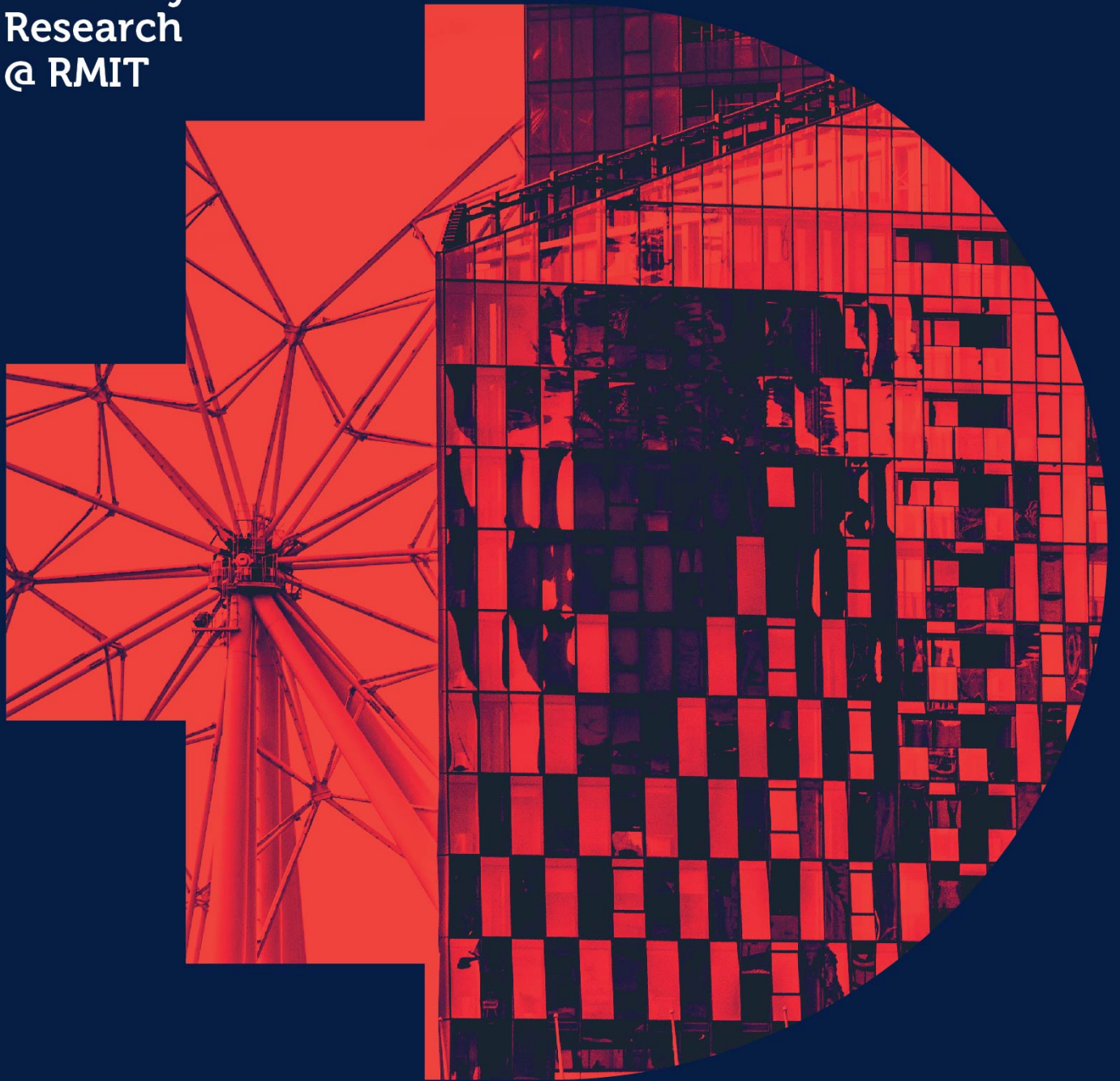


Construction
Work Health
and Safety
Research
@ RMIT



Development of Evidence Informed Health and Safety Performance Index - Report

October 2023

Published by
Construction Work Health and Safety Research @ RMIT

Copyright © 2023 RMIT University

Except external referenced documents and images

All rights reserved. Apart from any use permitted under the Copyright Act 1968 no part may be reproduced, stored in a retrieval system or transmitted by any means or process whatsoever without the prior written permission of the publisher.

Acknowledgements

This report was commissioned by the Suburban Rail Loop Authority.

Authors

Payam Pirzadeh, Helen Lingard, Amanda Benson and Joe Alderuccio

Citation details

Pirzadeh, P., Lingard, H., Benson, A. & Alderuccio, J. (2023). Development of Evidence Informed Health and Safety Performance Index – Report. Centre for Construction Work Health and Safety Research, Melbourne: Australia.

About Construction Work Health and Safety Research @ RMIT

Construction Work Health and Safety Research @ RMIT provides leading-edge, applied research to the construction and property industries. Our members are able to work with organisations to analyse health and safety (H&S) performance and identify opportunities for improvement. We can develop and evaluate innovative solutions, provide specialised H&S programs or undertake other research-based consulting activities. Our work addresses real-world H&S challenges and our strong international linkages provide a global perspective to our research.

Construction Work Health and Safety Research @ RMIT
Building 8, Level 8, Reception
360 Swanston Street
Melbourne VIC 3000
Phone: +61 3 9925 2230
Fax: + 61 3 9925 1939
Email: constructionwhs@rmit.edu.au
www.rmit.edu.au/research/health-safety-research

Development of Evidence Informed Health and Safety Performance Index - Report

October 2023

Contents

Executive summary	i
Part 1: Background	1
1.1 Performance management and measurement	1
1.2 Characteristics of effective safety performance measurement	3
1.3 Problems associated with the way health and safety are currently measured	5
1.4 Alternative types of safety performance indicator	6
1.5 Leading and lagging indicators	7
1.6 Considerations for the design of a Health and Safety Performance Index	9
1.7 Safety climate measurement	10
1.8 Integrated performance measurement	11
1.9 Final comments	12
Part 2: Research methods	13
2.1 Overview	13
2.2 Ethics	13
2.3 Interviews	14
2.4 Demographics and company profile	14
2.5 Data analysis	14
Part 3: Findings	15
3.1 Incident and injury data	15
Near miss and high-potential incidents	17
3.2 Leading indicators	19
Leadership engagement in safety	20
Supervisors	23
Hazard reporting	24
Risk management	26
Assurance activities	28
Incident investigation and lessons learnt	31
Corrective actions	33
H&S-related communication and workforce engagement	34
Resourcing, capability and competency	36
Training	38
Innovation	40
Occupational health and wellbeing	41
Culture and its influence on H&S	44
Collecting data and reporting performance	47
Part 4: Suggested SRLA Health and Safety Index	52
4.1 Component 1: H&S leadership	55
H&S leadership capability	55
Leaders' active engagement in H&S	55

Specific metrics of H&S leadership	56
4.2 Component 2: Risk management and governance	58
Adequacy of capability and resources	59
Incident reporting	59
Proactive risk management	59
Assurance activities	59
Specific metrics of risk management and governance	59
4.3 Component 3: Learning and sharing lessons	62
Specific metrics of learning and sharing lessons	63
4.4 Component 4: Health and wellbeing	64
Specific metrics of health and wellbeing	64
4.5 Indicator weights and calculating the index score	65
Part 5: Discussion and next steps	71
Part 6: References	74
Part 7: Appendix	83
7.1 Interview questions	83
7.2 Table of H&S metrics	84

List of Tables

Table 1.1: Key definitions (Source: Bititci et al. 2018)	1
Table 2.1: Details of interview participants	14
Table 4.1: Proposed H&S Index structure – components and subcomponents	53
Table 4.2: Metrics of H&S leadership capability	56
Table 4.3: Metrics of active H&S leadership	57
Table 4.4: Metrics of risk management and governance	60
Table 4.5: Metrics of learning and sharing lessons	63
Table 4.6: Metrics of health and wellbeing	64
Table 4.7: The suggested H&S index	67

List of Figures

Figure 1.1: Performance management and performance measurement	3
Figure 1.2: Bowtie model of safety	9
Figure 2.1: Research process	13
Figure 5.1: Using the H&S index in combination with safety climate surveys and lagging indicators	73

Executive summary

A suggested Health and Safety Performance Index was developed for use in the Suburban Rail Loop Authority (SRLA) program of construction work. The development of this suggested H&S Index was informed by a systematic process of research that involved the collection and analysis of data from a number of different data sources:

- first a review of the academic literature, industry reports and best practice guidelines was undertaken
- second the SRLA's Health and Safety Strategy and management approach were reviewed, and
- third, semi-structured interviews were conducted with 27 Australian and international industry experts representing, clients, contractors and other industry stakeholders.

The review of the academic literature provided insights into the different types of indicators in use (e.g. leading/lagging, drive/monitor, safety culture/climate surveys etc). The literature also identified challenges and advantages associated with the use of various types of H&S performance indicators and explored assumptions about the way that indicators are related to each other and to objective measures of H&S performance. In particular, recent arguments in favour of the use of a balanced mix of different types of indicators to measure H&S performance were explored. The literature also provided insight into the criteria that can be used to evaluate the effectiveness of H&S metrics and measures. These criteria, i.e., validity, reliability, actionability, sensitivity etc were utilised in selecting measures and metrics in the suggested H&S Index.

The industry-based 'grey' literature was also reviewed to identify a list of 387 H&S performance metrics and measures that are used in industry and that could be utilised in the construction context. These were grouped to reflect different types of indicator and categories of performance. This list became a useful resource in the development of the suggested H&S Index.

Interviews with industry experts covered three main topics:

- how participants measure H&S performance in their construction projects
- how participants use collected H&S data to manage performance, and
- what participants consider to be the best/most useful indicators of H&S performance.

Interview data was subjected to thematic content analysis. Key themes emerging from the interviews reflect aspects of an organisational H&S management context that participants identified as important and that should be incorporated into any H&S performance measurement framework. These were:

1. Leadership engagement in H&S - reflects the importance of active engagement in H&S by senior leaders. It includes quality of engagement with the workforce and shaping leadership behaviours to create a proactive environment for improving H&S.
2. Supervision – reflects the importance of frontline supervisors due to their proximity to the workforce, in creating the right environment and actively engaging with site-based workers.
3. Hazard reporting - reflects the importance of hazard reporting and responsive action.
4. Risk management – reflects an emphasis on proactive and ongoing risk management to deal with the dynamic nature of managing H&S in a project context.

5. Assurance activities - reflects the need to ensure processes are followed and high standards of H&S are maintained.
6. Incident investigation and lessons learnt – reflects a focus on learning from incidents and sharing lessons between projects and program participants.
7. Corrective actions – reflects the need to track the timely completion of corrective actions when problems are identified.
8. H&S-related communication and workforce engagement – reflects the importance of maintaining effective H&S-related communication between managers, supervisors and workers.
9. Resourcing, capability and competency – reflects the need to ensure the adequacy of resources and workforce capability to undertake work in a healthy and safe manner.
10. Training – reflects the importance of providing effective training in H&S and leadership.
11. Innovation – reflects opportunities to drive H&S improvement through innovation.
12. Occupational health and wellbeing – reflects the importance of including health and wellbeing in performance measurement metrics and management frameworks.
13. Culture and its influence on H&S -reflects the fact that a strong and supportive organisational culture is an important precondition for achieving effective H&S performance management.
14. Collecting data and reporting performance – reflects the fact that how performance data is collected and used is as important as what is actually collected.

Combining the three data sources, a suggested H&S Index was constructed. The index components were identified to reflect the key aspects of H&S management highlighted by the industry experts, as well as industry best practice in H&S performance measurement and SRLA strategy and management approaches.

The components and sub-components of the suggested H&S Index are shown in below.

Component	Subcomponent	Aim of the component
H&S leadership	H&S leadership capability	Developing and maintaining relevant H&S management capability and appropriate focus to support active H&S leadership. Actively engaging with frontline, encouraging conversations about H&S, setting a high standard through leaders' visibility and positive reinforcement, and creating an enabling environment for driving healthy and safe behaviour.
	Leaders' active engagement in H&S	
Risk management and governance	Adequacy of capability and resources	Creating and sustaining the capacity of a robust framework for anticipating H&S risks and effectively managing them, reviewing control strategies and making ongoing improvements, encouraging the adoption of initiatives and best practice to challenge risk, and motivating transparent reporting of outcomes through a focus on value-adding and positive performance.
	Incident reporting	
	Proactive risk management	
	Assurance activities	
Learning and sharing lessons	Incident investigation	Encouraging proactively learning and sharing lessons across the program to benefit the collective and the industry.
	Internal and external communication	
Health and wellbeing	Critical health & wellbeing risk management	Protecting and enhancing the health and wellbeing of the people across the program.
	Return to work	
	Positive physical and mental health initiatives	

The components of the suggested H&S Index are strongly linked to the SRLA H&S Strategy and the sub-components pick up important themes emerging from the subject matter expert interviews.

Components are defined and assigned with scoring protocols and weightings that underpin the operation of the suggested H&S Index. These scoring protocols and weightings will be subjected to further testing and sensitivity analysis with industry stakeholders.

The suggested H&S Index comprises mainly leading performance metrics. However, these metrics include a balance between drive indicators (i.e., those that focus on motivating certain H&S management actions to enhance H&S outcomes) and monitor metrics (i.e., those that monitor the efficacy of H&S management actions to check if the desired outcomes have been achieved). This allows the Index to measure both the level of H&S management/improvement actions (inputs) as well as the quality and effectiveness of these actions (by monitoring their outcomes).

Finally, it is recommended that the suggested H&S Index is used in conjunction with H&S climate surveys to cross-validate data and obtain a more comprehensive view of H&S performance. For example, comparing self-reported leadership activities with worker perception survey (safety climate data) provides a useful point of cross-checking the effectiveness of H&S leadership activities.

Part 1: Background

1.1 Performance management and measurement

Managing performance through measurement describes a process of measuring what matters, reporting these measures, reviewing performance and taking action (Bititci et al. 2018). Performance measurement has been defined as using metrics to quantify the efficiency and/or effectiveness of action (Neely et al. 1995), while performance management has been defined as the process of developing the metric set, setting goals, collecting, analysing, reporting, interpreting and assessing performance (Melnik et al. 2014). Smith and Bititci (2017) distinguish between performance measurement (which describes what to measure) and performance management (which describes how measurement is used to manage organisations' performance).

Bititci et al. (2018) argue that performance measurement and management are key elements of organisational or management control systems. In many cases these systems operate in constantly changing environments with the objective of responding to changes, the correction of problems and the prevention of undesired outcomes (Melnik et al, 2014). In the construction industry, not only are projects delivered in unpredictable and dynamic environments, but management control also occurs across inter-organisational boundaries (e.g., between client and principal contractor, principal contractor and sub-contractor etc). As such, control effected through performance measurement and management in construction projects involves social as well as technical components, and is inevitably influenced by relationships (Lingard et al. 2020).

Performance measurement is a form of technical control through which goals are set, performance measures are developed and data is collected, analysed, reported reviewed and acted upon. Whereas performance management is a form of social control (operating via cultural and behavioural routines) through which the performance measurement system is used to manage performance.

Importantly, Smith and Bititci (2017) argue that within an organisational environment, technical and social controls work together to shape workforce engagement and performance.

Table 1.1: Key definitions (Source: Bititci et al. 2018)

Concept	Definition
Performance	Efficiency and/or effectiveness of action
Performance measure	Qualitative or quantitative assessment of the efficiency and/or effectiveness of an action
Performance Measurement System	Process (or processes) of setting goals, developing a set of performance measures, collecting, analysing, reporting, interpreting, reviewing and acting on performance data (technical controls)
Performance Management	Cultural and behavioural routines that define how we use the performance measurement system to manage the performance of the organisation (social controls)

The relationship between performance management and performance measurement as they relate to workplace health and safety is depicted in Figure 1.1.

Figure 1.1 indicates that a performance *measurement* system can vary from low to high maturity. A low maturity performance measurement system is characterised by: fragmented health and safety measures focused on lagging indicators; a low understanding of inter-relationships between lagging and other indicators of health and safety performance; metrics not linked to strategic health and safety objectives, health and safety measures and trends not reported or accessible; and health and safety performance reviews being conducted at irregular intervals or being exclusively reactive, i.e. only conducted in response to an emergency.

In contrast, a high maturity performance measurement system is characterised by: the use of a balanced set of leading, lagging, and safety climate metrics; an understanding of the inter-relationships between leading, lagging and climate metrics; the use of metrics linked to strategic health and safety objectives; open reporting of health and safety measures and trends; and the conduct of regular/frequent health and safety performance reviews based on data.

Similarly, Figure 1.1 suggests that a performance *management* system varies according to the nature of relationships in an organisational environment. At one end of the spectrum, performance management takes a command-and-control approach, while at the other end of the spectrum a participative approach to performance management is taken.

A command-and-control approach to performance management is characterised by: a focus on prescriptive health and safety standards; top-down management of health and safety; heavy reliance on contracts to influence performance; a low level of consultation and worker engagement in health and safety management processes; and low levels of trust amongst those whose performance is being measured which, in turn, discourages open reporting of health and safety performance.

In contrast, a participative approach to performance management is characterised by: a focus on health and safety performance standards (flexibility); joint decision-making and supply chain/worker involvement in the management of health and safety; greater reliance on relationships to influence performance; high levels of consultation and engagement in health and safety management processes; and high levels of trust which encourage open reporting of health and safety performance.

Smith and Bititci (2017) argue that, as performance measurement systems become more mature, there is a tendency for organisations to shift towards a command-and-control style of performance management. They suggest that this is unhelpful because it can negatively impact workforce engagement and performance.

It is important that the interplay between performance measurement and performance management is acknowledged. Figure 1.1 proposes that the top right-hand quadrant in the diagram (i.e. one in which a mature measurement system operates within a participative management environment) is the preferred space within which a positive culture of health and safety performance improvement can occur.

The performance management-performance measurement framework developed by Smith and Bititci (2017) has informed the present study and the development of the SRLA Health and Safety Index, with a focus on maturity of performance measurement which will ideally be embedded in a participative performance management culture.

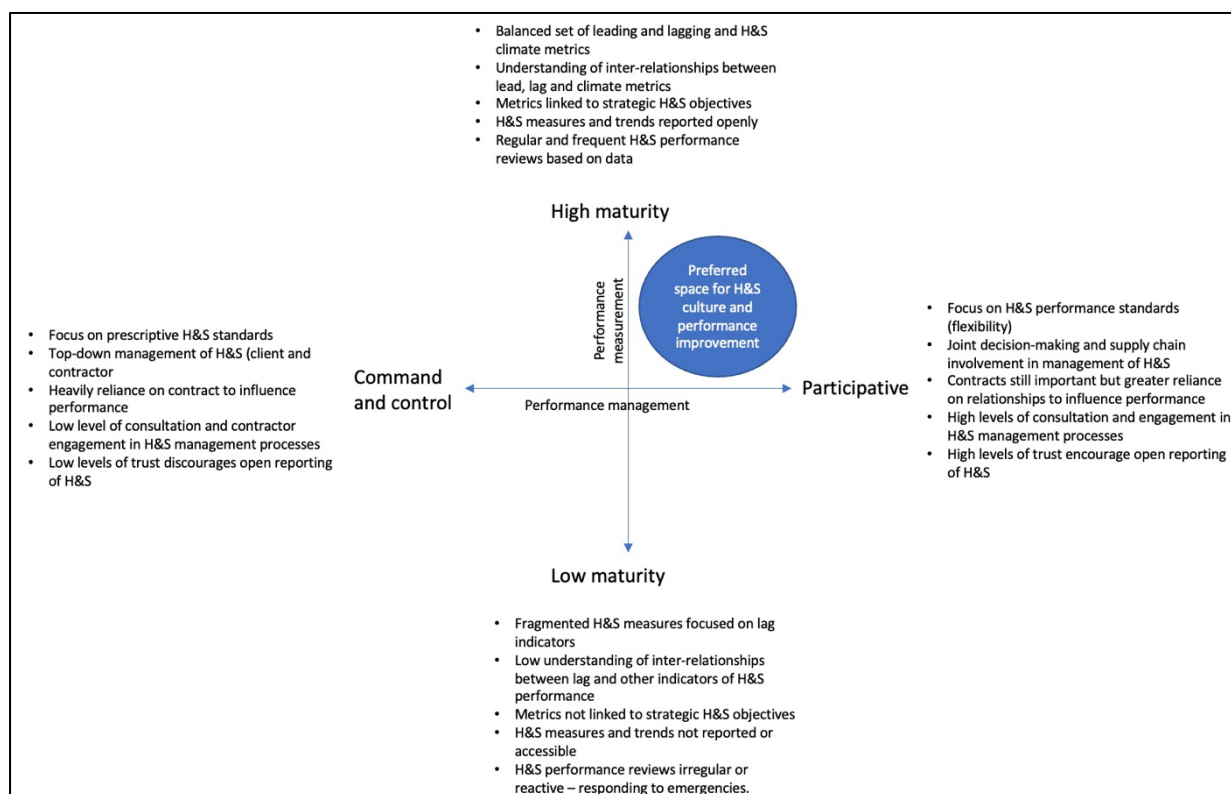


Figure 1.1: Performance management and performance measurement
(adapted from Smith and Bititci, 2017)

1.2 Characteristics of effective safety performance measurement

The SRLA Health and Safety Index development was also informed by an analysis of the characteristics of effective performance measurement.

A key function of effective measurement is to anticipate events at some point in the future and trigger proactive and corrective actions. Consequently, safety performance indicators should be based on a thorough understanding of the factors (both immediate and distal) that contribute to accidents and injuries (Grote, 2009; Dyreborg, 2009; Xia et al., 2018).

There is a growing recognition that both qualitative and quantitative approaches are valuable in understanding health and safety performance in an organisational context. For example, Hinze, Hallowell and Baud (2013) recognise the importance of having an organisation-specific combination of quantitatively and qualitatively valid safety performance indicators. Peñaloza et al. (2020) similarly emphasised that safety performance measurement systems should include both quantitative and qualitative data.

Oguz Erkal et al. (2021) identified four criteria against which predictors of serious injuries and fatalities in the construction industry should be assessed for their effectiveness:

1. indicators should be measurable (i.e., they are reasonably and consistently measurable using available resources)
2. indicators should be actionable (i.e., measurement of an indicator could reasonably trigger serious injury/fatality prevention action)
3. indicators should be simple (i.e., measurement should be easy to understand, define, and explain to workers and managers), and
4. indicators should be predictive (i.e., factors that are measured have a significant influence on the occurrence serious injury/fatality events).

There is a growing recognition that, in addition to capturing indicators that are able to predict adverse safety outcomes, safety performance measurement should also include indicators of positive safety outcomes (Kjellen 2009; Reiman and Pietikäinen, 2012). This is consistent with the position of Hollnagel (2008) that a state of safety reflects more than the absence of risk. Measuring the presence (rather than the absence) of safety enables managers to identify, understand and create the conditions required for safety success, as opposed to simply counting safety failures (Alexander et al., 2017a).

Guo et al. (2016) suggest that the practicability of safety performance indicators is an important factor in their effectiveness. Factors impacting practicability include the extent to which an indicator of performance is compatible with practical management requirements and is not susceptible to manipulation. The UK Health and Safety Executive (2001) argues that performance measurement should drive appropriate behaviour in relation to workplace health and safety. In some instances, indicators are reported to be subject to misuse or manipulation (Oswald et al., 2018). For example, poorly chosen metrics can sometimes lead to a focus on the frequency of a safety-related activity (e.g., counting the number of safety meetings or safety walks by managers), without capturing the quality of the activity, thereby not adequately reflecting the effectiveness with which workplace health and safety are being managed in an organisational context. Hallowell et al. (2020) argue that, unless the quality of the implementation of a safety management activity is captured by safety performance measures, organisations will be unable to distinguish between strong/meaningful and weak/ineffective implementation. When combined with targets and incentive schemes the measurement of safety performance by using simple frequency metrics can prompt people to 'manage the metrics' rather than focusing on improving the health and safety performance in a workplace. Given the potential for unanticipated consequences associated with the measurement of safety performance, it is recommended that safety performance indicators are monitored, reviewed periodically and adjusted if necessary (Hinze and Hallowell 2013; Guo and Yiu, 2015).

Reliability is also a characteristic of effective safety performance measurement (Hale, 2009). In this context, reliability refers to the extent to which performance indicators provide consistent results when they are used by different people. Reliability of measurement is particularly important when performance is being compared between different work areas or between different points in time.

While much of the commentary on effective measurement focuses on safety performance indicators, the importance of effective measurement applies equally to the measurement of work-related health performance.

1.3 Problems associated with the way health and safety are currently measured

Traditionally, construction organisations have relied on measures of the frequency with which undesirable safety outcomes have occurred as an objective indicator of performance. Thus, there are standardised ways to calculate lost time injury frequency rates (LTIFRs), total recordable injury frequency rates (TRIFRs) etc.

Such indicators are widely used because they are:

- relatively easy to collect
- easily understood
- easy to use in benchmarking or comparative analyses, and
- useful in the identification of trends over time (NOSHC, 1999).

However, these measures have been criticised on two grounds. First, because recordable incidents and injuries have a statistically low probability of occurrence over short time frames, they are usually neither valid, nor stable when measured at a single construction project (Hopkins, 2009a). Hopkins (2009b) terms this the “zoom” effect, referring to the fact that, even in very large construction projects, the frequency of accidents/injuries is insufficient to calculate a meaningful rate. Even a stable safety system will produce a variable number of injuries/incidents (Stricoff, 2000) and the absence of injuries/incidents does not necessarily mean that a workplace is safer than another workplace at which an injury/incident has occurred in the same period (Cadieux et al., 2006).

Similarly, Hallowell et al. (2021) question the statistical validity of total recordable injury rate and indicate a high degree of randomness and wide confidence intervals (i.e. low precision) for injury rates which essentially make the comparison of specific injury frequency rates between typical reporting periods meaningless. Based on these results, Hallowell and his colleagues strongly suggest that total recordable injury rates should be reported as a range (indicating confidence intervals).

Perhaps a more fundamental criticism of incident/injury rates is that they are retrospective indicators, capturing things that have already gone wrong in a work system. They measure the absence, rather than the presence of safety (Arezes and Miguel, 2003) and therefore cannot be regarded as a direct measure of the level of safety in a work system (Lofquist, 2010). Weick (1987) describes safety as a “dynamic non-event” and argues that, by definition, non-events cannot be counted. Consistent with this view, the preoccupation with measuring the absence of negative events has been widely criticised (Dekker and Pitzer, 2016).

The reliance on incident rates as a method of measuring performance can also have serious consequences for the effective management of safety performance. For example, Lofquist (2010) describes how relying on incidents as a safety indicator resulted in the failure to recognise a marked deterioration in safety that occurred in the Norwegian civil aviation industry during a period of organisational change. Pilots and air traffic controllers had observed a gradual decline in safety standards, but because no incident had occurred, decision-makers were not aware of the negative safety impact of the organisational change program. Thus, a low incident/injury rate does not guarantee that safety risks are being controlled or that incidents/injuries will not occur in the future (Mengolinim and Debarberis, 2008).

The use of injury/incident rates to underpin incentive schemes can also cause reporting problems. Tying incentives, such as management performance appraisals, bonus payments, or future tendering opportunities to injury/incident rates can encourage underreporting (Cadieux et al., 2006; Sparer and

Dennerlein, 2013). For example, Pedersen et al. (2012) describe how group-based rewards for periods of accident-free working encourages underreporting. Research also shows that workers who perceive that they have low levels of job security are less likely to report injuries and accidents (Probst et al., 2013). When underreporting occurs, data fidelity is compromised and erroneous conclusions can be drawn from analysis of performance. In fact, the greater the emphasis that is placed upon injury/incident rates in commercial incentive schemes, the less useful these measures are likely to be, because people learn how to manipulate them (Hopkins, 2009b). The extent of the problem is indicated by Daniels and Marlow (2005) who report that the actual level of reporting of non-fatal construction injuries in the UK construction industry is as low as 46%.

Kjellén (2009) also argues that injury rates fail to differentiate between severe injuries and minor ones. Hallowell et al. (2020) report that variation in total recordable injury rates has no association with the incidence of fatalities. They argue that fatality incidence follows a different pattern to the TRIFR, suggesting that serious incidents (e.g., fatalities) occur for different reasons. O'Neill et al. (2013) similarly argues that grouping injury events together, which is frequently done when calculating TRIFRs and LTIFRs, serves to conceal severe injuries (e.g., those causing fatalities and permanent disabilities) because the number of low consequence injuries typically far exceeds the number of high consequence injuries.

There is growing recognition of the importance of measuring the frequency of high impact safety events as a separate category of event. However, because catastrophic safety events are rare, the recording of high-impact injury events in a single organisation will not produce a sufficiently large data set to enable pattern recognition or reliable diagnostic statistics (McFadden and Towell 1999). To overcome this challenge Alexander et al. (2017a) recommend the collection of data relating to the occurrence of incidents or events that have the potential to produce high impact consequences (i.e., high-potential incidents or close calls).

1.4 Alternative types of safety performance indicator

As a result of the limitations associated with the exclusive use of retrospective injury or incident data for the measurement of safety performance within organisations, there has been a shift to new and different types of safety performance measurement (Sinelnikov et al., 2015). Ways to quantify the state of safety, irrespective of the occurrence of injury or incidents take various forms and include the use of safety leading indicators, precursor analysis, safety risk analysis, and safety climate assessment (Oguz Erkal et al 2021). The measurement of safety climate is discussed later in this review and is recommended as a supplement to the use of the proposed SRLA Health and Safety Performance Index.

Other measurement approaches involve quantifying the direct causes of accidents, such as hardware failures or operational errors (Mohaghegh and Mosleh, 2009). In addition, third party audits are sometimes used to measure the extent to which organisational safety management systems are compliant with pre-existing standards (see, for example, Teo and Ling, 2006).

The emphasis of new 'alternative' forms of safety measurement is on identifying and measuring specific indicators that predict safety performance at some future point in time, rather than counting injuries or incidents over time (Oguz Erkal et al., 2021; Hallowell et al., 2013; Alruqi and Hallowell, 2019).

For example, Salas and Hallowell (2016) used leading indicators to develop a predictive model for providing early warning signs of changes in a construction contractor's safety management performance. They suggest that clients and contractors could potentially use this model to reduce incidents, and continuously improve safety performance in projects (Salas and Hallowell, 2016). Alexander et al. (2017b) identified 16 precursors of construction fatalities. Examples include schedule pressure, fatigue, distraction and improvisation. Hallowell et al. (2020) similarly explored combinations of and interactions between work tasks, environmental conditions, human conditions and management systems that predict future safety performance. In particular, the inclusion of human factors in measurement models for safety is important in an industry like construction in which project-based workers make decisions and respond to events in a work environment characterised by change and uncertainty (Oguz Erkal et al., 2021).

1.5 Leading and lagging indicators

In the development of alternatives to traditional outcome-based safety indicators, the terms leading and lagging have been borrowed from the fields of economics and finance. In economics a leading indicator is something that changes before the economy changes, for example, building permit approvals and stock prices (Wreathall, 2009). However, as Kjellén argues, these terms were introduced to the field of safety without full consideration of their meaning as it applies to safety performance. As a result, they have been used inconsistently.

Leading indicators of safety are defined in different ways. Hopkins (2009a) states that "lead indicators are those that directly measure aspects of the safety management system, such as the frequency or timeliness of audits" (p. 460). However, Hopkins (2009a) also points out that the measurement of safety-relevant activity does not provide a direct measure of the state of safety in a particular situation. He illustrates this point by describing how an organisation may score poorly in relation to the percentage of equipment that is past its due date for inspection when all of the equipment is actually functioning properly. Moreover, measuring the frequency of management activity as a proxy for safety performance may not reflect a safer workplace because this could potentially produce behaviours that are designed to manage the indicator rather than the issue of workers' safety.

Leading indicators of safety have also been described as "precursors to harm that provide early warning signs of potential failure" (Shea et al., 2016). These two definitions reflect the fact that leading indicators can either be positive (e.g., preventative management activity) or negative (e.g., early warning signs).

The underlying logic is that the measurement of leading indicators provides an opportunity to detect and resolve safety issues before incidents or injuries occur (Sinelnikov et al., 2015; Hinze, Thurman and Wehle, 2013). However, there are some important conceptual questions about how the terms leading and lagging are understood in relation to workplace safety performance. In some interpretations the distinction between what is considered to be leading versus lagging lies in the position of the indicator in relation to the occurrence of harm - with lag indicators measuring harm directly and lead indicators measuring the precursors to harm. Alternatively, Hopkins (2009a) notes that any kind of failures, irrespective of whether they produce harm, should be considered lagging indicators. In this interpretation the distinction between leading and lagging depends more upon whether an indicator measures something positive, e.g., the functioning of the safety management system, or negative, e.g. the failure of a particular system defence or risk control mechanism. Leading indicators of safety have also been defined as practices that change before the actual level of risk people are exposed to changes, irrespective of whether harm eventuates (Kjellén, 2009).

The literature revealed two different approaches to the way safety indicators are described. The first reflects whether an indicator is viewed as an antecedent or outcome of safety. The second reflects whether the indicator captures positive or negative performance. The frequency of management activities (a commonly used form of leading indicator) is a positive indicator. However, if timing in relation to the occurrence of harm underpins the distinction between leading and lagging safety indicators, then an increase in the rate of errors, equipment failures, or deviations from standard operating procedures, could equally be regarded as leading (albeit negative) indicators of safety performance.

Some argue that the terms leading and lagging should be understood in a relative way, such that any event can be seen as leading or lagging depending on the perspective taken. Dyreborg (2009), for example, suggests that safety incidents may be considered as a lagging indicator of organisational safety performance but a leading indicator if they are reported to a safety regulator and used to inform policies for prevention.

Hopkins (2009b) criticises this relativist approach, arguing that incidents that produce harm cannot be regarded as leading in any circumstances. However, Hopkins (2009b) is also critical of an absolutist approach in which the distinction between what is considered a leading or lagging indicator is based on whether it occurs before or after a particular cut-off point.

This is the approach suggested by the “bowtie” model that is commonly used to explain the occurrence of safety incidents (Bellamy et al., 2007). The bowtie model, depicted in Figure 1.2, suggests that anything to the left of a top event (typically a loss of control or incident) should be considered to be leading, and anything to the right should be considered to be lagging. However, this approach creates some difficulty when considered in relation to contemporary understandings of incident causality, which see safety as the emergent product of a complex interplay of organisational, environmental, and individual factors.

Some models of construction incident causality identify causal factors in the immediate site environment, but trace these back to systemic factors in the project/organisational and external industry environments, for example poor design-decision-making (see, for example, Haslam et al., 2003; Gibb et al., 2014). If failures in systemic safety defences, e.g. poor design decisions, are regarded as lagging indicators, it is unclear where the distinction between leading and lagging indicators should be drawn. Using the bowtie model, it is also unclear how measurement of the effectiveness of emergency procedures should be classified. Measures of the effectiveness of emergency management systems are proactive measures of an organisation’s preparedness for safety incidents but they would fall to the right of the top event in the bowtie model, occurring after the event of a failure or escalation of risk.

The above discussion highlights how, although the terms leading and lagging indicators of workplace safety have been widely adopted in industry, the distinction between what leads and what lags can sometimes be unclear.

Importantly, describing indicators as leading or lagging suggests the existence of a time-dependent and directional relationship between safety performance indicators and safety-related outcomes. A longitudinal analysis of five years of data collected at a large transport infrastructure construction program in Melbourne, Australia, revealed that some indicators that were referred to as leading indicators sometimes operate as lagging indicators of safety performance (Lingard et al., 2017). For example, an increase in frequency of toolbox talks was found to decrease the TRIFR in the short term. However, over a longer period, the direction of causality between these two indicators changed,

such that a decrease in the TRIFR predicted a subsequent *decrease* in the frequency of toolbox meetings.

The fact that some categories of management activity changed significantly at time lags after observed changes in the TRIFR suggests that some of these management activities were triggered by changes in the frequency of occurrence of incidents/injuries. This may be partially explained by the nature of some of these activities, such as alcohol and drug testing, the review of safe work method statements and safety observations. With an increase in the frequency of incidents/injuries, the client and contractors engaged at the project may have emphasised the importance of monitoring site conditions and behaviours that are potential contributing factors to incidents/injuries.

A cyclical relationship was found in the data set, indicative of an 'incident cycle' in which managers respond to an increase in incident/injury rates by focusing greater attention on safety management practices (Lingard et al., 2017). However, as the incident/injury frequency rate falls, so too can the increased attention and emphasis placed on safety management in a workplace.

This feature of safety performance was observed by Stricoff (2000) who observed “when the recordable rate exceeds a facility’s upper-limit of perceived acceptability, management acts to drive the rate down. When the rate falls below that limit, attention to safety declines, and the recordable rate rises again. In this cycle, management action for improvement follows fluctuations in the injury frequency” (p. 37). Importantly, this type of cyclical behaviour does not produce sustained improvement in safety performance over time.

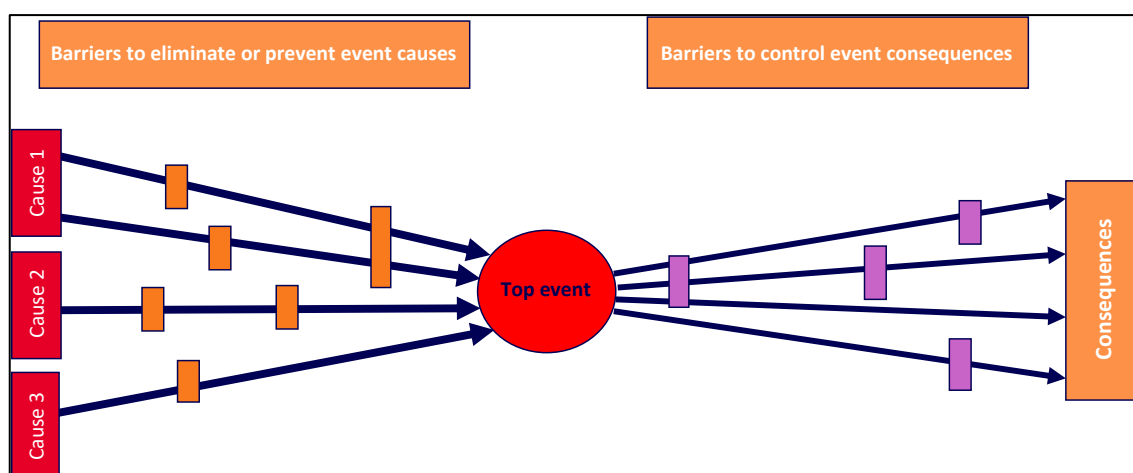


Figure 1.2: Bowtie model of safety

1.6 Considerations for the design of a Health and Safety Performance Index

However leading indicators of safety performance are understood, the literature reveals that they can operate differently in relation to performance. For example, in the nuclear power industry, Reiman and Pietikäinen (2010) classified leading indicators into:

- monitoring indicators, and
- driving indicators - which include situational factors like the quality of supervisors and hazard identification ability of personnel.

It is useful in the measurement of workplace health and safety performance to capture indicators that act as precursors to performance (driving indicators), as well as indicators of performance itself (monitoring indicators). Measuring both driving and monitoring indicators in relation to health and safety will allow an organisation to ascertain the extent to which the actions they plan, resource and implement (driving indicators) actually produce the desired outcomes in the workplace (as evidenced by monitoring indicators).

When thinking about measuring health and safety performance it is therefore useful to consider the type and purpose of different types of indicators to be included in performance measurement system, and how data that is collected should be analysed and utilised. Importantly, the choice of indicators used to measure safety should ultimately depend on beliefs about what constitutes and explains safety in a particular organisational context (Reiman and Pietikäinen, 2012).

It is also the case that measuring health and safety performance occurs at different levels in an organisational system. For example, Oguz Erkal et al. (2021) identified three levels of factors that operate as predictors of serious injuries and fatalities in the construction industry. These included:

- business factors, e.g., investment in safety research and development, the extent to which safety is considered in the supply chain, and the provision of frontline supervisor leadership training
- project characteristics, e.g., the supervisor to worker ratio, whether complete written operational procedures are in place, and the extent to which supervisors review pre-job meetings/plans, and
- crew demographics, e.g., the presence of clear assigned rules/responsibility, the extent to which projects are adequately resourced (understaffing), and crew size.

The selection of health and safety performance indicators also needs to consider the level at which measurement takes place and incorporate metrics and indicators that are appropriate to the level of analysis and reporting required.

1.7 Safety climate measurement

Neal and Griffin define safety climate as 'individual perceptions of policies, procedures, and practices relating to safety in the workplace' (Neal and Griffin, 2006, p. 947). Safety climate shapes workers' behaviour through the perception that workers form about how organisations reward and support safety (Lingard et al., 2012). Accordingly, a positive safety climate is expected to contribute to good safety behaviours and/ or performance. This proposition has been confirmed by considerable empirical evidence produced by studies in many industries, including construction. For example, safety climate was found to be negatively associated with risk behaviour in the rail industry (Morrow et al., 2010), unsafe behaviour in the chemical manufacturing sector (Bosak et al., 2013), and accident rate in the offshore industry (Mearns et al., 2003; Tharaldsen et al., 2008). A positive safety climate was reported to be strongly correlated to greater participation in safety-related activities in the health sector (Neal et al., 2000) and lower accident rates in wood-processing companies (Varonen and Mattila, 2000). In the construction industry, the strong link between safety climate and various aspects

of safety performance has also been reported in many studies (see for example, Siu et al., 2004; Zhou et al., 2008; Lingard et al., 2010, 2012).

Evidence from longitudinal studies indicates that safety climate is a valid leading indicator of safety, i.e., safety climate measured at one point in time predicts the occurrence of accidents or injuries at a future point of time. Wallace et al. (2006) conducted a survey in a large multinational shipping and transportation company and found that the safety climate within work groups measured from the survey was a significant predictor of the group's safety incident statistics collected 12 months after the survey. In a meta-analysis of 11 empirical studies, Alruqi et al. (2018) found that five dimensions of safety climate were strongly associated with future safety performance in the construction industry: (1) management commitment to safety; (2) supervisor safety role; (3) safety rules and procedures; (4) training; and (5) individual responsibility for health and safety.

Safety climate in the construction industry is a multi-level concept in that workers form perceptions of safety leadership and the relative priority placed on safety by clients, the principal contractor and within individual subcontracted work crews (Zhang et al., 2015). It is therefore possible for one subcontracted work group or project area to have a very different safety climate to other groups or work areas.

In construction there is a particularly strong connection between group-level safety climate (driven by frontline leadership practices) and safety performance owing to the multi-tiered subcontracting system and prevalence of semi-autonomous workgroups (Lingard et al., 2009). In this context, the influence of frontline supervisors is particularly strong, relative to that of senior management. Consequently group-level safety climate has been identified as a stronger, more proximal, predictor of safety performance (measured in terms of injury frequency rates) than organisational safety climate (Lingard et al., 2010).

Importantly, recent studies of safety climate in construction project environments have also found that safety climate changes over the life of a construction project, often in response to project events, time pressures etc (Zhang et al., 2018). Undertaking periodic safety climate assessments enables project management teams to understand the positive and negative factors impacting on project safety performance from the perspective of workers, and supports early intervention when cultural problems are identified.

1.8 Integrated performance measurement

There is growing recognition of the usefulness of combining measurement using leading indicators of safety performance with the use of safety climate survey tools (Hallowell, 2020). This approach was previously implemented at a transport infrastructure construction project in Melbourne at which an index of leading and lagging safety performance indicators (collected monthly) was supplemented with a quarterly safety climate survey (Lingard et al., 2013).

The use of the climate data enabled workers' perceptions of safety leadership and quality with which safety was being managed to be understood from the perspective of the workforce. Safety climate score changes over the life of the project enabled the leadership team to identify problems and intervene, solving important safety issues before the occurrence of incidents.

Worker surveys are particularly useful and possess a high level of 'face validity' when measuring the quality of safety leadership and management activity (such as whether projects are sufficiently well

planned and resourced). More recently, Shea et al. (2016) developed an index to measure employees' perceptions of the quality of various aspects of safety-related activity in a workplace.

Combining safety climate survey activity with the collection of other types of safety performance indicator data, allows for a 'reality check' of self-reported leading indicator data. For example, if organisations report extensive safety leadership activity but this is not reflected in the results of a safety climate survey, reasons for this disconnect should be explored. Possible explanations could be that the organisational leadership activities are not perceived favourably by the workforce or that leading indicator data may not be being reliably reported.

Hallowell et al. (2020) argue that the effective combination of leading indicator and safety climate measurement methods requires the careful selection of leading indicators (as measures of safety management activities) and corresponding climate survey items that measure workforce perceptions of the quality and effectiveness of those activities. By combining these two methods, a more comprehensive view of organisational or project safety performance can be achieved, and different data sources used to cross-validate and test the reliability of reported data. This is discussed further in Part 5 of this report (Discussion and next steps).

1.9 Final comments

There is an extensive body of literature on the subject of measuring safety performance within organisations. Much of this literature is critical of traditional lagging indicators of safety performance and recommends alternative approaches to performance measurement. The use of leading indicators has been widely promoted and has been adopted in many industry sectors, including construction. However, the leading/lagging terminology is not used consistently and the relationship between leading and lagging indicators of safety performance is likely to be more complex than is sometimes assumed. Notwithstanding this, the use of metrics that capture factors that predict some future state of safety performance are recommended and research is ongoing to identify what these factors might be at the levels of the business, the project and the workgroup in the construction industry.

Safety climate surveys are also widely used to gauge the perceptions of the workforce about the effectiveness with which safety is managed within an organisational environment. These climate scores often provide important insights into the quality of safety leadership and management activities.

Compared to the large amount of academic work addressing issues of how best to measure safety performance, there is much less work on how to measure work-related health performance. Consequently, this literature review deals, in the main, with the measurement of safety performance. It is recognised that due consideration needs to be given to the measurement of work-related health and that a balanced suite of metrics and indicators for health is also needed.

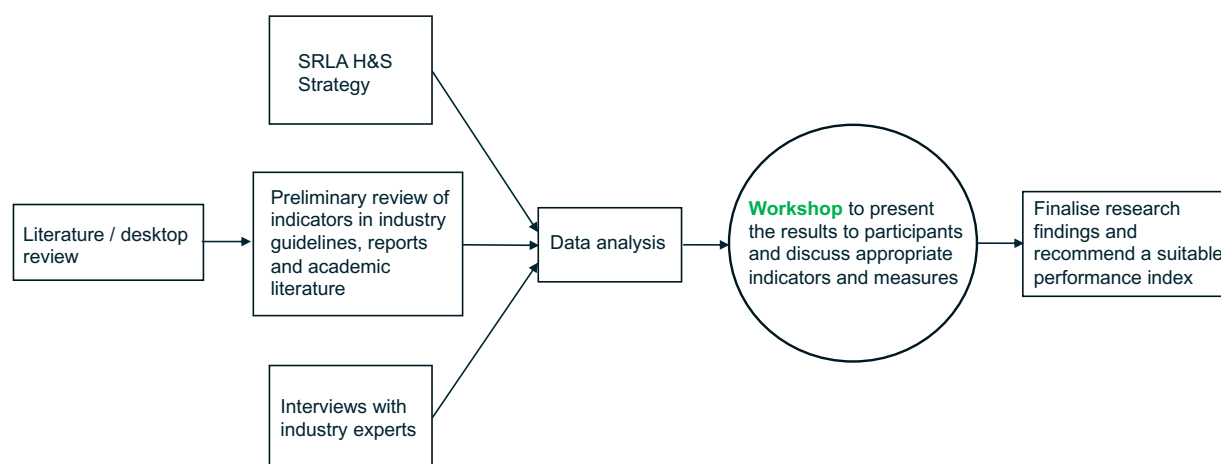
Lastly, it is important to note that performance measurement (i.e., what is measured) will interact with performance management (how measurement data is used) in an organisational environment. The ideal situation for the development of a strong and positive culture that supports workplace health and safety performance is likely to be a situation in which health and safety performance measurement is mature and performance management is participative.

Part 2: Research methods

2.1 Overview

Figure 2.1 shows the research process.

Figure 2.1: Research process



The research commenced with a review of peer reviewed academic literature and grey literature relating to best practice in health and safety performance measurement. As part of this review, a list of leading indicators and metrics which are relevant to construction was developed. The list can be found at Appendix 7.2.

The research also involved a review of the SRLA Health and Safety (H&S) strategy to ensure the SRLA strategic H&S objectives were considered in the development of the proposed Health and Safety Index. Industry experts from Australian and international construction organisations were interviewed to understand their views on what constitutes effective H&S performance measurement.

The outcome of the above steps informed the design of the proposed SRLA Health and Safety Index. Details of the interview data collection and analysis are briefly provided below.

2.2 Ethics

Before commencing the interviews, the data collection approach was approved by the RMIT University's Human Ethics Advisory Network.

Recruitment of interview participants was managed by SRLA and RMIT, who put out a call through their respective communication channels to invite a purposefully selected group of experts to participate in the work. An Expression of Interest was used in the recruitment process and interested parties were asked to contact RMIT researchers directly to ensure they were not identifiable to SRLA. If the prospective participant was willing to participate after learning more about the study, RMIT researchers scheduled a time for the interview to be conducted.

All data collected as part of the project, including recordings and any subsequent transcriptions, was stored on secured university Sharepoint drives. Only the researchers listed on the ethics application had access to the files. During the COVID-19 pandemic hardcopy files were not stored. Data collected were de-identified to remove any identifiable details of the participants from transcripts.

2.3 Interviews

The interviews covered three main topics:

1. how participants measure H&S performance in their construction projects
2. how participants use collected H&S data to manage performance, and
3. what participants consider to be the best/most useful indicators of H&S performance.

See Appendix 7.1 for a list of the interview questions.

Each interview was administered by two RMIT researchers and all interviews were audio recorded with the consent of the participants.

2.4 Demographics and company profile

Table 2.1 summarises participants' employment and job role details. There was a total of 27 participants (19 men and 8 women), from a total of 22 entities, including nine client organisations, ten contractor companies and three others (e.g., consultants, union, safety specialists).

Table 2.1: Details of interview participants

Participant	Total	Entity	Total
Men	19	Client	9
Women	8	Contractor (multiple participants in same entity)	10
		Other	3
Total participants	27	Total	22

2.5 Data analysis

The interview transcripts were analysed using a systematic thematic content analysis approach. The outcomes of this analysis are reported in Part 3 of this report. The interview findings informed the development of the recommended SRLA Health and Safety Index.

Part 3: Findings

The main themes emerging from the interviews are described in this section of the report.

3.1 Incident and injury data

While acknowledging the 'rear-view' nature of incident-focused measures, most of the interview participants indicated that lag measures (i.e., incident frequencies) are used in their organisations to track and report H&S performance. For example, an Alliance HSE Leader stated:

[We] look at both the lead and positive indicator measures as well as the lag measures. We understand the lag measures are still an indicator of performance and we need to have an eye on those as well.

The interviews indicated that injury-related measures, in particular Total Recordable Injury Frequency Rate (TRIFR) and Lost Time Injury Frequency Rate (LTIFR), are the most widely used lagging metrics. Other metrics mentioned were high-potential incident frequency rate, rail-safety events (for organisations involved in rail operation activities), critical incident frequency rate and utility strikes. Learning from incidents was considered to be the key benefit of collecting incident-related performance data.

Participants also explained that external government bodies and clients typically require lag indicators to be reported. However, a number of participants believed that there needs to be an emphasis on learning from the incidents rather than focusing on incident numbers and rates. For example, a contractor Executive General Manager commented that:

It's annoying that clients keep asking for them [injury rates] and that there's so much time and energy spent on how many injuries have you had. You go "Well that doesn't matter. What did we learn from them and what are we doing?"

Nevertheless, almost all the interview participants also indicated that they place more emphasis on leading indicators when it comes to H&S performance measurement. Furthermore, collecting data in relation to near-miss and high-potential events was identified as a way of enhancing the learning opportunities from negative events.

Some participants from client organisations indicated that their organisations have moved away from using TRIFR and have started using an All Injury Frequency Rate (AIFR), which includes fatalities, lost time injuries, medical treatment injuries as well as restricted work injuries and first aid injuries. As they explained, AIFR is a more comprehensive measure of injuries which allows for investigating trends in minor injuries. Further, because it includes all injury types, it is less susceptible to dispute (resulting from inconsistent interpretation of what is included in the measure) and under-reporting. For example, a client Deputy Director for Safety Operations explained that using AIFR increases consistency of reported data and helps to avoid arguments concerning injury classification that attempt to categorise some injuries as minor injuries rather than LTIs to reduce the number of reportable injuries.

It was also noted that including minor injuries in reported injury frequency rates can contribute to a better reporting culture and help with identifying H&S related issues. Although there is research evidence suggesting that minor injuries and serious injuries are likely caused by different underlying

factors, it was also noted that some high-potential events may lead to no injury or relatively minor injuries due to the particular circumstances in which they occur. Irrespective of the outcome, participants explained these events are important learning opportunities.

Notwithstanding support for its use, participants also pointed out that, in practice, the AIFR is inconsistently defined within the industry and therefore a standard definition is required to provide consistency about what types of incidents should be included in the AIFR metric. It was noted that what is currently included in AIFR varies between projects, even within some infrastructure client organisations, e.g. first aid injuries are not included in some AIFR calculations while they are in others.

Inconsistency of metric definitions was highlighted as a problem for data comparison and benchmarking in the construction sector. A client Senior Analyst explained:

AIFR is a nice one that is measured differently across different organisations. What we call an LTI might be different to what someone else calls an LTI so it does get a bit complex when you're trying to sort of standardise or measure or come up with a solution. Even though the KPIs may be the same the way in which we input it, the way in which we define it and the way in which we get that KPI might be different, slightly different ... [it] does make it difficult to compare because you're not comparing apples for apples.

A number of participants also noted the limitation of TRIFR and LTIFR in that these metrics are not sensitive to the severity of incidents because they combine all injuries in one metric and consequently mask the occurrence of severe injuries. To overcome this, some organisations already use, or intend to develop, additional measures that focus on consequences, such as time lost (e.g., days lost or hours lost per thousand days worked) or the financial consequences of injuries, e.g., in terms of the cost of the wages reimbursed as workers' compensation and the medical treatment costs within a 12-month waiting period. Another approach identified by interview participants was to allocate a higher weight to more serious incidents when calculating frequency rates.

In addition, collecting data in relation to incident severity and circumstances was considered to be beneficial for comparing events in different severity categories to better understand trends and contributing factors to severe incidents. For example, one client organisation is assigning tags to records in their incident management system to further break down the data, analyse patterns and identify sets of factors involved in particular types of incidents in their projects. Nevertheless, it was also acknowledged that incident descriptions do not come in a standard format and sometimes lack sufficient information which makes factorial analysis difficult. In addition, to identify significant patterns, data needs to be aggregated to the program level. As a client Delivery Safety Manager explained:

It's quite difficult to see patterns if you look from the project office level. And once you roll up to our level, they start to emerge, but some of those kinds of rare [incidents], but they're catastrophic, are very difficult to pick out of data itself.

Unreliability of injury frequency rates, due to inconsistency in categorising incidents and under-reporting, was highlighted by some participants as being a measurement challenge. As an alternative metric, a consultant Safety Director noted the usefulness of severity measures and suggested that measuring severity using workers' compensation data can be more reliable. The Safety Director explained that:

... one of the things from a lagging point of view that's still useful to probably look at in terms of the people space is thinking about severity and tracking severity. So we think the severity measure is quite a useful measure but it's not a useful measure for being predictive of where

your safety issues are...but it is I think a reasonable measure to understand whether you're improving in your safety performance or deteriorating in your safety performance. So it has a place in that space. The other thing that we like about severity is that we think severity should not be measured from safety statistics. You should only be measured from the workers' compensation data that's there. The experience has told us that the safety metrics are highly unreliable, highly manipulated and it's much more difficult to manipulate the workers' compensation metrics.

The Director further expanded on how the compensation data could be used, stating that:

We look at the time lost piece, so we generally use ... hours lost per thousand days worked out of that data. The other thing we look at is the financial cost in terms of, we combine two things being the cost of the wages that are reimbursed by the workers compensation and the medical treatment costs within a 12-month waiting period. So, no claims estimates, none of that, just a straight transactional data and express that as a percentage of payroll. So, what that gives you is something that scales up and scales down very readily.

Near miss and high-potential incidents

The majority of participants pointed out the importance of collecting and analysing near miss data and high-potential incidents. Apart from indicating gaps in risk management and risk controls, reporting these events was seen to provide a useful indicator of workforce engagement in H&S management. However, the definitions of high-potential incidents varied between organisations. Several participants mentioned that their organisations have developed specific definitions of what constitutes a high-potential incident.

One UK-based contractor organisation breaks down near-miss data into high-potential events (events which could lead to severe outcomes), close calls (events which could lead to less severe 'middle ground' outcomes) and hazards (potentials for harm which have not yet led to an adverse event). As the Safety, Health and Environment (SHE) Operations & Behavioural Management Director from this organisation highlighted:

The logic with that is – and we've got data over the last 10 years or more now to demonstrate this – is if we can increase hazard reporting, we see a drop off in accidents... [we] use that as what we call measure of workforce engagement.

The director further emphasised the importance of acting on the data to encourage reporting from workforce, stating that:

... so the principle being that if our workforce is engaged – as in, they're telling us what's wrong, then - and we act on it, obviously, so we don't just ignore it ... – then they're more likely to do the right things and tell us when things [are wrong].

Similarly, a client Head of H&S on a large construction program in the UK described a broad classification of near misses adopted on the program to encourage the workforce to have site-based conversations about things that were unsafe and report any improvement opportunities. Importantly, this also extended to opportunities to improve work-related health:

... for us, a near miss was not a biblical definition in terms of angels on the heads of pins. It was anything that you wanted to report that you thought wasn't quite right and could be improved ... The occupational health team, the hygienist, developed their 'near hit' reporting to do with exposures that was the equivalent of a near miss in safety terms.

Some organisations have developed measures based on actual incidents and potential incidents. One client/operator organisation has defined a measure of serious injury and fatality (SIF) which includes both events with the potential to cause a serious injury or fatality, as well as events that have caused

a serious injury or fatality. The proportion of the actual events to potential events is tracked and reported ($SIF_{\text{actual}} / SIF_{\text{potential}}$) as a lagging metric at an enterprise level. Further, as part of their new contractor safety management framework, the organisation is considering using KPIs based on SIF numbers and SIF rates (i.e., actual and potential SIF events as a portion of total events reported). The trend of the SIF rate will be monitored every quarter and is expected to be improved or maintained (i.e., not getting worse). An alternative SIF rate considered by the organisation is the number of SIF events per million hours worked. In addition, there will be a KPI based on the timeliness of hazard and incident reporting (requiring contractors to report hazards and incidents within 24 hours of their identification). A Safety Advisor from this organisation noted that the intent of the new SIF metrics is to focus on the events where the contractors were directly at fault, although it was acknowledged that, in practice, it would be difficult in some cases to decide which organisation is at fault. As the Safety Advisor explained:

The challenge with all of the SIF events - we really want to be focusing on the SIF events where the contractor was at fault or directly contributed to the SIF events occurring as opposed to be part of something or just happened to be on site at the wrong time. So, we're still working with our software development team and our project team in that field of the contractor module as to how can we identify which events the contractor actually contributed to versus which events they just happened to be on site for because we don't want to be penalising them for stuff that they just happened to be there but they couldn't have actually done anything to change that outcome at all.

The Client Safety Advisor also acknowledged the subjectivity in classifying events as SIF, particularly with regard to potential SIFs, and explained that a set of criteria (in the form of a decision tree) have been developed as part of their updated safety management system to classify incidents and events consistently. As the Safety Advisor explained, the SIF metric helps to focus on serious events and problems, although it was acknowledged that recurring minor events need to be noticed as well:

So, if we're looking to replace TRIFR with something, the actual or potential SIF events per million hours or per number of reported events gives a bit of an idea. Because, you know, if someone has 100 incidents but they are all pretty low level, is that as problematic as someone who has had five incidents but two of them were SIF? I don't want to penalise the company with 100 - except unless you start going, "well, you're not learning from stuff. You should have learned this by now, I don't know why you are continuing to have this many incidents".

Some interview participants mentioned that they require reporting of both high-potential incidents and high-potential hazards. As a Client Deputy Director of Safety Operations described, a high-potential incident involves an event that did not lead to severe injury or damage but which had the potential to do so. A high-potential hazard does not involve an event but can be an observed situation with the potential for serious harm. Further, the Deputy Director explained that reporting a high-potential incident is followed by an investigation, while reporting high-potential hazards is treated as a positive indicator.

Similarly, a contractor HSEQ Executive General Manager observed that high-potential incidents are followed up by three actions: a preliminary event notification and seeking immediate findings, an ICAM analysis and investigation report, and capturing lessons learnt in a repository which is being developed.

Another client organisation has developed a high-potential incident (HPI) index which comprises two components: lagging HPIs which are incidents with potentially severe consequences and leading HPIs which are hazards. It was argued that treating high-potential hazards as a leading indicator can incentivise hazard reporting.

3.2 Leading indicators

All the interview participants recognised the importance of using leading indicators in measuring H&S performance. A UK-based contractor SHE Operations & Behavioural Management Director noted their positive approach to H&S improvement by focusing on things that go right, rather than a focus on identifying problems, when defining H&S measures, stating that:

Over the last few years, we've really focused and stepped back on what is it that must go right in order to give us the performance we want, and as a result of that, that's what we're starting to measure now.

When asked about what leading indicators are used to track H&S performance on their projects, participants mentioned various leading measures and KPIs. These measures are grouped into the following 14 themes, and each will be discussed below. The discussion of each theme starts with a summary snapshot.

- Leadership engagement in safety
- Supervision
- Hazard reporting
- Risk management
- Assurance activities
- Incident investigation and lessons learnt
- Corrective actions
- H&S-related communication and workforce engagement
- Resourcing, capability and competency
- Training
- Innovation
- Occupational health and wellbeing
- Culture and its influence on H&S
- Collecting data and reporting performance

Leadership engagement in safety

Description	
This theme reflects the importance of active engagement in H&S by senior leaders. It includes quality of engagement with the workforce and shaping leadership behaviours to create a proactive environment for improving H&S.	
Key aspects	Evidence from interviews
Quality of the engagement	<i>...active field engagement by certain levels of leadership [involves] setting some requirements around their types of engagements both from a monthly measure.</i>
Conversations with the workforce	<i>You know, the senior managers have to participate in investigation or driving innovation</i>
Visibility of leaders on site	<i>how often are the leaders of the company, of the project, of the team, how often are they going onsite, are they visible, and are they talking about the safety on the project... the standard you walk past is the standard you</i>
Shaping leadership behaviours - creating the right environment to promote H&S	<i>... so if we want to change the workforce's behaviour, you have to change the supervisor; if we want to change the supervisor, we have to change the manager's behaviour; so on and so forth</i>
Leaders' influence in stopping unsafe work	<i>So, stop work orders are encouraged ... The aim is to encourage this behaviour particularly among senior people.</i>

Leaders' understanding of H&S priorities and their level of engagement in H&S management activities was highlighted as a key indicator of H&S performance by several participants. A client Safety Director explained:

So, for me that act of doing something and being committed to it is super important. ... Go out and tell me how well they're doing the pre-start, how well do they engage the workforce? You know, how are they talking to people on the site when things aren't quite right and getting them fixed? How are they engaging people? How are they enabling them? How are they making some of the systems on the job work for people? And often it's about the people having the background understanding of why they're doing certain things.

Frequently mentioned KPIs included tracking the frequency of safety leadership walks, leadership interactions with frontline staff, and inspections undertaken by the leadership team. For example, a contractor Managing Director referred to safety leadership walks where each of their project directors are tasked to go and visit a project other than their own. During these leadership walks, the leaders are expected to engage with the frontline workforce, listen to them and understand their challenges. The Managing Director further explained that, within their projects, members of the senior management team and supervisors are expected to participate in similar activities and the number of the activities is reflected in a Vigilance Index. When asked to identify what indicators of H&S are more effective, the Managing Director stated that:

I really strongly believe in leadership behaviours measure, and then how do you do that can be a bit subjective. But how often are the leaders of the company, of the project, of the team, how often are they going onsite? are they visible? and are they talking about the safety on the project? And I think this is, and it's cliché', but you know the standard you walk past is the standard you set...if you go onsite and you prioritise that and you engage with the people, you listen to them, and you make it clear to them that you're there to help them to make sure that they can work safely, this can change.

Some participants also noted the importance of ensuring the quality of leaders' engagements in health and safety and their interactions with the workforce, while also acknowledging difficulties associated with measuring the quality of these activities. Some organisations have adopted KPIs focusing on leadership visibility and engagement with members of the frontline workforce and require members of their leadership team and supervisors to document their leadership activities and their conversations with frontline workers and upload the evidence (e.g., inspection reports, photos, reports of conversations with workers and, most importantly, the outcomes of those conversations) to their H&S management and reporting platforms. For example, an alliance HSE Leader explained their KPIs which focus on active field engagement and include both quantitative and qualitative measures:

[Measuring] active field engagement by certain levels of leadership [involves] setting some requirements around their types of engagements both from a monthly measure, and then there's the other part of the measuring, which gets a bit around the qualitative stuff around the types of conversations, whether there's actions attached to that, whether there's curious conversation as to what that was about, was there follow up then, provided back to the workforce around what that observation was. They are a bit harder to measure and monitor. It would be best to say that, we haven't cracked the nut on those. We're certainly generating the fascination around that, rather than just the number and the score line.

Similarly, a client/operator General Manager of Safety, Environment, Risk and Quality mentioned that leadership H&S engagement KPIs are tracked at two levels in their organisation: at senior management level, and at project level. As the General Manager explained:

The level one is the CEO, the execs, and ... the GM level. And that is basically going on sites and having safety conversations and recording those safety conversations. So, it's a pretty basic set-up. You go on site, talk to the people on the ground, what are the hazards? what are the critical risks they're managing? any innovations that they've put in place, and also any pinch points that they see from a safety management system perspective, or anything that management or leadership can actually help them with. You record all that down, you take action, and progressively you demonstrate that sort of safety leadership through conversation, so that's one. Projects do it as a level two as well, so it's maybe two layers down from the Executive Director, and we do a similar process in which we go on site, we deliver safety moments, we have about six ways you can earn leadership points, ... You know, the senior managers have to participate in investigation or driving innovation. A whole bunch of things other than just site visits.

The General Manager explained that senior management (at level one) has a specific target for the frequency of engagement activities (e.g., once per month), while at level two, a point system is used where more points are given to more impactful activities. For example, running and completing an initiative to improve safety will earn a higher score than delivering a safety moment on a monthly basis. Thus, at divisional and project level, leaders and managers can exhibit their leadership skills in various ways. Regarding the frequency of data collection and evaluation, the General Manager added:

We measure that, on a fortnightly and monthly basis, just to get an indicator on how well we as a leadership group are performing in that aspect. And it's taken quite seriously. If we don't hit our target, definitely it gets focus from the Exec Director and the leadership team under him.

Some organisations have put programs in place that aim to shape leadership behaviours. One UK-based contractor organisation has developed a program that is focused on how managers and supervisors create the right environment for promoting H&S. This requires behavioural interventions at various organisational levels. As the SHE Operations & Behavioural Management Director of this organisation explained:

So, a big piece of the behavioural program is behaviours contingent on the environment we find ourselves ... Our supervisors don't tend to change, so our leaders don't tend to change that much, so we really focus on their behaviour working with our workforce to create those great environments to make it more likely they'll get hazard observations reported. So, if we want hazard observations reported by the workforce, I've got to get the supervisors to speak to the workforce and say, "Well, you've told us this, and we've done that. Thank you very much"; it might put an incentivisation mechanism to get it going. So, you know, best observation this week is from Fred and here's a five-pound voucher. So, it's what environment will it create because we work on the premise that if I want to change my children's behaviour, I probably have to change my behaviour first, so if we want to change the workforce's behaviour, you have to change the supervisor; if we want to change the supervisor, we have to change the manager's behaviour; so on and so forth. So, we really focus on creating that right environment to actually get the behaviours that we want.

This Director further described how the behavioural program focuses on shaping the behaviour of directors and managers throughout different organisational levels. The director stated:

We really look at the different levels, so we have SHE executive committee with the board, then we have divisional meetings, sector meetings, and contract meetings. So, we're looking at actually shaping the behaviour of the directors right the way through ... We have what we call interlocking behaviours, we call it behavioural contingency, I think the correct terminology is, but what we're starting to look at now at the divisional meetings is measuring those behaviours. So, are the sector directors having those [H&S management] conversations? Are the managing directors having the conversation with sector directors? So, we're starting to measure the things that we want to happen more and more.

A Hong Kong-based contractor organisation has developed a suit of proactive leadership KPIs which are used to assess leaders' safety-related behaviour and engagement in H&S promotion. As the Director of Sustainability, Health and Safety of this organisation explained, the KPIs were developed, through an iterative process, by considered what proactive actions project leaders and senior team members should be taking to promote H&S. The KPIs include: leaders' engagement in positive safety conversations with frontline workers, method statement peer reviews, temporary works peer review, proactive frontline risk reviews, actively encouraging the report of "bad news" / issues requiring urgent attention, and leaders' effective use of Stop Work Orders.

The influential role of leaders in stopping unsafe work was particularly highlighted by two participants. While explaining the significance of Stop Work Orders, the Director of Sustainability, Health and Safety of the above-mentioned contractor organisation noted the role of "real guys" on their projects, stating that:

So, stop work orders are encouraged, particularly with "real guys". Real guys are people who have disproportionate influence at sites, not all supervisors, not all subcontractor bosses, but people who have influence over others, they are encouraged to stop work and raise the issue and have a conversation with the engineer and safety officer when they see something is wrong and look at the risk assessment method before carrying on again. The aim is to encourage this behaviour particularly among senior people.

Similarly, a client Safety Director noted the benefit of Stop Work Orders made by managers in that they allow for a re-set of the work process and reinforce the importance of safety on site. The Director stated that:

So, there have been occasions there where alliance managers have had to make the call to actually stop occupations and put the program at risk to reset the workforce, and they've done it. They've actually pulled up the occupation and simply said, "Everyone in the sheds for a couple of hours. We're going to come round and talk to you all", and say, "You're in the sheds because safety is more important. We want you to sit down, read your SWMS, have a conversation amongst yourselves about how you're going to work safely, and we'll talk to you as well, but you working safely is more important than the occupation. We're stopping the job for two hours." And sometimes that reset has been really powerful. People realise they can do their jobs, but they're not going to be held to account to work – to deliver on time if it means working unsafely.

The above quotes indicate the influential role that leaders play in highlighting the importance and priority of safety on sites. Throughout the interviews, several participants reiterated that leaders set an example for the workers both through their own behaviour and through the conversations they have with frontline workers. Yet, it was also noted that establishing the right behaviour on construction sites takes time and needs a supportive organisation culture.

Supervisors

Description	
This theme reflects the importance of the supervisors due to their proximity to the workforce, in creating the right environment and actively engaging with the site.	
Key aspects	Evidence from interviews
Important role of supervisors	<i>They're so important, the supervisors, in terms of the best sites always run are the ones that have the best works managers and general foremen on, without a doubt.</i>
	<i>... the supervisor is actually fundamental in creating the right environment</i>
Engaging with the workforce	<i>... if they do see something that's significant enough or bothers them, they'll usually tell their general super or their supervisor or their team leader.</i>

The role of supervisors in promoting good H&S practices on-site was identified by several participants. A contractor HSE and Sustainability Director noted that:

They're so important, the supervisors, in terms of the best sites always run are the ones that have the best works managers and general foremen on, without a doubt. So, if we're not working with them, developing them, we're not going to have good sites.

A UK-based contractor SHE Operations & Behavioural Management Director mentioned the Frontline Supervisor Protocol that they have developed in their organisation. Based on the protocol, all supervisors are assessed and scored by senior management against a set of criteria on an ongoing basis. As the Director commented: *"It's almost used like a mini-improvement plan to develop them to get them where we want them to be."*

In addition, referring to a H&S performance index on a large infrastructure project in the UK, this Director stated:

I do like the [measures] back from line supervisors training because, again, it goes back to this premise that the supervisor is actually fundamental in creating the right environment. But the bit that I worry sometimes, we focus that much on a supervisor we forget that the supervisor is just a function of the environment of the manager, so got to be a little bit careful there.

The interview participants also mentioned some key attributes for effective supervisors, including the ability to step up and lead by example, as well as identifying unsafe behaviours and taking actions to resolve issues with their team directly rather than being reactive in waiting for safety issues to arise before pointing them out. In addition, the role of supervisors in engaging with the workforce and hearing their concerns was noted. This was echoed in the comment made by a contractor General Manager HSESQC. When explaining mechanisms through which workers raise H&S concerns, the general manager commented:

... as much everyone thinks everyone's got a smart phone, everyone knows how to use it, there still is a relatively low literacy in our industry... Most of [the workers], you know, they're at work at 6am. They just want to do the work and they want to go home and if they do see something that's significant enough or bothers them, they'll usually tell their general super or their supervisor or their team leader. They're not going to use an app or a tool or go into an incident database and raise it. They're just going to verbally do it.

This comment also highlights the workforce's preference to use verbal communication over other means if reporting hazards that involve the use of technology and writing.

Hazard reporting

Description	
This theme reflects the importance of hazard reporting and responsive action.	
Key aspects	Evidence from interviews
Positive indicator of a good H&S culture	<i>The hazard reporting, that's a great indication about how the project is and the mindset of people on the project</i>
Hazard reporting and safety culture	<i>We look at hazard reporting, that's a big indicator for us, and the more hazards that are being reported, we see as a positive</i>
	<i>... we've got data over the last 10 years or more now to demonstrate this – is if we can increase hazard reporting, we see a drop off in accidents.</i>
Proactively addressing hazards	<i>...we're moving people from just telling us things to actually taking ownership and fixing it and then telling us about it</i>

A number of participants identified hazard reporting as an important and positive indicator of a good H&S culture, workforce engagement in H&S, and a precursor to reducing incidents. The importance of hazard reporting was echoed in the comment made by a contractor National H&S Manager:

The hazard reporting, that's a great indication about how the project is and the mindset of people on the project... a drop in hazard reporting will always lead to an increase in incidents ... when you're investing in reporting hazards and getting the culture right and people are doing that, the lag indicator just follows and your injuries drop. So, I just wish the clients could really get that.

Similarly, a contractor Executive General Manager HSEQ noted the link between hazard reporting and safety culture by stating that:

We look at hazard reporting, that's a big indicator for us, and the more hazards that are being reported, we see as a positive. Not that the job has a lot of hazards, but we're seeing it as a really good safety culture, so we're measuring the culture on our projects.

This Executive General Manager further highlighted the relationship between hazard reporting and incident rates by stating that:

When you see the hazard reporting drop, there is a definite correlation with the increase in the number of recordable injuries. We follow that. We produce a graph on that and that's a pretty typical thing to follow but absolutely, a drop in hazard reporting will always lead to an increase in incidents.

Similarly, the SHE Operations & Behavioural Management Director of a UK-based contractor stated that “we’ve got data over the last 10 years or more now to demonstrate this – is if we can increase hazard reporting, we see a drop off in accidents”.

They went further and explained that they have developed a measure for “observations” to encourage their workforce to go beyond reporting hazards by proactively addressing them:

A hazard is “I have seen it and I have reported it”, but as a safety observation it will be “I have seen it, I have sorted it and have reported it”, so it's like a proactive hazard, or it could be a good idea, and the basis of that is that we're moving people from just telling us things to actually taking ownership and fixing it and then telling us about it - so we're seeing the hazard observation split over the last two years kind of tip more towards observations rather than hazards. ... [We] also breaking them down into who is reporting the hazards and observations ... the worker, the supervisor, the manager.

An important consideration in this approach is to ensure that workers are not held responsible for ‘fixing’ problems that are outside their control and that require managerial intervention.

Further, when asked about how to ensure the quality of reporting hazards and observations, the Director noted the process through which the desired reporting behaviour was shaped in their organisation, explaining:

When we first started the hazards and observations reporting, it was definitely a numbers game. I'd have things like, “I bought an apple from the canteen. It still had a sticker on it. I could have choked on it.” You know, it was stupid stuff. But that's going back 10, 15 years when we really started to drive this, and it's recognising that we have to start with a numbers game, get the numbers up, and then we can switch to quality, and then we can switch to – and it's that shaping process that we talked about before, so little shaping steps.

Risk management

Description	
This theme reflects an emphasis on proactive and ongoing risk management to deal with the dynamic nature of managing H&S in a project context.	
Key aspects	Evidence from interviews
Risk anticipation and proactive risk management	<i>It's really about working upstream in the design and the methods phases of the work ... to eliminate those safety risks, but also being mindful that things onsite can change... when you are preparing your method statement.</i>
Reviewing critical risk controls	<i>We try, and we've come a fair way in terms of the promotion of identifying whole points around critical risk in the field, all from a system point of view. Assessing system controls and field controls</i>

The majority of participants indicated that apart from tracking the completion of actions to address reported hazards, they also track the frequency of critical-risk control inspections. Several participants mentioned that their organisations have documented “critical risks” which are subject to proactive risk inspections. Ensuring the effectiveness of the critical-risk controls was identified as a key H&S indicator, with most organisations putting in place KPIs that track the involvement of the frontline workforce and management in risk control review and assurance activities. For example, a client/operator General Manager for Safety, Environment and Risk mentioned that they track the frequency of proactive critical-risk inspections as a leading indicator. Likewise, a client/operator Safety Strategy and Systems Manager explained that their newly introduced critical-risk control management program involves “*infield observations of controls, and looking at both frontline people doing observations, but also line leadership going out and verifying whether controls are in place and effective*”. This General Manager further explained that they also track any actions arising from the inspections, and while currently the focus is on the on-time completion of those actions, their intention is to ultimately also assess the effectiveness of the actions:

“So at the moment, we just measure whether an action is overdue, or has been completed as a result of something. Where we’re now moving towards actually verifying is that action in place, and has it had the impact it was intended to?”

Several participants noted the importance of risk anticipation. A contractor Senior HSE Manager explained that they use a “30-60-90 day risk review” process where they look at the work coming up in 30 days, 60 days and 90 days in the project plans, identify key risks and ensure they are effectively controlled. This involves embedding risk assessment and assurance activities in the work plans. Subsequently, once each of the 30-day, 60-day and 90-day milestones are completed, a review process is initiated to assess the risk management performance and compare the way work was done to what was planned to identify what worked well and what did not. Emphasising the proactive nature of this risk management process, this Senior HSE Manager noted that the 30-60-90 assessments change the H&S performance management paradigm so that there is a “*complete shift from the lag data being the catalyst for change to the lead data being the catalyst for change*”.

Similarly, a contractor National EHS Operations Manager described a campaign, which is focused on managing acute risk on their projects. The campaign involves the construction manager and site manager undertaking weekly and monthly individual safety walks identifying upcoming high-risk works

in the next quarter or next 90 days. The outcomes of safety walks are then reported on the organisation's global reporting platform and a mitigation strategy is required to be attached to the reports which are then reviewed by the regional managers and the operations managers. As the National EHS Operations Manager commented: "[This campaign is] a very, very good initiative, you're getting three months ahead, you're looking ahead."

Other participants described similar risk anticipation approaches in their organisations. A SHE Operations & Behavioural Management Director of a UK-based contractor referred to their Contract Targeted Risk Management (CTRM) process that involves looking at the significant risks coming up on their projects in a month and ensuring the effectiveness of controls for those risks. As this Director explained:

We used to have a simple walk round check sheet which – it was a tick-box exercise. But now this is giving us a really rich source of data because if we really drive the behaviours around this and get it right, hopefully we won't have the incidents because we'll pick it up nice and early, put the fix in place, understanding why, and so on and so forth..... so we've been having a real drive on this in the last four months, so we've got, "are we doing what we say?", percentage of CTRMs being carried out, average actions by CTRM and number of CTRMs per 100,000 hours.

Likewise, a contractor Managing Director mentioned "risk anticipation" as a pillar of their H&S strategy. This Director went on to explain how risk anticipation enables the workforce to deal with the changing nature of a construction site by ensuring that critical-risk controls remain effective and stop unsafe work:

It's really about working upstream in the design and the methods phases of the work to as much as possible, eliminate those safety risks, but also being mindful that things onsite can change. So that we have a big piece at the moment around change management and we want our people to instinctively stop. Life on a construction site is dynamic and it will always change from what you expect when you are preparing your method statement, etc, etc. So, we want our people to be really conscious of that and there's nothing wrong if something changes, but the first instinct needs to be to stop, go back to your methods, go back to your design, etc, etc, and reassess the risks before you start again.

An Alliance HSE Leader noted the positive view that is encouraged in their organisation in relation to identifying hazards and critical risks. This positive view involves seeing identified hazards and risks as improvement opportunities, focusing on effectively addressing them and learning from them. The HSE Leader explained that:

We try, and we've come a fair way in terms of the promotion of identifying whole points around critical risk in the field, all from a system point of view. Assessing system controls and field controls. But very much couching that as positive interventions, where we have a no go, for instance. If there's a critical risk or if there's a hazard in the field that we identify that, that's positively intervened or there's corrective action upon it, at the time or there's a stop to reassess. The fascination around that is, what did we learn from that? It's not the fact that we've identified it but it's what did we do? How did we respond? How do we communicate the learnings? It's been shifting that conversation around the number... Shifting fascination around zero. So, zero and green doesn't drive curiosity. It doesn't drive fascination. But identifying things where we've identified opportunities to improve that, drives a positive conversation which drives a curious conversation that we ask and we've done a lot of work, our lead is to try and program [our staff] or rewire them to be responding and asking those questions, not looking at just the number.

Overall, the above quotes highlight an emphasis on proactive and ongoing risk management in the interviewees' organisations to deal with the dynamic nature of managing H&S in construction projects.

In addition, the quotes indicate the presence of a continuous review and learning process embedded in H&S risk management, where the effectiveness of critical risk controls is frequently reviewed and opportunities for improvement are identified.

Assurance activities

Description	
Assurance activities theme reflects the need to ensure processes are followed and high standards of H&S are maintained.	
Key aspects	Evidence from interviews
Quality of assurance activities	<i>...when people are asked to do those [assurance activities], they generally do it in the most accessible area at the easiest time of the day.</i>
Corrective nature of the inspections	<i>It's more of a, "I've identified this gap, I've had a conversation with this responsible person on site, and we've rectified it... And the more you do that...you get the education benefit.</i>
Focus on workforce engagement	<i>It's about making sure people are going out on site and looking at the right things at the right time to reinforce the behaviour that we want</i>
Positive reinforcement	<i>...if we go out and report an inspection and everything's absolutely spot on, we should be recognising that and making notes about that and telling people, "Great job. Thank you very much".</i>

Most participants stated that their organisation records the number or rate of inspections and audits done on their projects. Several participants mentioned that their organisations measure the frequency of inspections that focus on specific critical risks. Furthermore, the importance of checking the quality of assurance activities was highlighted by a number of participants. A client Director of Safety stated:

My experience has been that when people are asked to do those [assurance activities], they generally do it in the most accessible area at the easiest time of the day. They may not be doing it at night shift. They might not be doing it in confined spaces or nooks or crannies or things where it's a little bit more challenging to look at. So at the moment, we're just... the receiver [of the information], maybe if that's the right word. But we are looking ... at ways to give us confidence of the quality of those inspections.

Some interview participants explained approaches that they use to ensure the quality of audits and inspections. A contractor Executive General Manager HSEQ mentioned that although they record the number of audits, they tend to keep the audit procedures simple and minimal to avoid a tick-box exercise and they verify audit results with onsite checks. Similarly, an OHS&E Manager suggested verifying internal audit results with external third-party evaluations.

A UK-based client Head of H&S described how audits were used as a mechanism to verify the effectiveness of risk control solutions and improvement actions across a large construction program. He stated that:

The way that we close the loop was that we said, "Here's a problem. Here's a solution we've agreed on. We'll continue to monitor because the solution might not be right and it may need to be amended in the light of experience. But here's a solution. We all agree to implement it," and then the audit program carried out on behalf of the client and obviously the contractors had their own internal audit arrangements, but to drive it through their supply chain, the audit program closed the loop by reporting that it had been done.

A client/operator General Manager for Safety, Environmental, Risk and Quality mentioned a rail safety inspection program which involves coaching to improve compliance with safe work procedures. The program was implemented after the organisation's H&S performance data indicated an increase in breaches of these procedures. As the General Manager explained:

I think before we put in our rail safety inspection program, probably we saw a lot of safe working breaches, so breaches to our safe working procedures, so just basically procedures on how to manage working in a railway, on site. Once you start intervening with a rail safety compliance inspection program, then the inspection program is there to identify where, on the ground, we've got the issues, but also where you find the issues, the person doing the inspection can actually coach and remedy that issue there. So, we've been seeing that safe working breaches trend drop, quite dramatically actually, and also we use it as a coaching element as well, for the people on site. So that's another initiative that we've reached in, we've seen the problem of our safe working breaches being over the limit, where we've set, and we've focused more on doing more of those type of inspections and coaching programs.

Further, emphasising the corrective nature of the inspections, and the focus on workforce engagement, the General Manager added:

It's part of the compliance inspection process, so it's done by a qualified person, and part of it is to remedy what they find on site. So it's not about just, "Oh, hang on a minute, I've identified a gap." It's more of a, "I've identified this gap, I've had a conversation with this responsible person on site, and we've rectified it." And the more you do that, I guess you get the education benefit, as well as data to support where we need to concentrate ... because we just didn't want to seem as though we're just slapping people on the wrist. We want to make it a proactive engagement.

A client Director of Safety explained the benefits of using a set of questions during inspections of critical risk controls. It was noted that the questions provide consistency in how the inspections are undertaken and help to collect details of any breach which can be used to identify frequent breach types that may signal underlying issues in the safety management system. The Director described the process as:

I use the example people and plant interaction. You'll probably find as you do these studies, people come back and say, "We had ten breaches of people and plant interaction." What this does is go to the next level. There's a suite of questions, and one of those questions might be, "Was there a plant operating zone in place?" so rather than just looking at this data and say, "We've had breaches of people and plant interaction," the dataset will come back to say, "We went out and asked this question a hundred times, and ten times the question was answered in a negative response, so there's a bit of concern there," or, "We've gone out and asked this question a hundred times, and a hundred times, people have said that there's been a plant operating zone in place, so that's okay."

Further, the Director emphasised the benefit of using questions, stating that:

"[The questions] really drill down where you look at a lot of inspection information and they'll say, "Yeah, 30 breaches in relation to working at heights," but instead saying, "Well, in relation to working at height, but the scaffolding wasn't in place." So to really identify the critical pieces of information that will prevent a fatality."

A number of participants emphasised the importance of senior managers and executives engaging in site visits and walk arounds. A client HSEQ Executive General Manager noted that management site visits are recorded in Visible Management Reports and senior managers are scored for the site visits that they conduct. A contractor HSE and Sustainability Director observed that requirements are sometimes put in place in infrastructure projects for a certain number of site visit reports and point-to-point risk assessments to occur. Reports of these are then reviewed and evaluated by the senior leaders and feedback is provided to site management personnel.

A UK-based contractor SHE Operations & Behavioural Management Director emphasised the role of site visits and inspections in reinforcing positive behaviour:

It's about making sure people are going out on site and looking at the right things at the right time to reinforce the behaviour that we want. So we talk a lot about reinforcement, so within the behavioural field we call it positive reinforcement or negative reinforcement – you do something because you want to, or you do something because you have to. Actually, an inspection at best is probably 'have to', but what we've got to get people in going out there, it's not just about finding things that are wrong, it's also finding things that are right. And, yeah, if we go out and report an inspection and everything's absolutely spot on, we should be recognising that and making notes about that and telling people, "Great job. Thank you very much." Equally, if things aren't right, then we need to fix them and hold people to account and the other side of that as well.

A contractor Senior HSE Manager noted that their organisation considers assurance activities as a positive measurement, as they tend to focus on identifying positive aspects of work (i.e., what has been done well) which drives initiatives and programs that support continuous improvement. Likewise, a Contractor National EHS Operations Manager explained that safety observations undertaken by their frontline supervisors and engineers include both good and bad practices. The organisation tracks the frequency of safety observations as a leading indicator. In addition, the organisation tracks the completion of any actions arising from assurance activities (EHS observations, audits, etc.) with the target of closing all actions within 14 days.

Similarly emphasising the importance of positive measures, a client Safety Operations Deputy Director commented that a lead indicator on their projects is the number of visits by regulators that do not result in an action being taken against the project. The measure is compared with the rate of improvement notices issued by the regulator, i.e., % of regulatory visits that lead to an improvement notice given by the regulator. As the Deputy Director explained:

The reason we treat that as positives is because obviously, WorkSafe inspectors do give improvement notices. So, if we're only reporting improvement notices and then, all I get is people going "Oh my God, [their project] had five improvement notices this week". Yeah, that's okay, but they've had 50 visits. So, that's only down to 5%. So, let's get into reality. So, anything we get negative on, we try and counteract it with a positive to show that there's an even marking coming through and it also, gives us an idea if there is [sic] issues with projects that they're spiking and having bad incidents or recurrence of problems on site.

Incident investigation and lessons learnt

Description	
This theme reflects a focus on learning from incidents and sharing lessons between projects and program participants.	
Key aspects	Evidence from interviews
Open and honest conversations	<i>I found [incident debrief sessions] to be extremely useful because when you have to speak out loud about what's happened, and you have to tell us, it has a lot of these lightbulb moments</i>
Ensuring the quality of investigations & recommendations	<i>So we want to be saying the right things, and not making assumptions on some of those failures.</i>
	<i>... we measure the quality of those investigations on a red, amber, green kind of scale, and that's – so that's another one of our lead indicators</i>
Sharing lessons and improved safety practices	<i>The leadership program was a mechanism by which you could take an individual issue that had arisen on an individual project and raised it to the level of the generic response across the whole program to address it.</i>

Several participants stated their organisations measure the frequency of accident and near miss investigations and use the findings from investigations to improve their H&S performance. For example, a contractor National EHS Operations Manager noted the requirement in their organisation that all critical incidents need to be reported within 48 hours of the event using their global reporting platform, followed by incident investigation and then reporting the outcomes within 30 days. The lessons learnt are then shared across the organisation to inform the development of new controls across all operations.

Participants noted several factors in relation to the effectiveness of investigations including ensuring the timeliness of investigations, the quality of recommendations from investigations and sharing findings. A client Safety Advisor mentioned that they have put in place a KPI for contractors in relation to the timeliness of investigations and reporting outcomes. Another client/operator General Manager for Safety, Environment and Risk mentioned that they use leading indicators that track whether investigations are done on time, quality assessments of investigations are done on time, and actions arising from investigations are closed on time. The General Manager further noted specific meetings conducted to discuss incidents, ensure the incident reports include sufficient details and decide follow-up actions. As the General Manager explained:

We do have those forums to ask questions, as a group of safety professionals, of the project, that have had those incidents, and making sure that, one, they're followed up, and two, they've reported the right thing, and also if it warrants getting them to review their risk assessments or getting them to do their investigation formally. So we do have that, to make sure that the quality of what we're getting is to a certain level, as well... So we want to be saying the right things [when reporting to the regulator], and not making assumptions on some of those failures.

A client Deputy Director of Safety Operations mentioned that for significant incidents and high potential incidents and hazards, the contractors are asked to provide a full ICAM report and a narrative, and present the findings in a leadership meeting, where open and honest conversations

take place about the incident circumstances and opportunities for improvements. The meeting normally takes place within 20 business days of the incident and involves the contractor senior managers to provide a debrief of the incident scenario to the client team in addition to the incident report. The Deputy Director went on to express: *“I found them to be extremely useful because when you have to speak out loud about what’s happened, and you have to tell us, it has a lot of these lightbulb moments.”*

The Deputy Director further referred to the observance of ‘Chatham House Rules’ in the meetings to encourage open and honest discussions about the incidents and lessons learned. The Deputy Director stated:

I see those as being really positive and powerful, and I treat them as a lead indicator because I do believe that it then has action because the Project Director’s going to go “Guys, we need to look at this. We can’t do that”. So, hopefully that may transfer to another area and if that prevents an incident in another area, then it’s a win.

A client Safety Delivery Manager stated that investigation findings are used to produce fact sheets for safety advisors to inform their conversations with the workforce, develop improvement actions and monitor control measures. Conversations with the workforce were identified as being critical to ensuring that important information is disseminated to those who need to implement improved ways of working.

A UK-based contractor SHE Operations & Behavioural Management Director described how they used performance indicators to proactively and progressively improve the effectiveness of incident investigations:

We measure accident investigations, so each significant investigation ... I will score each one of those investigations in terms of quality of the investigation and in terms of the recommendations and actions that come out of the bottom end. Now, we do a lot of what we call ... Shaping, so year 1 when we started looking at investigations, they weren’t being done on time in full, so year 1 the measure – yes, we measured about quality, but the main focus was to get them done on time and in full. Year 2, once we fixed that, was about getting the quality of the investigation up. Year 3 was still about that but we started to focus more on the recommendations, and now we put greater weight on the recommendations ... So within that metric we measure the quality of those investigations on a red, amber, green kind of scale, and that’s – so that’s another one of our lead indicators.

A UK-based client Head of H&S emphasised the importance of sharing findings across projects in a large construction program. As he explained, the leadership team, which included representatives from all contractors that worked on the program, met monthly and discussed H&S matters. The team took solutions informed by incidents from individual projects and discussed these at monthly leadership meetings to ensure lessons were shared and improved safety practices were implemented program-wide:

The leadership program was a mechanism by which you could take an individual issue that had arisen on an individual project and raised it to the level of the generic response across the whole program to address it.

Corrective actions

Description	
This theme reflects the need to track the timely completion of corrective actions when problems are identified.	
Key aspects	Evidence from interviews
Tracking the corrective action	<i>So any action that we have, whether or not it's an improvement initiative that's an idea from someone, or it's come out of an activity, such as an assurance activity or an investigation, we'll be able to track all of those things.</i>

A number of participants indicated they track the timely completion of corrective actions in their projects. For example, one client/operator organisation specifies timeframes for the completion of corrective actions and requires contractors to complete at least 95% of the corrective actions assigned to them within the required timeframe. As the client/operator Safety Advisor commented:

I'm a bit of a fan of the corrective action management because it's showing – to me – it's showing someone's commitment to improvement ... I like the corrective action management because it's quite tangible and it shows us working together with contractors, but it also shows how willing they are to work with us and it also helps us get a bit of a sense of how much they value safety as well.

Similarly, a client/operator General Manager for Safety, Environment, Risk and Quality described tracking the completion of actions that arise from incident investigations and following up overdue actions on their projects weekly:

So we get incident reports. It could be hazard, an occurrence, an event, an accident. Actions come out, if they're immediate actions, they would have been done by the time the report's entered into the system. But if there's a level of investigation that comes out of it, either a risk review or a level two and a level one investigation ... we do track them. And Execs, I think, track level one actions closures, so it's quite serious. It's tracked and we send out weekly action closure reports to the project teams, and make sure that we report on close-to-overdue actions, so there's follow-up. So we do take action closure pretty seriously.

Another client/operator Safety Strategy and Systems Manager described the adoption of a broad-based metric that tracks implementation of improvement actions that arise from assurance activities, investigations and other improvement initiatives:

We're also introducing a Safety Action Plan implementation measure. So [we are] trying to get a leading indicator into our measures, where we come up with initiatives on how we're going to improve safety and track progress against those particular initiatives, ... it'll look at any type. We've just implemented a new system that gives us better oversight of all of our actions. So any action that we have, whether or not it's an improvement initiative that's an idea from someone, or it's come out of an activity, such as an assurance activity or an investigation, we'll be able to track all of those things. So we're looking at both proactive intervention, but reactive intervention as well."

H&S-related communication and workforce engagement

Description	
This theme reflects the importance of maintaining effective H&S-related communication between managers, supervisors and workers.	
Key aspects	Evidence from interviews
Developing the capacity to engage in conversations	<i>the idea is that we really tried to create an environment in which all of the team has an opportunity to get together and to share what's coming and how it will be executed safely</i>
	<i>... this is a challenge because it requires certain skills of the people, not just technical skills, but communication skills as well, on how they are able to interact and to share that with the frontline guys, and this is not easy.</i>
	<i>My main role was to maintain a conversation about health and safety with everyone, with workers, with supervisors with managers</i>
Effectiveness of SWMS	<i>we developed this thing called a Simplified Safe Working Procedure which is very much more pictorial, simple sketches, etc., to try to make it easier to really explain to the guys how things should be delivered safely</i>

The frequency and quality of H&S related communication was identified as a key factor in effective H&S management. A client Safety Director underlined the importance of developing the capacity within the workforce to engage in conversations about safe work methods and procedures. Similarly, a contractor Managing Director explained:

So, we want to have much more interaction between the frontline guys delivering and the guys who are preparing the work. So, we are measuring now the number of ... toolbox talks or task launch meetings, but the idea is that we really tried to create an environment in which all of the team has an opportunity to get together and to share what's coming and how it will be executed safely. And this is a challenge because it requires certain skills of the people, not just technical skills, but communication skills as well, on how they are able to interact and to share that with the frontline guys, and this is not easy.

Other measures noted by the participants include tracking the frequency of H&S Committee meetings and the type of issues discussed in these meetings and other ways of involving workers in H&S-related communication, e.g., workforce participation in the development of simplified Safe Work Method Statements (SWMSs) and providing opportunities for the workers to raise issues and receive feedback. One Hong Kong-based contractor Corporate Safety Director highlighted the importance of involving frontline workers in developing SWMSs and explained the process implemented to improve the usability of their SWMSs:

We were really saying well, is this document [SWMS] really going to help the guys deliver the work safely onsite? And going back a few years, more often than not the answer was probably no. So, we've moved really towards, and we developed this thing called a Simplified Safe Working Procedure which is very much more pictorial, simple sketches, etc., to try to make it easier to really explain to the guys how things should be delivered safely.

Maintaining H&S-related conversations was considered a key success factor to safely deliver a large construction program in the UK. As the client Head of H&S explained:

My main role was to maintain a conversation about health and safety with everyone, with workers, with supervisors with managers. The more that people were talking about what could make this a healthy and safe site, the less they were reliant on me being a bloody genius or a layer of geniuses working out what the risks were, and the more that they were sharing their knowledge about risk and how it ought to be managed. And it was that collective effort that made it the safest and healthiest program that the UK had ever seen on a construction program.

The following example indicates how structured conversations were conducted with the workforce to understand how work is actually performed (which may deviate from formal documented processes) and to inform H&S improvement actions to cope with situational contingencies.

Example - An Alliance HSE Leader explained a process aimed at promoting workforce engagement in H&S by having conversations with them, understanding their perspectives and providing feedback in relation to the issues they raise. As the HSE Leader noted, conversations with workers are important in understanding how activities are undertaken and identifying the gaps between work as performed and work as imagined:

There's some ways you can structure the conversation, most of it is sitting down with the workforce, understanding from their perspective what's working well? What's not working well? What are the positives? What are the opportunities for improvement? And agreeing collectively on some actions or responses to that, in a way that's quite informal...The key to that conversation being the follow up so, that they actually see, and this is what we try and measure too ... We try and not just measure the fact that we've engaged with the workforce. We've captured that information and we promote that fascination around the activity that we're closing the loop on that.

If there's an agreed action, we actually come back to the workforce to say, we've evaluated that. On this occasion we can't do that but we're going to try and do this. We think that's a great idea. Thanks for that and we'll try and work around that, as an action. We call it a 'collective insight' process, fundamentally, it's exploring the gaps where work is done versus where work is imagined. It's a really great tool for getting that more granular workforce perspective. Not just our perspective on what's working well and what's not working well.

And that then triggers, so that then pours through a measure of safety, it's a positive indicator in the way we report our performance around how many types of those engagements have been undertaken per month? Have there been actions that have been part of those conversations? How are we going in terms of closing that loop, in terms of going back to the workforce? You're grabbing trust, so when you go back to have the next conversation it's powerful

The HSE Leader further emphasised the opportunity for identifying improvement initiatives through workforce engagement by adding:

When you sit down and have the conversation around, imagine work like this. But this is actually what is occurring onsite, understanding what the challenges have been. Understanding some of the workarounds. We work in a complex environment. Some workarounds create risk but some workarounds are actually not workarounds at all, they're actually an inherently safer way of doing something.

Alliance HSE Leader

Resourcing, capability and competency

Description	
This theme reflects the need to ensure the adequacy of resources and workforce capability to undertake work in a healthy and safe manner	
Key aspects	Evidence from interviews
Importance of resources in delivering good outcomes	<i>... we have a monthly project review and there's a question in there specifically that the project gets asked about, "do you have adequate resourcing" just to make sure that they are addressing it.</i>
Role clarity	<i>You're going to have a good outcome on a project if it's fully resourced and you've got people on the job who understand, are very clear about their roles, and what they have to do.</i>
Competency	<i>We've set a minimum requirement scope for each of the defined competency requirements and we'll be tracking them against and getting them to provide us evidence...</i>

Interviewees noted the positive impact of having a well-resourced project with appropriately skilled, experienced and capable workers at all levels. A contractor HSEQ General Manager explained:

You're going to have a good outcome on a project if it's fully resourced and you've got people on the job who understand, are very clear about their roles, and what they have to do...So that would be an indication of a good project for health and safety.

The Executive General Manager further described how their organisation monitors the level of resourcing in their projects:

We've got a safety capacity index which we've just started using and the resourcing is part of that so we ask the question – we have a monthly project review and there's a question in there specifically that the project gets asked about "do you have adequate resourcing" just to make sure that they are addressing it. What we're doing, we're starting now to look at that and look at the lag indicators and see do we have projects and does it correlate that where you haven't got the resources that you intended originally, are we seeing an increase in injuries or an increase in incidents happening – maybe not injuries but that sort of thing. So we're trying to see if there is that correlation happening. Generally, and I can't give you numbers around it, but generally that is absolutely there.

However, resourcing challenges were also noted. For example, a contractor National EHS Operations Manager reflected on the large volume of work that is underway in the Australian construction industry and which is likely to cause a resourcing stretch within the industry. This Manager highlighted the importance of workforce training and capability development in infrastructure projects as less experienced workers enter the sector to take up job vacancies.

Similarly, while explaining the minimum competency requirements specified in new rail infrastructure construction projects, a client Deputy Director of Safety Operations commented that:

We are going to be severely stretched for resource in the coming three years, especially with [several major rail projects] following quite quickly as well and then, you've got all of the other projects happening around Australia. So, we're all going to be fighting for the same resources and to address the competency issues where we're going to be pulling people down from high rise construction. We're going to be pulling people from domestic construction. We've really pinpointed what we want people to know in terms of railway safety and going above and beyond what the Rail Transport Operators currently provide.

When asked about how competency development is tracked, the Deputy Director explained:

We've set a minimum requirement scope for each of the defined competency requirements and we'll be tracking them against and getting them to provide us evidence that they have set up an onboarding training course or let's say, within the first six months, they have an approach to make sure that by the end of Year One, the team are where they need to be in terms of understanding safety risk on [the project] sites and that they're actually able to manage themselves and manage other people in accordance with the requirements.

The skills shortage is exacerbated by the industry's reliance on sub-contracting, with consequences for H&S. A contractor Executive General Manager (HSEQ) explained:

Normally for us, that is where the incidents happen is with the subcontractors. So most of our time, our health and safety advisors on site, most of their time is spent actually doing for the subcontractors what they should be doing themselves and providing that health and safety advice to their workers, because they tend to try and save money and maybe not have a health and safety advisor on site. So that's where that resourcing links in – if you don't have enough people who are clear about their role, it sort of falls down... if subcontractors for instance don't have their own health and safety person, we become too stretched to be able to monitor their work fully, and then you've got one person who's covering a bigger area and that's when things get missed and incidents happen.

This Executive General Manager further noted the importance of capability and role clarity and explained that their organisation has developed a capability matrix that sets out the exact requirements of each position (not just for the H&S team) which creates role clarity and indicates training and capability needs. The matrix is also used for staff performance evaluations. In addition, the competency of trades and operators who come on-site is verified.

Similarly, a Hong Kong-based contractor Managing Director mentioned the verification of competency and assessment of safety behaviour and skills for high-risk trades which is done on their project sites. He explained that:

We started with the crane lorry operators ... we were basically assessing when the guy came onsite, and in the case of if [they] are using equipment and the plant ... so we would ask the guy, well show us how you set up the crane lorry, show us how you, what are the various things you go through before you lift, before you sling, etc. So, there was an onsite field competency assessment of the operator before we let him loose onsite, that was what we did with the crane. And I think we were doing something similar with the scaffolders ... assessed apart from the statutory licences ... we assess their safety behaviour and their skills ... the combination of technical skills and behaviour for me is what competency is.

Training

Description	
This theme reflects the importance of providing effective training in H&S and leadership.	
Key aspects	Evidence from interviews
Building capability through the supply chain	<i>... we had a subcontractor there with multiple incidents and he'd send different people each day but that didn't matter. Those people came in, we would train them, train them, train them</i>
Assessment of training content	<i>We will have also done that pre-check and surveillance piece to make sure that the course content matches up with the minimum requirements that we've set in the contract.</i>
Assessment of training retention	<i>There's a survey we do, pre-program, post-program surveys, to understand whether or not people are using the skills and how effective has the training been.</i>

Participants stated that they typically measure the number of training sessions or training hours completed as an indicator of training performance. The majority of participants indicated that safety-related training and leadership behaviour training are provided by their organisations. However, a contractor Executive HSEQ General Manager also mentioned that mental health and resilience training is performed and tracked in their organisation.

Some organisations provide H&S training to subcontracted personnel and provide feedback on training performance data. For example, a contractor HSEQ Executive General Manager explained:

...we treat subcontractors as if they're direct employees...When they come on our site, they do the same induction. They do everything the same. We share with them results on what we're measuring.

The Executive General Manager provided another example of building H&S capability through supply networks:

[In] New Zealand in particular, there's a huge issue there with workforce ... they'll just climb up on anything, and you sort of go guys, you need to wear a harness...we had a subcontractor there with multiple incidents and he'd send different people each day but that didn't matter. Those people came in, we would train them, train them, train them. They weren't going to work on our site again but at least when they went to another site they would have a better approach. This particular subcontractor actually went on to win a health and safety award for their people and at the award ceremony he actually acknowledged the fact that we were the one who had been training his subcontractors. So you just have to treat subcontractors as if they're your own.

In some cases, training delivered to subcontractor personnel is given to ensure a consistency of leadership. For example, the HSE Director of a UK-based Contractor noted training in their organisational behavioural safety program is provided to subcontractors' leadership and tracked as a leading indicator:

We've got at the moment behavioural safety. So that's our internal behavioural safety training program, and we have various tiers of that, and the tier that we're measuring at the moment, our leading indicators, is what we call platinum, which is the top level, and that's rolled out at senior leader level, but also into our supply chain. So, any of our key suppliers, their top

directors, we expect [them] to be put through this training as well to indoctrinate them in [our] way.

However, the prevalence of subcontracting in construction can affect the quality and validity of training data as an indicator of H&S performance. A contractor HSESQC General Manager explained:

From a lead indicator perspective, there's training statistics but they're always a little bit rubbery because of the fact that in our industry we have such a high prevalence or high use of subcontractor workforce. That training data, I say the word rubbery depending on how deep you want to dig into it really impacts its validity.

The General Manager also highlighted the difficulty that the transient workforce creates for the delivery of training and its effectiveness, explaining that this challenge has been exacerbated by the Covid-19 pandemic:

We chase our tail a lot especially in that training space. We could have people here for two days. We could have people here for 200 days. Like I said this Covid environment, it's very, very transient because where a subcontractor used to be able to give you a dedicated two crews or whatever, right now they're giving you whoever they can bloody get. Whoever's not in iso[lation].

Staff turnover and project procurement settings were also identified as structural challenges that make it difficult to achieve a 100% performance score for training, even when it is mandatory. One contractor HSE Director explained:

We've got a big focus on supervisors...our supervisor development program. So we've got a number of mandatory training modules, which they should be doing, and we're also working on a more advanced kind of leadership program for them at the moment. But the measure at the moment is just around the mandatory training that they need to do, and actually getting our compliance up over 85%. You might say it's mandatory it should be 100. Yeah, we've struggled, we struggled with this one, for lots of reasons. Turnover, actually trying to get a list of supervisors, believe it or not, is quite challenging sometimes, particularly when you've got a lot of joint ventures and transient staff and the like.

Several participants explained that, in addition to measuring training hours, they have put processes in place to verify the effectiveness of training. A client/operator Safety Strategy and Systems Manager explained:

We have a leadership program around how to better coach and work with your team to improve safety. There's a survey we do, pre-program, post-program surveys, to understand whether or not people are using the skills and how effective has the training been.

A Hong Kong-based contractor Managing Director described using an independent consultant to audit electricians' practices at their worksites. These audits assess competency and check for non-compliance with safe working procedures. Where necessary training is provided to electricians about to rectify the issues identified by the audits. Following the training, the organisation uses further verification audits to assess whether the training has improved the electricians' practices.

To ensure the quality of training, the representative of one client indicated they assess the content of H&S-related training. The Deputy Director of Safety Operations for this client organisation described how training requirements are stipulated in contracts, requiring contractors to provide specialised training to workers in areas of competence relevant to the project. The client undertakes an assessment of training course content to ensure its relevance and quality. The Deputy Director explained:

[The contractors] will be providing us a baseline set of data about how many new people they've got, how many people have gone through the [training] process. We will have also done that pre-check and surveillance piece to make sure that the course content matches up with the minimum requirements that we've set in the contract, and we'll take it from there.

Innovation

Description	
This theme reflects the opportunities to drive H&S improvement through innovation.	
Key aspects	Evidence from interviews
Understanding the capacity of the supply chain for introducing innovations on projects	<i>So, at that workshop we will be seeking to understand any limitations from their [contractor's] perspective against what we've set in the requirements.</i>
	<i>we have to understand from their perspective how they're going to leverage the wider industry capability buying power, how they're going to strategise.</i>
incentivising H&S innovation	<i>we've gone away from penalising the contractors for not doing brilliantly in innovation and initiatives and we have gone and flipped it on its head and said "Okay, well, we are not going to take money off them if they do poorly, but if they do well, we are going to really give them the opportunity ... for doing well in this space.</i>

One client organisation described their development of a suite of KPIs that focus on the adoption of innovative approaches to enhance H&S in infrastructure projects. Contractors are incentivised to meet the KPIs. Two components are covered:

- Compliance: includes 14 pre-identified initiatives (as minimum requirements) mostly related to the use of new technology (e.g., moving away from cabled tools and equipment to reduce slip, trip and fall risks and electrocution risk by adopting battery operated tools, AI technology fitted on machines to reduce plant-people incidents), and
- Requirement for ongoing innovation – contractors are required to research, develop and trial at least one new innovation each quarter. This requirement was introduced to encourage contractors to engage in innovation above and beyond the minimum requirements associated with the 14 pre-identified initiatives.

Nevertheless, it was acknowledged that successfully introducing and adopting new technology on projects also depend on supply-chain capacity as well as the relationship with external stakeholders and will require early contractor involvement in projects. Recognising these challenges, the client has taken a stepped approach through the different years of the contract by quarterly mapping contractors' progress in relation to achieving the innovation KPIs.

The client Deputy Director for Safety Operations explained their positive approach to incentivising good performance:

... that is an important point, so we've gone away from penalising the contractors for not doing brilliantly in innovation and initiatives and we have flipped it on its head and said "Okay, well, we are not going to take money off them if they do poorly, but if they do well, we are going to really give them the opportunity, millions of dollars for doing well in this space".

Furthermore, the Deputy Director noted the collaborative way in which innovation KPI targets are collaboratively established in a workshop with contractors, so that they are realistic and achievable:

...at that workshop we will be seeking to understand any limitations from their [contractor's] perspective against what we've set in the requirements, so that we can really get a feel and an understanding of what excellence looks like, what average looks like and what poor performance looks like. And again, that will help us when we come to the tracking piece ... Talk it through in more detail to understand what they see as really good performance, what's physically going to be available and achievable and then, work out the next steps.

So, we're saying, let's say for the people/plant interface AI tech on machines, as an example, we're asking for 70 percent of machines to be fitted with that in year one, but if they say "Oh, we can only get 30 percent of the machines fitted because there just isn't any resource", we'll have to take that, consider it and then say "Okay, but what are you doing about it? What have you said to your supply chain so that, by the end of Year One, we get to that 70 percent, or we can at least demonstrate a considerable improvement based on the limitations we knew about on day one?". ... That's a lot of different contractors all fighting over the same plant tools and equipment in terms of the new technologies. So, we have to understand from their perspective how they're going to leverage the wider industry capability buying power, how they're going to strategise ... to make sure that we have enough available through their procurement chains to be able to facilitate this.... we're having this interactive phase at the moment through procurement to collaborate with the contractors who are bidding for the work, to understand where we see that there might be some limitations.

These comments reflect a highly participative approach to performance management in this client organisation.

Occupational health and wellbeing

Description	
This theme reflects the importance of including health and wellbeing in performance measurement metrics and management frameworks.	
Key aspects	Evidence from interviews
Consider health & wellbeing	<i>I still think there is a bit of a view that [health is] secondary to safety, which is obviously what we're trying to eliminate. So I think if we see good performance in the health bit, it's normally quite a good indicator that an area is taking everything very seriously.</i>
	<i>People is the biggest concern at the moment.</i>
Protentional for harm	<i>... the occupational hygiene team developed what they called 'near hits', where people were identified as having been exposed to health risks and we began to operate on the basis that that meant that there was the potential for harm.</i>
Mental health	<i>It's been probably for me one of the most challenging two years from a mental health perspective with our workforce. It just shows how physically hard the work is as well as that additional mental impact.</i>

It was acknowledged by interviewees that occupational ill-health outcomes are sometimes difficult to measure due to their long latency, i.e., the outcomes of exposures are not necessarily immediate and many occupational health issues are associated with repeated exposure to hazards resulting in ill-health developing over time. A UK-based client Head of H&S pointed out that the time lag between

exposure and outcome combined with the mobility of the workforce in construction makes it hard to link ill-health outcomes with hazards and work exposures.

Nevertheless, participants noted the importance of managing occupational health and wellbeing performance and indicated their organisations have implemented measures to track health and wellbeing performance. A contractor HSE Director explained:

...the health one is quite interesting. I still think there is a bit of a view that that's secondary to safety, which is obviously what we're trying to eliminate. So I think if we see good performance in the health bit, it's normally quite a good indicator that an area is taking everything very seriously.

Three client participants indicated their organisations have developed maturity matrices to assess the health performance of their projects. Further, one contractor HSE Director indicated that the health matrix used by their organisation covers various areas including: governance, wellbeing (strategy, plan, support, initiatives), health by design, employee engagement, mental health (promotion, training, support), leadership, learning & development, supply chain engagement, innovation, and work life balance.

One participant reflected on his experience as the client Head of Health and Safety on a large construction program in the UK and explained that a 'near hit' metric was developed to focus on the potential for ill-health:

The concentration for health was looking at the potential for ill health to develop, whereas in safety, it was the actuality of risks being expressed in incidents that resulted in regular reporting to the management team, to directors, and to the outside world ... with ill health, the occupational hygiene team developed what they called 'near hits', where people were identified as having been exposed to health risks and we began to operate on the basis that that meant that there was the potential for harm.

Another client organisation stipulated contractual requirements for fatigue management on their projects, requiring contractors to provide evidence of effective shift management that involves analysing, auditing and managing fatigue risks. For this purpose, the UK Health and Safety Executive's (HSE) fatigue calculator is used to assess how well shifts are organised and ensure sufficient break times are provided. Fatigue related audits are undertaken to assess how shift management plans are implemented and contractors are encouraged to adopt innovation in fatigue management, e.g., using rapid eye movement assessment tools for assessing fatigue levels when workers arrive at a worksite.

Mental health was highlighted as a key area requiring attention in construction. It was noted that the demands of construction work coupled with the restrictions and the stress caused by the Covid-19 pandemic have contributed to mental ill-health. A contractor HSESQC General Manager explained:

When I talked about the Covid fatigue over the last couple of years, that was absolutely cemented with me that mental health piece and the fact that [workers] had wives at home yelling at them because they've been home with four kids home schooling and when are you getting home, and they had family and parents who fell ill and they were trying to deal with travel issues. We don't necessarily term it FIFO like traditional mining FIFO, but we have a very transient workforce, and we have a lot of people in our industry that they wouldn't term it FIFO but they are away from home. They might have the farm up at Shepparton and whatever and work in Melbourne Monday to Friday or they might be specialist technicians who will go work on a rail job in NSW for six weeks. So that is really still quite common and all of a sudden, you've got that plus the additional [Covid-related stress], that's hard as it is from a mental health perspective as well as, the physical fatigue of the hours they work and the weather they work in."

Similarly reflecting on the effects of the Covid-19 pandemic on the way people work and the need to address employees' wellbeing and retention, a contractor HSEQ Executive General Manager commented:

We've just set up a whole additional meeting we're going to have every month that is purely about people. People is the biggest concern at the moment. A lot of things have happened over the last two years. We've got people now who only want to work at home. We've got people who are sick of it and only want to be in the office or on site. We've got people who have decided they don't want to work anymore and want to go and live on the beach. We can't move people; we've got borders closed. Training – it's finally been recognised within companies that people are everything. So that would be our biggest risk at the moment...making sure everybody's happy and they've got a good life. It's not all about working 14-hour days.

A number of participants identified difficulties in measuring mental health, as experiences are also influenced by factors outside the work environment. Some participants referred to programs that have been implemented in their organisations to promote mental health and wellbeing (e.g., mental health champion programs, training of mental health first aiders, employee support programs, and programs targeting financial literacy, gambling and addiction). Often, workforce participation in these programs is measured (e.g., tracking the number of mental health first aiders or tracking the utilisation of Employee Assistance Programs). A client/operator Safety Strategy and Systems Manager explained:

We have a mental health strategy. So, one of the measures that we have in that space is how we're tracking against our plan. So, what are the initiatives we're implementing to enhance health and wellbeing? So, a bit like what we've done for Safety Action Plan implementation, we have a list of activities that we're intending to complete, and how effectively have they been embedded in the business. We also measure our EAP take up, so how many people are using Employee Assistance Program. And we also have a mental health first aid program. We measure how many people are actually participating in that mental health first aid, so how many people are being trained to become mental health first aiders.

A client Deputy Director of Safety Operations similarly noted that, in new contracts, contractors are required to provide a mental health and wellbeing subplan. The intention is for this to eventually be audited against ISO Standard 45003:

So, you have your overarching health and safety management plan and now there's a requirement for a specific mental health and wellbeing subplan and also, we're pushing for accreditation to the new ISO standard, which was launched last year, [ISO 45003], it's a standard for managing psychosocial risk in the workplace, so it goes a lot broader than just mental health and wellbeing. It talks about stress and all sorts of other things. So, we're really pushing for the contractors to consider how they perform against that international standard. It sits very well and complements ISO 45001, which all of our leading contractors have anyway. So, it shouldn't be a huge step change for them, but it's about achieving that accreditation piece as an international benchmark of excellence.

Culture and its influence on H&S

Description	
This theme reflects the fact that a strong and supportive organisational culture is an important precondition for achieving effective H&S performance management	
Key aspects	Evidence from interviews
Viewing H&S performance	<i>... if they [project] get reds, the question is, "what is it we can do to help?" You know, so we've actually shaped their behaviour quite significantly over the years.</i>
Reporting data	<i>So here, no matter what the impact on our statistics and our frequency rate and so on, we want incidents being reported ... we're saying to everyone it doesn't matter if you have a near miss, if you have an incident, we report it, we learn from it, and we share that amongst the company here, but in the broader group as well.</i>
Successful implementation of H&S KPIs	<i>... it really depends on how people see the KPIs and the safety, I would say the safety culture and the safety maturity about how successful those KPIs can actually be</i>
Assessing safety climate	<i>I'd say the culture thing is the biggest piece</i>
	<i>I think the culture surveys are definitely coming into their own. They are really good ... you can compare your precincts or you can compare your projects ... if you do them frequently enough you can actually start to get a bit of a flavour for what's going on.</i>

Participants explained that a strong, positive and mature organisational culture is an important precondition for effective H&S performance management.

The culture of an organisation was identified as having a significant influence on the way that senior managers understand H&S performance measurement and its role in managing H&S performance. The SHE Operations & Behavioural Management Director of a UK-based contractor described how the mindset of senior management about H&S performance measurement and the way that data is used to manage performance has changed over time:

We used to have an issue a number of years where we had what we call a scored inspection process, so each project gets an independent assurance visit or inspection each month by one of our independent team. We've done it for years and used to be numbers of reds, ambers, greens. So if you got X number of reds, the Executive Board used to get very excited, and it felt like you were getting beaten up. We've got to the point now where if they get – and we don't have many, but if they get reds, the question is, "what is it we can do to help?" You know, so we've actually shaped their behaviour quite significantly over the years. That's not to say if they get another red the following month for exactly the same thing, that's a slightly different conversation then. So no one's perfect, let's learn from it, let's make sure we learn from it and then get back into it.

A contractor HSE Leader also highlighted the progression of their organisational performance reporting from tracking failure to measuring positive performance:

...back in the day, it would have all been around TRIFR, LTIFR. It would have been all that data that, would have been in the headlines. Now, our Board report includes that information but it's quite subordinate to the other measures around critical risk, engagement, leadership involvement. It's getting that prominent to have and make sure that, the conversations are based upon that first and foremost.

The culture of an organisation was also identified as having an impact on the reliability of H&S reporting. A contractor National H&S Manager stated: “[The] culture of the organisation is important to develop the right mindset that reporting is OK as it leads to an improved worksite.” Similarly, a contractor Managing Director stated:

So here, no matter what the impact on our statistics and our frequency rate and so on, we want incidents being reported ... we're saying to everyone it doesn't matter if you have a near miss, if you have an incident, we report it, we learn from it, and we share that amongst the company here, but in the broader group as well.

Participants commented that there is considerable value in trying to measure aspects of organisational culture that are linked to excellent H&S performance, while admitting that measuring culture is hard. An Alliance HSE Leader explained:

I suppose I've come to really appreciate the power of, the importance of people feeling empowered and trusted more ... the focus we've got around those, within our philosophy, understanding when people feel empowered and trusted, the many things that flow from that, the commitment, the passion, the space to innovate, that supportive environment. How do you measure that? [It] is really difficult. It's probably the next challenge we've got, but they would be the things that I think are the opportunities.

A union representative similarly argued that indicators of a good organisational culture include workers feeling comfortable to voice H&S concerns and feeling that, no matter their level of seniority, they can express themselves without fear of negative consequences:

I believe that workers need to feel empowered to be able to stop work, and to challenge whatever system or whatever process they're doing. But also then, given the autonomy, that there's no negative employment ramifications. And it doesn't matter whether they're on the lowest level of the chain, the builder's labourer, or the highest, being the most senior site engineer; either one should be able to say, “You know what, this isn't going to work, we need to sit down, stop, work through it, and then come up with a better way”. And I think if companies could probably measure that more, ... I think that's probably one of the best ways to measure a company's safety management system and how they're tracking. So see in the number of times that they stop work in a positive way, rather than a negative way.

Interview participants explained the culture of a project is shaped by both the client and the principal contractor, and therefore both parties have a role to play in creating a culture that is supportive of H&S: An Alliance HSE Leader explained:

That sort of environment that you create, as a principal contractor, we do have significant roles in creating that environment... We're often in that position where we're the middle person and the middle ground. It does start with the environment that's created by a client and what's driving them. We can buffer that, to an extent ... They're [subbies] organisations that are small to medium enterprises that are largely influenced by the environment they find themselves in. We're in an envious position, really, in that respect to be able to have a fair degree of influence with many organisations we deal with.

The following example describes the perspective of a client Head of H&S on creating a cooperative project environment.

Example: A UK-based client Head of H&S describes a collaborative leadership program, initiated by the client and driven by principal contractors.

[We] established a leadership program very early on, where the most senior person representing a main contractor ... We centred on getting them properly sheep-dipped in the arrangements that we were evolving, in consultation with them so that they co-owned it, and they were responsible for driving that understanding and that behavioural approach, not just by individuals but corporately, from their supply chain companies. They were responsible for driving that, but it was monitored. So, we had an audit program where each of the principal contractors' projects had a critical friend of a health and safety professional that would visit the site, walk the site, get to know the management team, participate in management meetings, in the health and safety meetings on a monthly basis and all of those things, as well as looking at the reporting. And there was a lot of self-reporting, a lot of data generated. And they would give advice to the principal contractor that would cascade down to the supply chain, to try and keep that project aligned with all the other projects. And on a monthly basis, the leaders of all the projects were brought together where for an hour, sometimes it ran a little bit longer, but in the main, for an hour, all of the leaders of the projects were brought together to only discuss health and safety. And contractual issues, commercial issues, program issues, etcetera, were left at the door.

Head of H&S

Several participants indicated that they use or have used safety climate/culture surveys at their projects. For example, a contractor HSEQ Executive General Manager explained how workforce culture is assessed and progressively improved using measurement within their organisation:

I'd say the culture thing is the biggest piece. We do a culture survey at the start of a project—and that includes all the subcontractors as well, just to make sure everybody's on the same page as to how we're going to operate on that project – and then we do a culture survey towards the end of the project and we see how the project has moved over time and if we have improved the culture. Then that's useful to us because of course as a construction company we have multiple projects. So, we may be using people from one project and they'll move to another project and so on. So, if you're looking at the culture and improving the culture, at least when they go to the next project, in theory, you're starting from a step ahead and so it goes on.

A client Head of Health and Safety also commented on the usefulness of safety climate surveys, stating that: “*the climate survey is absolutely a vital part of contributing to a sense that health and safety is something that's done **with** people and **not to** them.*”

Likewise, referring to monthly safety climate surveys, a contractor General Manager HSESQC commented:

I think the culture surveys are definitely coming into their own. They are really good ... These surveys, like I said I think they are hopefully going to be something we see more and more of because again, you can compare your precincts or you can compare your projects ... if you do them frequently enough you can actually start to get a bit of a flavour for what's going on.

A UK-based client Head of H&S also observed that the use of climate surveys can act as a ‘reality check’ of leading indicator data reported by contractors:

There's a whole range of issues that the maturity matrix seeks to explore [that] we believed were precursors to a safe and healthy worksite, or precursors to accidents and ill-health arising... But the important thing about the maturity matrix is that it was used contemporaneously with the culture testing in the climate survey ... which meant that if managers were reporting "we always treat complaints seriously" and the climate survey said "these buggers never listen to us", then we would say, "Look, there's a mismatch here. You are underreporting problems, overreporting how good you are and your climate survey from your own staff, your own workers on site, your own supply chain, doesn't bear out what you're self-reporting. And either you are lying to us but probably actually, you're [lying to] yourselves. You need to be a bit more honest because you're going to be missing opportunities to make your project better."

The same client Head of H&S described how lagging indicators (in this case sickness absence) could also be correlated and compared with H&S climate survey data:

Managing sickness absence is one of the things that you get out of really looking after people and making them feel that they're loved and cherished, and your climate survey tells you whether that's what they feel, and your maturity matrix is also trying to get a handle on how you're treating them. So, we had some correlative measures to try and calibrate how reliable each of the measures was.

Collecting data and reporting performance

Description	
This theme reflects the fact that how performance data is collected and used is as important as what is actually collected.	
Key aspects	Evidence from interviews
Simplified data collection	<i>We try and keep the actual amount of data as minimal as possible because we don't want that tick box exercise ... the actual data we collect into our system, it's designed to be as easy to use, minimal, you can actually use it on your phone, so it has to be pretty simple</i>
Clear definition of H&S metrics	<i>Even though the KPIs may be the same the way in which we input it, the way in which we define it and the way in which we get that KPI might be different.</i>
Understanding and using H&S performance data	<i>You've got to have some idea of what you do with the leading indicator data, otherwise, it just hangs there in the air...Leading indicators by themselves are not directors and managers and workers doing things in the right way. They're simply an aid to understanding what's going on, but you still need mechanisms for managing what's going on and improving it."</i>
Reviewing and updating H&S indicators	<i>Every year there's a full strategic review.... We'll look backwards and then we'll look forward at what we're planning.</i>

Most of the participants indicated that H&S performance data is collected using online platforms in their organisations. Safety incident data is required to be reported within specified timeframes, typically within 24 hours. In addition, most organisations have put systems in place through which workers can report hazards. For example, one contractor organisation provides QR codes on site, so

anyone can report a hazard or incident using a mobile device: “We’ve got a QR code, so when you go onto the project site you can just scan the QR code - people at all levels have access to [our] system”.

Some organisations use online systems for recording the outcomes of leadership engagement activities, e.g., leadership walks and conversations with the workforce, as well as assurance activities such as inspections and observations.

It was noted that keeping data simple can help to prevent a ‘tick-box’ approach to meeting H&S performance targets. While commenting on the quality of data, a contractor Executive General Manager for HSEQ explained how H&S management procedures are reviewed to simplify data collection:

So one thing we did, about three years ago, we went through all of our procedures and documentation. We probably cut about half of it, I would guess, because we went “that’s pointless”, it is becoming – if you’ve got a checklist for something, if it’s three pages long, forget it, you have to keep it minimal...But the actual data we collect into our system, it’s designed to be as easy to use, minimal, you can actually use it on your phone, so it has to be pretty simple. It can’t be long questions, it has to be short answers. We internally audit to make sure people aren’t doing just a tick-box exercise.

Participants explained that having a clear definition of H&S metrics is critical to ensure consistency and comparability of data across organisations and projects. For example, a client/operator General Manager for Safety, Environment, Risk & Quality identified challenges in consistent use of the AIFR:

AIFR is measured differently across different organisations. What we call an LTI might be different to what someone else calls an LTI, so it does get a bit complex when you’re trying to sort of standardise or measure or come up with a solution. Even though the KPIs may be the same, the way in which we input it, the way in which we define it and the way in which we get that KPI might be different.

The importance of understanding and using H&S performance data to manage H&S was emphasised by a UK-based client Head of H&S, who argued that measuring leading indicators in itself does not improve performance:

You’ve got to have some idea of what you do with the leading indicator data, otherwise, it just hangs there in the air as if leading indicators in themselves improve a program. They don’t. ...Leading indicators by themselves are not directors and managers and workers doing things in the right way. They’re simply an aid to understanding what’s going on, but you still need mechanisms for managing what’s going on and improving it.”

Dealing with the sheer volume of performance data that is captured was also identified as a challenge to its use in informing H&S performance management. A contractor HSESQC General Manager explained:

You’ve got to remember we’ve got 20, 30, 40 projects going at any one time. So if you look at the size of [the project], that’s got different areas and then within them there’s subareas. We definitely get the data volume but to have systems that are smart enough to be able to pull out that type of information isn’t there right now. I think a huge volume of data gets collected by an organisation our size but for someone to go in and do that ... we do quarterly reviews, things like that but it’s a very manual process.

Performance data is reviewed at different organisational levels. Data is typically reported monthly or quarterly to senior management and board members. Long-term planning is undertaken using the H&S performance data which is aggregated across projects or divisions. Significant trends and findings from the data are discussed to inform long-term action plans and initiatives. In addition,

weekly or fortnightly reports are sometimes generated at project/division level to inform short-term interventions and plans. At this level, more specific trends are discussed and driven down into pre-start meetings, toolbox talks, and health and safety committee meetings. It is important that data collection analysis and reporting is well suited to the window within which a specific area of performance is being managed and change is expected to occur.

Referring to different levels of data reporting and decision-making, a client/operator General Manager for Safety, Environment, Risk & Quality explained:

So you have the day-to-day type of reactivity, that it informs you what you need to do. Let's just say we've had a lot of incidents in one area or one project or multiple projects but same issue, we'd intervene pretty quickly, within a week or two, if we see a trend across the board, either through safety bulletins or reaching out and increasing our compliance or coaching programs on the ground.

But then, longer term, every 12 months, we'd look at the data and make sure that our 12-month compliance program is focused on the right risk controls, and any education we need to do, and we plan and resource that for the next 12 months, even three years, depending on the program.

So, for example, one of the initiatives that we've kicked off is looking into fatigue, because we're seeing sporadic fatigue incidents, or fatigue reports that come in, and we know in general, that in the industry, that needs a bit more thought, so that's one of the long-term projects that we're doing.

The majority of participants indicated that performance data, particularly relating to safety incident reporting, is analysed to identify trends that highlight problems in their organisation's H&S management. For example, one client organisation tags reports to be able to search the cumulative database and identify particular patterns. The findings from analysing this data are then discussed with project delivery leaders in monthly meetings. Similarly, a UK-based contractor SHE Operations & Behavioural Management Director highlighted their company's focus on addressing specific trends identified within project data:

We're keeping an eye on [trends] obviously, looking for high-level trends, but, by and large, I'm more interested in are the projects spotting the trends, are they addressing the trends, are they preventing them from going any further?

The Director went on to note the difficulty in identifying high-level trends and emphasised the importance of addressing issues at a project level, stating that:

We had a lot of discussion early days just going, well, we need to be measuring the trends across the business. Well, our business is vast and the type of projects are vast. We can't say, right, I've got a problem with trucks falling over because actually two thirds of our business don't use them, but actually the third that is using them is so much of a problem that it's actually skewing the data across everything, so more interesting is, are the projects dealing with their data sets?

The following example indicates how trend analysis led a contractor organisation to conduct further investigation enabling them to understand and resolve underlying issues safety issues.

Example: A contractor HSESQC General Manager explained how noticing a high number of unsafe behaviours in incident performance data was followed up by investigation and conversation with workforce which helped to identify underlying issues.

We'd look at consistent trends. Just as an example before Christmas, one of the areas we were having was a lot of unsafe acts, so that was across the board. So that's things like people putting themselves in a position of danger like the working at height incident, so that was something that was significant enough and it was being seen nationally and it was being seen across different divisions. A lot of work went on there, as far as a working at height campaign, but also trying to drill down as to what was happening, and what we were finding is, there was a fair bit of fatigue in the industry on the back of the two-week shutdowns. The Covid shutdowns that happened in Sydney and Melbourne created a lot of impact because the programs then fell behind. Subcontractors weren't paid during that time, a lot of them, so there was a lot of fatigue that crept in and people were trying to get the job done.

We did a lot of interviews, a lot of site walks and discussions with the people on the ground, try to work out what was actually going on. We've seen similar at the start of this year. The type of trends we're seeing is, and we say fatigue-related, not fatigue like they're tired as in the hours of work, but fatigue in the fact that there's all these additional tasks that have been put on [them]. Everything from check-ins to RAT testing to QR Codes to kids at home, home schooling, so all of a sudden there was this significant fatigue that was being felt in the industry, and that was something that was picked up very much at OST [Operational Safety Team] level because they could see that trending across the business and then they actually were out talking to the operational people to find out what was going on.

Contractor HSESQC General Manager

It was also noted that the H&S indicators and metrics need to be reviewed and updated periodically to ensure their relevance, particularly as the organisational context and risk profile change. Most organisations undertake this review each year, however, a few participants suggested that short-term reviews (e.g., every 6 months) could be beneficial. A contractor HSESQC General Manager explained:

Every year there's a full strategic review... the indicators are part of what's looked at ... We'll look backwards and then we'll look forward at what we're planning. We look forward at what we're planning and whether the metrics that we've got in place are right and if they're different and if there's new ones. We try to work on a three- to five-year strategic plan, but each year that's reviewed to see if it's still relevant ... For example... There's a lot of work going on at the moment looking at high-risk training and procedural awareness training in the subcontractors. Now we're just looking at how we can report on it and how accurate the data is that's coming out of the system. No doubt this year, when the strategy's finalised, that'll be a KPI I would imagine that gets built in.

However, it was also pointed out that project governance settings may cause difficulty for introducing new metrics. A client Deputy Director for Safety Operations explained the issue of changing performance measures mid-way through a project:

... theoretically I can change anything I want within my contract, problem is, it's the verification that comes, so then they [contractors] go "Oh, you beauty. This is going to cost you" and then commercial go "No, no, no, lock it out, block it". So, that's where we fall over on those. So, with the longer-term contracts, I haven't had the ability to change it, but with the smaller and more regional contracts, I've changed heaps in those.

The impact of project procurement settings on performance measurement and reporting was also highlighted. For example, participants observed that within a collaborative setting, such as Joint Ventures (JV) or Alliances, the H&S measures and reporting requirements largely depend on the H&S management system of the organisation that leads the project. This may cause difficulties for participating organisations if their safety management systems are not aligned. For example, a UK-based HSE Director commented on their experience of working on Joint Ventures:

... for me, where I have a lot of JVs is very hard, because a lot of the JVs don't work to our management system. And if they don't work to our management system, then sometimes we'll leave them completely out of the metrics. Sometimes we'll leave them partially out of the metrics... If they're doing them fortuitously then we report on them. If they're not, we can't measure them, for example, on doing our behavioural safety program, because they're not doing it.

Similarly, a contractor HSESQC General Manager commented on the complexities of working in a JV:

The way the joint ventures work from a health and safety perspective there is always a principal contractor, so there's always one party that their system sits over the top as an umbrella. ... They are quite challenging because then they almost become like their own ecosystem as well, the projects, depending on the size. So, if it's our system that's been implemented then yes, we do have that umbrella approach so then the lead and lag indicators will be ours. They'll show up in our monthly report. Where we aren't principal contractor on a JV ... things like the culture survey will still go to [our] people but as far as what lead and lag indicators that's dependent on whoever sits over the top and that's where you get real complexities especially the longer they go on.

Part 4: Suggested SRLA Health and Safety Index

The suggested SRLA H&S Index was developed following a systematic process that involved:

- a review of the industry guidelines, reports and academic literature in relation to H&S performance measurement
- 22 semi-structured interviews with 27 industry experts, and
- consideration of the SRLA H&S strategy and H&S management plan.

A comprehensive review of the academic and grey literature in relation to H&S performance measurement was conducted. Through the literature review, 387 H&S performance metrics were identified and classified based on specific aspects of H&S management which the metric referred to. These metrics are provided in Appendix 7.2.

Further, 27 industry experts were interviewed to explore their views on the important aspects of H&S performance measurement, the way H&S performance data is collected on their projects, the way the data is used to inform decision-making, and participants' opinions about what they find to be the most useful H&S performance indicators and why. The findings of these interviews were combined with the literature review and the review of SRLA's strategic H&S objectives to inform the design of the suggested SRLA H&S Index.

The suggested H&S Index comprises four components and 11 subcomponents. Three of the components reflect the objectives and key areas specified in the SRLA H&S Strategy, namely: H&S Leadership, Risk Management and Governance, and Learning and Sharing Lessons. Health and Wellbeing was included in the index as a fourth component to recognise the increasingly recognised importance of health and wellbeing considerations in construction, and the historical lack of attention paid to measuring health (in contrast to safety).

Subsequently, themes from the analysis of the interview data were used to specify and develop the Index subcomponents. The inclusion of these subcomponents ensured that the suggested H&S Index focuses on measuring the aspects of H&S performance highlighted by the industry experts and using approaches recommended by the experts, hence ensuring the validity of the index. The index components and subcomponents are shown in Table 4.1.

Table 4.1: Proposed H&S Index structure – components and subcomponents

Component	Subcomponent	Aim of the component
H&S Leadership	H&S Leadership capability	Developing and maintaining relevant H&S management capability and appropriate focus to support active H&S leadership. Actively engaging with frontline, encouraging conversations about H&S, setting a high standard through leaders' visibility and positive reinforcement, and creating an enabling environment for driving healthy and safe behaviour.
	Leaders' active engagement in H&S	
Risk management and governance	Adequacy of capability and resources	Creating and sustaining the capacity of a robust framework for anticipating H&S risks and effectively managing them, reviewing control strategies and making ongoing improvements, encouraging the adoption of initiatives and best practice to challenge risk, and motivating transparent reporting of outcomes through a focus on value-adding and positive performance.
	Incident reporting	
	Proactive risk management	
	Assurance activities	
Learning and sharing lessons	Incident investigation	Encouraging proactively learning and sharing lessons across the program to benefit the collective and the industry.
	Internal and external communication	
Health and wellbeing	Critical health & wellbeing risk management	Protecting and enhancing the health and wellbeing of the people across the program.
	Return to work	
	Positive physical and mental health initiatives	

The next step in developing the suggested H&S Index involved identifying specific metrics for each of the subcomponents. The selection of metrics was also informed by the interviews and the literature review. While selecting the metrics, each needed to satisfy the criteria established for effective H&S performance measurement:

- Measurable - they present rates or percentages to enable tracking the performance over time and comparing them across the SRL program.
- Actionable – scores could be set for the metrics to easily detect different performance levels and clearly define improvement actions to achieve higher performance.
- Valid - there is a clear link between the metrics and the key aspects of the subcomponents of the index, to ensure that the metrics focus on the aspects of H&S performance highlighted as important by the industry experts. Moreover, selecting the metrics through the review of academic literature and industry best practice guides further established their validity.
- Reliable - the measures are clearly defined, can be easily understood and will give consistent results when used by different people.
- Consider both frequency and quality – a combination of frequency-focused and quality-focused metrics were selected for each component to ensure both the frequency of H&S improvement activities and the quality of outcomes from the activities are tracked. For example, under Risk Management, some metrics track rates and progress of risk control activities while other

metrics evaluate the effectiveness of risk control activities as well as the timeliness of their implementation.

- Scalable – expressing the metrics as rate or percentage, and normalising the data where possible (e.g., by dividing to hours worked), ensures that the metrics can be scaled up or down, and are comparable between different work packages with different amount of work activities.
- Flexible – when defining the metrics, where possible, the metrics identify groups of H&S management activities rather than focusing on specific activities. For example, the metric about supervisors' engagement with the workforce includes a range of activities such as being involved in developing JSA/SWMSs, running toolbox talks, reviewing high-risk activities, conducting focused conversations with workers, etc. Defining the metrics in this way helps to avoid being too prescriptive and provides flexibility to project teams to decide (within a specific group of actions) what actions to take to improve H&S outcomes in a particular context. Thus, a participatory approach to managing H&S performance is encouraged. Further, the flexibility of metrics ensures that they stay relevant in different work contexts, as the type of activities differ between work packages and over project lifecycle.
- Sensitive – the extent that metrics sensitively measure change over short periods of time was considered, so trends can be specified and monitored for the metrics. Therefore, passive indicators, which typically remain relatively static once implemented (e.g. presence of a H&S management plan, contract conditions that require compliance with specific policies), were not included in the index because they do not reflect short or medium term changes in H&S conditions and provide little insight into the day-to-day progression of safety related activities.
- Include a balance of drive and monitor metrics – effort was made to reach a balance between drive metrics (those that focus on motivating certain H&S management actions to enhance H&S outcomes) and monitor metrics (those that monitor the efficacy of H&S management actions to check if the desired outcomes have been achieved). This design seeks to measure both the level of H&S management/improvement actions (inputs) and the quality and effectiveness of these actions (by monitoring their outcomes).
- Consider Inter-relationships between metrics – within the proposed H&S index, a number of metrics build on each other. This interrelationship between the metrics enhances the robustness of the index and ensures that various aspects of the H&S management system are considered. For example, the data for high-potential incidents reported (metric 2.9 in Table 4.4) is used in calculating metric 3.1 (in Table 4.5) which measures the incident investigations completed on time. Together, these two metrics measure the effectiveness of incident reporting and investigation processes which underpin continuous learning and improvement. Similarly, metrics 1.1, 1.2 and 1.3 (Table 4.2) measure relevance, quality and delivery of H&S leadership training provided in an organisation, while metrics 1.4 and 1.5 (Table 4.2) measure the percentage of managers and supervisors who receive the training (as an output of the training process). Together these metrics assess the effectiveness of H&S leadership training process in an organisation from various perspectives.

The index components and metrics are explained in more detail below.

It is important to note that weightings and score definitions are suggestions only and should be subjected to subsequent testing and sensitivity analysis prior to instrument finalisation.

4.1 Component 1: H&S leadership

The H&S leadership component focuses on two key aspects:

- (i) Developing and maintaining H&S leadership capability, and
- (ii) Leaders' active engagement in H&S.

H&S leadership capability

This subcomponent focuses on developing and maintaining relevant H&S leadership capability and appropriate focus on H&S among leaders to support active H&S leadership. Developing H&S leadership capability is a fundamental area of importance noted in the SRLA H&S strategy. Furthermore, during the interviews with industry experts, leaders' H&S capability was highlighted as a key indicator of H&S performance on projects. The capabilities noted during the interviews include: leaders' understanding of H&S priorities, their ability to effectively engage with the workforce to prioritise H&S performance and lead by example, and having constructive conversations with the workforce about how activities are performed in a safe and healthy manner and understand and be responsive to workers' experiences. The H&S leadership capability subcomponent of the suggested H&S Index seeks to ensure that leaders at different organisational levels (senior managers, middle managers and supervisors) possess these capabilities.

Leaders' active engagement in H&S

This subcomponent emphasises leaders' active engagement in H&S. Active leadership in H&S is an objective referred to in SRLA H&S strategy. Leaders' active engagement in H&S was also a key theme emphasised in the interviews.

The evidence from the interview data suggested that leaders' awareness of how work is performed on site and the H&S needs of the workforce, and leaders' level of engagement in H&S management activities are key factors contributing to H&S performance on projects. As the data reflected, leaders (at different organisational levels) play an influential role in reinforcing the importance and priority of H&S. Through their behaviour and the conversations they have with the workers, leaders set an example and establish expectations about the priority of H&S in a work context, even when under time pressure. Engagement in activities, such as safety leadership walks, inspections undertaken by leadership team, and leaders' interactions with the workforce were frequently mentioned during the interviews as examples of active H&S leadership. Participants also noted the importance of assessing the quality (not just the quantity) of leadership engagements in H&S and interactions with workers, while acknowledging difficulties associated with measuring the quality of these activities.

Furthermore, the role of frontline leaders (including supervisors) in promoting good H&S practices on-site was highlighted by several participants. As the literature review reported, due to supervisors' high visibility and frequent interactions with workers, they play a fundamental role in creating the right environment for promoting H&S on-site.

Specific metrics of H&S leadership

Nine metrics were selected for the H&S Leadership component. Five metrics focus on developing and maintaining leadership capability as indicated in Table 4.2.

Table 4.2: Metrics of H&S leadership capability

No.	Metric	Metric Weight	Score definition		
			3	2	1
1.1	Capability gap analysis and training need analysis performed frequently	0.2	> 1 analysis per 3 months	Once per 3 months	< 1 analysis per 3 months
1.2	Each training program is assessed for quality, relevance and adequateness for the works	0.2	Every 3 months	Every 6 months	Less frequent than every 6 months
1.3	H&S leadership training sessions conducted / planned (%)	0.1	100%	≥ 90%	≥ 75%
1.4	% senior managers and middle managers trained in H&S leadership and communication	0.25	100% trained	≥ 90% trained	≥ 75% trained
1.5	% supervisors/frontline leaders trained in H&S leadership and communication	0.25	100% trained	≥ 90% trained	≥ 75% trained

Metrics 1.1 and 1.2 focus on the relevance and quality of H&S leadership training. A high score in metric 1.1 indicates that an organisation is frequently performing H&S leadership capability gap analysis to understand their training needs and effectively targeting them by providing relevant training. A high score in metric 1.2 indicates that the quality and relevance of the training material is frequently assessed in light of the training needs, and is updated to ensure the adequateness of the content.

Metric 1.3 reflects the progress of training delivered (versus planned). A high score in metric 1.3 indicates that training is delivered as planned across an organisation. Metrics 1.4 and 1.5 focus on the output of the training process, i.e., they indicate what percentage of leaders at different organisational levels have received the training. A high score in metric 1.4 reflects that senior and middle managers have a high participation in H&S leadership training and develop the relevant H&S leadership and communication capabilities and refresh their knowledge frequently. A high score in metric 1.5 indicates that supervisors and frontline leaders (who have a key role in promoting H&S on-site) are trained in both leadership and communication skills and maintain their capability through regular training.

With respect to weighting, 50% of the total subcomponent weight is assigned to the planning and provision of training (metrics 1.1 – 1.3). Metrics 1.1 and 1.2 which relate to the training needs analysis and ensuring training quality each have 20% of the total weight and metric 1.3 has 10% of the total subcomponent weight. The other 50% of the total weight is equally assigned to the two metrics for training outcomes (metrics 1.4 and 1.5).

The next subcomponent (leaders' active engagement in H&S) then focuses on how the H&S leadership capabilities acquired through training are utilised by leaders in projects. In other words, this component indicates how effective the development of H&S leadership capability is in practice. This subcomponent comprises four metrics as indicated in Table 4.3.

Table 4.3: Metrics of active H&S leadership

No.	Metric	Metric Weight	Score definition		
			3	2	1
1.6	Officers' documented engagement in Due Diligence checks – number of activities per officer	0.25	≥ 5 per officer per month	≥ 3 per officer per month	2 per officer per month
1.7	Senior managers' documented engagement in work sequencing and work planning forums e.g., facilitation of CRAW, attendance at SiD workshops, developing and presenting a critical risk review / HPI to executives or workforce – number of activities per manager	0.25	≥ 5 per manager per month	≥ 3 per manager per month	2 per manager per month
1.8	Average frequency of senior and middle managers' engagement with frontline (documented engagement in safety walks and talks, conversations with workforce, delivering toolbox talks, attend prestart meetings at the right time, introduce inductions, review of high-risk activities, recognition of good behaviour ...) - frequency calculated per month as (No. of activities / No. of managers)	0.25	≥ 5 per manager per month	≥ 3 per manager per month	≥ 2 per manager per month
1.9	Average frequency of supervisor engagement with workers (involvement in writing JSA/SWMSs and setting up controls with the workforce, peer review of planned high-risk tasks, lead toolbox talks, focused conversations with workforce to reinforce good practice or recognise good behaviour, observations accompanied with workers, review of high-risk activities with workers, ...) – frequency calculated per month as (No. of activities / No. of supervisors)	0.25	≥ 10 activities per supervisor per month	≥ 8 per supervisor per month	≥ 5 per supervisor per month

Metric 1.6 reflects Officers' active involvement in Due Diligence checks. This includes a record of Officers' conversations with employees, the feedback from employees and the outcomes.

Metrics 1.7, 1.8 and 1.9 relate to active involvement of senior managers, middle managers and supervisors in H&S leadership activities. Together, these metrics encourage a coherent H&S leadership engagement across the management hierarchy in an organisation/project.

To keep the metrics flexible and ensure their applicability to different work packages and across the project lifecycle, the metrics do not denote specific management activities (i.e., they do not measure the frequency of one particular activity, such as involvement in toolbox talks or leadership walks). Instead, they measure leaders' engagement in a range of H&S leadership activities, including safety walks and talks, conversations with the workforce, delivering toolbox talks, involvement in prestart meetings, inductions, review of high-risk activities, etc. This flexibility emphasises a participatory approach in H&S management (rather than a prescriptive approach) and enables managers to demonstrate engagement in a range of activities that they deem suitable in different contexts.

Furthermore, to ensure the quality of the engagement activities, the associated activities and the outcomes need to be documented. For example, regarding leaders' engagement with workers, a record of the engagement needs to be provided that documents the conversations held with the workforce, feedback from the workforce and the agreed outcomes that are entered as corrective actions.

To ensure the applicability of the metrics to various organisation sizes and work packages with different scopes of activities, metrics 1.6 to 1.9 measure the average frequency of H&S leadership activities per manager or supervisor for each month. This enables direct comparison between work packages or between months as the number of managers may differ. In addition, the average frequencies can easily be scaled up to reflect average frequency of H&S leadership activities across the SRL program of works.

It is also noteworthy that metrics 1.8 and 1.9 include leaders' positive reinforcement activities, i.e. positive observations and recognition of good behaviour. Thus, the metrics encourage a focus on promoting good behaviour and moving away from a blame culture and concentration on failure. The evidence from the interviews and the literature review indicates that leaders' recognition of positive behaviour can motivate workers to behave safely and participate more in promoting H&S on-site.

All metrics in this subcomponent have equal weights. That is, 25% of the total weight for this subcomponent is assigned to each of the metrics (1.6 – 1.9).

4.2 Component 2: Risk management and governance

Risk management and governance are fundamental areas of focus specified in SRLA H&S strategy. The risk management and governance component of the suggested H&S Index focuses on creating and sustaining a robust framework for anticipating H&S risks and effectively managing them. It seeks to encourage proactive risk management, planning and reviewing control strategies and making improvements continually, encouraging the adoption of initiatives and best practice to challenge risk, and motivating transparent reporting of outcomes through a focus on value adding and positive performance.

Risk management and governance comprises four key subcomponents which were identified from and supported by the evidence from the interviews. These subcomponents include: 1) ensuring adequacy of capability and resources, 2) promoting incident reporting, 3) proactive risk management, and 4) assurance activities. The subcomponents are briefly discussed below.

Adequacy of capability and resources

This subcomponent focuses on acquiring and maintaining adequate knowledge, skills and resources to manage H&S risks and perform work in a healthy and safe manner. Several interview participants noted the importance of having sufficient and competent workforce on projects for achieving good H&S performance. Insufficient human resources, cost saving practices and lack of role competency were frequently highlighted as contributing factors to incidents. Resource planning, i.e., arranging for adequate time, equipment, skilled workers, supervision, defining capability requirements, competency assessment and providing effective training to the workforce were mentioned by the interview participants as proactive measures to ensure the adequacy of capability and resources.

Incident reporting

This subcomponent focuses on timely reporting of incidents. The majority of the interviewees highlighted the importance of collecting and analysing data about severe and high-potential incidents. Apart from indicating the gaps in risk management and risk controls, reporting incidents was regarded as a reflection of workforce engagement in H&S management and an indicator of a good culture that encourages reporting bad news and underpins the importance of learning from both failure and success.

Proactive risk management

This subcomponent focuses on identifying and addressing H&S risks in the upcoming work activities. Several interview participants emphasised the importance of risk anticipation and control. Risk anticipation was noted as a pillar of the H&S strategy in one organisation and several interviewees mentioned that the upcoming work activities on their projects are continually reviewed to ensure critical risks are effectively controlled and the controls remain effective. The review is typically undertaken for the work coming up in a month, as well as in 60 days and 90 days in some organisations. This process underpins a systematic and proactive risk management approach and ensures that critical risk controls are in place and remain effective as site conditions and work plans change.

Assurance activities

This subcomponent reflects the frequency and effectiveness of assurance activities that organisations use as a mechanism to verify the effectiveness of their H&S risk management processes and the critical risk controls. The timely implementation of corrective actions arising from the assurance activities as well as the improvement initiatives is also tracked. The inclusion of this subcomponent in the index was informed by the interviewees who identified the importance of frequently performing assurance activities on projects to ensure the effectiveness of risk controls and to identify improvement opportunities.

Specific metrics of risk management and governance

The risk management and governance component includes 10 metrics as indicated in Table 4.4 below. The metrics combine measures of frequency and quality to avoid a narrow focus on meeting the minimum target number of activities. The combination of metrics is intended to assess whether risk management activities are performed continually and efficiently (i.e., in a timely manner) as well as whether the risk control outcomes remain effective. In addition, indicators of workforce

engagement in risk management (initiatives and insights from workers) are incorporated in the metrics.

Table 4.4: Metrics of risk management and governance

No.	Metric	Metric Weight	Score definition		
			3	2	1
2.1	% workforce trained in site specific H&S risk awareness and management	0.1	100% trained	≥ 90% trained	≥ 80% trained
2.2	Resource review and demonstrated capability - % of planned work activities that have adequate resources (human, knowledge and capability, time, equipment, supervision) in place to perform the tasks in a healthy and safe manner	0.1	100%	≥ 90%	≥ 80%
2.3	Proactive risk planning (risk assessment and control for upcoming work) – (% completed vs planned)	0.1	100%	≥ 90%	≥ 80%
2.4	Critical risks are documented, and critical risk control reviews are occurring - % of critical risk controls reviewed for effectiveness in the past 3 months	0.1	100%	≥ 90%	≥ 80%
2.5	Risk control effectiveness - % of risks that are controlled using elimination, substitution or engineering controls.	0.1	≥ 80%	≥ 70%	≥ 60%
2.6	Control measures implemented (initiatives, recommendations from investigations, follow up corrective actions from audits and inspections, etc.) – % closed out on time	0.1	≥ 90%	≥ 80%	≥ 70%
2.7	Timeliness of critical risk control activities - Critical risk control activities closed on time vs total planned (%)	0.1	100%	≥ 90%	≥ 80%
2.8	Residual risk management (% risks closed and transferred)	0.1	100%	≥ 90%	≥ 80%
2.9	High-potential incidents/fatalities reporting rate	0.1	0	≤ 2 per 100k work hours	≤ 4 per 100k work hours
2.10	Timeliness of incident notification and reporting – % incidents reported via SIMS within 1 day of occurrence	0.1	100%	≥ 90%	≥ 80%

Together the ten metrics cover the four key areas (subcomponents) described in the previous section. Metrics 2.1 and 2.2 reflect the adequacy of workforce capability and resources to undertake the project in a healthy and safe manner. Metric 2.1 focuses on the extent of training provided to workers

about site specific risks to ensure workers have an awareness and ability to identify, report and address H&S risks in their work area.

Metric 2.2 reflects the adequacy of resources for upcoming work activities. The intent of this metric is to encourage frequent and proactive resource planning and review for upcoming work (e.g., on a monthly basis). Frequent resource planning can accommodate the changing nature of work plans and conditions on construction sites and helps to gain a realistic view of the resource requirements to perform work in a healthy and safe manner. In addition, metric 2.2 incorporates various types of resource, including human resource, their competency and skills, time, equipment, and supervision. Therefore, to achieve a high performance in this metric, organisations need to take a comprehensive approach in their resource planning. Furthermore, using this metric requires resource needs analysis for the upcoming work based on work plans. Performance is measured as a percentage of work-tasks for which resource planning is undertaken. This ensures the metric is applicable to different project contexts where the amount and type of work differs. The metric needs to be accompanied by a set of criteria to determine the adequacy of quantity and quality of resources.

Metric 2.3 relates to risk anticipation and proactive risk management which was highlighted as a key aspect of effective risk management in the interviews. Similar to the previous metric, this metric encourages organisations to frequently review the upcoming work, assess the risks involved and ensure that the risks are addressed. Thus, the metric ensures that a systematic look ahead of upcoming work in the program is undertaken and involves identification of risk and addressing it according to the As Low As Reasonably Practicable (ALARP) principle. The frequent nature of risk assessment and control helps to accommodate the changing nature of the work and site conditions. The focus on work coming up in short-term (e.g., in a month) enables a more realistic view of risks as work conditions will be clearer in the short-term and there will be less reliance on assumptions about how work is performed. This helps to identify risk control solutions that suit specific work conditions rather than relying on generic solutions, thus ensuring planning and risk control solutions consider the interfaces with other packages. A high score in metric 2.3 indicates that organisations continually review their planned work, assess the risk for the planned activities and ensure these are addressed, and that their risk registers are live documents. The proactive risk management activities need to include subcontractors and require organisations to understand and document their critical risks.

Metrics 2.4 to 2.8 reflect the effectiveness and efficiency of risk control activities. Metric 2.4 encourages that organisations maintain an up-to-date document of their critical risks and frequently review critical risk controls to ensure they remain effective and do not degrade. Metric 2.5 specifically evaluates the effectiveness of risk control solutions by indicating the portion of the identified risks that are controlled by eliminating the hazard at source, substituting the hazard with something less hazardous/risky, or using an engineering control. Based on the Hierarchy of Controls, these are the most effective ways of addressing risk. Expressing the metrics as rates ensures their relevance to different contexts and their comparability between months or work packages. Together, metrics 2.4 and 2.5 ensure that organisations remain vigilant about their critical risk controls.

Metric 2.6 encourages implementing improvement actions for issues identified through various processes including assurance activities, investigations and reports by the workforce. The metric acknowledges that issues can be identified in various ways, therefore the metric is not focused on addressing issues from a particular source. Instead, the metric encompasses all the corrective actions devised by an organisation (including initiatives from the workforce) and encourages their timely implementation. In contrast, metric 2.7 specifically focuses on the timeliness of critical risk control activities. Together, metrics 2.6 and 2.7 consider a broad range of improvement activities to address

risks (achieved through metric 2.6), while putting a higher emphasis on the implementation of critical risk controls (achieved through metric 2.7).

Metric 2.8 ensures that organisations monitor residual risks and ensure they are appropriately managed, documented and communicated to the relevant stakeholders. Maintaining a high score in this metric indicates that organisations remain aware of their residual risks and continually monitor them to ensure they remain ALARP and they are communicated appropriately.

Metrics 2.9 and 2.10 relate to incident reporting. Reporting of high potential incidents reveal gaps in risk management and control measures. Metric 2.9 captures the rate of reported high-potential incidents and fatalities per 100k work hours. Normalising the report rate (per 100k work hours) allows for comparison between different work packages with different amounts of work. To achieve a high performance in long-term, a low rate of high-potential incidents and fatalities is desired by this metric. It is also noteworthy that metric 3.1 (under the Learning and Sharing Lessons component below) builds on metric 2.9 by reflecting on what percentage of the reported incidents are investigated.

Metric 2.10 builds on metric 2.9 and encourages timely notification and reporting of incidents through the SRLA online incident management system (SIMS) to ensure compliance and enable investigation and learning from these events (metrics related to the effectiveness of investigation and learning are provided in a separate component in the following sections).

All the metrics in this component are equally weighted.

4.3 Component 3: Learning and sharing lessons

Component 3 relates to one of the strategic dimensions noted in the SRLA H&S strategy, i.e., *Integrating SRL - sharing lessons learned and actively contributing to drive the industry forward*. The learning and sharing lessons component focuses on encouraging learning from both positive outcomes (i.e., capturing effective solutions and good practices) and negative outcomes (i.e., investigating incidents and high-potential events), and proactively sharing lessons across the SRL program to benefit the collective and the industry.

During the interviews, several participants mentioned that their organisations measure the frequency of accident and near miss investigations and use the investigation findings to improve H&S performance on their projects. Key aspects highlighted by the participants in relation to the effectiveness of investigation and learning process included facilitating open and honest conversations about incident circumstances and identifying opportunities for improvements, ensuring the quality and timeliness of the investigations conducted and enhancing the quality of recommendations resulting from the investigations. In addition, the importance of sharing effective solutions and lessons learnt across projects to avoid recurring issues was noted by the interview participants.

Specific metrics of learning and sharing lessons

The learning and sharing lessons component includes three metrics as indicated in Table 4.5 below.

Table 4.5: Metrics of learning and sharing lessons

No.	Metric	Metric Weight	Score definition		
			3	2	1
3.1	Investigations completed on-time with root-causes identified and recommendations provided Vs total incidents reported (including high-potential and near miss) (% completed)	0.4	≥ 90%	≥ 80%	≥ 70%
3.2	Adequate communication to inform the workforce about outcomes of investigations, addressing issues raised by workforce, lessons learnt or good practices - % completed vs planned	0.3	≥ 100%	≥ 90%	≥ 80%
3.3	Lessons, successful initiatives, and best practices shared across the program - % completed vs planned	0.3	≥ 100%	≥ 90%	≥ 80%

Metric 3.1 focuses on the efficiency and quality of investigations of incidents, including high-potentials and near misses. A high score for this metric indicates that the majority of the reported incidents and high-potential events have been thoroughly investigated, in a timely manner and using adequate techniques considering the severity of the incidents, and the investigation has resulted in identification of root-causes and development of recommendations for improving health and safety.

Metric 3.2 encourages internal communication on projects to provide the workforce with H&S-related information that will enable and encourage them to work in a healthy and safe manner. The information includes investigation outcomes and recommendations, lessons learnt from events, good practices identified, issues raised by the workforce and the way they have been addressed. Keeping the workforce informed about improvement actions and investigation outcomes can enhance buy-in from the workforce and increase the likelihood that the improvement actions and recommendations lead to behavioural changes and H&S improvements. Furthermore, as the interviews suggested, informing the workforce about how the issues they raise are being addressed can encourage the workforce to participate in H&S improvement and reinforces the message that H&S is taken seriously.

Metric 3.2 does not specify the communication format to provide flexibility for organisations, however, it encourages frequent communication events which will keep the workforce informed and engaged in H&S. Organisations need to indicate that a communication plan is in place and is implemented. The metric measures the progress against the communication plan, i.e., the metric indicates the percentage of communication activities completed against the plan.

Metric 3.3 encourages external communication and sharing lessons learnt across projects. As supported by the evidence from the interviews, sharing good practices and lessons across projects contributes to proactive risk management because it enables management teams on different projects (within an organisation or program) to share what issues they face and how they resolve them, so other project teams can prevent those issues; hence, the likelihood of recurrent problems happening across multiple projects will be reduced as organisations benefit from each other's experience. Sharing lessons and best practices can also benefit the whole industry. Similar to the previous metric,

metric 3.3 encourages organisations to develop a communication plan and indicate its implementation. The metric measures the percentage of communication activities completed against the plan.

With respect to weighting, 40% of the total component weight is assigned to incident investigation (metric 3.1) and the remaining weight is equally distributed between the internal and external communication metrics. Thus metrics 3.2 and 3.3 each have 30% of the total component weight.

4.4 Component 4: Health and wellbeing

The health and wellbeing component focuses on protecting and enhancing the health and wellbeing of the people across the SRL program. The component aims to encourage a specific focus on promoting health and wellbeing outcomes which are often less pronounced in H&S performance measurement compared to safety outcomes. During the interviews, several participants indicated that their organisations have included health and wellbeing measures (in the form of metrics as well as maturity matrices) in the suite of indicators they use.

Specific metrics of health and wellbeing

The health and wellbeing component includes six metrics as listed in Table 4.6 below.

Table 4.6: Metrics of health and wellbeing

No.	Metric	Metric Weight	Score definition		
			3	2	1
4.1	% of relevant physical occupational health risks (e.g. noise, dust and MSD) that are being controlled by elimination, substitution or engineering controls	0.2	90%	≥ 80%	≥ 70%
4.2	Fatigue management plans developed and monitored - % of planned work activities that have mitigation plans in place to monitor and address fatigue risk and/or provide fatigue counter measures, signed off by supervisor or manager	0.16	100%	≥ 90%	≥ 80%
4.3	Physical and mental health improvement initiatives identified vs implemented - % implemented	0.16	100%	≥ 90%	≥ 80%
4.4	% of workers returned to pre-work hours and duties after injury and illness as specified in return to work plans	0.16	100%	≥ 90%	≥ 80%
4.5	% of identified psychosocial hazards that have been eliminated or risks reduced through work design	0.16	100%	≥ 90%	≥ 80%
4.6	% of activities for which monitoring occupational health exposure has been completed (of total number specified as per risk assessment)	0.16	100%	≥ 90%	≥ 80%

Metrics 4.1 and 4.2 focus on how effectively critical health and wellbeing risks, including risk associated with noise, dust, musculoskeletal disorder (MSD), and fatigue are monitored and controlled. The metrics encourage organisations to consider their planned work activities on an ongoing process and ensure that critical health and wellbeing risks are identified and effectively controlled. Guidance material is required to indicate the innovative and effective approaches to control risks and provide consistency across similarly exposed groups within the workforce (SEGs).

Metric 4.3 encourages the implementation of physical and mental health initiatives. High performance in this metric is expected to lead to a healthy and motivated workforce, higher morale, reduced illness and absenteeism, and reduced workforce turn-over. The metric measures the percentage of the identified initiatives implemented as planned.

Metric 4.4 focuses on workers' return to work after injury or illness. The metric reflects the effectiveness and outcome of return-to-work programs by indicating the percentage of workers who have successfully returned to their duties and previous work arrangement prior to their injury or illness.

Metric 4.5 specifically focuses on effectively managing psychosocial risks. The metric indicates how effectively an organisation identifies psychosocial hazards and addresses them. The metric measures the percentage of identified psychosocial hazards which are eliminated or their risks are controlled through work design.

Metric 4.6 reflects how effectively occupational health exposure is monitored on sites. The metric encourages frequent monitoring to ensure exposure is within acceptable limits. The metric is expressed as a percentage of work activities for which monitoring is completed as per specific risk assessments.

The metrics in the Health and Wellbeing component are equally weighted except for metric 4.1. Metric 4.1 focuses on the effectiveness of controls for physical health risks and has a slightly higher weighting due to the high prevalence (and potential severity) of physical occupational health risk factors in civil construction work.

4.5 Indicator weights and calculating the index score

Apart from the weights for the metrics within each component, the components have specific weights to reflect their relative contribution to the overall index score. Higher weights have been assigned to components 1 and 2 as these components include more metrics compared to components 3 and 4. Assigning higher weights to components 1 and 2 helps to underscore the importance of H&S leadership and H&S risk management when measuring H&S performance.

The weights for the index components and subcomponents are shown in Table 4.7. Each of the two subcomponents in H&S Leadership (component 1) has a weight of 1. Thus, component 1 in total has a weight of 2. Similarly, a weight of 2 has been assigned for Risk Management and Governance (component 2). The other two components, i.e., Learning and Sharing Lessons Learnt (component 3) and Health and Wellbeing (component 4) each has a weight of 1.

The index score is calculated through the following steps:

1. the score for each metric (ranging from 0 – 3), is multiplied by the metric weight and the component weight
2. the results are added together across all the metrics to calculate a total score for the index.

The maximum index score is 18. The actual index score can be expressed as a score between 0 and 18 (out of 18) or can be divided by 18 and multiplied by 100 to be expressed as a percentage.

Table 4.7: The suggested H&S index

Component No.	Component	Metric No.	Metric	Metric Weight	Component weight	Score definition		
						3	2	1
1	H&S leadership	1.1	Capability gap analysis and training need analysis performed frequently	0.2	2	> 1 analysis per 3 months	Once per 3 months	< 1 analysis per 3 months
		1.2	Each training program is assessed for quality, relevance and adequateness for the works	0.2		Every 3 months	Every 6 months	Less frequent than every 6 months
		1.3	H&S leadership training sessions conducted / planned (%)	0.1		100%	≥ 90%	≥ 75%
		1.4	% senior managers and middle managers trained in H&S leadership and communication	0.25		100% trained	≥ 90% trained	≥ 75% trained
		1.5	% supervisors/frontline leaders trained in H&S leadership and communication	0.25		100% trained	≥ 90% trained	≥ 75% trained
		1.6	Officers' documented engagement in Due Diligence checks – number of activities per officer	0.25		≥ 5 per officer per month	≥ 3 per officer per month	2 per officer per month
		1.7	Senior managers' documented engagement in work sequencing and work planning forums e.g., facilitation of CRAW, attendance at SiD workshops, developing and presenting a critical risk review / HPI to executives or workforce – number of activities per manager	0.25		≥ 5 per manager per month	≥ 3 per manager per month	2 per manager per month

Development of Evidence Informed Health and Safety Performance Index - Report

		1.8	Average frequency of senior and middle managers' engagement with frontline (documented engagement in safety walks and talks, conversations with workforce, delivering toolbox talks, attend prestart meetings at the right time, introduce inductions, review of high-risk activities, recognition of good behaviour ...) - frequency calculated per month as (No. of activities / No. of managers)	0.25		≥ 5 per manager per month	≥ 3 per manager per month	≥ 2 per manager per month
		1.9	Average frequency of supervisor engagement with workers (involvement in writing JSA/SWMSs and setting up controls with the workforce, peer review of planned high-risk tasks, lead toolbox talks, focused conversations with workforce to reinforce good practice or recognise good behaviour, observations accompanied with workers, review of high-risk activities with workers, ...) – frequency calculated per month as (No. of activities / No. of supervisors)	0.25		≥ 10 activities per supervisor per month	≥ 8 per supervisor per month	≥ 5 per supervisor per month
2	Risk management and governance	2.1	% workforce trained in site specific H&S risk awareness and management	0.1	2	100% trained	≥ 90% trained	≥ 80% trained
		2.2	Resource review and demonstrated capability - % of planned work activities that have adequate resources (human, knowledge and capability, time, equipment, supervision) in place to perform the tasks in a healthy and safe manner	0.1		100%	≥ 90%	≥ 80%
		2.3	Proactive risk planning (risk assessment and control for upcoming work) – (% completed vs planned)	0.1		100%	≥ 90%	≥ 80%

Development of Evidence Informed Health and Safety Performance Index - Report

		2.4	Critical risks are documented, and critical risk control reviews are occurring - % of critical risk controls reviewed for effectiveness in the past 3 months	0.1		100%	≥ 90%	≥ 80%
		2.5	Risk control effectiveness - % of risks that are controlled using elimination, substitution or engineering controls.	0.1		≥ 80%	≥ 70%	≥ 60%
		2.6	Control measures implemented (initiatives, recommendations from investigations, follow up corrective actions from audits and inspections, etc.) – % closed out on time	0.1		≥ 90%	≥ 80%	≥ 70%
		2.7	Timeliness of critical risk control activities - Critical risk control activities closed on time vs total planned (%)	0.1		100%	≥ 90%	≥ 80%
		2.8	Residual risk management (% risks closed and transferred)	0.1		100%	≥ 90%	≥ 80%
		2.9	High-potential incidents/fatalities reporting rate	0.1		0	≤ 2 per 100k work hours	≤ 4 per 100k work hours
		2.10	Timeliness of incident notification and reporting – % incidents reported via SIMS within 1 day of occurrence	0.1		100%	≥ 90%	≥ 80%
3	Learning and sharing lessons	3.1	Investigations completed on-time with root-causes identified and recommendations provided Vs total incidents reported (including high-potential and near miss) (% completed)	0.4	1	≥ 90%	≥ 80%	≥ 70%

Development of Evidence Informed Health and Safety Performance Index - Report

		3.2	Adequate communication to inform the workforce about outcomes of investigations, addressing issues raised by workforce, lessons learnt or good practices - % completed vs planned	0.3		≥ 100%	≥ 90%	≥ 80%
		3.3	Lessons, successful initiatives, and best practices shared across the program - % completed vs planned	0.3		≥ 100%	≥ 90%	≥ 80%
4	Health and wellbeing	4.1	% of relevant physical occupational health risks (e.g. noise, dust and MSD) that are being controlled by elimination, substitution or engineering controls	0.2	1	90%	≥ 80%	≥ 70%
		4.2	Fatigue management plans developed and monitored - % of planned work activities that have mitigation plans in place to monitor and address fatigue risk and/or provide fatigue counter measures, signed off by supervisor or manager	0.16		100%	≥ 90%	≥ 80%
		4.3	Physical and mental health improvement initiatives identified vs implemented - % implemented	0.16		100%	≥ 90%	≥ 80%
		4.4	% of workers returned to pre-work hours and duties after injury and illness as specified in return to work plans	0.16		100%	≥ 90%	≥ 80%
		4.5	% of identified psychosocial risks that have been eliminated or reduced through work design	0.16		100%	≥ 90%	≥ 80%
		4.6	% of activities for which monitoring occupational health exposure has been completed (of total number specified as per risk assessment)	0.16		100%	≥ 90%	≥ 80%

Part 5: Discussion and next steps

The suggested H&S Index was developed through a systematic process which involved:

- reviewing academic literature, industry reports and best practice guidelines
- interviewing 27 Australian and international construction industry experts, and
- considering SRLA's H&S strategy and management plan.

The index components were identified to reflect the key aspects of H&S management highlighted by the industry experts, as well as the industry best practice in H&S performance measurement. This contributes to validity of the H&S index. Furthermore, selecting best practice metrics for each component in the index and clearly defining how each metric is scored and how the overall index score is calculated contributes to the reliability of the index.

The suggested H&S Index was designed with consideration of the features of a mature performance measurement system, as indicated in Figure 1.1 in Part 1. Consideration of the SRLA H&S Strategy when developing the index ensured alignment between index metrics and SRLA's strategic H&S objectives, ensuring the relevance of the index to SRLA's organisational context. Further, including active, measurable and sensitive metrics in the index facilitates tracking and reporting trends in time series data that can be used in regular H&S performance reviews. Importantly, the suggested index can be used in conjunction with lagging metrics and H&S climate surveys to cross-validate data and obtain a more comprehensive view of H&S performance, as indicated in Figure 5.1.

The suggested index has also been designed to facilitate a participative H&S performance management approach. The H&S metrics included in the index are designed to be flexible and put an emphasis on achieving H&S performance standards rather than being overly narrow or prescriptive. The metrics typically identify groups of H&S management activities or behaviours rather than focusing on single activities or behaviour. For example, a wide range of leadership engagement activities is covered by metrics 1.7 – 1.9. Similarly, metric 2.6 includes a wide range of risk control and improvement activities, and metrics 3.2 and 3.3 cover a range of communication activities. Defining the metrics in this way helps to avoid being prescriptive and provides flexibility to project teams to take a participatory approach to H&S management and decide (within a set of performance standards) what actions to take to improve H&S and report the results. Hence, the focus is on the effectiveness and outcomes of the H&S management activities. Also, the interrelationship between the metrics and the inclusion of both drive and monitor metrics in the index helps to consider various aspects of H&S management system to check if the activities undertaken produce the intended outcomes over time. Furthermore, inclusion of a component that encourages sharing lessons and best practices across the SRL program of work enhances the opportunities for transparency, consultation and relationship-building to benefit all parties as well as the broader construction industry.

As mentioned above, there is also the potential to use the suggested H&S Index in combination with lagging indicators and H&S climate surveys. The combination of different types of H&S indicators provides the opportunity to cross-validate the performance measures. Figure 5.1 indicates this combination.

H&S climate surveys provide the advantage of understanding workers' perceptions in relation to the effectiveness of H&S management activities, their participation in H&S improvement activities, and the adequacy of resources that workers need to perform the work safely. Combining climate surveys with the data provided by the suggested H&S Index (which focuses on the management of H&S) provides the opportunity to assess whether the H&S management/leadership activities are effective in workers' views (as the recipients of the H&S management/leadership activities) and if they encourage workers' participation in H&S improvement. Understanding workers' perceptions is important, because, due to their proximity to site activities and conditions, workers have a great understanding of the work requirements and issues that impact H&S. Furthermore, workers' perceptions of H&S management activities and leadership priorities shape their behaviour and affect their engagement in H&S. Therefore, H&S climate surveys can be used both to check the effectiveness of H&S management/leadership activities and to reflect any issues that may contribute to workers' unsafe behaviours and/or low participation in H&S-related activities. The insights from H&S climate surveys can be used to update H&S performance management plans and measures.

In a similar way, combining the performance data from the suggested H&S Index with lagging indicator data can provide insights into whether the management of H&S is leading to a reduction in the actual and potential negative outcomes. Any discrepancy between the performance results needs to be investigated to identify the underlying issues, e.g., where measures indicate a high score in the H&S index (i.e. H&S management activities) but a low H&S climate score or a high rate of incidents. These discrepancies indicate that the H&S management activities reflected by the index are not producing the desired outcomes and a more detailed investigation may be needed to reveal the underlying issues.

The suggested H&S Index needs to be reviewed periodically to ensure it remains relevant and supports effective management of H&S. The effectiveness of metrics in driving the desired behaviours and producing the expected outcomes needs to be evaluated using the collected performance data. Further, as the SRL program context changes over time, the index components and H&S metrics need to be reviewed and updated to reflect these changes and to ensure they remain focused on the priority areas and H&S objectives. Periodic modification of the scoring criteria and metric weights may also be needed to keep performance targets challenging and ensure continual improvement of H&S.

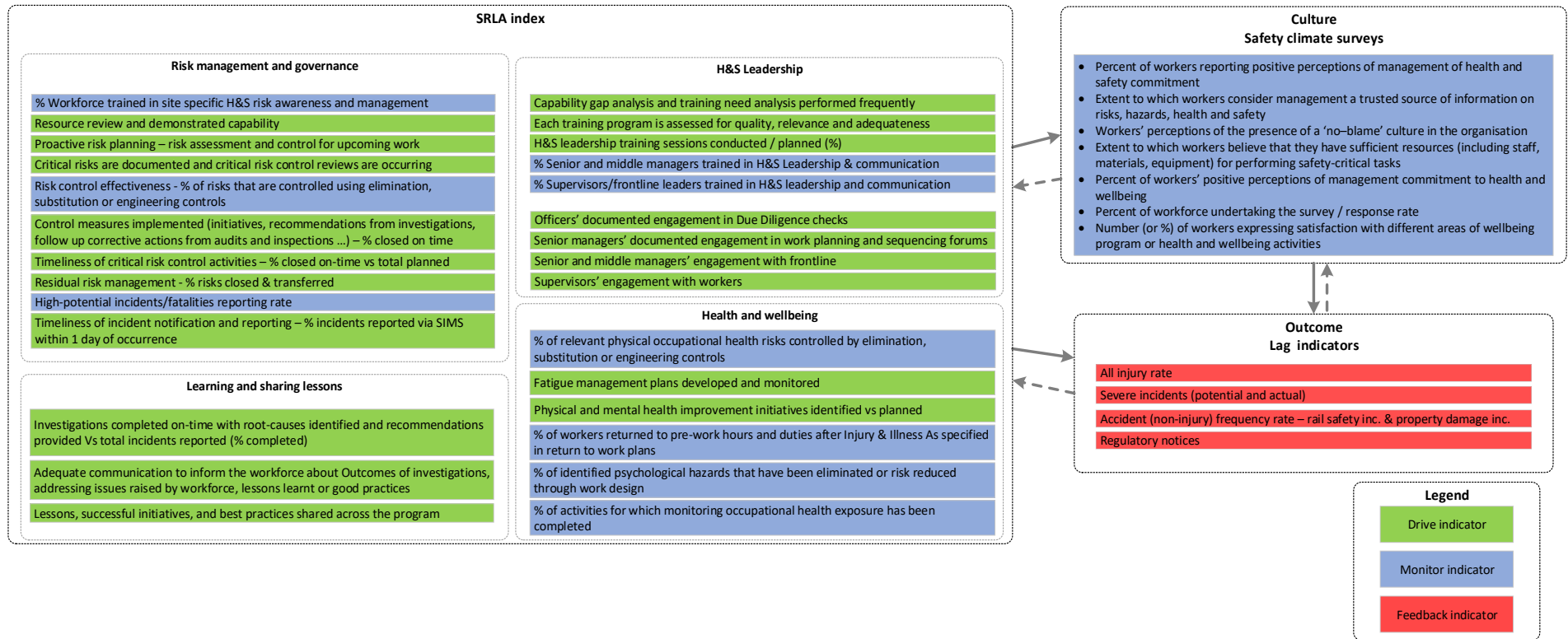


Figure 5.1: Using the H&S index in combination with safety climate surveys and lagging indicators

Part 6: References

- Aksorn, T., Hadikusumo, B.H.W. (2008). Critical success factors influencing safety program performance in Thai construction projects. *Safety Science*, 46(4), 709-727.
- Alexander, D., Hallowell, M., & Gambatese, J. (2017a). Precursors of construction fatalities. I: Iterative experiment to test the predictive validity of human judgment. *Journal of Construction Engineering and Management*, 143(7), 04017023.
- Alexander, D., Hallowell, M., & Gambatese, J. (2017b). Precursors of construction fatalities. II: Predictive modeling and empirical validation. *Journal of Construction Engineering and Management*, 143(7), 04017024.
- Alruqi, W. M., Hallowell, M. R., & Techera, U. (2018). Safety climate dimensions and their relationship to construction safety performance: A meta-analytic review. *Safety Science*, 109, 165-173.
- Alruqi, W. M., & Hallowell, M. R. (2019). Critical success factors for construction safety: Review and meta-analysis of safety leading indicators. *Journal of Construction Engineering and Management*, 145(3), 04019005.
- American College of Occupational and Environmental Medicine (ACOEM). (2020). Guide to a Safe and Healthy Workplace. Available at: <<https://fdocuments.net/document/guide-to-a-healthy-and-safe-workplace-effective-health-safety-and-environmental.html?page=2>> (accessed 20 May 2022).
- American Industrial Hygiene Association (AIHA). (2020). Best Practice Guide for Leading Health Metrics in Occupational Health and Safety Programs. Available at: <<https://aiha-assets.sfo2.digitaloceanspaces.com/AIHA/resources/Guidance-Documents/Best-Practice-Guide-for-Leading-Health-Metrics-in-Occupational-Health-and-Safety-Programs-Guidance-Documents.pdf>> (accessed 20 May 2022).
- Arezes, P.M., Miguel, A.S. (2003). The role of safety culture in safety performance measurement. *Measuring Business Excellence*, 7, 20–28.
- Australian Constructors Association (ACA). (n.d.). Lead indicators - Safety measurement in the construction industry. Available at: <https://kipdf.com/download/lead-indicators-safety-measurement-in-the-construction-industry_5add783e7f8b9a236f8b460d.html> (accessed 18 May 2022).
- Australian Council of Superannuation Investors (ACSI). (2019). The Future of Health and Safety Reporting. Available at: <<https://acsi.org.au/wp-content/uploads/2020/02/The-Future-of-Health-and-Safety-Reporting-10-Dec-2019.pdf>> (accessed 18 May 2022).

Bhandari, S., Hallowell, M., Scheve, C., Upton, J., Alruqi, W. M., & Quashne, M. (2022). Assessing the Quality of Safety-Focused Leadership Engagements. *Professional Safety*, 67(01), 22-28.

Bellamy, L.J., Ale, B.J.M., Geyer, T.A.W., Goossens, L.H.J., Hale, A.R., Oh, J., Mud, M., Bloemhof, A., Papazoglou, I.A., Whiston, J.Y. (2007). Storybuilder—A tool for the analysis of accident reports. *Reliability Engineering & System Safety*, 92(6), 735–744.

Bititci, U. S., Bourne, M., Cross, J. A. F., Nudurupati, S. S., & Sang, K. (2018). Towards a theoretical foundation for performance measurement and management. *International Journal of Management reviews*, 20(3), 653-660

Bosak, J., Coetsee, W.J. and Cullinane, S.J. (2013) Safety climate dimensions as predictors for risk behavior. *Accident Analysis & Prevention*, 55, 256–64.

Boyd, W, Brockhaus, A, Chini, M, et al. (2001). Industrial Hygiene Performance Metrics. Falls Church: American Industrial Hygiene Association.

Cadioux, J., Roy, M., Desmarais, L. (2006). A preliminary validation of a new measure of occupational health and safety. *Journal of Safety Research*, 37, 413–419.

Campbell Institute (2015). Elevating EHS Leading Indicators from Defining to Designing. Available at: <<https://www.thecampbellinstitute.org/wp-content/uploads/2017/05/Campbell-Institute-Elevating-EHS-Leading-Indicators-From-Defining-to-Designing-WP.pdf>> (accessed 18 May 2022).

Campbell Institute (2019a). Practical Guide to Leading Indicators: Metrics, Case Studies & Strategies. Available at: <<https://www.thecampbellinstitute.org/wp-content/uploads/2017/05/Campbell-Institute-Practical-Guide-Leading-Indicators-WP.pdf>> (accessed 23 May 2022).

Campbell Institute (2019b). An Implementation Guide to Leading Indicators. Available at: <<https://www.thecampbellinstitute.org/wp-content/uploads/2019/08/Campbell-Institute-An-Implementation-Guide-to-Leading-Indicators.pdf>> (accessed 20 May 2022).

CDC (2014). Health ScoreCard Manual. Available at: <https://www.cdc.gov/dhds/pubs/docs/HSC_Manual.pdf> (accessed 23 May 2022).

CDC (2019). Worksite Health ScoreCard Manual. Available at: <<https://www.cdc.gov/workplacehealthpromotion/initiatives/healthscorecard/pdf/CDC-Worksite-Health-ScoreCard-Manual-Updated-Jan-2019-FINAL-508.pdf>> (accessed 23 May 2022).

Center for Chemical Process Safety (CCPS). (2011). Process Safety Leading and Lagging Metrics – You Don't Improve What You Don't Measure. Available at: <https://www.aiche.org/sites/default/files/docs/pages/CCPS_ProcessSafety_Lagging_2011_2-24.pdf> (accessed 19 May 2022).

Chevron (2020). Sustainability Performance Data. Available at: <<https://www.chevron.com/-/media/shared-media/documents/2020-sustainability-performance-data.pdf>> (accessed 23 May 2022).

Construction Industry Institute (CII). (2012a). Implementing Active Leading Indicators 284-2. Austin, Texas.

Construction Industry Institute (CII). (2012b). Measuring Safety Performance with Active Safety Leading Indicators 284-1. Austin, Texas.

Council of State and Territorial Epidemiologists (CSTE). (n.d.). Occupational Health Indicators. Available at: <<https://www.cste.org/page/%20OHIndicators?&hhsearch-%20terms=%22leading+and+per-%20formance%22>> (accessed 23 May 2022).

Daniels, C., Marlow, P. (2005). Literature Review on the Reporting of Workplace Injury Trends, HSL/2005/36. Health and Safety Laboratory, HSE, London.

Dekker, S., Pitzer, C. (2016). Examining the asymptote in safety progress: a literature review. *International Journal of Occupational Safety and Ergonomics*, 22 (1), 57–65.

Dyrborg, J. (2009). The causal relation between lead and lag indicators. *Safety Science*, 47, 474–475.

Forsknings Center (2007). Questionnaire on Psychosocial Factors at Work. Available at: <https://nfa.dk/-/media/NFA/Vaerktojer/Spoergeskemaer/COPSOQ/Copenhagen-Psychosocial-Questionnaire-COPSOQII/5_copsoq-ii-medium-size-questionnaire-english.ashx?la=da> (accessed 23 May 2022).

Gibb, A., Lingard, H., Behm, M., Cooke, T. (2014). Construction accident causality: learning from different countries and differing consequences, accepted for publication. *Construction Management and Economics*, 32, 446–459.

Grabowski, M., Ayyalasomayajula, P., Merrick, J., & Mccafferty, D. (2007a). Accident precursors and safety nets: leading indicators of tanker operations safety. *Maritime Policy and Management*, 34(5), 405-425.

Grabowski, M., Ayyalasomayajula, P., Merrick, J., Harrald, J. R., & Roberts, K. (2007b). Leading indicators of safety in virtual organizations. *Safety Science*, 45(10), 1013-1043.

Grote, G (2009). Response to Andrew Hopkins. *Safety Science*, 47(4), 478.

Guo, B. and Yiu, T. (2015). Developing Leading Indicators to Monitor the Safety Conditions of Construction Projects. *Journal of Management in Engineering*, 10.1061/(ASCE)ME.1943-5479.0000376, 04015016.

Guo, B.H., & Yiu, T.W. (2016). Developing leading indicators to monitor the safety conditions of construction projects. *Journal of Management in Engineering*, 32(1), 04015016.

- Hale, A. (2009). Why safety performance indicators? *Safety Science*, 4(47), 479-480.
- Hallowell, M. R., & Gambatese, J. A. (2009). Construction safety risk mitigation. *Journal of Construction Engineering and Management*, 135(12), 1316-1323.
- Hallowell, M. R., Hinze, J. W., Baud, K. C., & Wehle, A. (2013). Proactive construction safety control: Measuring, monitoring, and responding to safety leading indicators. *Journal of Construction Engineering and Management*, 139(10), 04013010.
- Hallowell, M. R., Bhandari, S., & Alruqi, W. (2020). Methods of safety prediction: Analysis and integration of risk assessment, leading indicators, precursor analysis, and safety climate. *Construction Management and Economics*, 38(4), 308-321.
- Hallowell, M., Quashne, M., Salas, R., MacLean, B., & Quinn, E. (2021). The statistical invalidity of TRIR as a measure of safety performance. *Professional Safety*, 66(04), 28-34.
- Haslam, R.A., Hide, S.A., Gibb, A.G.F., Gyi, D.E., Atkinson, S., Pavitt, T.C., Duff, R., Suraji, A. (2003). Causal Factors in Construction Accidents. Health and Safety Executive, HSE Report.
- Health and Safety Executive (2001). A Guide to Measuring Health and Safety Performance. HSE, UK.
- Hinze, J., & Hallowell M. (2013). Construction Industry Institute. Going Beyond Zero Using Safety Leading Indicators 284-11. Austin, Texas.
- Hinze, J., Hallowell, M., & Baud, K. (2013). Construction-safety best practices and relationships to safety performance. *Journal of Construction Engineering and Management*, 139(10), 04013006.
- Hinze, J., Thurman, S., & Wehle, A. (2013). Leading indicators of construction safety performance. *Safety Science*, 51(1), 23-28.
- Hollnagel, E. (2008). Safety management—looking back or looking forward. *Resilience Engineering Perspectives*, 1, 63-77.
- Hopkins, A., (2009a). Thinking about process safety indicators. *Safety Science*, 47, 460–465.
- Hopkins, A., (2009b). Reply to comments. *Safety Science*, 47, 508–510.
- International Council on Mining & Metals (ICMM). (2012). Health and safety critical control management – good practice guide. Available at: <
<https://www.minerals.org.au/sites/default/files/ICMM%20Health%20and%20safety%20critical%20control%20managment%20-%20good%20practice%20guide.pdf>> (accessed 19 May 2022).
- Kjellén, U. (2009). The safety measurement problem revisited. *Safety Science*, 4(47), 486-489.

Lingard, H., Cooke, T. and Blismas, N. (2009). Group-level safety climate in the Australian construction industry: Within-group homogeneity and between-group differences in road construction and maintenance. *Construction Management and Economics*, 27(4), 419–432.

Lingard, H., Cooke, T. and Blismas, N. (2010). Safety climate in conditions of construction subcontracting: A multi-level analysis. *Construction Management and Economics*, 28(5), 813–825.

Lingard, H., Cooke, T. and Blismas, N. (2012). Do perceptions of supervisors' safety responses mediate the relationship between perceptions of the organizational safety climate and incident rates in the construction supply chain? *Journal of Construction Engineering and Management*, 138(2), 234–41.

Lingard, H., Wakefield, R., & Blismas, N. (2013). If you cannot measure it, you cannot improve it: Measuring health and safety performance in the construction industry. In *19th Triennial CIB World Building Congress, Queensland University of Technology, Brisbane, Queensland, Australia*.

Lingard, H., Hallowell, M., Salas, R., & Pirzadeh, P. (2017). Leading or lagging? Temporal analysis of safety indicators on a large infrastructure construction project. *Safety Science*, 91, 206-220.

Lingard, H., Wakefield, R., & Walker, D. (2020). The client's role in promoting work health and safety in construction projects: balancing contracts and relationships to effect change. *Construction Management and Economics*, 38(11), 993-1008.

Lofquist, E. A. (2010). The art of measuring nothing: The paradox of measuring safety in a changing civil aviation industry using traditional safety metrics. *Safety Science*, 48(10), 1520-1529.

McFadden, K. L., & Towell, E. R. (1999). Aviation human factors: a framework for the new millennium. *Journal of Air Transport Management*, 5(4), 177-184.

Mearns, K., Whitaker, S.N., Flin, R., (2003). Safety climate, safety management practice and safety performance in offshore environments. *Safety Science*, 41, 641–680.

Melnyk, S.A., Bititci, U., Platts, K., Tobias, J. and Andersen, B., (2014). Is performance measurement and management fit for the future? *Management Accounting Research*, 25(2), 173-186.

Mengolini, A., & Debarberis, L. (2008). Effectiveness evaluation methodology for safety processes to enhance organisational culture in hazardous installations. *Journal of Hazardous Materials*, 155(1-2), 243-252.

Mohaghegh, Z., Mosleh, A., 2009. Measurement techniques for organizational safety causal models: characterization and suggestions for enhancements. *Safety Science*, 47, 1398–1409.

Morrow, S.L., McGonagle, A.K., Dove-Steinkamp, M.L., Walker, C.T. Jr, Marmet, M. and Barnes-Farrell, J.L. (2010). Relationships between psychological safety climate facets and safety behavior in the rail industry: A dominance analysis. *Accident Analysis & Prevention*, 42(5), 1460–7.

Neal, A., Griffin, M.A. and Hart, P.M. (2000). The impact of organizational climate on safety climate and individual behavior. *Safety Science*, 34(1–3), 99–109.

Neal, A. and Griffin, M.A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of Applied Psychology*, 91(4), 946–53.

Neely, A., Gregory, M., & Platts, K., (1995). Performance measurement system design: a literature review and research agenda. *International Journal of Operations & Production Management*, 15(4), 80-116.

Occupational Safety and Health Administration (OSHA). (2019). Using Leading Indicators to Improve Safety and Health Outcomes. Available at: <https://www.osha.gov/sites/default/files/publications/OSHA_Leading_Indicators_Guidance-07-03-2019.pdf> (accessed 19 May 2022).

Oguz Erkal, E. D., Hallowell, M. R., & Bhandari, S. (2021). Practical Assessment of Potential Predictors of Serious Injuries and Fatalities in Construction. *Journal of Construction Engineering and Management*, 147(10), 04021129.

O'Neill, S., Martinov-Bennie, N., Cheung, A., & Wolfe, K. (2013). Issues in the measurement and reporting of work health and safety performance: A review. Safe Work Australia, Safety Institute of Australia and CPA Australia, online. <<https://www.safeworkaustralia.gov.au/system/files/documents/1703/issues-measurement-reporting-whs-performance.pdf>> [accessed 9 May 2022].

Organisation for Economic Co-operation and Development (OECD). (2008). Guidance on Developing Safety Performance Indicators for Industry. Available at: <<https://www.oecd.org/env/ehs/chemical-accidents/41269710.pdf>> (accessed 18 May 2022).

Oswald, D., Zhang, R. P., Lingard, H., Pirzadeh, P., & Le, T. (2018). The use and abuse of safety indicators in construction. *Engineering, Construction and Architectural Management*, 25, 1188–1209.

Pedersen, L.M., Nielsen, K.J., Kines, P. (2012). Realistic evaluation as a new way to design and evaluate occupational safety interventions. *Safety Science*, 50(1), 48–54.

Peñaloza, G. A., Saurin, T. A., & Formoso, C. T. (2020). Monitoring complexity and resilience in construction projects: The contribution of safety performance measurement systems. *Applied Ergonomics*, 82, 102978.

Pirzadeh, P., Lingard, H., Blismas, N., Mills, T., & Kleiner, B. (2015). Proactive evaluation of occupational health and safety performance in construction projects using the hierarchy of controls concept. *Proceedings CIB W099 Belfast*, 439-449.

Probst, T.M., Barbaranelli, C., Petitta, L. (2013). The relationship between job insecurity and accident under-reporting: a test in two countries. *Work Stress* 27, (4), 383–402.

Rajendran, S. (2013). Enhancing Construction Worker Safety Performance Using Leading Indicators. *Practice Periodical on Structural Design and Construction*, 18(1), 45-51.

Rajendran, S., & Gambatese, J. A. (2009). Development and initial validation of sustainable construction safety and health rating system. *Journal of Construction Engineering and Management*, 135(10), 1067-1075.

Reiman, T., & Pietikäinen, E. (2010). Indicators of safety culture-selection and utilization of leading safety performance indicators. Report, Swedish Radiation Safety Authority.

Reiman, T., & Pietikäinen, E. (2012). Leading indicators of system safety—monitoring and driving the organizational safety potential. *Safety Science*, 50(10), 1993-2000.

Salas, R., & Hallowell, M. (2016). Predictive validity of safety leading indicators: Empirical assessment in the oil and gas sector. *Journal of Construction Engineering and Management*, 142(10), 04016052.

Shea, T., De Cieri, H., Donohue, R., Cooper, B., & Sheehan, C. (2016). Leading indicators of occupational health and safety: An employee and workplace level validation study. *Safety Science*, 85, 293-304.

Sinelnikov, S., Inouye, J., Kerper, S., (2015). Using leading indicators to measure occupational health and safety performance. *Safety Science*, 72, 240–248.

Siu, O.L., Phillips, D.R. and Leung, T.W. (2004). Safety climate and safety performance among construction workers in Hong Kong: The role of psychological strains as mediators. *Accident Analysis & Prevention*, 36(3), 359–366.

Smith, M. and Bititci, U.S., (2017). Interplay between performance measurement and management, employee engagement and performance. *International Journal of Operations & Production Management*, 37(9), pp.1207-1228.

Sparer, E. H., & Dennerlein, J. T. (2013). Determining safety inspection thresholds for employee incentives programs on construction sites. *Safety Science*, 51(1), 77-84.

Step Change in Safety (n.d.). Leading performance indicators: Guidance for effective use. Available at: <<http://www.lustedconsulting.ltd.uk/step%20change%20-%20leading%20performance%20indicators.pdf>> (accessed 20 May 2022).

Stricoff, R.S. (2000). Safety performance measurement: identifying prospective indicators with high validity, *Professional Safety*, 45(1), 36-9.

- Teo, E.A.L., Ling, F.Y.Y. (2006). Developing a model to measure effectiveness of safety management systems of construction sites. *Building and Environment*, 41, 1584–1592.
- Tharaldsen, J.E., Olsen, E. and Rundmo, T. (2008). A longitudinal study of safety climate on the Norwegian continental shelf. *Safety Science*, 46(3), 427–39.
- Toellner, J. (2001). Improving safety & health performance: identifying & measuring leading indicators. *Professional Safety*, 46(9), 42.
- Tomlinson, C. M., Craig, B. N., & Meehan, M. J. (2011). Enhancing safety performance with a leading indicators program. *Human Factor in Ship Design and Operation*, 16-17.
- U.S. Department of Energy (DOE). (1996). Guidelines for performance management. Available at: <<https://www.directives.doe.gov/directives-documents/100-series/0120.1-EGuide-5/@@images/file>> (accessed 20 May 2022).
- U.S. Navy (2018). Defence Occupational and Environmental Health. Readiness System – Industrial Hygiene (DOEHRS-IH). The Bureau of Medicine and Surgery (BUMED). Available at: <https://www.med.navy.mil/Portals/62/Documents/NMFA/NMCPHC/root/Industrial%20Hygiene/DOEHRS-IH_BUMED_IPR_IH_Metrics_Tools_Info_Queries-Reports_Explanation.pdf?ver=xdKENXWizb6LOLVSGl349w%3D%3D> (accessed 20 May 2022).
- Varonen, U. and Mattila, M. (2000). The safety climate and its relationship to safety practices, safety of the work environment and occupational accidents in eight wood-processing companies. *Accident Analysis & Prevention*, 32(6), 761–9.
- Wallace, J.C., Popp, E. and Mondore, S. (2006). Safety climate as a mediator between foundation climates and occupational accidents: A group-level investigation. *Journal of Applied Psychology*, 91(3), 681–688.
- Wehle, H., & Hinze, J. (2009). A Survey of Leading Indicators among the Members of the CII Safety Community of Practice. Construction Industry Institute. Austin, Texas.
- Weick, K.E., (1987). Organizational culture as a source of high reliability. *California Management Review*, 29, 112–127.
- WorkSafe New Zealand (2018). SafePlus Lead Indicators - examples across industry sectors. Available at: <<https://worksafe.govt.nz/dmsdocument/3350-lead-indicators>> (accessed 18 May 2022).
- Wreathall, J. (2009). Leading? Lagging? Whatever! *Safety Science*, 4(47), 493-494.
- Xia, N., Zou, P. X., Liu, X., Wang, X., & Zhu, R. (2018). A hybrid BN-HFACS model for predicting safety performance in construction projects. *Safety Science*, 101, 332-343.

Zhang, R. P., Lingard, H., & Nevin, S. (2015). Development and validation of a multilevel safety climate measurement tool in the construction industry. *Construction Management and Economics*, 33(10), 818-839.

Zhang, R. P., Pirzadeh, P., Lingard, H., & Nevin, S. (2018). Safety climate as a relative concept: Exploring variability and change in a dynamic construction project environment. *Engineering, Construction and Architectural Management*, 25(3), 298-316.

Zhou, Q., Fang, D. and Wang, X. (2008). A method to identify strategies for the improvement of human safety behavior by considering safety climate and personal experience. *Safety Science*, 46(10), 1406–19.

Part 7: Appendix

7.1 Interview questions

1. How do you measure OH&S performance in your construction projects?
 - a. Explore whether they use lead/**positive performance indicators**? ask for examples.
 - b. **How often** collected?
 - c. any **health and wellbeing indicators**?
 - d. If they work with subcontractors: How do they measure their performance?
 - e. What **lag/negative indicators** are captured?

2. How do you use the collected data?
 - a. Explore the extent to which data is used to **inform decision-making** (does it trigger any actions?)
 - b. Do you **report** the analysis results? To whom?
 - c. How often do you **update/revise** the indicators/metrics you use?

3. Thinking about your indicators and metrics,
 - a. What are the **most useful** indicators and metrics? Why?
 - b. If you were to design a new suite of OHS indicators to measure construction project performance, what is the **best mix of indicators**, lead/lag etc, quantity vs quality metrics, objective vs subjective measures?

4. Is there anything else you'd like to tell us about indicators and OHS performance measurement? anything we missed that you want to add?

Ask the interviewees if they can share a list of the indicators and associated metrics they use, or an example of how they measure and report H&S performance.

7.2 Table of H&S metrics

The following list of health and safety (H&S) metrics have been developed following a comprehensive review of industry guidelines and reports and academic literature.

In the table below, the following aspects were considered to classify the leading indicators:

Positive/negative: refers to the nature of the measurement reflected by metrics, i.e. a higher score for positive metrics indicate better performance or presence of desirable conditions while high scores on negative metrics indicate worse performance or undesirable conditions.

Proximity to hazard: Proximity of the indicators to hazard/incident is determined based on the Construction Accident Causation model (Haslam et al. 2003). The model identifies 3 levels of contributing factors to incidents: originating influences (e.g. deficiencies in risk management and project management), shaping factors (e.g. supervision, site constraints, poor communication), and immediate circumstances (e.g. workers capability and behaviour, work site environment). The model is used here as a framework to classify the indicators based on the level of factors referenced.

Drive, monitor, feedback: The Swedish Radiation Safety Authority (Reiman and Pietikainen, 2010) categorises indicators into:

- Drive indicators: Indicators of priority areas and activities to manage H&S, i.e. change, maintain, reinforce, or reduce something to direct organisational activity by motivating certain safety management activities.
- Monitor indicators: Indicators that reflect the potential and capacity of an organisation to perform safely. The indicators monitor functions such as the effectiveness of the control measures and proactive actions to enhance safety status.
- Feedback indicators: Indicators of the outcomes, i.e. a result of a process or activity.

Development of Evidence Informed Health and Safety Performance Index - Report

Indicator / Category	Metric	Reference	Positive / negative	Proximity to hazard	Drive – monitor - feedback
Strategic H&S management - A systematic approach in place to manage health and safety risks	There is a qualitative description of the approach or framework for identifying, managing, monitoring and reporting material health and safety risks	ACSI (2019)	+	Originating influence, shaping factor	Drive
Strategic H&S management – H&S integrated in management of organisation	Health and safety is systematically and visibly considered in the organization's plans and strategy documents	Reiman and Pietikainen (2012; 2010) Guo and Yiu, (2015)	+	Originating influence	Drive
	H&S is criteria in management decisions		+	Originating influence	Drive
Strategic H&S management – Safety policy	Safety policy is defined, and regularly reviewed and updated	Reiman and Pietikainen (2010) Mengolini and Debarberis (2008)	+	Originating influence	Drive
	Clear and relevant H&S goals are defined, both for short term and long term		+	Originating influence	Drive
	Workforce participation is defining safety goals		+	Originating influence	Drive
	Safety policy is communicated to all relevant stakeholders		+	Originating influence	Drive
Governance and oversight of health and safety	Qualitative description of health and safety structure, responsibility and cadence at the most senior level (e.g. board)	ACSI (2019) Reiman and Pietikainen (2010)	+	Originating influence	Drive
	An action program is in place for achieving H&S goals, with clear responsibilities and accountabilities		+	Originating influence	Drive
	The clarity of the organizational structure including the extent to which roles and responsibilities have been clearly and unambiguously described		+	Originating influence	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

Overall health and safety leadership capability of managers and executives	Percent of workers reporting positive perceptions of leadership capability for management of health and safety (e.g. from an annual leadership-oriented survey)	ACSI (2019) WorkSafe New Zealand (2018)	+	Originating influence	Monitor
	Performance outcomes of programs specifically designed to uplift health and safety leadership capability of managers and executives (e.g. from an annual leadership-oriented survey)		+	Originating influence	Feedback
	Percent of supervisors, middle management, and senior management who have received training in relation to safe (and healthy) work observations		+	Originating influence	Monitor
	Percent of supervisors who have received training in H&S communication and engagement		+	Originating influence	Monitor
H&S leadership engagement	Management is committed to, and visibly involved in, H&S activities	Reiman and Pietikainen (2010) ACSI (2019) Campbell institute (National Safety Council, 2015) Reiman and Pietikainen (2012) Aksorn and Hadikusumo (2008) WorkSafe New Zealand (2018) OECD (2008) Bhandari et al. (2022) Hinze et al. (2013) Hallowell et al. (2013)	+	Originating influence	Drive
	Management provides financial resources for H&S		+	Originating influence	Drive
	Percent of workers reporting positive perceptions of management of health and safety commitment (e.g. from an annual leadership-oriented survey)		+	Originating influence	Monitor
	Assessment of the quality of safety-focused leadership engagements with workers (e.g. using a scorecard approach)		+	Originating influence	Monitor
	Linking health and safety program performance reporting with the relevant executive program sponsor (accountable for the program)		+	Originating influence	Drive
	Evidence that leadership survey results are incorporated into health and safety strategy and planning		+	Originating influence	Drive
	Number of employee suggestions implemented by leadership		+	Originating influence	Monitor

	Extent suggestions and complaints from employees result in improvements in health and safety		+	Originating influence	Monitor
	Number of times health and safety is a topic in the management meetings		+	Originating influence	Monitor
	Senior managers provide positive feedback on staff's safety-conscious behaviour		+	Originating influence	Drive
	Existence of formal appraisal systems that include safety performance		+	Originating influence	Drive
	Opportunities for workers to participate in safety planning and development sessions (with an "open" atmosphere) and a procedure for implementation and feedback from such sessions		+	Originating influence	Drive
	Specific incentives for good safety performance		+	Originating influence	Drive
	Managers / supervisors visible participation in safety activities including focus audit, site inspections, training sessions, walkarounds, safe (and healthy) work observations (outside their own work area)		+	Originating influence	Drive
	Number of times leaders/managers have safety related conversations with staff on-site		+	Originating influence	Drive
	Number of times that a manager or supervisor has stopped unsafe (or unhealthy) work in a period (e.g. in one month or per 200,000 work hours)		+	Shaping factor	Drive
	Number of times managers involve in follow-up of incidents		+	Originating influence / Shaping factor	Drive
	Percent of toolbox meetings attended by site supervisors/managers		+	Originating influence / Shaping factor	Drive
	Percent of pre-task planning meetings attended by site supervisors/managers		+	Originating influence / Shaping factor	Drive

Development of Evidence Informed Health and Safety Performance Index - Report

	Frequency of project management team members' participation in site safety activities		+	Originating influence / Shaping factor	Drive
Leadership walks / visits	Leaders' attendance at risk workshops and safe design workshops and audits	ACA (N.d.) Reiman and Pietikainen (2012) Hinze and Hallowell (2013).	+	Originating influence / Shaping factor	Drive
	Number of safety walks undertaken by management per month		+	Originating influence / Shaping factor	Drive
Leadership involvement in communication	Senior managers' planned, scheduled and documented interactions with frontline employees about workplace safety or with supervisors on new bid/opportunity	ACA (N.d.) OECD (2008)	+	Originating influence / Shaping factor	Drive
	Extent to which senior managers deliver introduction to orientation sessions, or attend toolbox meetings		+	Originating influence / Shaping factor	Drive
	Extent to which workers consider management a trusted source of information on risks, hazards, health and safety		+	Shaping factor	Monitor
H&S communication across project	Employees are regularly informed about H&S performance and challenges	Reiman and Pietikainen (2010) Campbell institute (National Safety Council, 2015) OECD (2008) CII (2012a,b) Rajendran (2013) Lingard et al. (2017) Grabowski et al. (2007) Rajendran and Gambatese (2009) OSHA (2019) Hallowell et al. (2013)	+	Originating influence	Drive
	Feedback is provided to employees on incidents and near misses (e.g. measure frequency)		+	Originating influence	Drive
	There are both formal and informal communication channels for raising safety concerns		+	Originating influence	Drive
	The safety significance of various rules and procedures is clearly communicated to the personnel		+	Originating influence	Drive
	Sufficient opportunities exist for exchanging safety relevant information within and between units (e.g. workgroups, sites, projects)		+	Originating influence	Drive
	Workers can easily access information that is relevant for work		+	Originating influence	Drive

	Information flow in change of shifts situations is assured		+	Originating influence	Drive
	Number of users of H&S dashboard		+	Shaping factor	Monitor
	Number and frequency of employee meetings		+	Shaping factor	Drive
	Number of pre-start safety talks/pre-task planning meetings conducted		+	Shaping factor	Drive
	Number of toolbox meetings completed		+	Shaping factor	Drive
	Attendance in toolbox meetings		+	Shaping factor	Monitor
	Percent of toolbox talks attended/delivered by supervisors/ managers		+	Shaping factor	Drive
	Percent of pre-task planning meetings attended by supervisors/managers		+	Shaping factor	Drive
	Number of bulletin boards with current/relevant information		+	Shaping factor	Monitor
	Percent conformance with communication expectations/needs		+	Shaping factor	Monitor
	Frequency of communication between stakeholders, employees, and management		+	Shaping factor	Monitor
	Employees' satisfaction with the feedback on the outcome of safety meetings/communication		+	Originating influence / Shaping factor	Monitor
	Frequency of discussions about health and safety between workers and supervisors		+	Shaping factor	Monitor
	Number of hazards reported by contract/temporary workers versus total site workers		+	Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	On-time incident reporting (e.g. % notifiable incidents reported/entered into an online platform by next working day)		+	Shaping factor	Monitor
	Frequency of foremen discussions and feedback meetings with the owner's/client's PM		+	Shaping factor	Monitor
	Employees' use/apply health and safety information (e.g., based on an independent review of day-to-day activities)		+	Shaping factor	Monitor
	Opportunities and incentives for employees to relate safety concerns and suggestions to supervisors and managers, (on an anonymous basis if preferred)		+	Originating influence / Shaping factor	Monitor
	Extent to which key findings of risk assessments, audits, inspections, and similar activities are communicated and known to workers		+	Originating influence / Shaping factor	Monitor
Leadership skills contribution to the organisation's health and safety culture	Key themes, results and programs from health and safety leadership or culture assessments	ACSI (2019)	+/-	Originating influence	Monitor
	Outcomes of change through positive or appreciative inquiries		+	Shaping factor	Monitor
Safety Climate Survey	Percent increase in perceived safety commitment and priority in organisation/project	ACA (N.d.) Reiman and Pietikainen (2010)	+	Originating influence	Monitor
	Percent increase in perceived safety participation by workers		+	Originating influence	Monitor
	The extent to which workers have a motivation to spend effort on safety related issues		+	Originating influence	Monitor
	The extent to which the personnel are interested in safety matters, and try to learn more on hazards and safety		+	Originating influence	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	The extent to which the personnel prioritize safety over production in conflict situations or under time pressure		+	Originating influence	Monitor
	The extent to which workers feel that they can influence safety related issues		+	Originating influence	Monitor
	The extent to which workers have a willingness to spend personal effort on safety issues and take responsibility for their actions		+	Originating influence	Monitor
	The extent to which the workers perceive a wider responsibility for the overall safety of the project		+	Originating influence	Monitor
	The extent to which the relationships between the management and the workers are based on trust		+	Originating influence	Monitor
	The extent to which the relations between various work groups are based on trust and shared safety norms		+	Originating influence	Monitor
Employee opinion survey which includes health and safety	Percent of workforce undertaking the survey / response rate	ACA (N.d.)	+	Shaping factor	Monitor
	Increase in positive perceptions towards safety		+	Originating influence	Monitor
	Workers' perceptions of the presence of a 'no-blame' culture in the organisation	Grabowski et al. (2007)	+	Originating influence	Monitor
Safe behaviour recognition and reinforcement programs	Number of recognitions for safe behaviour – positive feedback is given on safety conscious behaviour	Campbell institute (National Safety Council, 2015)	+	Originating influence	Monitor
	Percent of personal H&S systems goals met	Reiman and Pietikainen (2010)	+	Shaping factor	Monitor
Workforce engagement and participation in H&S	Number of on-the-job observations from workforce	Campbell institute (National Safety Council, 2015)	+	Shaping factor	Monitor
	Number of off-the-job observations from workforce		+	Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Number of workers personally engaged by supervisors in walkarounds	WorkSafe New Zealand (2018) OSHA (2019) Hallowell et al (2013)	+	Shaping factor	Monitor
	Number of workers volunteering for initiatives		+	Shaping factor	Monitor
	Percent of coached observations		+	Shaping factor	Monitor
	Number and quality of comments from workforce observations		+	Shaping factor	Monitor
	Number of H&S issues raised by workers		+	Shaping factor	Monitor
	Percent attendance at safety committee meetings		+	Shaping factor	Monitor
	Number of safety meetings or safety initiatives lead by workforce		+	Shaping factor	Monitor
	Number of improvement/risk mitigation suggestions by workers		+	Shaping factor	Monitor
	Number of times workers stop unsafe work in a period (e.g. in one month or per 200,000 work-hours)		+	Shaping factor	Monitor
	Number of workers involved in developing safety procedures		+	Shaping factor	Monitor
	Number of workers involved in developing task-specific job safety analyses/job hazard analyses on how to perform routine tasks safely		+	Shaping factor	Monitor
	Frequency of conversations held with the workforce about H&S issues and incidents		+	Originating influence / Shaping factor	Monitor
	Percent job turnover		-	Shaping factor	Feedback
Recognition and use of the know-how of workforce	Variety of views and opinions are encouraged, and decisions are made based on expertise not formal position	Reiman and Pietikainen (2010)	+	Originating influence / Shaping factor	Drive

Development of Evidence Informed Health and Safety Performance Index - Report

	The hands-on experience of workers and technicians is utilised by foremen, managers and engineers		+	Originating influence / Shaping factor	Drive
Client involvement in Safety planning/review	Client review and approval of safety plan	CII (2012a)	+	Originating influence	Drive
Client participation in safety management	Extent of client's participation in safety orientation sessions (% of orientation sessions in which client's representative is an active participant)	Salas and Hallowell (2016) Hinze and Hallowell (2013) Hallowell et al. (2013)	+	Originating influence	Monitor
	Extent of client's participation in safety walks / frequency of client safety walkthroughs		+	Originating influence	Monitor
Investment in H&S risk management	Size of H&S budget - Safety, occupational health, mental health and wellbeing (planned) budget as % of total operational budget	ACSI (2019) Toellner (2001).	+	Originating influence	Monitor
	Expenditure on new control measures that directly relate to material risks, with a focus on higher order controls		+	Shaping factor	Monitor
H&S Staffing and resource management	The availability of sufficient workforce	Reiman and Pietikainen (2010) CII (2012a) OECD (2008)	+	Originating influence	Drive
	Ratio of safety supervisors to workers		+	Shaping factor	Monitor
	Tools, equipment and instruments are appropriate and up to date		+	Shaping factor	Drive
	There is a system for ensuring that time pressure does not compromise safety		+	Originating influence / Shaping factor	Drive
	Human performance issues such as fatigue and communication are considered in work schedule planning		+	Originating influence / Shaping factor	Drive
	Extent of incidents attributed to problems related to human resources as a root or intermediate cause (e.g., staffing levels, training, competency)		-	Originating influence / Shaping factor	Feedback

Development of Evidence Informed Health and Safety Performance Index - Report

	Extent to which workers believe that they have sufficient resources (including staff, materials, equipment) for safety-critical tasks		+	Shaping factor	Monitor
	Time pressure and workload of staff performing safety-critical tasks		+	Originating influence / Shaping factor	Monitor
	The amount of slack resources to cope with unexpected or demanding situations		+	Originating influence / Shaping factor	Monitor
	Staffing in critical roles		+	Originating influence / Shaping factor	Monitor
H&S risk profile reflecting what is measured and reported	Summary of health and safety risks for the company informed by the risk management processes in place and reflect the full spectrum of H&S risk and control measures in place	ACSI (2019)	+	Originating influence	Monitor
	Statement showing how reported health and safety indicators directly relate to risks identified in risk register or risk management profile		+	Originating influence	Drive
Health and safety related reporting	Clear procedure in place for reporting (e.g. rule breaches, near misses, potential hazards), with defined roles and responsibilities	Mengolini and Debarberis (2008) Grabowski et al. (2007)	+	Originating influence	Drive
	Workers' positive perception of the effectiveness of the reporting system		+	Originating influence / Shaping factor	Monitor
	Ontime reporting of incidents (e.g. % reported on the same day)		+	Immediate circumstances	Monitor
	Reporting of deviations, worries and own mistakes is encouraged by the management		+	Originating influence	Drive
Near miss reporting	There is a clear definition of reportable events (near miss, close call, high potential, ...)	Reiman and Pietikainen (2012)	+	Originating influence	Drive

Development of Evidence Informed Health and Safety Performance Index - Report

	Workers' encouragement by management to report and discuss events (e.g. incentives for reporting, an open atmosphere without fear of punishment, formal mechanisms for reporting, taking action and giving feedback)	Campbell institute (National Safety Council, 2015) OECD (2008) Hallowell et al. (2013)	+	Originating influence / Shaping factor	Drive
	Number of near misses reported per exposure hours (hours worked)		+	Immediate circumstances	Feedback
	Ratio of near misses reported to accidents		+	Immediate circumstances	Feedback
	3-month moving average of the number of near misses reported per 200,000 exposure hours		+	Immediate circumstances	Feedback
Near miss investigation and feedback	Number of near misses investigated vs near misses reported	Hinze and Hallowell (2013) Grabowski et al. (2007) OECD (2008)	+	Originating influence / Shaping factor	Monitor
	Extent to which lessons learnt are shared		+	Originating influence / Shaping factor	Monitor
	Workers' satisfaction with the feedback about near misses that occur		+	Shaping factor	Feedback
Critical Event Learning	Sustainably preventing the potential for a repeat critical event (near miss) by implementing effective controls and sharing the solutions.	ACA (N.d.)	+	Originating influence / Shaping factor / immediate circumstances	Drive
H&S procedures	H&S procedures are clear, current, concise and include required content	CCPS (2011) Reiman and Pietikainen (2010)	+	Originating influence	Drive
	H&S procedures and instructions are up-to-date and revised as conditions change		+	Originating influence	Drive
	Revisions in procedures and instructions are communicated to the users		+	Originating influence	Drive
	The know-how of the frontline workforce is utilised in creating and revising of rules and instructions		+	Originating influence	Drive

	Non-literate workers are considered when developing work procedures (e.g., use of video, illustrations, etc.)		+	Originating influence	Drive
	The discrepancy between formal rules and instructions, and actual work is monitored (work as planned vs actual work)		+	Originating influence	Drive
	Work Permit System is implemented and continuously developed		+	Originating influence	Drive
	The interfaces and interaction of various work processes is identified and managed		+	Originating influence	Drive
	The extent to which work is carried out in accordance with the processes described in the procedures and management system		+	Shaping factor	Monitor
	Failure to follow procedures/safe working practices (Number of safety critical tasks observed where all steps of the relevant safe working procedure were not followed/Total number of safety critical tasks observed)		-	Immediate circumstances	Feedback
Deviations/violations	A systematic corrective action program is in place to deal with deviations	Grabowski et al. (2007).	+	Originating influence	Drive
Safety observations	Workplace observations of frontline employees to assess safe / unsafe practices and conditions	ACA (N.d.) Campbell institute (National Safety Council, 2015) Hallowell et al. (2013)	+	Immediate circumstances	Monitor
	Number of unsafe observations (conditions or behaviours)		-	Immediate circumstances	Monitor
	Number of safe observations (conditions or behaviours)		+	Immediate circumstances	Monitor
	Number of unsafe observations per inspection		-	Immediate circumstances	Monitor
	Number of unsafe observations reported per employee per period		-	Immediate circumstances	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Ratio of safe to unsafe observations		+	Immediate circumstances	Monitor
	Weighted percent of safe observations (using risk matrix)		+	Immediate circumstances	Monitor
	Number of comments for unsafe observations that clarified nature of the hazard		+	Immediate circumstances	Monitor
	Number of unsafe observations recorded by a trained person		+/-	Immediate circumstances	Monitor
	Percentage of supervisors meeting observations goals		+	Immediate circumstances	Monitor
	Number of positive feedback provided by frontline supervisors on safety conscious behaviour of the workers		+	Shaping factor	Monitor
	Ratio of peer-to-peer observations to supervisory observations		+	Immediate circumstances	Monitor
	Ratio of high-risk observations to low-risk observations		-	Immediate circumstances	Monitor
	Percent of coached observations		+	Immediate circumstances	Monitor
	3-month moving average of the number of safety observations per 200,000 work-hours		+	Immediate circumstances	Monitor
Task reviews	Planned, scheduled and documented review of high-risk construction work tasks in the field	ACA (N.d.) ICMM (2012)	+	Shaping factor / Immediate circumstances	Monitor
	Rate of job safety analysis (JSA) reviewed per supervisor per month		+	Shaping factor / Immediate circumstances	Monitor

	Number / rate of tasks reviewed and documented		+	Shaping factor / Immediate circumstances	Monitor
Hazard identification	Proactive procedures in place to identify new hazards and improve existing safety measures	ACA (N.d.) Campbell institute (National Safety Council, 2015) OECD (2008) Reiman and Pietikainen (2010)	+	Originating influence	Drive
	Hazard identification and risk assessments are used in decision-making and to develop policies, procedures and practices		+	Originating influence	Drive
	Clear responsibilities are outlined for hazard identification in the organization		+	Originating influence	Drive
	Hazard identification deals with technical, human and organizational issues in adequate depth		+	Originating influence	Drive
	Number and percent of previously unknown or uncategorized hazards discovered		+	Shaping factor / Immediate circumstances	Monitor
	Number of staff trained in hazard identification		+	Shaping factor / Immediate circumstances	Monitor
	The extent to which workers understand the hazards that are related to their work		+	Shaping factor / Immediate circumstances	Monitor
	Hazards raised in the period vs hazards closed		+	Shaping factor / Immediate circumstances	Monitor
	Number of incidents related to unforeseen hazards (i.e., not identified in risk assessments)		-	Shaping factor / Immediate circumstances	Feedback
Risk assessment / risk profile	Number (or %) of critical risk assessments conducted per plan/schedule	Campbell institute (National Safety Council, 2015)	+	Shaping factor / Immediate circumstances	Monitor

	Percent of jobs/tasks for which risk assessment was performed	ICMM (2012) WorkSafe New Zealand (2018) OECD (2008) Reiman and Pietikainen (2010)	+	Shaping factor / Immediate circumstances	Monitor
	Ratio between the levels of risk identified (high, medium, low)		N/A	Shaping factor / Immediate circumstances	Monitor
	Number of assessment results communicated		+	Shaping factor / Immediate circumstances	Monitor
	Number of risks mitigated or controlled effectively		+	Shaping factor / Immediate circumstances	Monitor
	Number of assessments validated by EHS manager		+	Shaping factor / Immediate circumstances	Monitor
	Percent of assessments re-evaluated and revalidated		+	Shaping factor / Immediate circumstances	Monitor
	Number of incidents with a root cause related to inadequate risk assessment		-	Shaping factor / Immediate circumstances	Feedback
	Number of root causes not previously categorized or identified in risk assessment		+	Originating influence / Shaping factor / Immediate circumstances	Feedback
	Number of repeated findings from risk assessments		-	Shaping factor / Immediate circumstances	Monitor
	Number of assessments deemed unacceptable		-	Shaping factor / Immediate circumstances	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Percent of life-threatening risks, low severity risks, etc.		-	Shaping factor / Immediate circumstances	Monitor
	Number of unacceptable risks that have not been adequately addressed		-	Shaping factor / Immediate circumstances	Monitor
	Percent reduction in overall risk score		+	Shaping factor / Immediate circumstances	Monitor
	Number of risks by specific category (e.g. fall protection, confined space, housekeeping, etc.)		N/A	Shaping factor / Immediate circumstances	Monitor
	Timing for hazard identification and risk assessments (addressing the various stages of project)		N/A	Shaping factor / Immediate circumstances	Monitor
	The extent to which tasks and situations where routines may develop and where they might have consequences for safety are identified		+	Shaping factor / Immediate circumstances	Monitor
Risk control	Critical controls (or equivalent) program implemented (% complete actual vs planned)	ACSI (2019) Campbell institute (National Safety Council, 2015) ICMM (2012) WorkSafe New Zealand (2018)	+	Shaping factor / Immediate circumstances	Monitor
	Percent of high order (technological) risk controls implemented		+	Shaping factor / Immediate circumstances	Monitor
	Occupational exposure monitoring results compared to exposure limits across workforce		N/A	Shaping factor / Immediate circumstances	Monitor
	Percent of significant risks without high order controls (per the hierarchy of controls)		-	Shaping factor / Immediate circumstances	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	% of high-consequence low-incidence risks for which control measures and monitoring responsibilities have been reviewed/assessed in a month		+	Shaping factor / Immediate circumstances	Monitor
	Number or percent of supervisors and manager who have completed training in permit-to-work systems		+	Shaping factor	Monitor
	Percent of near misses or risks that have had corrective actions completed (e.g. in a month)		+	Shaping factor / Immediate circumstances	Monitor
	Percent of high-risk safety (and health) risk controls reviewed for effectiveness in the past six months		+	Shaping factor / Immediate circumstances	Monitor
	Frequency of safety committee meetings during which the effectiveness of H&S risk controls is reviewed		+	Shaping factor / Immediate circumstances	Monitor
	Time spent on planned versus unplanned maintenance of machinery/equipment		+	Immediate circumstances	Monitor
	Number of defects found in machinery/equipment		-	Immediate circumstances	Monitor
Lifecycle safety management	A long-term plan is in place for monitoring the condition of safety critical components and assuring that safety functions remain available in future	Reiman and Pietikainen (2010)	+	Originating influence	Drive
	A long-term plan is in place for maintaining and repairing the facility to ensure safe operation		+	Originating influence	Drive
Incident investigation	Systematic procedures in place to investigate root-causes of incidents and near misses	Rajendran and Gambatese (2009)	+	Originating influence	Drive
	Number (%) of incident investigations conducted vs outstanding incident investigation actions	Tomlinson (2011) CCPS (2011)	+	Shaping factor / Immediate circumstances	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Percent of incident reports for which root cause analysis was undertaken		+	Shaping factor / Immediate circumstances	Monitor
	Percent of incident investigations with appropriate recommendations and follow up actions		+	Originating influence / Shaping factor / Immediate circumstances	Monitor
	Recurrence of incidents with similar root causes		-	Originating influence / Shaping factor / Immediate circumstances	Feedback
Actions close out / corrective actions	Number of actions (from hazards raised, incidents, audits and inspections) closed on time vs overdue	ACA (N.d.) Grabowski et al. (2007) Campbell institute (National Safety Council, 2015)	+	Shaping factor / Immediate circumstances	Monitor
	Responsiveness to verify control effectiveness of corrective actions		+	Shaping factor / Immediate circumstances	Monitor
	Average days to close out corrective actions		-	Shaping factor / Immediate circumstances	Monitor
	Number of days to complete actions		-	Shaping factor / Immediate circumstances	Monitor
	Percent closed on time (within X hours or by due date)		+	Shaping factor / Immediate circumstances	Monitor
	Number of open issues with no corrective action assigned/implemented		-	Shaping factor / Immediate circumstances	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Percent of preventive and corrective actions communicated		+	Shaping factor / Immediate circumstances	Monitor
	Number of effective corrective actions verified by managers		+	Shaping factor / Immediate circumstances	Monitor
	Number of corrective actions for critical issues validated for effectiveness by managers		+	Shaping factor / Immediate circumstances	Monitor
	Number and percent of implemented controls in conformance with recommended corrective actions		+	Shaping factor / Immediate circumstances	Monitor
	Percent or ratio of corrective actions at each level of control (according to hierarchy of controls)		N/A	Shaping factor / Immediate circumstances	Monitor
	Percent or ratio of corrective actions according to hazard type (e.g. confined space, fall protection, etc.)		N/A	Shaping factor / Immediate circumstances	Monitor
	Number of issues flagged at 30 days, 60 days, etc.		-	Shaping factor / Immediate circumstances	Monitor
	Number of corrective actions prioritized by risk (e.g. high severity, low severity, life-threatening, etc.)		+	Shaping factor / Immediate circumstances	Monitor
	Number of divisional targets that have dropped below a 90%-completed rate		-	Shaping factor / Immediate circumstances	Monitor
	Employees' satisfaction with follow up actions and measures taken after incidents and near misses		+	Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

Management of change	Procedures in place to address the management of change (technical, organisational, and administrative change), which cover all the necessary steps from planning to implementation and follow-up	Campbell institute (National Safety Council, 2015) OECD (2008) Reiman and Pietikainen (2010)	+	Originating influence	Drive
	Number of gaps in management of change review		-	Originating influence	Monitor
	The amount and pace of change that the organisation can handle is considered when planning changes		+	Originating influence	Drive
	Number of incidents resulting from failure to manage change appropriately		-	Originating influence / Shaping factor	Feedback
	Percentage of change requests that are processed as "emergency changes" (i.e., requiring immediate attention for safety reasons)		-	Originating influence	Monitor
	Human and organizational factors are adequately considered in change management		+	Originating influence	Drive
	It is assured that the organizational memory is not lost with the changes by e.g. documentation and knowledge transfer		+	Originating influence	Drive
Safety in design	Mechanisms in place to ensure health and safety considered during the design phase	CII (2012a) Campbell institute (National Safety Council, 2015) Pirzadeh et al. (2015) OECD (2008)	+	Originating influence	Drive
	Procedures are in place for maintaining and updating design documentation and for communicating the design to relevant stakeholders		+	Originating influence	Drive
	Number or percent of design solutions that effectively address risk (e.g. assessed based on hierarchy of Control)		+	Originating influence	Monitor
	Number or percent of design solutions that pass validation		+	Originating influence	Monitor
	Number of incidents where engineering design is identified as a root or intermediate cause		-	Originating influence / shaping factor	Feedback

Development of Evidence Informed Health and Safety Performance Index - Report

Contractor selection	Contractor selection based on safety records/capabilities	Hinze and Hallowell (2013) Reiman and Pietikainen (2012) Guo and Yiu, (2015)	+	Originating influence	Drive
Sub-contractor selection	Number (or %) of subcontractors selected based on satisfying specific safety criteria	CII (2012a)	+	Originating influence	Monitor
Contractor / sub-contractor / supplier engagement in safety	Contractors/subcontractors are trained on safety culture issues and safe work practices of the project	Reiman and Pietikainen (2012) Salas and Hallowell (2016) Hinze and Hallowell (2013) OECD (2008) Hallowell et al. (2013)	+	Originating influence / shaping factor	Drive
	Number (or %) of subcontractors participating in safety meetings		+	Shaping factor	Monitor
	Number of health and safety kick-off meetings		+	Originating influence / Shaping factor	Monitor
	Extent of training provided to subcontractors		+	Shaping factor	Monitor
	Clear channels of communication between management and subcontractor, with encouragement for the subcontractor to come up with suggestions and initiatives		+	Originating influence / Shaping factor	Drive
	Percentage of suppliers or subcontractors entering site with appropriate safety planning		+	Originating influence / Shaping factor	Monitor
	Percentage of suppliers in compliance with site policies and procedures		+	Originating influence / Shaping factor	Monitor
Frontline Supervisor Safety Training	The number (or %) of frontline supervisors (and managers) who have completed Supervisor Safety Training	ACA (N.d.) Salas and Hallowell (2016)	+	Shaping factor	Monitor
	Percent of supervisors who have completed training on effective communication		+	Shaping factor	Monitor
	Hours of H&S training		+	Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Number (or %) of safety training sessions completed vs. scheduled		+	Shaping factor	Monitor
Training needs	Number of assessments to identify the type of training needed	ACA (N.d.) Campbell institute (National Safety Council, 2015)	+	Shaping factor	Monitor
	Training need analysis performed based on risk profile		+	Shaping factor	Monitor
	Percent of training completed to the requirements of the training needs analysis		+	Shaping factor	Monitor
Training delivery and effectiveness	Extent of H&S orientation and training delivered	Salas and Hallowell (2016) Hallowell and Gambatese (2009) Hallowell et al. (2013) CII (2012a) Campbell institute (National Safety Council, 2015) Reiman and Pietikainen (2012; 2010) WorkSafe New Zealand (2018) OECD (2008)	+	Shaping factor	Monitor
	Number (or %) of health and safety talks and training sessions completed vs. scheduled		+	Shaping factor	Monitor
	Number (or %) of people trained		+	Shaping factor	Monitor
	Number of training hours (per hours worked, per time period, per site, per staff)		+	Shaping factor	Monitor
	Number of safety culture and leadership training hours for leaders		+	Shaping factor	Monitor
	Site specific orientation delivered (number of participants, hours, ...)		+	Shaping factor	Monitor
	Project-specific training and regular safety meetings		+	Shaping factor	Monitor
	Percent of training sessions per worker that have specifically focused on work related H&S risks		+	Shaping factor	Monitor
	Number of incidents with a root cause that includes lack of training		-	Shaping factor	Feedback
	Extent of training on emergencies		+	Shaping factor	Monitor
	Number of new employees who complete orientation		+	Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Number and percent of positive post-training evaluations		+	Shaping factor	Monitor
	Extent to which the personnel have suitable skills, knowledge and experience to carry out their tasks safely and effectively		+	Shaping factor	Monitor
	Establishment of mechanisms to ensure the adequacy of training scope, content and quality (qualitative measure e.g. a list of criteria against which training quality is evaluated)		+	Originating influence / Shaping factor	Drive
	Establishment of mechanisms to ensure that training is performed according to the training program and that it achieves desired outcomes		+	Originating influence / Shaping factor	Drive
	Feedback is gathered from the trainees and it is utilized in developing the training program		+	Originating influence / Shaping factor	Drive
	Training delivery take into account non-literate workers are considered in training delivery (e.g. training include videos, demonstrations, etc if needed)		+	Originating influence / Shaping factor	Drive
	Simulators and simulated operations are utilized in training		+	Originating influence / Shaping factor	Drive
	Assessment of effectiveness of on-site induction and training (on basis of time taken for workers to adopt safe behaviour)		+	Originating influence / Shaping factor	Monitor
Investment in building worker capability	Extent of investment in supervisor and frontline leadership training (e.g. hours, \$ per supervisor)	ACSI (2019) Campbell institute (National Safety Council, 2015)	+	Originating influence / Shaping factor	Monitor
	Extent to which investment in training and competency is aligned to health and safety risks and findings from incidents and assurance activities (e.g. training developed to address incident learnings)		+	Originating influence / Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Number of certified trainers		+	Originating influence / Shaping factor	Monitor
Competency assessment and management	Qualitative description on key areas for training and competency for current and emerging workforce requirements	ACSI (2019)	+	Originating influence / Shaping factor	Drive
	Demonstrated commitment to ongoing compliance with competency frameworks across entire workforce at all levels (e.g. % compliance of workforce competent against training and competency matrix, which includes but is not limited to health and safety)		+	Originating influence / Shaping factor	Monitor
Auditing/assurance program	Auditing program and schedule in place	Hinze and Hallowell (2013) Reiman and Pietikainen (2010)	+	Originating influence	Drive
	Independent safety reviews are carried out regularly and proactively		+	Originating influence	Drive
Audits completed	Number of audits completed vs. planned according to the published annual audit schedule	ACA (N.d.) Campbell institute (National Safety Council, 2015) ACSI (2019) Salas and Hallowell (2016)	+	Originating influence / Shaping factor	Monitor
	Number of management/supervisor safety audits		+	Shaping factor	Monitor
	Number and frequency of the internal and external EHS management system audits performed		+	Originating influence	Monitor
	Number of findings (instances of non-conformance)		-	Originating influence / Shaping factor / Immediate circumstances	Monitor
	Number of corrective actions		+	Originating influence / Shaping factor / Immediate circumstances	Monitor
	Completion of critical controls (or equivalent) verification program (% planned vs actual)		+	Shaping factor / immediate circumstances	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Close out of audit recommendations by hierarchy of controls and priority (% completed within agreed time frames, year on year)		+	Originating influence / Shaping factor / Immediate circumstances	Monitor
	Frequency of contractor/subcontractor safety audits		+	Originating influence / Shaping factor / Immediate circumstances	Monitor
Inspections	The number of inspections completed vs planned according to the published annual monitoring schedule	ACA (N.d.) Campbell institute (National Safety Council, 2015) OSHA (2019)	+	Originating influence / Shaping factor / Immediate circumstances	Monitor
	Inspection count (collection of observations)		+	Shaping factor / Immediate circumstances	Monitor
	Number of joint inspections with the regulator (completed vs planned)		+	Shaping factor / Immediate circumstances	Monitor
	Number of checklists filled out		+	Shaping factor / Immediate circumstances	Monitor
	Number of regulatory inspections with/without findings		-/+	Shaping factor / Immediate circumstances	Monitor
	Percentage of inspections that include a follow-up inspection to ensure that the hazard has been controlled		+	Shaping factor / Immediate circumstances	Monitor
Audit/inspection results	Safety audit score calculated and monitored	Tomlinson (2011) CII (2012a)	+	Originating influence / Shaping factor / Immediate circumstances	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Qualitative record of inspections outcomes	Campbell institute (National Safety Council, 2015) Salas and Hallowell (2016) Hinze et al. (2013) Hallowell et al. (2013) Reiman and Pietikainen (2010)	+	Shaping factor / Immediate circumstances	Monitor
	Percent of compliance found by jobsite safety audits/inspections		+	Originating influence / Shaping factor / Immediate circumstances	Monitor
	Number of findings indicating non-conformance		-	Originating influence / Shaping factor / Immediate circumstances	Monitor
	Number of management system root causes identified by incident investigations		-	Originating influence / Shaping factor	Feedback
	Follow up actions based on audit results		+	Originating influence / Shaping factor / Immediate circumstances	Monitor
	Contractor safety audit scores		+	Originating influence / Shaping factor / Immediate circumstances	Monitor
	The extent to which external audits provide results that are in accordance with the finding of internal audits		+	Originating influence / Shaping factor /	Monitor
Feedback from audits	Procedure in place to communicate the audit/inspection results and follow up actions	Mengolini and Debarberis (2008)	+	Originating influence	Drive
Responsiveness to breaches	Number of breaches, penalties	ACSI (2019)	-	Shaping factor / Immediate circumstances	Monitor
	Responsiveness of company to manage and close corrective actions following breaches		+	Originating influence / Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Responsiveness to verify control effectiveness of corrective actions		+	Originating influence / Shaping factor	Monitor
Organisational Learning	There is a comprehensive system for reporting and investigating incidents and other learning experiences such as near misses	Reiman and Pietikainen (2010)	+	Originating influence	Drive
	A systematic corrective action program is in place to deal with deviations		+	Originating influence	Drive
	A system is in place for gathering development initiatives from the workforce		+	Originating influence	Drive
	A system is in place for investigation and analysis of internal incidents that takes into account technical, human and organizational factors		+	Originating influence	Drive
	A system is in place for analysing the common safety related findings (trends, root causes, changes, variety of corrective actions) from events and near misses		+	Originating influence	Drive
	A system is in place for sharing findings and lessons across the organisation/program of works		+	Originating influence	Drive
Contingency planning and emergency response	On-site emergency preparedness plan is adequate and up to date	Reiman and Pietikainen (2010)	+	Originating influence	Drive
	Regular training on emergencies on-site is provided		+	Originating influence	Drive
	Adequate information on the potential hazards and accident scenarios have been provided to the public authorities such as first response personnel, medical facilities, and the environmental authorities		+	Originating influence	Drive
Health and wellbeing					
Substance abuse	Substance abuse program in place	Rajendran and Gambatese (2009)	+	Originating influence	Drive
	Frequency of drug and alcohol tests		+	Originating influence	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Percent negative (or positive) results on random drug/alcohol tests	CII (2012a)	+(-)	Shaping factor / Immediate circumstances	Monitor
Worker health support	Percent of employees with restrictions returned to work through structured return to work programs	ACOEM (2020) cited in AIHA (2020) Campbell institute (National Safety Council) (2019a) cited in AIHA (2020) CSTE/NIOSH (2018) cited in AIHA (2020)	+	Originating influence	Monitor
	Percent of employees with health insurance		+	Originating influence	Monitor
	Ratio of occupational safety and health professionals to employees		+	Originating influence	Monitor
	Percent of eligible employees receiving employee assistance programs		+	Originating influence	Monitor
Health focused perception surveys	Percent positive/negative poll results	Campbell institute (National Safety Council) (2015) cited in AIHA (2020) Step Change in Safety (n.d.)	+/-	Shaping factor	Monitor
	Percent of workers' positive perceptions of management commitment to health		+	Shaping factor	Monitor
Leadership engagement in health program	Number of leadership reviews confirmed/scheduled	ACOEM (2020) cited in AIHA (2020)	+	Originating influence	Monitor
Health focused Inspections/audits	Percent of inspection action closed on-time	ISHN (2010) cited in AIHA (2020) Campbell institute (National Safety Council) (2019a) cited in AIHA (2020) ACOEM (2020) cited in AIHA (2020)	+	Originating influence	Monitor
	Number of compliance program requirements met		+	Originating influence	Monitor
	Percent of medical records reviewed that were compliant		+	Originating influence / Shaping factor	Monitor
	Percent of completed health corrective actions by due date		+	Originating influence / Shaping factor	Monitor
Emergency response	Number of corrective actions/lessons learned from drills, table-top sessions, and incidents	ACOEM (2020) cited in AIHA (2020)	+	Originating influence	Monitor
Pandemic planning	Percent of drills and assessments of readiness for pandemic plans	ACOEM (2020) cited in AIHA (2020)	+	Originating influence	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

Fitness for duty	Percent of employees with completed required medical surveillance	ACOEM (2020) cited in AIHA (2020)	+	Shaping factor	Monitor
	Percent of required qualified personnel involved in job assessments to establish functional requirements		+	Shaping factor	Monitor
Health hazard recognition	Percent of permits to work reviewed and found to meet health requirements	Step Change in Safety (n.d.) Campbell institute (National Safety Council) (2015a) cited in AIHA (2020)	+	Shaping factor	Monitor
	Percent of observations confirming healthy conditions		+	Shaping factor	Monitor
Health risk assessment	Percent of health risk assessments completed as compared to health risk assessments planned	Step Change in Safety (n.d.) Campbell institute (National Safety Council) (2015) cited in AIHA (2020) Boyd et al. (2001) cited in AIHA (2020) U.S. Navy (2018) cited in AIHA (2020)	+	Originating influence	Monitor
	Number (or %) of occupational hygiene assessments performed vs planned		+	Originating influence	Monitor
	Percent of identified health risks mitigated or controlled		+	Originating influence / Shaping factor	Monitor
	Percent of jobs for which occupational health exposures assessment has been completed (of number required)		+	Originating influence	Monitor
	Percent planned qualitative exposure assessments completed		+	Originating influence	Monitor
	Percent of locations with defined similar exposure groups (SEGs)		+	Originating influence / Shaping factor	Monitor
Health risk monitoring	Supervisors monitor workers' coping skills, stress and fatigue levels as well as technical skills	Reiman and Pietikainen (2010) U.S. Navy (2018) cited in AIHA (2020) ACOEM (2020) cited in AIHA (2020)	+	Originating influence / Shaping factor	Drive
	Percent of locations with completed baseline monitoring (of locations requiring baseline monitoring)		+	Originating influence / Shaping factor	Monitor
	Percent of locations participating in industrial hygiene monitoring activities		+	Originating influence / Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Percent of personal monitoring samples completed against sample plan		+	Originating influence / Shaping factor	Monitor
	Frequency of hygienist site visits (completed vs planned)		+	Originating influence / Shaping factor	Monitor
	Number of results that exceed permissible exposure limits (of total number of workers monitored)		-	Immediate circumstances	Feedback
Health risk monitoring - Noise	Number of noise surveys completed (of total number of noise surveys planned)	U.S. DOE (1996) cited in AIHA (2020) Boyd et al. (2001) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
	Number or percent of workers exposed to hazardous noise		-	Immediate circumstances	Feedback
	Percent compliance with required audiometric testing		+	Shaping factor / Immediate circumstances	Monitor
Health risk monitoring – Musculoskeletal disorders	Percent of worksites that conduct ergonomic assessments for workspace and equipment when problems are identified or anticipated	CDC (2019) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
Health risk exposure evaluation – Musculoskeletal disorders	Percent of workers with reported risk factors completing repetitive stress injury self-assessment and annual training	Chevron Health Metric (2020) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
Medical surveillance	Percent of medical surveillance completed as compared to health surveillance required	ACOEM (2020) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
Health risk control	Percent of risk factors (e.g., ergonomic) reported by employees which have been resolved	CDC (2019) cited in AIHA (2020) Boyd et al. (2001) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
	Percent of identified engineering controls for health hazards which have been implemented		+	Originating influence / Shaping factor	Monitor
	Percent of reduction in the use of PPE (e.g., hearing protection, respiratory protection) as a result of implementing more effective controls		+	Shaping factor / Immediate circumstances	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

Health risk control – respiratory protection	Percent of workers in a respiratory protection program with current qualifications to wear a respirator	WorkSafe New Zealand (2018) Boyd et al. (2001) cited in AIHA (2020)	+	Shaping factor	Monitor
	Percent of workers having annual lung function testing (spirometry) to monitor their exposure		+	Originating influence / Shaping factor	Monitor
Health risk control – hearing protection	Percent of hearing protection fit tests completed versus those required	Boyd et al. (2001) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
Health risk training	Percent of workers trained in health risk management	ACOEEM (2020) cited in AIHA (2020) ICMM (2012) Campbell institute (National Safety Council) (2019b) cited in AIHA (2020) WorkSafe New Zealand (2018)	+	Shaping factor	Monitor
	Percent of positive post-training evaluation results		+	Shaping factor	Monitor
	Number of assessments to determine the type of PPE training needed		+	Originating influence / Shaping factor	Monitor
	Percent of 'at-risk' workers who completed appropriate job-related health-risk awareness and training programmes		+	Shaping factor	Monitor
	Percent of toolbox talks that included discussion of specific health risks (e.g. working around construction dust such as silica, asbestos, wood dust, etc.)		+	Shaping factor	Monitor
Employee assistance programs	Number (percent) of employee assistance programs offered, per year	ACOEEM (2020) cited in AIHA (2020)	+	Originating influence	Monitor
Sponsored health screenings	Number (percent) of employees participating in health screenings	ACOEEM (2020) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
Health promotion/ wellness activities	Existence of a strategic plan that includes goals and measurable organizational objectives for the health promotions/wellness activities	Chevron Health Metric (2020) cited in AIHA (2020) Campbell institute (National Safety Council, 2019b)	+	Originating influence	Drive
	Existence of wellbeing programs that cover the following areas: physical/biometric wellbeing, mental, emotional, and financial wellbeing		+	Originating influence	Drive

Development of Evidence Informed Health and Safety Performance Index - Report

	Number (or %) of workers expressing satisfaction with different areas of wellbeing program or health and wellbeing activities		+	Shaping factor	Monitor
	Investment in (budget allocated to) health and wellbeing programs and activities		+	Originating influence	Monitor
	Participation in health and wellbeing programs and activities (e.g., % of contractors signed up for health/wellbeing promotion initiatives)		+	Originating influence / Shaping factor	Monitor
Health promotion/ wellness activities	Percent of health programs, or other interventions, to optimize return on investment for health, attendance, and productivity (e.g., weight loss, health clubs)	ACOEM (2020) cited in AIHA (2020) Campbell institute (National Safety Council) (2019a) cited in AIHA (2020)	+	Originating influence	Monitor
	Percent of locations (projects, sites, etc.) offering health promotion and wellness activities		+	Originating influence	Monitor
	Percent of workers who participate in health promotion and wellness activities		+	Originating influence / Shaping factor	Monitor
	Percent of employees surveyed who express satisfaction with health promotions and wellness activities		+	Shaping factor	Monitor
Health promotion – smoking cessation	Number of workers that stop smoking as result of smoking cessation program	Campbell institute (National Safety Council) (2019b) cited in AIHA (2020) Chevron Health Metric (2020) cited in AIHA (2020) ACOEM (2020) cited in AIHA (2020)	+	Immediate circumstances	Feedback
	Percent of sites that provide incentives for not being a tobacco user or for being enrolled in a tobacco cessation program		+	Originating influence	Monitor
	Percent of smoke-free workplaces		+	Originating influence	Monitor
Health promotion – healthy diet	Percent of locations that subsidize or provide discounts on healthier food items in cafes and snack bars	Chevron Health Metric (2020) cited in AIHA (2020) ACOEM (2020) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
	Percent of healthy food options provided through catering/vending		+	Originating influence / Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

	Percent of sites that provide visible nutritional information for the food and beverages	CDC (2019) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
Health promotion – exercise	Percent of sites with gym/other environmental supports for recreation or physical activity	CDC (2019) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
Fatigue management	Percent of sites that have mitigation plans in place to monitor and address fatigue risk and/or provide fatigue countermeasures	Chevron Health Metric (2020) cited in AIHA (2020) CDC (2019) cited in AIHA (2020) CCPS (2011)	+	Originating influence / Shaping factor	Monitor
	Fatigue risk education (number of affected workers who received training on fatigue risk management vs total number of affected workers)		+	Originating influence / Shaping factor	Monitor
	Percent of managers completing training to improve understanding of safety and health risks associated with poor sleep		+	Originating influence	Monitor
Fatigue management – work hours	Contract enforcing work hours restrictions	CII (2012a) Campbell institute (National Safety Council, 2019a) CCPS (2011)	+	Originating influence	Drive
	Percent overtime		-	Shaping factor	Feedback
	Average hours worked per worker per month		N/A	Shaping factor	Monitor
Understanding the prevalence of mental health issues	Employee engagement surveys, health and safety culture surveys or regular pulse surveys focused on mental health	ACSI (2019)	+	Originating influence / Shaping factor	Monitor
	Facilitated focus groups to gather feedback on psychological health and safety and organisational climate around mental health reporting		+	Originating influence / Shaping factor	Monitor
Raising awareness about psychological health	Extent of information sharing on psychosocial risk management processes (e.g. feedback, experiences, outcomes, improvement opportunities)	ACSI (2019)	+	Originating influence / Shaping factor	Monitor

Development of Evidence Informed Health and Safety Performance Index - Report

Return to work monitoring	Number of workers returned to pre-work hours and duties after being off with a mental illness, recovery duration, and identifying trends and any relationship to initiatives and processes in place	ACSI (2019)	+	Shaping factor	Monitor
Psychological risk exposure	Percent workers reporting being exposed to psychosocial hazards at their workplace in the last 12 months (including: bullying, undesired sexual attention, feeling that work drains so much energy that it has a negative effect on private life; employees unable to express their views and feelings; feeling of lacking any influence on what they do at work)	Forsknings Center (2007) cited in AIHA (2020)	-	Shaping factor / Immediate circumstances	Feedback
Psychological risk control	Percent of worksites that provide free or subsidized clinical assessments for depression by a provider, followed by directed feedback and clinical referral when appropriate	CDC (2014) cited in AIHA (2020)	+	Originating influence / Shaping factor	Monitor
	Percent of worksites that provide educational materials on stress management		+	Originating influence / Shaping factor	Monitor