive map or via the index ranking of 187 countries. The results draw on data from the World Bank, World Economic Forum, UN Development Programme, Consumers International and Institute for Health Metrics and Evaluation, as well as UL's own data.

Underwriters Laboratories Inc (UL) is an American non-profit safety consulting, standards and certification company headquartered in Illinois, with offices in 46 countries. It released the UL Safety Index in September 2016, based on the most current data at that time from 2013. This was updated to 2015 data during 2017. The Index was created in response to UL's desire to appraise where its work could make the greatest contribution to safety, particularly when having to choose between projects such as working to help tackle road safety in India or developing a safety framework for Myanmar to enable it to become a credible manufacturing destination.

The UL Safety Index works to quantify the relative state of safety in 187 countries, with 0 representing the lowest level of safety and 100 representing the highest (see figure 7). Based on current data, Netherlands (95) and Norway (94) secure the highest scores, with South Sudan (19) and Somalia (16) at the bottom.

The Index is compiled based on metrics that score the national resources, institutions, safety systems and frameworks against specific safety outcomes related to unintentional injury, such as road traffic accidents, drowning, falls, fire, and exposure to the forces of nature. The Index currently explicitly excludes safety data related to crime, suicide or war (instances of intentional injury) as well as disease, economic loss and environmental damage, and is supported by an extensive outline of the underpinning methodology[19]. Table 1 shows the data and types of indicator that the Index brings together.

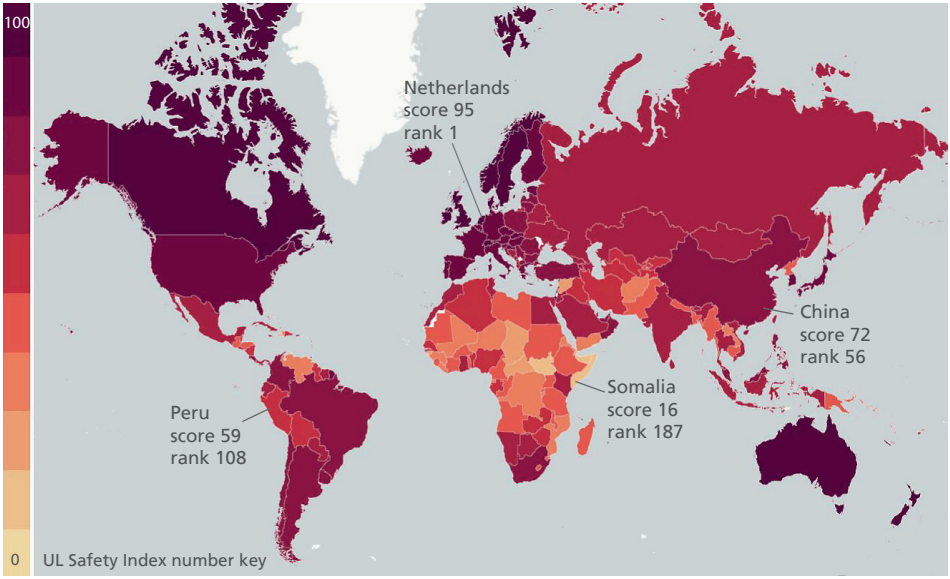


Figure 7: Data visualisation of the UL Safety Index, 2017

The UL Safety Index integrates different types of data to provide a more complete assessment of the safety profile of different countries than could be established from any single data source alone. It does not currently aggregate the results into a workplace or industry index. Data related to safety outcomes are currently based on available lagging indicators to do with injuries and fatalities, but may evolve to give more attention to leading indicators. Because of the need to incorporate diverse datasets that are published at different times, not all the data is always fully up to date and could possibly be several years old.

Driver	Indicator	Data source
Institutions and resources	Wealth	World Bank
	Education	UN Development Programme
	Government effectiveness	World Bank
	Technology	World Economic Forum
Safety frameworks	Codes and standards	UL
	Consumer protections	Consumers International
	Labour protections	UL
Safety outcomes	Transport injuries	Institute for Health Metrics and Evaluation
	Falls	
	Drowning	
	Fires, heat and hot substances	
	Poisoning	
	Exposure to mechanical forces	
	Injuries due to foreign bodies	
	Exposure to forces of nature	
	Other unintentional injury	

Table 1: Data and types of indicator used in the UL Safety Index

A regulatory view: UK's Health and Safety Executive

The Health and Safety Executive (HSE) maintains an online database of health and safety workplace statistics[20] (see figure 8), which includes information on European comparisons.

Eurostat[21] is the key resource for accessing data about European countries. Unlike most European countries, HSE data excludes road traffic accidents, while Eurostat publishes data that both includes and excludes such accidents. Eurostat data is constantly updated which sometimes makes it difficult to replicate results over time. Additional data is available at the European Foundation for the Improvement of Living and Working Conditions website[22] and the European Agency for Safety and Health at Work[23].

Different countries typically have multiple departments looking after different aspects of safety. For instance in the UK, the Department of Transport holds data on road traffic accidents, while the HSE looks at work-related fatalities, which exclude road traffic accidents, fatalities to workers travelling by air or sea, fatal injuries due to natural causes, suicides, accidents to members of the armed forces, and members of the public killed due to intentional injury or physical violence. The Office of National Statistics holds data on mortality rates and causes of death.

Businesses report their workplace impacts on health and safety to the HSE through the system for Reporting of Injuries, Diseases and Dangerous Occurrences (RIDDOR) (see table 2 overleaf). However there are varying degrees of confidence in the system's coverage. The US also has a system requiring employers of a certain size to log work-related injury and illness and while the system is reportedly robust, there are issues of uncertainty around data being withheld or through ignorance. For instance, there are a number of conditions (such as heart attacks or suicide) where work's contribution may not be entirely clear, or where the impact of work on a chronic disease and fatality may simply not be known.

When it comes to occupational diseases in the UK, Labour Force Surveys are the most comprehensive data source, designed to be representative of a defined population, and complemented by death certificates and medical reports. The latest estimates are of around 13,000 deaths each year from occupational lung disease and cancer due to past exposures to dust or chemicals at work. In 2016/17, some 1.3 million people reportedly suffered illness they believed to be caused or made worse by work, with around 80% being musculoskeletal disorders, or stress, depression or anxiety[24].

There is awareness of the need and value of more joined-up and accessible data and intelligence on the many aspects of health and safety at work, home and in communities. In 2018, the HSE and Lloyd's Register Foundation initiated a programme to consolidate data from different government departments in the UK and overseas. This will allow more interactive visualisations and access to data and trends on the many areas that impact society's safety and well-being, from workplace exposure to transport, food quality, air quality, infectious and non-communicable diseases.

In the UK safety data is collected by various government organisations and departments. The focus is lagging indicators of mortality and injury, published annually. Work is underway to consolidate data from different government departments to allow a more consolidated view.

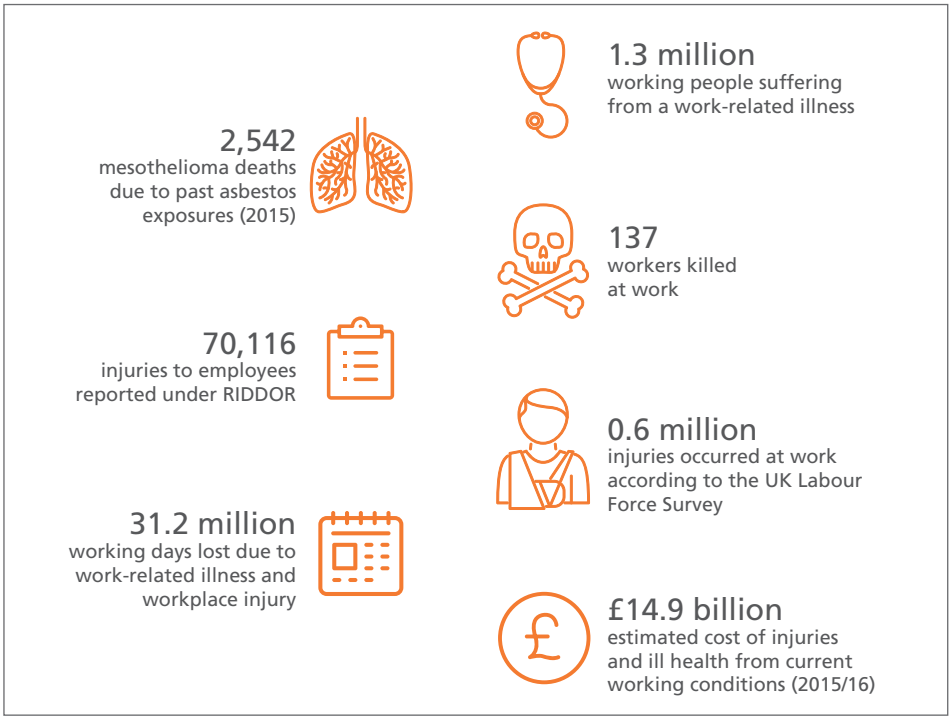


Figure 8: Key HSE statistics for Great Britain 2016/17[25]

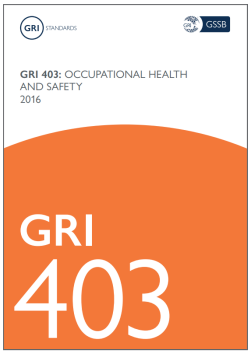
Industry sector	Fatalities
All industry	137
Agriculture, forestry and fishing	27
Mining and quarrying	4
Manufacturing	19
Electricity, gas, steam and air conditioning supply	3
Water supply, sewerage, waste management and remediation activities	14
Construction	30
Wholesale and retail trade; repair of motor vehicles and motorcycles; accommodation and food service activities	12
Transportation and storage	14
Information and communication; financial and insurance activities; administrative and support service activities	8
Public administration and defence; compulsory social security; education; human health and social work activities	6

Table 2: UK RIDDOR statistics for fatal injuries by sector (2016/17)[26]

A business perspective: Global Reporting Initiative

The Global Reporting Initiative (GRI) holds a Sustainability Disclosure Database[27] of corporate sustainability reports, including annual disclosures on health and safety performance. At the start of 2018, the database held over 45,000 reports from over 11,500 organisations, with 65% of reports self-assessed to the GRI Standard. The database is currently searchable by company.

GRI helps businesses and governments worldwide understand and communicate their impact on critical sustainability challenges, such as climate change, human rights, governance and social well-being. The GRI Sustainability Reporting Standards[28] (GRI Standards) are the most widely adopted global standards for sustainability reporting, developed with multi-stakeholder contributions and rooted in the public interest. Thousands of companies currently report their annual sustainability performance, including over 93% of the world's largest 250 enterprises[29].



The Global Sustainability Standards Board, GRI's independent standard setting body, reviews the GRI Standards on a regular basis. The GRI 403: Occupational Health and Safety Standard underwent such a review in 2017-18[30]. The review was led by a multi-stakeholder expert working group, including business, civil society, regulators, labour bodies and others, who raised and addressed a variety of industry wide themes and challenges, including:

- Broad acceptance of a tendency for companies to under-report health and safety data.
- Awareness that traditional lagging indicators of fatalities and injury do not necessarily help drive improvement or better safety outcomes.
- Recognition that individual company approaches to standardising and normalising data have no consistent methodology and so enable little comparative value across businesses, sectors or indeed occasionally within the same company.

The subsequent revisions to the standard paid more attention to leading indicators, such as:

- The value of more specific narrative on safety culture as reflected in management approaches, risk assessment, the hierarchy of controls and accountabilities, and the extent and nature of worker participation and training.
- Greater focus on more proactive assessment and management of health and safety hazards, particularly those with high-potential impacts on the workforce and, where there have been accidents, descriptions of events, lessons learned and how they have been embedded.
- Recommendations of greater attention to worker health promotion through voluntary programmes to address non-work health risks, such as smoking and diet.

Perhaps fundamentally, on the important lagging indicator of work related injury and illness, the standard has been revised to require more emphasis on the actual impacts on workers as opposed to the less tangible measure of lost time or productivity.

While GRI sets a standard and guidance for companies to report health and safety performance, it does not compile or hold data directly. It does hold a database of GRI based reports that contain the annual performance data for health and safety for thousands of companies. Its revised standard will introduce new requirements, going beyond lagging indicators of fatalities and work-related incidents, to include more precise corporate narrative on management approaches, hazard identification and control, and worker participation.

Unstructured data: a prototype country, company and sector safety scorecard

'Unstructured data' is the immense volume of data published online and in social media that holds extensive insight to concerns, events, discussions, influencers and analysis of health and safety issues and performance at global, country, company, sector and indeed individual levels. New technology now enables rapid interrogation and visualisation of unstructured data in multiple languages giving early warning of specific problems, and evidence of systemic fragility across a range of indicators. Such intelligence can support intervention actions, for example by regulators.

At the start of 2017, over half the world's population, some 3.77 billion people, had access to the internet. Of these, 2.8 billion were social media users, a 21% increase on the previous year. Asia-Pacific now has more than half the world's internet users, with the Middle East also growing rapidly. In Africa, only 1 in 3 people reportedly has access to the internet. Europe has seen uptake slow in recent years, with the US having the highest degree of users at 88% of its population[31].

Polecat[32, 33] is a software company specialising in the development of natural language taxonomies and algorithms. These are used to interrogate the growing amounts of unstructured data for specific insights in near real-time and over time. For example Polecat can show how people talk and report on health and safety in different languages. It can identify and aggregate specific associations with particular topics (such as types of disease, injury, illness, labour standards, modern slavery) and specific entities (such as companies, countries or sectors). The results can reveal where there is heightened concern, helping to provide early warnings and benchmark perceived risk exposure.

As part of Polecat's contribution to this review, it developed a prototype Global Safety Scorecard appraising near real-time conversation in unstructured data about 11 KPIs relevant to global safety, as listed in the key to figures 9 and 10 on the next page.

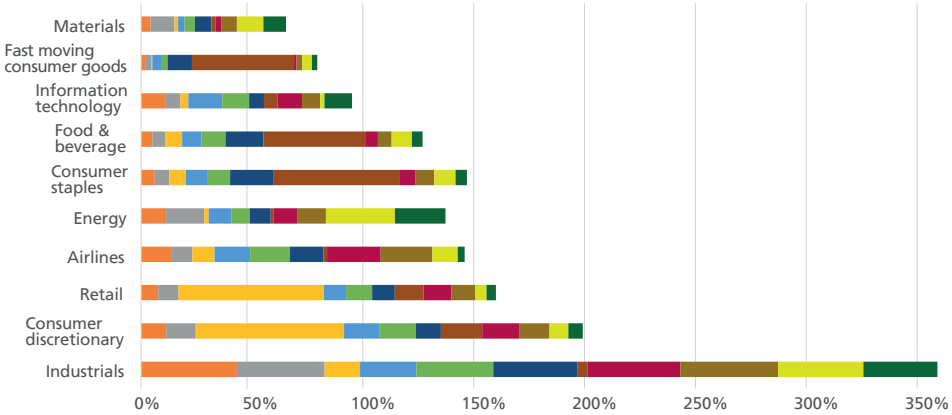


Figure 9: Sectors plotted for conversation share on 11 safety KPIs in English (Feb-Aug 2017)

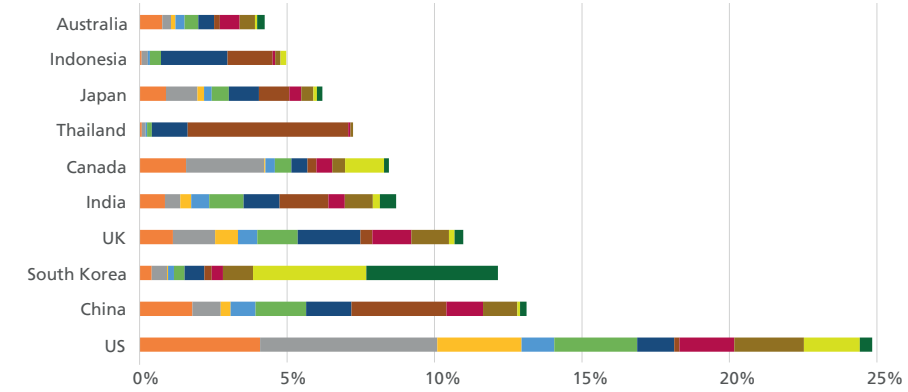


Figure 10: Countries plotted for conversation share on 11 safety KPIs in English (Feb-Aug 2017)

Safety in general
Safety in the workplace
Illness in the workplace
Risk in general
Risk in the workplace
Labour practices
Child labour & modern slavery
Incidents, accidents & investigations
Incidents, accidents & investigations in the workplace
Workplace injuries
Workplace fatalities

The prototype examined conversation in English language, from mid-February to mid-August 2017, scouring over 8 million online publications, including media, regulatory, government, business, NGO, academic and civil society publications, and tens of millions of social media posts each day.

In particular, it looked for conversation related to 7,000 companies around the world, and from that dataset extracted conversation connected to specific sectors and countries. See figures 9 and 10 for the top 10 results respectively.

Because the prototype was applied specifically to the English language, English-speaking countries generate and receive more coverage in the results (future models can add additional languages). Accordingly the United States (figure 10) had the highest score, particularly in regard to indicators linked to safety generally and safety in the workplace. China has a higher score related to the indicator pertaining to child labour and modern slavery practices. South Korea had high indicators in relation to workplace injuries and fatalities.

The Global Safety Scorecard prototype also ranked all sectors, with the industrial sector overall having highest scores over the 180 day period reflecting a median performance across all indicators rather than high exposure against any specific indicator. By contrast, the consumer and retail sectors came second and third respectively, because of high indicators to do with illness in the workplace.

Similar to more traditional labour force surveys there is potential cultural bias regarding how people talk about safety issues and the extent to which attitudes reflect community levels of awareness and understanding. For some countries, as safety awareness improves and culture changes, better engagement on the topic may actually increase the score.

Similarly the ILO has recommended a 'confidence-led KPI' for the UN Sustainable Development Goal for Decent Work[34]. There is an expectation that some countries will see adverse performance measures linked to improved data accuracy.

A key difference between the Polecat prototype and labour force surveys is that the latter is questionnaire-based primary research into a narrow cohort (thousands rather than millions) at one point in time and designed to be representative of a defined population. By contrast unstructured data distils intelligence from many millions and potentially billions of conversations online, offering a near real-time window onto safety activities, concerns and perceptions globally.

Polecat's Global Safety Scorecard prototype currently focuses on all global conversation and does not (yet) distinguish between expert publications and public opinion. It is the only data source that is constantly up-to-date on the events and published analysis defining how safety performance is being understood around the world. It offers high degrees of flexibility, with the ability to focus on specific and different data sources and to add or remove key indicators (or search parameters) driving the data and scorecard. In addition to unstructured data, it could also take on board structured data to enable direct comparisons. As with all data, it requires subject matter experts to read and interpret the results.

Key learning points from the case studies

These case studies illustrate that Lloyd's Register Foundation's development of a global safety evidence base should consider these points:

- Wide ranging variations in data quality and in the reliability of systems generating data at government, sector and company level exist, with some countries lacking any functioning systems for health and safety data collection and disclosure. Producing a consolidated view of such data will be challenging. It will be important to collaborate and encourage confidence-led KPIs to inform data quality, to share good practice and to explore technological solutions.
- Non-safety specific datasets can provide a critical context for safety, such as GDP, existence of regulatory and enforcement frameworks, transparency and the rigour of notification systems, investments in education and health outcomes.
- Industry best practice approaches uses both lagging and leading indicators of health and safety performance, and improved data collection.
- Data on health and how health is managed is currently a focus for many businesses seeking to understand and track leading indicators of safety. The Foundation can play a role in convening and supporting good practice.
- There is a need to capture and understand data from weak signals, near misses and emerging patterns related to safety performance as well as intelligence from a smaller number of high impact, high profile catastrophes.
- There is value in using unstructured data and new analytical techniques to identify a range of health and safety performance indicators. The Foundation can play a leadership role in fostering innovation using new data sources, analytics, and unstructured data, which can be integrated alongside more traditional approaches.
- Subject matter experts are important in interrogating and giving meaning to this increasingly rich and complex data landscape and the insights to be revealed about the safety of the world and the cultural contexts and drivers shaping safety outcomes.

Research insights: the future of safety data?

This chapter draws on the findings of the research and provides insights into how data systems and their uptake may evolve in the future.

Data variability and quality

Every business and country goes about the business of gathering safety data differently.

Legislation and methodologies for collecting and reporting data vary between countries, sectors and even within companies, and so it is notoriously hard to make reliable and meaningful comparisons at any level.

When it comes to fatalities in the workplace, some countries include suicides and homicides and others do not. Some countries are comprised of multiple states and territories and numerous state departments, all with different applications of health and safety law and subsequently different and inconsistent approaches to data collection. Many countries have little or no formal structure to record and collect any data at all.

Labour force surveys are one specific method used by many governments and national statistics offices to engage with a selected cohort of their working population (usually annually) to gather views on a range of issues, including occupational health and safety. Because labour force surveys tend to ask a similar set of questions across different countries, they are regarded as generating useful cross-country and cross-sectoral comparisons. However, because labour force surveys capture the qualitative opinions and responses of individuals, they are notoriously subject to cultural bias. More macho cultures, for instance, may resist discussion of ailments or injuries and the part played by work. For this reason, although the results are highly valued, they are read with appropriate caveats.

This context of data variability and quality is directly informing the ILO's work on the UN Sustainable Development Goal related to Decent Work[34] and has prompted its recommended development of a confidence-led KPI that will require countries to provide a measure of their confidence in their data collection and results. One outcome has been that some countries are expecting to see their performance decline against previous years as their data recording and accuracy improves.

In terms of alternative approaches to the challenge of mapping a global view on safety, the UL Safety Index[35] is an online resource that has been developed by the independent non-profit Underwriters Laboratories (see page 18). The Index works to overcome data variability to quantify the relative state of safety of 187 countries around the world. Focused specifically

on annual outcomes related to unintentional injuries (or example, road traffic accidents, drowning, exposure to forces of nature), the Index provides an assessment of the contribution of national resources, institutions and frameworks to the injury outcomes, and ranks countries accordingly.

Big data solutions are leveraging intelligence in unstructured data – the world of conversation online – to understand concerns that are being articulated about safety in general as well as those associated with types of work, specific companies, disease and injury, certain countries or supply chains, and so on. Where labour force surveys provide a partial view of workers' experiences, big data is working to interrogate and segment global conversation to yield comparably granular results.

Lagging to leading indicators – measuring safety culture

Data about safety performance has traditionally focused on lagging indicators of fatalities, injuries and lost time incidents – the data that comes in the wake of safety failure, and the results of which have tight correlation with insurance premiums and compensation. While this data remains essential, it has not necessarily evolved in response to the questions of: 'what data is most important to occupational health and safety', 'what data provides the best measure of whether or not there is a concerted culture of safety and respect for the value of life.'

As a result, a growing number of businesses and standards bodies are working on developing indicators that give more consideration to the culture, for example the leadership, management systems and framework of accountabilities, that inform how safety is integrated and managed strategically and operationally to deliver improved safety outcomes.

- The Global Reporting Initiative (GRI) (see page 24) is one such independent international standards body that works to help businesses, governments and other institutions assess and report their impact on diverse sustainability topics. Over the course of 2017-18, GRI worked in collaboration with business, trade unions and institutions specifically to better define the enablers and leading indicators of safety performance. The review of its GRI 403: Occupational Health and Safety Standard[30] will introduce new requirements – going beyond lagging indicators of fatalities and work related incidents – to include more precise corporate narrative on management approaches, hazard identification and control, and worker participation.
- A new ISO standard on occupational health and safety[36] (ISO 45001) has been published with a similar focus on the occupational health and safety management systems needed to enable active improvement of performance and prevention of injury and ill health.
- In its approach to a global safety index, Underwriters Laboratories created a methodology to appraise the safety context or culture of each country based on an appraisal of its wealth and resources, the quality of institutions delivering education, effective government and technology, the existence of safety codes and standards, and measures to ensure labour and consumer protection. The UL Safety Index is subject to peer exposure and feedback on an ongoing basis.
- Interrogation of live unstructured data, such as the Polecat prototype, can provide early warning and intelligence on cultural trends and indicators of poor safety performance at a country, company, sector or site level.
- The UK's HSE provides an online safety culture assessment tool[37], which particularly looks to evaluate management commitment and leadership, the effectiveness of communication and employee involvement, training and motivation along with rigorous procedural compliance and a culture of genuine learning and continuous improvement.
- Lloyd's of London published a report in 2017, Reimagining History: Counterfactual Risk Analysis. This emphasised the need for better understanding of 'near misses' to explore 'what if' scenarios that help build better appreciation of potential risk and the mitigating features, and work against potential complacency and bias that may underestimate a hazard because the worst outcome has not historically come to pass[38].

Case study: The link between financial pressure and injuries
A recent Harvard University study[39] investigated the potential correlation between companies in the US that are struggling financially and injury rates. It found that injury / illness rates are 5%-15% higher in periods when a firm only just meets or beats analyst forecasts.

"When managers believe their company may be close to missing earnings benchmarks, they may increase employees' workloads by pressuring them to work faster or for longer hours. In addition, employees may compromise their own safety by overexerting themselves or ignoring safety protocols that slow workflows. All of these behaviours can undermine worker safety."

The study also found that industries with high unionisation reported over 6% lower injury rates than industries with low unionisation, attributed to the role unions play in ensuring account is taken of employees' safety concerns. In addition US states with high worker compensation premiums had a nearly 5% lower injury rate, ie where injuries are more costly, managers are more diligent.

Role of health management in safety outcomes

As the focus develops from lagging to leading indicators of safety, the relationship between health and wellbeing – and how they are managed – to safety is also being explored.

Traditional approaches to risk assessment have tended to assume that all people involved in a work activity are broadly 'the same'. However individual physical and mental health will impact the effectiveness of safety measures identified in a typical risk assessment (for example, impaired cognitive and reasoning abilities due to mental health challenges or a reduction in physical responsiveness due to musculoskeletal issues). NIOSH's Total Worker Health[40] approach seeks to assess safety controls alongside the capability and capacity of the worker.

Organisations, like GRI (as part of the update to its occupational health and safety standard, in collaboration with businesses, labour organisations and others) have recommended a new disclosure on worker health promotion, looking at whether workers have access to voluntary programmes to address non-work-related health risks, such as smoking or unhealthy diet. Singapore is frequently cited as a location where businesses are piloting innovative technology, like Fitbit, to collect biodata to help assess employee health and shape incentives to encourage healthier living[41].

The case for improved productivity and cost savings from a healthier workforce – who suffer less illness and are more resilient to injury – is clearly a strong business driver. However, while fostering a healthy workforce is naturally welcomed by many as positive, there are critical privacy concerns regarding the use and protection of personal data. This is particularly the case where wearable tech and innovative technologies are involved and where data is being recorded as part of wellness programmes that could then inform insurance and compensation premiums.

Trade unions and labour bodies are especially alert to the potential 'slippery slope' from wellness programmes to decisions about employees based on company-held data about physical and mental traits. The argument is that employers must do their utmost to protect and ensure safe working conditions for all workers, regardless of data held on individual traits.

These issues play into a broader debate about where the balance of responsibility for managing health and safety lies between the individual, employer and society at large. Some postulate a shift from the costly prevention and promotion of health being largely under the control of governments to more personalised prevention through insurance encouraged by employers. Whatever form the future takes, strong regulation with appropriate checks and balances will be key.

Case study: Germanwings plane crash

Mental health was identified by many interviewees as a particularly sensitive area. The incident of the Germanwings pilot, Andreas Lubitz, who committed suicide by crashing a plane into the French Alps in March 2015, killing 144 passengers and six crew, was cited several times as an example where warning signs of depression and suicide risk – including a doctor's note declaring Lubitz unfit to work – should have been identified, but were withheld from the company by the pilot.

While there is wide appreciation of the multiple potential causes of mental distress (work and non-work related), there is also acute awareness of the potentially serious implications for an individual's ability to work, particularly in high risk jobs. Annual medical checks for individuals working in such roles and aptitude and behavioural appraisals are not unusual.

The Germanwings tragedy prompted interviewees to reflect on a range of questions related to the challenges of managing mental health within occupational health and safety frameworks. Whether it may be possible to develop real-time measures to identify people at a particular time who are more prone to risky behaviour; the degree to which sensitive personal data can be anonymised but still serve as a precursor to predict and prevent potential issues and tragedies; and the workplace changes that need to take place to reflect society's growing understanding of mental health and enable more supportive cultures and employment contracts.

Under-reporting of chronic disease associated with workplace exposure

The WHO estimates that 1 in 4 deaths globally are associated with exposure to an unhealthy environment in the workplace, home or community. In the UK, HSE statistics show that ill health in the workplace outstrips injuries, with a greater number of cases, days lost and higher costs. In 2016/17, 1.3 million workers suffered from work-related new or existing ill health in the UK as compared to 609,000 injuries in the same time frame[25].

However, an area where medical and technical advances have not (yet) yielded more precise data is the link between workplace exposure and non-communicable and chronic diseases that may lead to death, on many occasions long after an employee has left the workforce. While acute health impacts – such as chemical poisoning or dermatitis – are often more easily defined and reported as workplace events, this is not always the case for chronic ailments such as asbestosis or cardiovascular disease, where there is recognition of substantial under-reporting. This is seen to be as much a medical as a workplace challenge, with doctors sometimes not connecting a chronic illness back to a workplace exposure and so not reflecting the potential link in medical records or on death certificate data, a key input to illness fatality statistics in many countries.

The challenge of under-reporting also relates to progress in epidemiology and advances in knowledge about hazardous exposure over time. Some workers who may have operated in an unmonitored environment years ago might find that the same environment today is now subject to careful monitoring and recording of exposures. Additionally, it is unusual for exposure data associated with an employee to be portable; should that employee move to another company, the data typically stays with the original employer, making the cumulative exposures for an individual over a life time of work harder to trace. One exception, and proof point to the contrary, is the nuclear industry.

While advances in wearable tech and personal health data do raise important privacy concerns, the potential for wearable tech to record more sophisticated individual exposures over time brings potential benefit with regard to better understanding levels of exposure and linkages with disease. Workers in high hazard environments have long been used to wearing protective equipment, bodycams, heat and vibration sensors, as well as location monitors. General unspecific use of such monitoring technology raises more concerns compared to gathering such intelligence about specific roles and environments where there is mutual benefit to improving understanding of exposure and risk.

Unstructured data also offers a potential new seam of intelligence on the link between chronic disease and employment through its ability to review, for instance, all published obituaries that typically record name, cause of death and employment history. Natural language algorithms mean that millions of obituaries can be interrogated for associations and patterns between diseases, companies, time periods and life spans to yield a potential new source of statistical intelligence for regulators, business and actuaries alike.

Safety challenges arising from the casualisation of work

The rise of more flexible workforces with short term and freelance workers presents new complexities and challenges to monitoring, understanding and managing health and safety.

In the UK, a report by Frank Field MP and senior parliamentary researcher Andrew Forsey, captured the following testimony from a driver: "I have been fined over £400 for being too sick to get to work for just one day and once had to pay for a company employee's overtime to come out on [the] route with me whilst I sat next to him with a bucket in case I was sick."[42]

While the rise of mobile technology and global uptake of smartphones has enabled new business models to offer flexible work to an army of independent contractors, it has all come at the price of failing to provide any of the health and safety provisions of established employment law. This is leading to government and legal scrutiny of the new business models, the potential misclassification and abuse of workers by employers, and the need for changes to regulation. Some recent employment tribunals have already redefined independent contractors as workers entitled to limited rights, although in some cases these are currently subject to appeal.

One of the challenges of this new form of highly distributed and informalised work force is the inability of regulators, prosecutors or others to easily identify workers involved through usual mechanisms, prompting alternative approaches, such as leveraging social media as a source of intelligence and to collect data. In the same way that new technologies inspired new business models, they also empower individuals to record and communicate individual experiences for publication online, creating a new type of database, where data is unstructured but can be accessed and analysed by new technology and software.

Labour practices, emerging economies and global supply chains

While national regulators collect data on the health and safety footprint within their specific countries, many emerging economies struggle to do so. In these countries there are competing priorities and only immature or non-existent structures to regulate, source and manage meaningful data and statistics.

However, many of today's largest businesses are global, with an economic presence and reach that outstrips many individual countries. In a list published by the World Economic Forum in 2016, of the world's top 100 global economic entities 69 were companies but only 31 were countries[43]. The ability of the world's leading brands to drive good practice throughout their global supply chains – especially with regard to health and safety – has become a key reputational issue and brand differentiator, particularly and precisely when it comes to performance in parts of the world where there is weak governance and regulation.

In 2016, the ILO and G7 initiated the Vision Zero Fund[44], with the explicit aim to prevent deaths, injuries and disease in global supply chains by improving occupational safety and health practices and conditions in key sectors and also by strengthening institutional frameworks, such as labour inspectorates and employment injury insurance schemes, in key supplier countries.

Certain industries, such as mining and garment manufacturing, have received more scrutiny than others. Several interviewees observed that even when tragedy leads to greater scrutiny, such as in the wake of Bangladesh's Rana Plaza disaster in 2013, tackling engrained supplier cultures and government indifference to certain poor practices can still be profoundly challenging even for some of the world's wealthiest and most influential brands and investors. The Accord on Fire and Building Safety in Bangladesh[45] arose in direct response to the Rana Plaza disaster and provides some valuable examples of work-in-progress to tackle such challenges.

UL's global safety index has found a direct correlation between the development status of a country and its safety performance, with repressive governments scoring particularly poorly. Countries where enforcement of regulations are vulnerable to bribery and corruption also perform less well.

In countries where governance and data on safety performance is minimal and where annual supplier monitoring is insufficient to ensure compliance, unstructured data is increasingly being used by companies, NGOs and investigative media to identify the locations, commodities, suppliers and companies engaged in unsafe and illegal practices. Earlier this year Thomson Reuters Foundation[46] published research from data intelligence firm, Polecat[32], whose platform interrogated unstructured data to reveal tea, coffee, coal, sugar, coal and tobacco as the sectors most likely to be associated with modern slavery practices and conditions.

Case study: Rana Plaza disaster and Bangladesh Accord

The Rana Plaza disaster in April 2013 saw 1,129 deaths and 2,500 injured when a garment factory collapsed in the Dhaka District of Bangladesh. Many of the factory's products were destined for western retailers, who saw a consumer backlash in the wake of the tragedy.

The Bangladesh Accord was developed in response as a five year legally binding agreement between global brands, retailers and trade unions to build a safer and healthier Bangladeshi garment industry. The Accord makes provision for the independent inspection of factories, public disclosure of the findings and recommendations, provision of funds to enable remediation, designation of health and safety committees within factories, and the empowerment and training of workers to participate and understand their right to refuse unsafe work.

Some of the challenges in implementing the Accord have arisen precisely because of very poor data availability – there is little knowledge about the workers, who themselves possess minimal formal identification, some not even knowing their date of

birth. Factory audits frequently found premises to be constantly sub-standard with poor lighting and broken machines contributing to ongoing low-level injuries, with poor ventilation exposing workers to breathing in fibres and chemical exposure from the dyes, whose long term impacts are neither known or monitored.

The dearth of data about employees and their well-being means that it is very hard to appraise risk and raise investment funds to improve working conditions. Some retailers are looking at impact investing, with funds expected to generate returns on investment based on low cost loans to factory owners who are willing to be assessed and audited to identify investment priorities to improve operating performance and enhance quality controls.

As the five-year anniversary of the disaster approaches in 2018, there are calls for the five year legally binding agreement to be extended.

Emerging issues

The majority of interviews that informed this report reflected a sense that the landscape of data collection, how safety of life and property is reported and understood, is undergoing rapid change. This has implications for governments, regulators, business and indeed across civil society. A wide range of emerging issues were discussed:

- Seismic changes regarding the very nature of work and trends towards increased casualisation of labour, and the rise of micro-manufacturing heralded by 3-D printers, bring a host of new health exposure and safety challenges.
- The implications of medical advances for insurance and compensation, pose questions: 'How does what you're exposed to at the age of 20 impact your life at 80 and, as we understand that better, where will liability lie for past or future life styles?' 'What does health insurance mean given the medical sector's ever-increasing insight and the significance for defining pre-existing conditions?' 'Who will be responsible for the health impacts of working in a city with sub-standard air quality, where you may be exposed to breathing high levels of pollution as you commute each day?'
- The future of transport, particularly in the context of more people reportedly dying on the way to work than at work. New business models were identified, such as the Israeli company Nexar[47], which uses dashcams to record driver behaviour that indicates a potential hazard (such as hard brakes) and aggregates the intelligence to identify and communicate hazard hot spots across its network as well as using its data and footage to support insurance claims. Such innovation may be very disruptive in the transport sector.

- The advent of autonomous cars and their significance for health and safety prompted much reflection on the trend from individual to more systemic safety risk. A key benefit of autonomous cars is to remove human error from the traffic equation and reduce the likelihood of accidents, but there is then the question of a wider systems failure through hacking, sabotage or simple failure that could then lead to a catastrophic scale of accident, albeit less probable.
- Discussion of autonomous cars also prompted discussion about the significance of commercial relationships with algorithm providers and the potential consumer expectation that such a commercial arrangement might mean that – in the event of a potential accident – the consumer's life is safe-guarded above perhaps a pedestrian crossing into the road. Such a commercial proposition is not seen as likely to be acceptable to society and so the role of regulation will be key. Related to this is the likelihood of growing regulatory scrutiny of how certain types of computer code are assured and whether due consideration is being given to safety and other critical factors.
- The increased digitisation and interconnectivity of our society, via the so-called internet of things or the industrial internet, means that we will have more intelligence than ever before on the interconnection of a whole host of variables – from air quality at certain traffic junctions at certain times to the quality of food in our fridge at a certain temperature and how all of this impacts our physical and mental wellness via indicators that we can see at a glance on the gadget on our wrist.

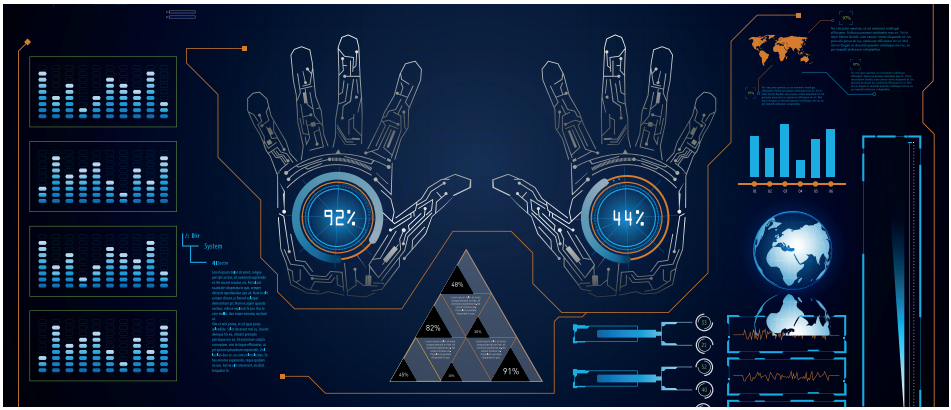
The challenges and opportunities to be unlocked by a new world of technology and data are perhaps greater today than at any other time in history.

Key learning points

Lloyd's Register Foundation's development of a global safety outlook needs to be informed by:

- The varying quality and many different quantitative and qualitative approaches to data collection around the world – both in relation to traditional approaches of data collection as well as new analytics and big data approaches.
- Increased attention to leading indicators of safety performance and safety culture. Examples of such leading indicators include: the presence of regulatory frameworks; the rigour of notification systems; wider education and healthcare contexts; and safety performance and culture in the workplace.
- Better understanding of health considerations. How they influence safety outcomes and how they can be managed in the workplace in particular. Such considerations include technology enabled health and lifestyle data and the associated issues of personal data privacy.
- Concerns regarding the widely acknowledged gap in data and understanding of the link between chronic diseases and workplace exposure. New technologies can support monitoring of exposure to a range of hazards. Advanced analytics, alongside unstructured data can help unlock historic insights to workplace exposure and causes of death.
- Challenges presented by new business and employment models and more flexible and casual workforces in many countries. These can lead to compromised health and safety and makes it hard to collect performance data through traditional mechanisms.
- The lack of data in some emerging economies and the changing health and safety landscape. Initiatives are being undertaken by a range of civil society, institutional and corporate initiatives to raise standards across global supply chains, build local inspection and insurance capabilities, and to access intelligence from unstructured data.
- The wide-ranging impacts of new technology and analytics, including opportunities for the generation of new products, new sources of data and new forms of analysis, all of which simultaneously present new issues to do with privacy, regulation and where accountability for safety lies.

In summary: Lloyd's Register Foundation's development of a global safety outlook evidence base needs to be informed by the many ways in which new technology is changing how we work and live our lives through the creation of new business models, the radical disruption of old ones, the generation of new forms of data and also new types of risk, many of which are still not fully understood, let alone regulated.



Conclusions and recommendations

This report has identified challenges and opportunities for the development of a global safety evidence base.

- There is consensus on the immense variability in data consistency and quality at all levels, and that this presents serious hindrance to making meaningful comparisons between countries, sectors and businesses. Indeed, there can be challenges making comparisons between different government departments in the same country and within the same multinational business. Without more consistent and comparable data, it is difficult to reach defensible and meaningful conclusions on strengths, weaknesses and areas for intervention.
- There is a need to improve the accuracy and reporting of data on lagging indicators of fatality and injury. In particular, there is a need to improve understanding of the links between chronic disease fatalities and workplace exposure over a life time. There is ambition that medical advances and new technology will play an important part in improving this knowledge base.
- There is impetus and activity to focus more attention on leading indicators of safety performance. At a country level, this has involved looking at the regulatory frameworks and investments that influence unintentional injury outcomes and creating a comparative index of 187 countries. At a business level, it is involving more attention to the management systems and hierarchy of accountabilities for safety, with greater focus on risk management – particularly for high potential hazards – and a requirement for more data on the actual harm done to employees rather than lost time rates, for which there is no consistent methodology.
- How health is managed as a contributory factor in workplace safety is seen as a key leading indicator of safety performance, presenting an array of issues and opportunities. The use of new technology, such as Fitbits, to track workforce health and collect biodata prompts concern about privacy issues and a potential slippery slope from a benign focus on wellness to the selection of employees based on physical and mental traits with implications for compensation and insurance. There seem to be fewer such issues for individuals in recognised high-risk jobs,

This report has identified challenges and opportunities for the development of a global safety evidence base.

where personal protective equipment – which may include bodycams and a variety of sensors – has long established protocols and safeguards.

- Technology is creating new forms of data and enabling different ways to interrogate and visualise multiple and inter-related types of data of significance to safety performance and outcomes. New business models are being developed precisely to record and aggregate data about road safety incidents via dashcams in order to alerts others and to support insurance claims. This is just the tip of an iceberg of an internet of things which will enable more insight to diverse correlations and help improve understanding of the potential for cause and effect.
- The world's online conversation about all sorts of matters to do with safety at work and at home can now also be interrogated at scale by technology that uses natural language algorithms to pin point and visualise specific conversations of relevance to precise topics, locations and assets – from expert epidemiological publications to everyday social media accounts. The ability to review global conversation against diverse indicators of safety performance allows regulators, investors, businesses, civil society and others to identify early warning signals of vulnerability and enable rapid intervention.
- In summary, all pointers are to a big change in the types of data available on safety performance and safety outcomes. Even in countries where there is no reliable government framework for collecting data about safety, new forms of technology are able to gather unstructured data to provide new forms of evidence and intelligence about performance and help build a baseline for decision-making and improvement. Such technology is already being leveraged by multinational businesses keen to monitor and protect their reputations from allegations of making a profit at the expense of individual safety elsewhere in the supply chain.

Recommendations

A critical period of change lies ahead with diverse parties working to compile new and better data on safety performance and outcomes, but without obvious concerted co-ordination or explicit ambition to create a global safety outlook. The inability to achieve global comparisons and insights is a primary driver for many organisational initiatives.

Lloyd's Register Foundation is in a unique position to deliver leadership by bringing together and building upon its exisiting investments and research in global safety. For example through its work with the Institute for the Public Understanding of Risk in Singapore, with The Alan Turing Institute in the UK on the engineering applications of big data to enhance the safety of life and property, and with the UK's Health and Safety Executive on consolidating safety data across government departments.

The Foundation is also well placed to convene other leaders who contributed to this research, such as the ILO, GRI, industry and others innovating new approaches to understanding global safety data and performance.

As this future takes shape, the Foundation can:

- Use existing data sources to identify and communicate global safety priorities.
- Identify opportunities to continuously improve and enrich available safety data and intelligence.
- Identify which evidence-based interventions and research can be made by Lloyd's Register Foundation, in collaboration with others, to improve world safety outcomes.
- Make global safety analysis and data accessible for public use.
- Scope education and development programmes for the global community.

By convening and enabling shared learning and greater co-ordination among organisations with an interest in a global view of future safety management and outcomes, and by fostering innovations in data collection and interpretation, Lloyd's Register Foundation can play an essential role in helping to devise and visualise – for the first time – a global safety outlook.

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