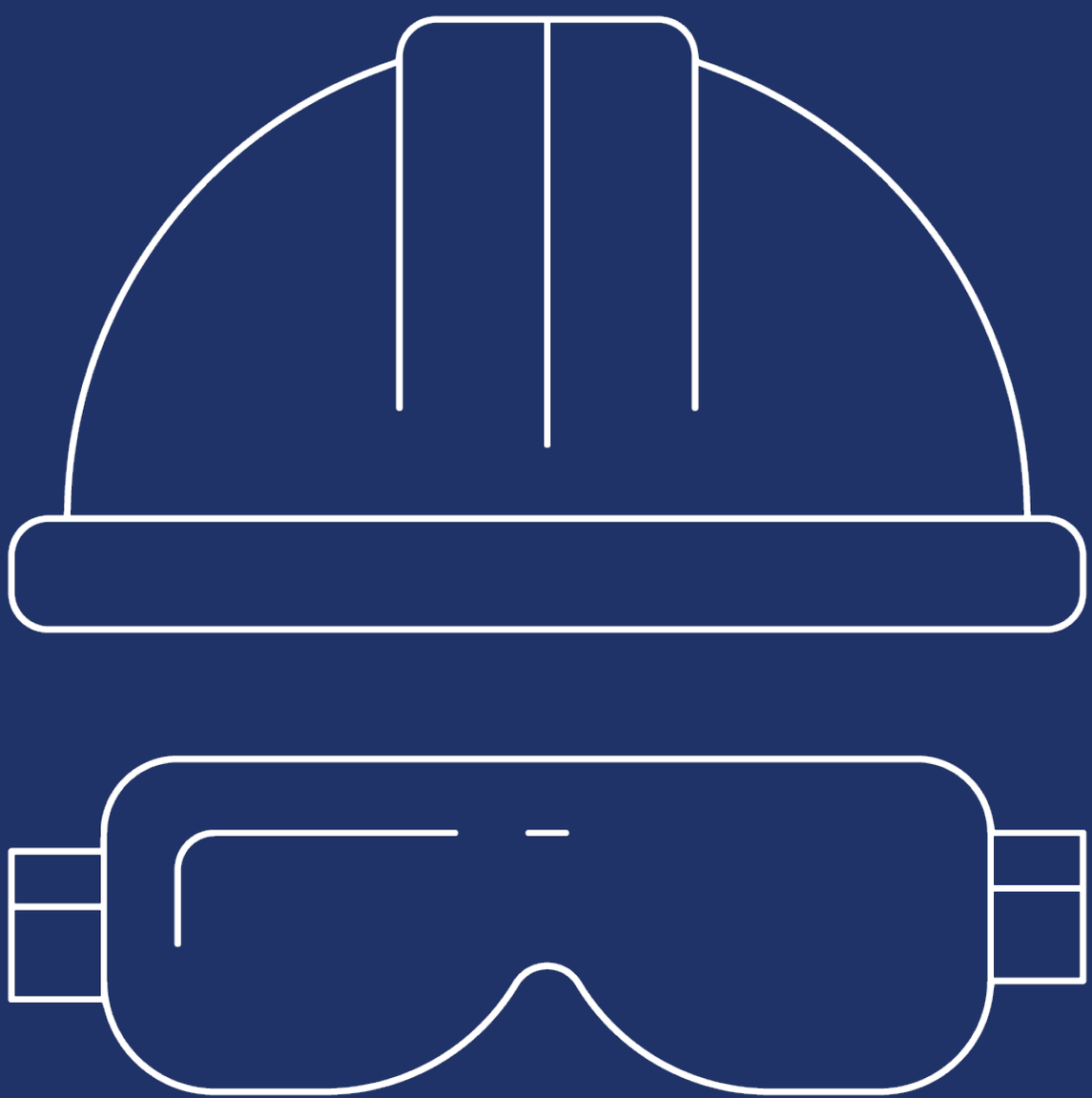
Performance and safety in the construction industry

Where are we and where to next?



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Why Construction?

The Australian construction industry is undergoing some major changes in an environment of unprecedented pressure. It is our experience working in both high-risk and high-reliability industries, that safety tends to experience the flow-on effects first.

It is with this view that we decided to conduct research within the Australian construction industry, in order to support the uplift of safety during a time where safety performance is at most risk.

The parallels between the challenges faced in the construction industry and those faced in adjacent high-risk industries were clear and did not surprise us. This provides some strong support for our proposed directions within this report, based on their years of development and testing in more safety and performance-mature industries.

Performance and Safety in the Construction Industry

Where are we and where to next?

THIS ARTICLE EXAMINES THE CURRENT STATE OF SAFETY AND PERFORMANCE WITHIN THE AUSTRALIAN CONSTRUCTION INDUSTRY. IN-DEPTH INTERVIEWS WERE RUN WITH 30 MEMBERS OF THE AUSTRALIAN CONSTRUCTION INDUSTRY WITHIN 14 COMPANIES. A NUMBER OF THEMES WERE IDENTIFIED HIGHLIGHTING THE INDUSTRY'S RELIANCE ON TRADITIONAL APPROACHES TO SAFETY AND PERFORMANCE. THE ARTICLE CONSIDERS A THE BROADER RAMIFICATIONS OF THESE FINDINGS AND PROPOSES A NEW APPROACH FOR THE CONSTRUCTION INDUSTRY: ULTRA-RESILIENCE. A TAILORED HUMAN PERFORMANCE RISK TOOL IS ALSO OFFERED TO SUPPORT THIS APPROACH.

Introduction

10% of all construction employees suffer injuries on a job site each year. Safe Work Australia reports receiving 35 serious claims per day for construction site injuries.

Construction is a risky business. The parallels with high-reliability industries, where small errors can lead to major consequences, are undeniable. Unfortunately, in Australia the construction industry has some of the poorest health and safety outcomes compared to other industries [1].

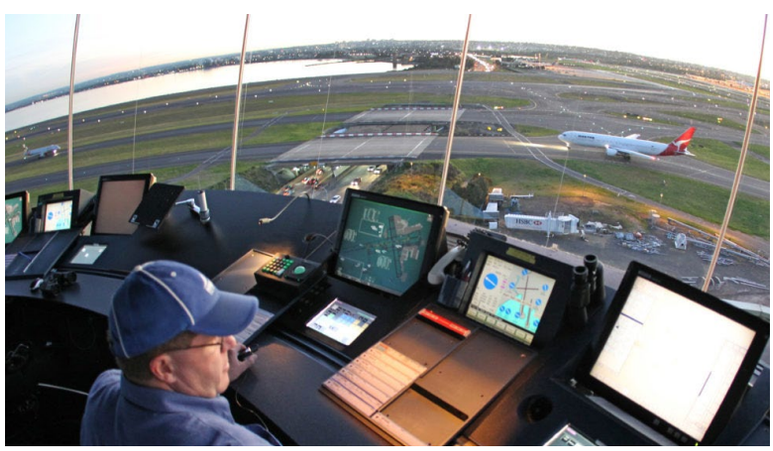
Despite a plateau over recent decades, the construction industry still holds the highest rate of serious work-related injury claims, and construction-related fatalities remain 34% higher than the national average [2]. However, Australia is not alone in this problem. Construction-related safety is a worldwide concern, with the construction sector lagging behind other high-risk industries on a global scale. While developing countries have significantly poorer safety profiles than developed countries (due to stricter economic constraints, fewer regulations, and less skilled workforces [3]), the Australian construction industry still faces significant challenges in terms of time, cost, quality, culture, environment, regulation, and sustainability. For example, the industry's reliance on sub-contracting allows for greater competition and flexibility to manage ever-changing market conditions [3]. However, it also increases the fragmented nature of the workforce, and makes co-ordination, communication, and organisation all the more complex [3]. Furthermore, the results and deadline-based nature of construction contracts places an additional burden on workers both physically and psychologically [3]. These demands often lead to competing priorities between meeting project deadlines and maintaining safety standards [3]. While such constraints reinforce the complex, dynamic, and demanding nature of construction, where every major project is bespoke, they are not unique to

construction alone. So, what is it about the construction industry that makes it more susceptible to safety and performance concerns compared to other high-risk industries, and what lessons can be learnt from adjacent high-risk industries to improve the related risk outcomes? We looked to answer these questions by interviewing construction industry members and reviewing the latest evidence and trends in human factors and safety.

Background: The traditional approach to safety and performance

The construction industry remains largely reliant on a traditional approach to safety and risk management [4]. This is where safety is viewed as an absence of errors, accidents, or adverse events, and has been coined as a Safety-I approach [5, 6]. This approach sees errors and accidents as having a "root cause", with fault commonly attributed to an individual or system malfunction [5, 7]. Safety-I attempts to reverse engineer accidents and incidents to identify and explain what went wrong so that they may be eliminated or controlled in future [8]. This linear "cause-and-effect" approach to safety and performance can be useful, particularly for less complex systems where limited variability and high compliance can be expected. These systems are commonly referred to as "ultra-safe", where all risks are avoided and excluded as far as possible through centralised control [6, 9]. However, industries involving complex socio-technical systems (e.g., aviation and power), where risk is an inherent part of the profession, are commonly referred to as "high-reliability" [6]. More mature high-reliability industries are now focused on managing and adapting to risk, rather than

The construction industry remains largely reliant on a traditional approach to safety and risk management



attempting to control or eliminate that which is unknown and inevitable [6]. Consequently, a purely Safety-I approach can be limiting when it comes to understanding complex socio-technical systems like those in construction [10]. Furthermore, Safety-I concentrates on errors and risks, which means that systems are only investigated when something goes wrong. This sees organisational learning built around how work is expected to be done (or "work as imagined") rather than how it is performed in reality (or "work as done") [4]. Furthermore, research shows that significant gaps invariably exist between "work as imagined" and "work as done", particularly as complexity increases in the system [9, 11]. Cortexia has observed evidence of this across several industries. While a Safety-I perspective can be helpful in managing low-complexity

systems, many believe that the "root cause" approach of Safety-I has contributed to the culture of blame and shame, and reductionism, that exists across high-risk industries like construction [7]. To address these limitations, safety scientists have proposed new approaches to safety, coined as Safety-II, Safety Differently and Ultra-Resilience [8].

Our research approach

A forty-minute semi-structured interview was run with 30 members of the Australian construction industry. Participants included a wide range of roles within the industry including workers, project managers, site supervisors, safety specialists, senior managers, board members and CEOs. Tier 1, 2 and 3 companies were represented, for a total of 14 Australian construction companies. The in-depth interview consisted of two broad sets of questions: the first set relating to current issues within the industry impacting safety and performance, and the second set relating to the current baseline of safety and performance methods applied within the industry. Qualitative data analysis known as Emergent Themes Analysis [12] with elements of Grounded Theory [13] were then run on the resulting data, allowing for the identification of major themes, categories and patterns across the two sets of questions.

Our findings

Key themes relating to industry impacts on safety and performance:

A total of 4 key themes relating to industry impacts were noted: project pressures due to deadlines; shortage of skilled labour; fear of reporting; and the 'complexity waterfall'.

A total of four key themes were identified within the data. Unsurprisingly, **project pressures around deadlines and money** were the most common cited impact on safety and performance. This point cannot be understated as all interviewees stated its perceived negative impact on operations. This finding mirrors the literature [3] and anecdotally was cited as a frequent contributor to work site incidents.

Another commonly cited theme was the **shortage of skilled labour** (noted by 90% of all interviewees), amplified by COVID-19. Interviewees almost always (93% of those 90%) highlighted the resulting effects of increased fatigue and susceptibility to distraction. This was also cited, anecdotally, as common contributors to incidents. Fewer interviewees (70% of those 90%) It must be noted that the shortage of skilled labour covered site workers, supervisors and project managers.

The third theme was noteworthy not only because of its frequency (70% of all interviewees), but also because of the disparity between management staff and site workers. The third theme was **fear of reporting issues or when things go wrong**. This was cited as a key factor with all site workers and safety specialists, but only 50% of management interviewees. This disparity may either point to a disconnect between front-line staff and management or simply represent the nature/focus of the different roles. It must be noted that even more progressive companies with well-designed and intentioned "speak up"

campaigns often had sub-contractors highlighting this theme of fear. For example, one site worker stated, *"I think some people do want us to highlight when things aren't right, but a lot of us have seen mates that have spoken up who were then moved out into a different project."* Another sub-contractor stated, *"You will definitely speak up when something is dangerous but anything else can label you a trouble-maker, and you don't want that."*

The final theme was less frequently voiced but was often cited as having immediate, observable, profound and tangible impacts on site. We have coined this theme the **'complexity waterfall'.** Over 40% of interviewees highlighted that each new build has its own inherent complexities and challenges, which can be difficult to identify early in the project lifecycle. One interviewee stated, "In some ways all new builds are bespoke… whether in building methods or site challenges, there is always something new that you all too often have to grapple with when you start the job. This cascades down to the individuals doing the work, where you see the distractions and mistakes. Often they are just trying to get the job done the best they can against a new challenge." These newly introduced complexities were often cited as resulting in increased unfamiliarity, pressure and distraction on site. Such a complexity waterfall ultimately begins at the design stage of a project but inevitably falls on the site workers with an increased likelihood of error.

Key themes relating to safety and performance approaches

A total of four themes relating to safety and performance approaches were identified. The first theme centred around **positive safety promotion and recognition**. It was clear from the interviewees that safety was not only valued and taken seriously, but that safety efforts were both well intentioned and effectively promoted. This is no small feat given the amount of information staff are confronted with at work. Site workers and management staff alike recognised companies' intentions as well as the programs in place to recognise when people go above and beyond. This is to be rightfully applauded within the industry as promotion and recognition are often lacking in adjacent industries. As noted in the previous section's findings

A total of 4 key themes relating to approaches were identified: project positive safety promotion and recognition; reliance on traditional approaches to safety and performance management; lack of awareness of more mature safety and performance concepts developed outside the construction industry; and a 'set and forget' culture.

however, there is still a gap between the safety programs goals and their effects on the ground.

The second theme backed up similar findings in the literature [4] where there was a **reliance on traditional approaches to safety and performance management**. As with most high-risk industries, there was a focus on lagging indicators with only one example of a Tier 1 company attempting to identify leading indicators. Given the substantial focus construction industry stakeholders (shareholders, clients, governments and regulators) place on lagging indicators, it was no surprise that the vast majority of construction companies do the same thing. This focus was shown to trickle down to sub-contractors on-site where there was a strong emphasis on physical safety, hazards and controls.

The third theme highlighted the **lack of awareness of more mature safety and performance concepts developed outside the construction industry**. There was an observed gap between the maturity of safety and performance concepts within the construction industry and those developed in other industries such as aviation. This may be due to a lack of inter-industry exposure (including not having the time to undertake such endeavours), or a perception that the construction industry is unique in its challenges and therefore outside concepts not transferable. Such a view however would not align with the findings above, where challenges align to a number of other high-risk industries including transportation, power generation and power distribution. Some examples of this theme included a general lack of (and awareness of) integrated Just Culture programs, tailored contributory factors taxonomies, human factors investigations, human performance risk assessments, and, identification, addressing and monitoring of systemic issues. It must be noted that there was a significant exception to this theme, where one company highlighted programs designed to identify work practices aligned with projects that were successful across criteria (money, time and safety). This was a noteworthy practice (aligned to Safety II) and something we rarely witness even in more safety and performance mature industries such as aviation.

The fourth theme related to risk management culture, where the majority of interviewees (66%) identified a **'set and forget' culture**; something we have directly observed in a number of high-risk and high-reliability industries. Statements included *"We have a lot of pretty high-level risk and control charts, but I'm not sure they reflect what happens on site or even identify*

the stuff that keeps tripping people up out in the field.", and, *"We'll investigate and often it'll come down to some form of training or suggesting a new process. Then it's often out of sight, out of mind; we just move on to the next project without unearthing the more sinister stuff.*" This was coupled with a strong focus on 'root causes', where resulting actions were often training/process related or recommended mechanical controls. Though some attempts at identifying contributing factors (either via PEEPO or ICAM) were evidenced, there often weren't attempts at analysing and addressing such factors. There was very little evidence of any attempts to systematically identify and address systemic issues that can create the conditions that allow the contributing factors to exist across projects. Such a culture is not unique to the construction industry and permeates many organisations across high-risk industries.

A New Proposed Approach: Ultra-Resilience in Construction

A new approach, matured in high-reliability industries is now warranted. One that harnesses both the safety and performance benefits of Ultra-Resilience in the construction industry.

We feel that a new approach, that complements, but does not need to replace Safety I, is now warranted within the construction industry. One that has been matured in adjacent high-risk industries. Safety-II acknowledges that there are multiple social and technical elements within a work system that interact and "contribute to" both wanted and unwanted outcomes [8]. In contrast to Safety-I, this approach seeks to understand where, why, and how things "go right" through the observation and analysis of day-to-day practice [8]. In other words, Safety-II proactively looks towards the factors that strengthen and build safety and how work is performed in reality (i.e., "work as done") compared to "work as imagined" [9]. This does not mean that incidents aren't investigated, but that a shift in focus is consciously made from individuals to systemic contributory factors is made along with strategies that permit a high-performance culture. Consequently, a Safety-II approach can provide significantly more data to better understand human performance as things go right much more often than they fail. This approach also reminds us that prescribing the "correct" behaviour and actions for the unknown and uncertain is not always beneficial. It is important to note that Safety-II is not intended to replace the Safety-I approach. Instead, these two approaches are complementary [9], where procedures and rules are used to guide and support workers, not to control the uncontrollable. This is where we learn from the things that go wrong (and how to avoid them), while also learning how to make more things go right, and where the differences might lie between the two. This form of integrated approach has also been referred to as "Ultra-Resilience", "Safety Differently", and "Resilience Engineering" [5, 14, 15].

While the integration of Safety-II and the concepts of Ultra-Resilience and Safety Differently have received significant attention in high-risk industries over recent years, application within construction remains limited. This integrated approach acknowledges that human beings will inevitably make unintentional errors and deviate away from prescribed actions [14]. However, so too will technical systems fail. Expecting humans or technology to work exactly as prescribed at all

times is rigid and unrealistic. This expectation also fails to acknowledge that the human ability to endlessly adapt (unlike technical systems) is a precious resource that is essential for the maintenance of a flexible and resilient work system [14]. Instead, employees should be encouraged and made to feel comfortable voicing concerns and reporting errors, issues and successes at work. Fostering this type of environment can be referred to as a "Just Culture", where workers trust that they will not be punished for being human and making honest mistakes (which is distinct from intentionally reckless behaviour) [17]. Though companies lacked Just Culture programs, a number identified initiatives that aligned to the notion of 'speaking up'. Building a Just Culture is also associated with increased organisational learning (due to greater reporting and sharing of information), and a subsequent increase in innovation, engagement, well-being, flexibility, and resilience [14, 17]. By collecting such data the company is able to build forecasting models of performance and leading indicators [17]. Developing a Just Culture would go a long way in addressing the findings relating to fear, the reliance on lagging indicators for risk monitoring data, and the 'set and forget' risk management culture.

Our research also highlighted that though some attempts are made to identify contributory factors (using models such as PEEPO and ICAM for example), the industry still largely focusses on "root causes" such as "human error", without taking necessary steps to identify systemic trends and address such issues. As stated by the late Dr James Reason, *"Failures are like mosquitoes. They can be swatted one by one, but they keep coming. The best remedies are … to drain the swamps in which they breed."* [18]

"Failures are like mosquitoes. They can be swatted one by one, but they keep coming. The best remedies are … to drain the swamps in which they breed." [18]

In this case, the swamps are the systemic issues that remain in the company to impact future builds and sub-contractors, even after the person who made the error is re-trained or moved. By focusing on systemic issues or adopting a systems thinking approach to investigations, we can avoid the oversimplification of complex, multi-dimensional and interdependent problems and ensure that key contributing and systemic factors are documented and analysed rather than just noted or overlooked [4, 6, 9]. Implementing an industry-tailored contributing factors taxonomy and basic human factors analyses within current investigations methods will improve risk monitoring by supporting the ability to systematically identify such factors, along with their trends. From this objective data, we can then develop targeted interventions with measurable ROI. This includes collecting data on when "things go right". These concepts are illustrated in the infographic we prepared on the following page with a hypothetical example.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John's Story
The dirty dozen was an early attempt to identify contributing factors to safety and performance, which were first used in the Canadian transport sector. We've adapted those 12 factors for the construction industry below.
The construction Industry is a high-risk industry that takes safety very seriously. However, awareness of these dirty dozen isn't enough; systemic issues that produce them often go unnoticed and serious accidents continue to occur.
Time Pressure
Distraction
Fatigue
Workload
Norms
Supervision & Leadership
Awareness
Familiarity & Experience
Working Environment
Training
Monotony & Autopilot
Teamwork & Communication
John is an apprentice on a understaffed construction site that is requiring him to work consecutive overtime shifts. John also has a newborn baby at home that keeps him up at night. Dave, John's foreman, told John they are under pressure to get all the steel beams in for the second story framing. While Dave is showing John how to strap the beams to the crane, he tells him he does not need to strap it all the way down, just enough to where it seems it won't go anywhere. And to just try stay clear from standing underneath while the beam is being moved. These shortcuts often need to be made to get everything finished in time. John is standing under some scaffolding, which is yet to be secured to the building. When the scaffolding is struck by a beam that fell out of loose straps, the scaffolding falls on John, who is seriously injured.
Lack of Human Factors Risk Assessments
Understaffed
Rushed & Missing Training
SWAMP
Unfamiliarity & Complexity of Bespoke Build
Unrealistic Deadlines
Skilled Labor Shortage
Fear of Speaking Up
"Failures are like mosquitoes. They can be swatted one by one, but they keep coming. The best remedies are ... to drain the swamps in which they breed" (Reason, 2000, p.669).
In this case, the swamps are the 7 systemic issues above that remain in the organisation to impact future builds and sub-contractors, even after the person who made the error is re-trained or redeployed.
OPTION 1 : SWAT MOSQUITOES
Design a new lock mechanism on straps that forces secure closure but is difficult and time-consuming to employ.
Retrain both John and Dave, then redeploy onto builds and work not requiring cranes.
These options can be tempting, and in some instances, required. However, they often do little to address the underlying conditions that allowed the failures to manifest. Those conditions will remain and likely allow other failures on future builds.
OPTION 2 : DRAIN THE SWAMP
Pushback on unrealistic pressures citing objective risk data.
Conduct initial Human Factors risk assessments on all projects focussing on bespoke/new methods and requirements.
Provide Threat & Error Management training to address the perceived need to rush.
Develop and sustain a just culture where people feel safe to speak up.
Only bid on projects with realistic deadlines.
Identify risk-based skill shortages and address with training before project start.
Identify build/project-specific rules around min-max shifts and staff numbers.
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Through industry-first TEM programs, we can improve sub-contractor resilience skills by allowing the better detection, response and management of these threats and errors, preventing them from contributing to adverse events/states in the future [20, 21, 22].

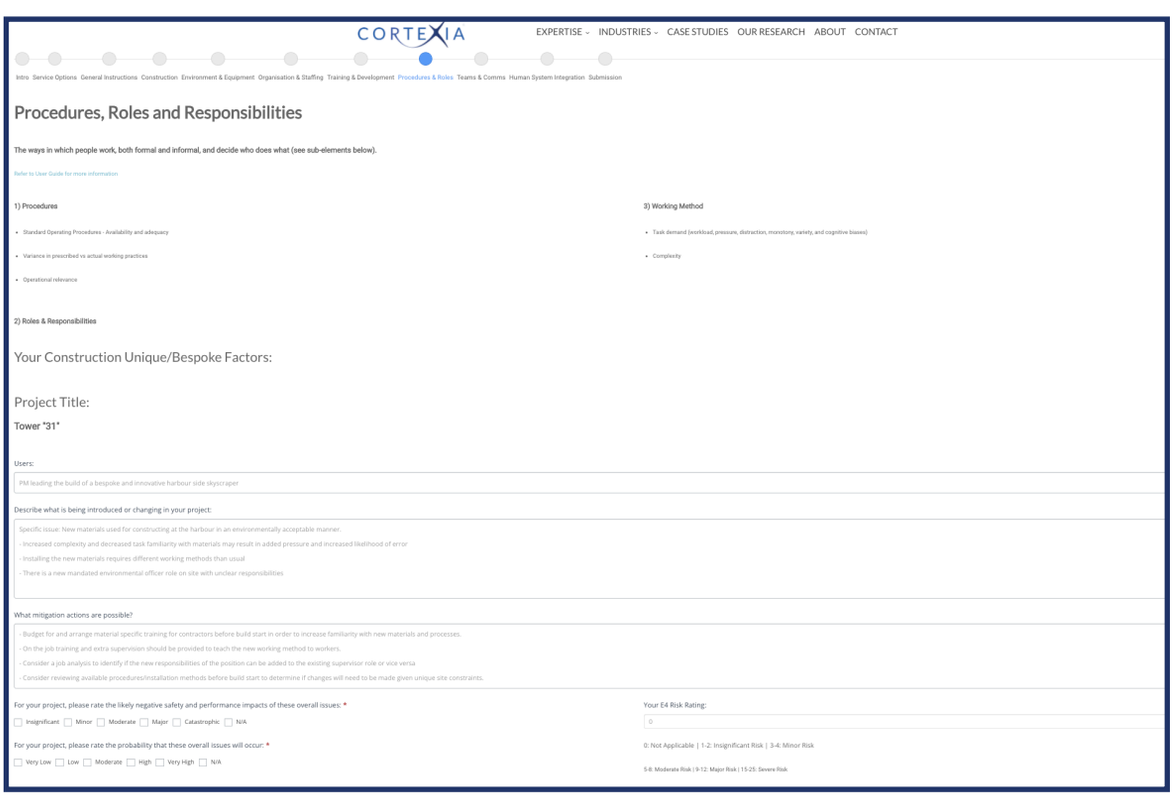
Over half of the respondents noted a 'set and forget' risk management culture (or notion akin to this) within the industry, where there was a strong focus on risk controls such as JSAs, Take 5s, site induction training and Toolbox Talks, without necessarily questioning their effectiveness or attempting to identify latent conditions or systemic issues that may not be addressed by such controls. With risk as inherent, inevitable and part of the very essence of the construction industry, attempts to engineer all risk out with more controls can prove counterproductive and redundant. Instead, the application of Threat and Error Management (TEM) principles allows the identification of threats (such as distraction, pressure, fatigue, monotony and anxiety), and the actions/inactions that exacerbate those threats (errors) and increase the chances of an adverse event occurring [19]. Through industry-first TEM programs, we can improve sub-contractor resilience skills by allowing the better detection, response and management of these threats and errors, preventing them from contributing to adverse events/states in the future [20, 21, 22]. Coupled with a systematic attempt to identify and address systemic issues (as outlined in the previous paragraph), a TEM program can enhance employee resilience and wellbeing without placing an unfair burden on staff to shoulder the total risk of latent conditions and organisational issues [21, 22]. TEM programs may also help address some of the concerns cited around the inevitable project pressures and the reliance placed on less experienced staff given the shortage of skilled labour.

The 'set and forget' mentality is certainly not unique to the construction industry and is often reported in high-reliability organisations when 'drift' sets in [23]. We believe that there may be a link between this mentality and the complexity and pressure challenges faced within the industry. As noted in the results, construction firms and their sub-contractors are under a lot of pressure, both in terms of schedule deadlines and budgets. Participants also noted what we have termed the 'complexity waterfall', where each new build contains its own new and unique challenges, creating their own additional pressures which cascade down to the workforce on site. It is our opinion that this complexity waterfall may be contributing to the 'set and forget' mentality. The aviation and rail industries have responded to such organisational risk by introducing certain safety and human factors requirements at critical project lifecycle phases. This ensures that relevant system safety and human performance risk assessments and activities

are carried out throughout the project in order to deliver safe, efficient and effective systems and/or changes. Within the human factors discipline, such an approach is known as Human Systems Integration – where the focus is on systematically identifying human performance related risk early in the project lifecycle, permitting cost-effective mitigation strategies well before hand-over, where changes are costly both in terms of money and reputation. We posit that some of the same methods can be augmented into existing construction project management lifecycles, particularly around human performance. We predict improved outcomes around safety, project performance and delivery.

We are making available an industry first online human factors risk tool designed to identify critical human performance risks and issues, along with recommended actions, at the beginning of a project.

To test this hypothesis we are making available an industry first human factors risk tool ("Initial Human Factors Assessment – IHFA") designed to identify critical human performance risks and issues, along with recommended actions, at the beginning of a project. We designed this tool using Eurocontrol's Human Factors Case [24]. Our tool was designed to be used by human factors specialists alongside industry project managers and safety specialists. The IHFA includes construction examples for each human factors risk category along with a user guide. Our hope is that the tool can improve performance and safety with very minimal cost, at a time where pressures are mounting within the industry. Please contact us to learn more about the IHFA.



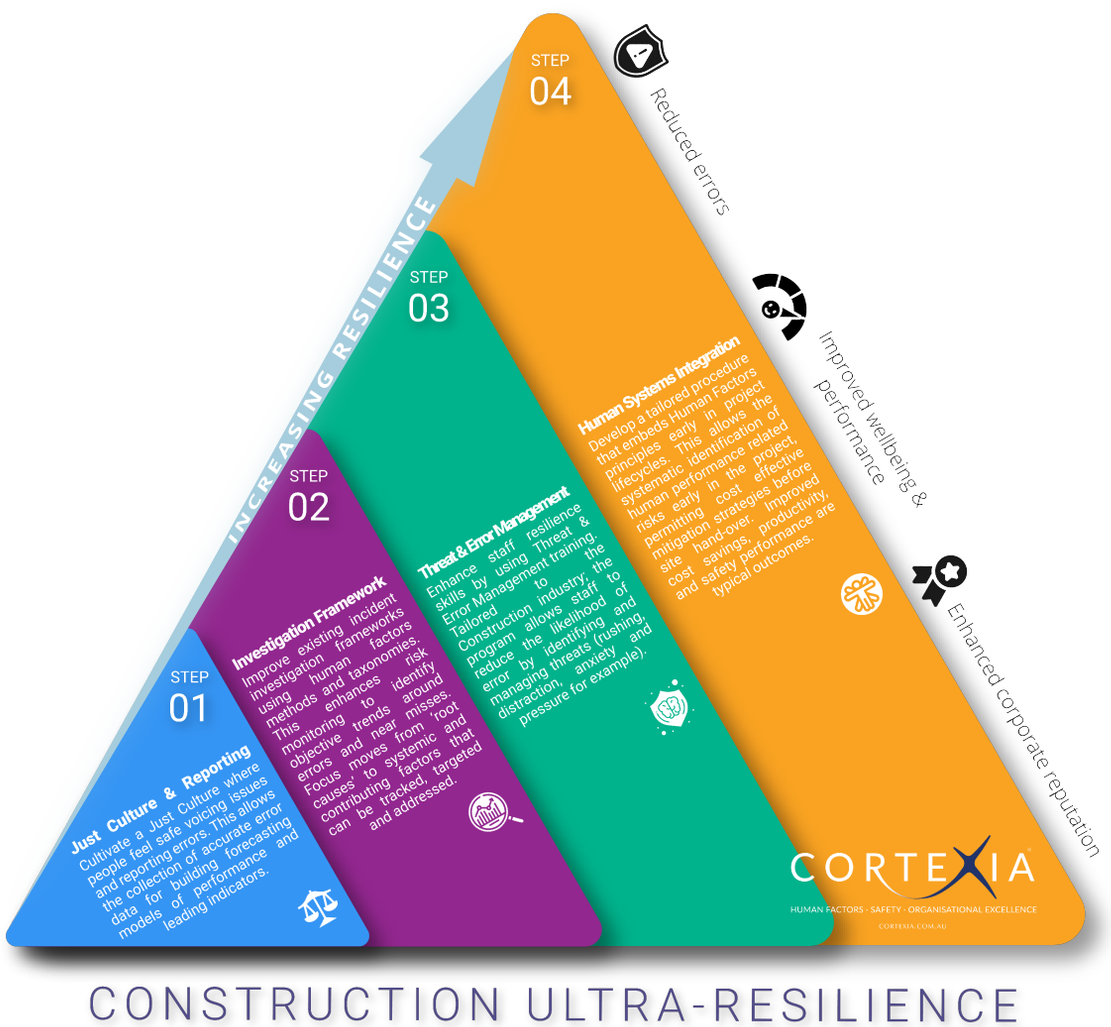
The theme around staff being overworked and fatigued was particularly concerning and mirrors the challenges currently faced in a number of other industries. This issue was not only cited with and by staff working on site, but also was a present factor for management and specialist staff. Fatigue risk management systems

Fatigue risk management systems have long been employed in the aviation industry to manage the impact of fatigue on operations. By identifying higher fatigue-risk staff based on their unique factors, countermeasures can be used both tactically and strategically to better manage the fatigue risk.

have long been employed in the aviation industry to manage the impact of fatigue on operations. By identifying higher fatigue-risk staff based on their unique factors (such as number of hours worked, consecutive shifts and distance to drive to site), countermeasures (such as free transport to and from site, longer breaks, or coffee vouchers) can be used both tactically and strategically to better manage the fatigue risk. It is advised that companies wanting to holistically address wellbeing should also take note of the alarming trends relating to wellbeing, gender diversity and excessive working hours [25, 26]. Research has identified a number of benefits (in addition to employee wellbeing) of a 5-day working week, programs addressing issues limiting gender diversity and, creating a parallel focus on both physical safety and mental health [25, 26].

Conclusion

The figure below illustrates our concept of Ultra-Resilience tailored to the construction industry based on the results of our research and proven outcomes in adjacent high-risk industries. It is an amalgamation of Safety II, Human Factors and Ultra-Resilience principles, along with our own experience of successfully tailoring and piloting similar approaches. The figure illustrates the four major elements discussed in the section above along with the key benefits and outcomes.



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