Rethinking Construction Safety

by

Eleanor J. Harvey

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Abstract

Recent human-induced disasters have prompted concerns that conventional risk management (quantifying and controlling hazards) is not only reaching its limits but introducing vulnerabilities which increase the probability of accidents. These compliance or behaviour-based approaches can obscure risks, suppress data, and detract from major hazards — feeding complacency and reducing resilience as the workforce becomes disfranchised and deskilled. In response to this, emerging constructs favour non-prescriptive methods for managing risk and look to support the human factors which underpin these. This is known as the 'fifth' or 'Adaptive' age of safety.

Adaptive safety differs from its predecessors in two fundamental ways: Firstly, it refutes notions of accident causation as predictable and, consequently, it casts doubt on our understanding of the human contribution to accidents. Both these undermine traditional risk management models. Instead, an approach is advocated which accounts for complex systemic interactions and interpersonal aspects of risk management. As yet there is a lack of evidence and guidance to support Adaptive safety in industry.

The construction sector is particularly challenging with respect to safety because of its litigation culture, affinity for traditional safety, project-based network structure, and transient workforce. The emerging Adaptive paradigm could potentially be a valuable opportunity to improve construction safety: Moving towards engaging workers, drawing on their expertise, increasing vigilance, and enabling a response to the unexpected; however, its applicability to this unique sector is disputed.

This research uses mixed qualitative methods to examine the compatibility of Adaptive safety with construction, theoretically and then in practice. The first part of this thesis explores leadership as a means to foster an Adaptive culture in organisations. A framework for 'Adaptive safety leadership' is synthesised from literature on safety leadership, Safety Intelligence, and Adaptive safety, and evaluated against construction practice in an interview study. The findings show many safety practitioners and policy-makers in construction recognise the need for systems thinking and relational aspects of leadership, but the structure, pressure, and culture of the industry mean the tendency to blame workers and bureaucratise risk is difficult to overcome. The relationships between these systemic 'Originating Influences' and the 'Immediate Circumstances' surrounding accidents are crystallised in an update of Haslam, Hide, Gibb, Gyi, Pavitt, Atkinson and Duff's (2005) contributing factors in construction accidents (ConCA) model — explaining the challenges to taking an Adaptive approach and demonstrating the value of systems thinking in construction.

The second part of this thesis case studies Adaptive safety in practice, following two pioneering infrastructure megaprojects as they embrace Dekker's (2017*a*) 'Safety Differently'. Proactivity, relationships, communication, and job-satisfaction are improving as the new philosophy is cultivated and allowed to evolve in collaboration with the workforce. The role of safety leaders in embedding this concept in frontline work and factors contributing

to their success are examined. Aspects of the company, project, and London's megaproject ecology have meant Laing O'Rourke has been uniquely well-equipped to make this transition, but the sector's pace of change and persistent culture have been challenging.

These insights contribute an improved understanding of the mechanisms of Adaptive safety and the factors which support and hinder its success with a view to its wider implementation. However, the work also warns against substituting engagement for safety; questions the ethics of responsibilising workers; and stresses the need for a context-sensitive balance of new and old safety paradigms. It highlights the inadequacies of this construct which need to be resolved before it can be operationalised.

Keywords: Adaptive Safety; Construction; Ergonomics; Health and Safety; Human Factors; Resilience Engineering; Safety Differently

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Publications

Full journal articles

1. **Harvey, E.J.,** Waterson, P., and Dainty, A.R.J., 2016. *Applying HRO and Resilience Engineering to Construction: Barriers and Opportunities*. Safety Science. DOI:10.1016/j.ssci.2016.08.019 (In press, corrected proof. Online since August 2016)

2. **Harvey, E.J.,** Waterson, P., and Dainty, A.R.J., 2018. *Beyond ConCA: Rethinking Causality and Construction Accidents*. Applied Ergonomics, 73, pp.108-121. DOI: 10.1016/j.apergo.2018.06.001

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1. **Harvey, E.J.,** Waterson, P., and Dainty, A.R.J., 2015. *Comparing safety intelligence in air traffic management and construction: A conceptual comparison*. In: Raidén, A.B., and Aboagye-Nimo, E. (Eds) Proceedings of the 31st Annual ARCOM Conference, 7-9 September 2015, Lincoln, UK. Association of Researchers in Construction Management, pp. 1115-1124.

2. **Harvey, E.J.,** Waterson, P., and Dainty, A.R.J., 2016. *Towards an alternative approach to safety in construction.* In: Waterson, P., Hubbard, E.M., and Sims, R. (Eds) Contemporary Ergonomics and Human Factors 2016. 19-21 April 2016, Daventry, UK. Taylor and Francis, UK, pp. 20-24.

3. **Harvey, E.J.,** Waterson, P., and Dainty, A.R.J., 2018. *Impact of the Contributing Factors in Construction Accidents (ConCA) Model*, in: Bagnara, S., Tartaglia, R., Albolino, S., Alexander, T., Fujita, Y. (Eds) Proceedings of the 20th Congress of the International Ergonomics Association, 26-30 August 2018, Florence, Italy. Springer, New York, NY, pp. 310-319.

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1. **Harvey, E.J.,** 2015. *A new way to improve safety among construction workers*. At: Loughborough University Research Conference. 9 November 2015, Loughborough, UK. Loughborough University.

2. **Harvey, E.J.,** 2017. *Oblivious, complacent, and rebellious? A systems thinking view of construction workers' attitude problem*. At: 7th Annual DesRes Conference 2017. 14 March 2017, Loughborough, UK. Loughborough University.

3. O'Loughlin, M., and **Harvey, E.J.,** 2017. *Resilience in safety: A shift and opportunity for the construction sector*. At: 2017 Annual Conference: Transforming Health and Safety Across the World. 20-21 November 2017, Birmingham, UK. Institute of Occupational Safety and Health.

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2. **Harvey, E.J.,** 2017. *Don't blame the builder*. At: Graduate School Summer Showcase. 22 June 2017, Loughborough, UK. Loughborough University. And at: Resilience Conference 2017. 20-21 September 2017, London, UK. Loughborough University London.

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Abbreviations

AI appreciative inquiry

ARCOM Association of Researchers in Construction Management

ATM air traffic management

CDM construction design and management

CEO chief executive officer

CIEHF Chartered Institute of Ergonomics and Human Factors

ConCA contributing factors in construction accidents

CSCS Construction Skills Certification Scheme

CSO combined sewer overflow

EQ emotional intelligence

ETTO efficiency-thoroughness trade-off

FLO Ferrovial Agroman and Laing O'Rourke

FSR fatal and severe risk

HF human factors

HFE human factors engineering

HRA human reliability analysis

HTA hierarchical task analysis

HRO high reliability organising

HSE health and safety executive

HSW health and safety at work act

i3P infrastructure industry innovation platform

IEA International Ergonomics Association

IOSH Institute of Occupational Safety and Health

JCS joint cognitive systems

KPI key performance indicator

LMX leader-member exchange

LOR Laing O'Rourke

NAT normal accident theory

NDM naturalistic decision making

NEBOSH National Examination Board in Occupational Health

OSH occupational safety and health

PPE personal protective equipment

PPP public-private partnership

PvA planned versus actual

RCT rational choice theory

RE resilience engineering

RI requisite imagination

SARF social amplification of risk

SMS safety management system

SSM soft systems methodology

STS sociotechnical system

SWOT strengths weaknesses opportunities threats

TCR Tottenham Court Road station

TMO temporary multiple organisation

TTT Thames Tideway Tunnel

UCATT Union of Construction, Allied Trades and Technicians

WYLFIWYF what you look for is what you find

1 Introduction

Contents

1.1 The landscape of safety

Since the introduction of the *Health and Safety at Work etc. Act* (1974, c. 37), the past 45 years have seen the devolution of occupational safety and health (OSH) — shifting responsibility from the government's factory acts, to organisational safety management systems (SMSs), and to teams within organisations. Safety has been described as progressing through a series of ages, each distinguished by its emphasis on different aspects of the system. There are multiple accounts of these ages: Hale and Hovden (1998) proposed a Technical age, Human Factors age, and Management systems age; while Reason (1997), the Person, Engineering, and Organisational safety models; and Hudson (2007), waves of Technology, Systems, and Culture.

Contemporary safety has been described as the 'fifth' or 'Adaptive' age of safety (Borys, Else and Leggett 2009). Vincent, Burnett and Carthey (2013, p. 21) describe six conceptual approaches to safety which show how the Adaptive age has evolved from systems safety in the 1970s.

- Safety as defences in depth (James Reason)
- Systems safety (James Reason and Charles Vincent)
- High reliability theory and safety (the Berkeley group)
- Safety as collective mindfulness (Karl Weick and Kathleen Sutcliffe)
- System dynamics and safety (René Amalberti)

- Safety as resilience (Erik Hollnagel and David Woods)

(Vincent et al. 2013)

This era encompasses high reliability organising (HRO) and emerging theories of resilience engineering (RE) and 'Safety Differently' (Dekker 2017*a*). It encourages a holistic view of jobs, work, and systems (Hale and Hovden 1998, Wilson 2014) and a humanistic view — seeing people as a valuable source of responsiveness and resilience rather than a liability to be constrained, and focussing on ensuring safe operations, rather than preventing unsafe ones (Hollnagel 2008, Hollnagel 2014).

The five ages are illustrated alongside the associated safety approaches in the timeline in Figure 1.1.

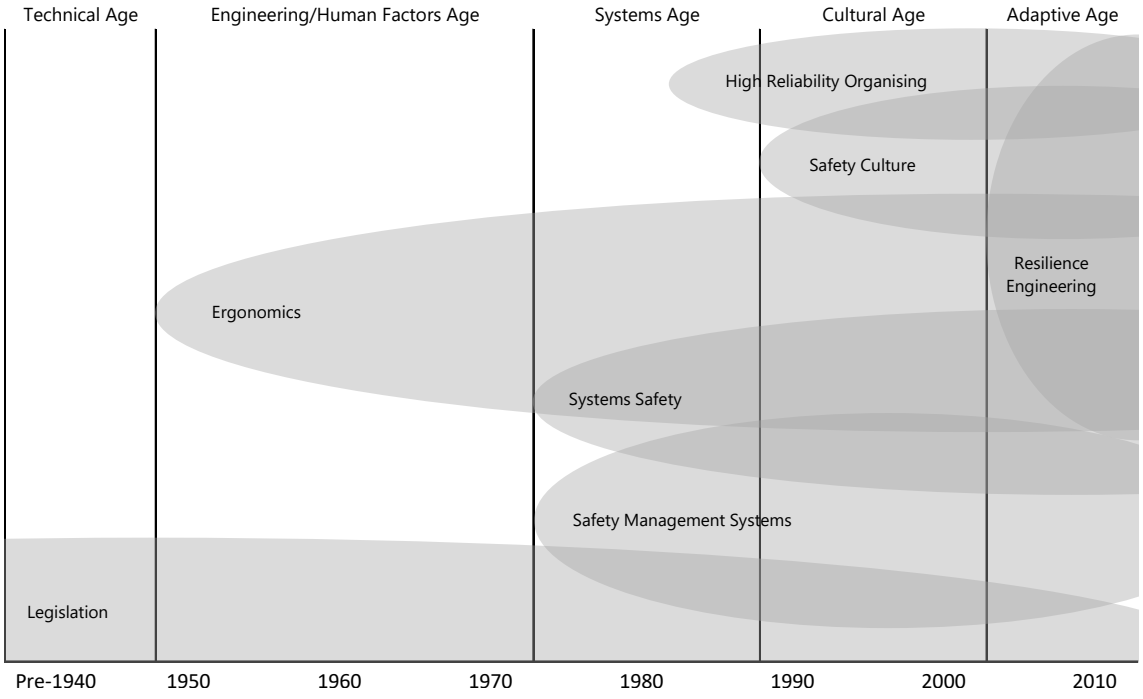


Figure 1.1: The ages of safety based on Waterson et al. (2015)

1.1.1 Systems safety and ergonomics

Progress through the ages of safety has been driven by milestone events, the growing complexity of sociotechnical systems (STSs) (Reason 1997) and scientific insights into human performance and error. In the early 20th century the human factor was defined as *"Mental, physical and moral shortcomings that predispose a person to accident"* (Dekker 2015). Accidents of the Industrial Revolution were primarily blamed on accident-proneness or a lack of attention, and factory inspectors were only interested in accidents *"with technical causes, since others could not reasonably be prevented"* (Hale and Hovden 1998, p. 129).

The emergence of ergonomics in the 1940s shifted the focus away from so called *"shortcomings"* (Dekker 2015) and approached accidents from the point of view that by applying

research regarding human capabilities and limitations to the design of tools, tasks, jobs and environments human error could be mitigated (IEA 2018). Early ergonomics resembled scientific management, decomposing tasks using hierarchical task analysis (HTA) and integrating tasks and operators (human factors engineering (HFE)) to improve efficiency.

STS theory developed in the 1950s and originally focussed on the impact of technology at work, but has since been applied to risk, health, safety, and accidents (Waterson et al. 2015). This era introduced naturalistic and contextualised approach to human error *"to provide a 'holistic' assessment of work–system interfaces and to capture the interaction between these"* (Waterson et al. 2015). Rather than mitigating errors, STS sees humans as assets and technology as a tool — emphasising quality of life and respect for individual differences (Eason 2008, Read, Salmon, Lenné and Stanton 2015).

> There is growing interest in how social processes of organizing, wider socio-cultural considerations, and the situated production of safety can contribute.
>
> (Turner and Gray, 2009, p. 1259)

The role of social and cultural factors in accidents, as well as political, economic, legislative and regulatory influences, has been recognised for 40 years (Pidgeon and O'Leary 2000, Turner 1978). Fundamental to an STS approach to risk management is the belief that accidents *"are not only caused by direct physical events, nor by human errors alone. They have their roots in organisational settings and in the sociotechnical system companies are active in"* (Swuste 2008). A systems ergonomics approach advocates considering the role of humans in accidents while taking account of context, interactions, complexity, emergence and alternative perspectives (Wilson 2014). This systemic view has liberated workers from fear of blame and punishment, and the concept of 'accident-proneness' is now regarded as politically incorrect, unethical, and legally questionable (Dekker 2015).

1.1.2 Understanding causation

Each of these eras has brought with it a new understanding of accident causation. Heinrich's 1931 Domino Theory (Heinrich, Peterson and Roos 1980) conveys a linear chain of events resulting from a root cause. In the 1980s, complex or systemic accident models were introduced: These were based on the theory that accidents were caused by the interaction of multiple failures, some of which lie dormant in the design for many years (Reason 2000).

Both these historical perspectives suppose that accidents are caused by technical malfunctions or human failures. Conversely, contemporary perspectives understand accidents as an emergent consequence of performance variability which can interact in unexpected ways with other functions (Hollnagel 2012, Hollnagel 2009). These dynamic, non-linear interactions mean even the 'safest' organisations are vulnerable to highly improbably 'black swan' (Taleb 2008) events.

Below, Pariès and Amalberti (2000) describe the way in which accident causation is perceived has changed between 1960s and 1990s. This model has been updated with most recent two decades.

- 1960s: Accidents are the result of individual human errors due to a lack of skill
- 1970s: Accidents are the result of individual human errors due to a lack technical proficiency
- 1980s: Accidents are the result of crew errors e.g. 'team synergy failures' and poor resource management
- 1990s: Accidents are the result of multiple organisational failures that shape frontline actions
- 2000s: Accidents are the result of complex interactions between organisational factors
- 2010s: Accidents are the result of normal performance variation

(Based on Pariès and Amalberti 2000)

1.2 The Adaptive age

As traditional models of accident causality (and thus risk management) are questioned, researchers and practitioners are turning towards methods which emphasise resilience and empowerment over control and compliance. The past ten years have seen growing interest in organisational resilience and how this can be developed within organisations (Hollnagel and Woods 2006).

Safety-critical sectors are seeing important changes in the way safety is managed — moving towards a less calculative approach that no longer depends upon identifying and eliminating a 'root cause'. This enlightened approach recognises rigid procedures can prime inappropriate responses (Bieder and Bourrier 2013); unrealistic targets such as *'zero accidents'* suppress incident reporting and breed scepticism (Long 2012, Sherratt and Dainty 2017); and risk aversion or *"striving for a utopia"* can stifle creativity and learning (Sherratt 2016*b*, Dekker 2017*b*, Dekker 2018, Price, Bryman and Dainty 2004).

The move towards Adaptive safety has seen a paradigm shift in our understanding of the aetiology of accidents; the human contribution; and consequently the way in which risk is managed (Pariès and Amalberti 2000, Hollnagel 2008). These changes are described in Table 1.1 (Hollnagel 2014, p. 147).

Table 1.1: A comparison of Safety I and Safety II (based on Hollnagel 2014, p. 147)

	Safety I	*Safety II*
Definition of safety	As few things as possible go wrong	As many things as possible go right
Safety management principle	Reactive, respond when something happens, or is categorised as an unacceptable risk	Proactive, continuously trying to anticipate developments and events
Explanations of accidents	Accidents are caused by failures or malfunctions	The purpose of an investigation is to identify causes and contributory factors
Attitude to the human factor	Humans are predominantly seen as a liability or a hazard	Humans are seen as a resource necessary for system flexibility and resilience
Role of performance variability	Harmful, should be prevented as far as possible	Inevitable but also useful. Should be monitored and managed

The umbrella term 'Adaptive safety' is used throughout this thesis to describe this emerging school within safety science which sees safety as created by more than formal rules and bureaucracy. There are many terms used for this age in the literature: HRO or Organisational Resilience (Weick and Sutcliffe 2007), Safety II (Hollnagel, Wears and Braithwaite 2015, Hollnagel 2018), Safety Differently (Dekker 2017*a*), and Resilience Engineering (Hollnagel and Woods 2006). As well as encompassing these similar theories, Adaptive safety avoids the connotations of engineering as a 'hard' approach to systems, rather than a social one.

1.3 The challenges of construction

Construction is a unique industry: It has been characterised as an organic (Lingard and Rowlinson 2005), heterogeneous network of subcontractors who form temporary multiple organisations (TMOs) (Stringer, 1967) to produce unique projects. Employment is fragmented, plans dynamic, and finances constrained (Lingard and Rowlinson 2005, Sherratt 2016*b*), and as such it is difficult to develop and invest in a long-term risk management strategy like permanent organisations are able to.

As a result, construction's approach to risk management is one of control and compliance, aligning with a traditional Safety I philosophy (Hollnagel 2014). Research in construction safety has focused on technical aspects — accident statistics, causes, and costs (Zhou, Goh and Li 2015) — rather than taking a holistic STS approach (Haslam et al. 2005, Asilian-Mahabadi, Khosravi, Hajizadeh, Hassanzadeh-Rangi, Bastani and Behzadan 2014). In terms of preventing fatal injuries in construction sites, a Cochrane review found most interventions focus on workers' knowledge, skills, or attitudes and motivation. There is

weak evidence that any of these interventions are effective (van der Molen, Lehtola, Lappalainen, Hoonakker, Hsiao, Haslam, Hale, Frings-dresen and H 2012, van der Molen, Basnet, Hoonakker, Lehtola, Lappalainen, Frings-Dresen, Haslam and Verbeek 2018).

1.3.1 Plateauing accident rates

Fatality rates in construction are three times higher than the average across all industries — 1.94 per 100,000 workers compared to 0.46 across all sectors in the UK (HSE 2016) and 10.1 compared to 3.4 in the US (Bureau of Labor Statistics 2015). The sector contributes substantially to the total number of occupational fatalities worldwide: 31% in the UK (HSE 2014*a*), 18.9% in the US (NIOSH 2011), 20.9% in the EU-28 (Eurostat 2016), and 13.6% in Australia (SWA 2013).

These statistics have improved significantly over the past century, yet progress has stalled in recent years (Bureau of Labor Statistics 2015, HSE 2014*a*). It remains the second most dangerous industry — recording around 40 fatalities each year and costing the UK economy £1.1 billion (HSE 2014*a*). Dekker and Pitzer (2016) claim traditional forms of safety will never reduce accidents to zero because the methods themselves overcomplicate matters and draw focus onto trivial risks, leaving organisations vulnerable to catastrophic and unpredictable accidents.

1.3.2 The divorce of safety from operations

SMS have been a significant part of risk management since the Three Mile Island accident in 1979 and have been growing in complexity to keep pace with developing technology ever since (Reason 1997). So-called *"safety inflation"* (Brown and Krauss 2014, p. 251) has resulted in cynicism: The UK's liberal economic policies have fostered a strong regulatory culture whereby sectors are increasingly focussed on *"secondary risk management"* (p. 59) — avoiding responsibility, blame, and financial penalties — rather than managing the risks of their primary activities (Power 2004). OSH has become about protecting vested interests, shirking responsibility, enhancing company image, and reducing common sense (Brown and Krauss 2014).

Criticism of the bureaucratisation (Bieder and Bourrier 2013, Dekker and Nyce 2014) and professionalisation of safety is growing (Provan, Dekker and Rae 2018). SMS have become *"divorced from operations in the field … diverting attention away from what was actually happening in the practical functioning of the plants"* (Dawson and Brooks 1999 p. 200 cited in Smith 2016): They create a false sense of security (Amalberti 2013) and focus on the expected rather than the unexpected (Bieder and Bourrier 2013).

There is a pressing need to change attitudes within construction that safety management is a *"bureaucratic burden"*(p. 1333) that detracts from production and that risk is an inherent part of work (Swuste, Frijters and Guldenmund 2012). A discourse of engagement rather than enforcement is needed (Sherratt, Farrell and Noble 2013) to understand the gap between procedure and practice (Dekker 2006, Hollnagel, Woods and Levenson 2006).

1.3.3 Behavioural safety programmes

The influence of culture on safety was first recognised following the Chernobyl disaster in 1986 (INSAG 1991). Now, the critical role of safety culture (defined as *"the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management"* (Health and Safety Commission 1993, p. 23)) has been widely acknowledged in accident prevention (Feng, Teo, Ling and Low 2014). It is considered a validated construct and a robust predictor of outcomes (Zohar 2010) — once advocated as the *"the best way to establish an intrinsically motivated workforce"* (p. 1), reducing the need for enforcement and rewards to extrinsically motivate compliance (Hudson, Parker, Lawton, Verschuur, van der Graaf and Kalff 2000).

Although safety culture can be credited with bringing a social dimension to risk management — drawing on psychology, sociology, anthropology and management (Feng et al. 2014) — the lack of a precise definition or clear understanding of culture has led to liberal use of the term, depriving the construct of its utility (Myers, Nyce and Dekker 2014).

> It's become an exasperation to me that culture is now used too extravagantly to explain almost anything. It's used as a kind of shorthand for saying, *"We don't know what's going on, but it's all about the culture,"* as if somehow this is a great insight.
>
> (Dixon-Woods in Wachter 2017)

Hudson (2007) describes an exemplary safety culture as one in which safe working is *"fully internalised"* as a value and safe behaviour *"fully integrated"* into all work activities. Progression towards this requires increasing trust, accountability, and information flow (Westrum 1991); however, *"what remains unclear is how organisations move from one step on the ladder to another"* (Borys et al. 2009). As a result, behavioural safety programmes aim to manipulate culture, viewing people as simply a *"black box"* (Geller 1993 in Guldenmund 2010) and tackling only the part of the iceberg above the water — observable behaviours, rather than the hidden interpretations, beliefs, assumptions and values beneath (Hall 1976).

> Behaviour modification is overtly manipulative, potentially ignores internal needs and intrinsic rewards, and can be seen as a threat to individual dignity and autonomy. It can be viewed as a simplistic and transparent attempt at manipulation.
>
> (Huczynski and Buchanan, 2007, p. 121)

Disillusionment with the once promising concept of safety culture is growing (Sileby 2009, Guldenmund 2010, Long 2012, Sherratt and Dainty 2017, Dekker 2017*b*, Dekker 2018). Behavioural safety programmes have been criticised for suppressing reporting,

preventing learning, encouraging fraud, and infantilising workers — blaming and punishing them for injuries and illnesses because of their *"failure to practice individual responsibility"* (Grey 2009 cited in Dekker 2018). Furthermore, rewarding and reinforcing behaviours is resource-intensive; the results vary due to individual differences (Huczynski and Buchanan 2007); and public relations and superficial branding can overtake the real issues of OSH (Sherratt 2016*a*).

1.4 Problem statement

The plateau in accident rates and doubts raised about the efficacy of Systems and Cultural approaches mean construction's safety strategy is in need of a rethink. New approaches which promise to reduce paperwork and regulation should be welcomed within construction; however, the sector has remained untouched by Adaptive safety, and little is known about generalising this theory outside the safety-critical sectors in which it developed (HSE 2011).

Systems safety research increasingly focusses on ultra-safe high-risk sectors which are vulnerable to rare but catastrophic accidents (such as plane crashes and explosions) and neglects hazardous work like construction. Hence, when translating this new philosophy into an industry like construction — which sees frequent, individual casualties — clashes arise. This growing disconnect between traditional OSH and the emerging ideas of Adaptive safety mean the latest developments in risk management are unsuitable for contexts where the need for innovation is greatest.

1.5 Aims and objectives

The aim of this thesis is to improve safety in construction by exploring how to operationalise Adaptive safety in this sector.

In order to achieve this, the antecedents and mechanisms of organisational resilience need to be understood. With a view to providing guidance on the best way to cultivate resilience, the objectives of this research are as follows:

- To appraise the underlying theory of Adaptive safety through the lens of construction.
- To understand the factors which facilitate and hinder an Adaptive response by:
    1. Exploring the role of safety leadership
    2. Understanding the challenges of construction as a system
    3. Observing Safety Differently in practice in construction

1.6 Thesis overview

Chapter 2

Emerging Concepts in Safety

This literature review critiques the principles of the Adaptive age of safety through the lens of the construction industry. There are many barriers which mean this fragmented network of litigious stakeholders and temporary organisations is not compatible — explaining why OSH and systems safety have diverged. A research agenda is proposed which emphasises understanding individual or social aspects of safety.

Chapter 3
Safety Leadership in Construction

The second literature review looks in detail at safety leadership and how this creates resilience in high-risk sectors. Comparing the roles of 'Safety Intelligent' leaders from different industries shows how construction's approach differs and where there are opportunities to improve. A vision of Adaptive safety leadership is proposed which will be compared with contemporary practice in Chapter 5.

Chapter 4
Methodology

The problems of viewing risk management as an absolute science have become clear. This chapter explains the importance of studying safety as a social process and justifies the use of qualitative methods — a interview study and a case study — to understand the role of leadership in creating resilience and safety.

Chapter 5
Safety Leadership for Resilience

A panel of expert interviewees contributed their views on best-practice safety leadership, attitudes to risk, and the potential for resilience (Objective 1). Findings show interpersonal aspects of safety leadership are already recognised as an important part of safety and many of these traits and behaviours — transformational leadership, delegation, trust, worker engagement — align with Adaptive safety.

Chapter 6
Construction as a Complex System

Although managers recognise the value of worker engagement, many aspects of construction as a system discourage and obstruct this. Applying a systems thinking approach to the interview data reveals how accidents at the frontline relate to the culture, structure, and governance of the sector (Objective 2). The findings are used to expand Haslam et al.'s (2005) contributing factors in construction accidents (ConCA) framework.

Chapter 7
Adaptive Safety in Practice I

The first part of this case study discusses how Laing O'Rourke have interpreted, adapted, and implemented Dekker's (2017*a*) Safety Differently and the rationale behind their decisions. Their toolkit of collaborative, streamlined, and flexible procedures is examined; how these have been received; and their impact on the business.

Chapter 8
Adaptive Safety in Practice II

Proactivity, relationships, communication, and job-satisfaction are improving as Safety Differently has been cultivated and allowed to evolve. The second part of this case study discusses the role of stakeholders in diffusing or diluting this innovation (Objective 3). Aspects of the company, project, and London's megaproject ecology have meant Laing O'Rourke has been uniquely well-equipped to make this transition, but the sector's pace of change and persistent culture have been challenging.

Chapter 9
Discussion

This chapter reflects back on the Adaptive safety movement and discusses its compatibility with construction. It questions whether resilience — which relies on organisational learning — is suited to a dynamic network; if empowering workers addresses construction's blame culture; and the degree to which a more traditional version of safety (procedures, competence, experience, and compliance) is better suited to this sector.

Chapter 10
Conclusion

This thesis contributes an improved understanding of the mechanisms of Adaptive safety and the factors which support and hinder its successful operationalisation. The concluding chapter summarises the its insights into Adaptive safety, limitations, and areas for further research.

Emerging Concepts in Safety

2

Contents

2.1 Introduction

This chapter reviews two of the most influential approaches in contemporary safety science — high reliability organising (HRO) and resilience engineering (RE). Although these stem from different traditions; use different methods; and take different stances on risk, both HRO and RE share a focus on social aspects of safety and coping with complexity (Haavik, Antonsen, Rosness and Hale 2016). Their principles form the foundation of Borys et al.'s (2009) 'Adaptive' safety movement, promising a move away from bureaucracy and a means to manage safety without sacrificing performance.

Efforts to apply these ideas outside the ultra-safe sectors within which they developed have so far been limited (HSE 2011). In this chapter the construction industry is used as a test case to explore the applicability of HRO and RE in a less highly regulated context. Contrasting construction with the environments in which HRO and RE have previously been studied (organisations with permanent, stable structures, and a clear purpose) provides an interesting lens through which to explore their potential and how these theories would need to be adapted to fit another context. This discussion highlights research gaps which have limited the expansion of these approaches in new sectors and perpetuated the disconnect between occupational safety and health (OSH) and systems safety.

There are many aspects of the construction sector — project-based organisations, transient workforce, widespread outsourcing of labour, and financial pressure — which prevent it developing capabilities advocated by HRO and RE; however, there is potential for construction to incorporate their principles at an individual or worker-centred level rather than organisational. These opportunities offer a useful perspective for reframing safety debates in construction.

This work has been published as a journal article in Safety Science (Harvey, Waterson and Dainty 2016*a*) and as a conference paper (Harvey, Waterson and Dainty 2016*b*) which was presented at the conference of the Chartered Institute of Ergonomics and Human Factors (CIEHF) in Daventry.

2.1.1 The organisation of this chapter

Section 2.2 introduces HRO and RE, unpacking their different philosophies and metrics alongside the current state of safety research in construction to show how these nascent fields have diverged from traditional OSH. Section 2.3 explores implementing HRO and RE in construction to identify opportunities where elements of these concepts — their approach to risk management, organisational principles, and worker-centred principles — could be applied or adapted to improve safety. Section 2.4 draws out key themes, and Section 2.5 proposes a research agenda which highlights the need to extend and adapt aspects of HRO and RE in order to tackle some of the unique characteristics of construction.

2.2 Comparing HRO and RE

2.2.1 Origins and traditions

HRO theory developed in response to normal accident theory (NAT) (Perrow 1984), demonstrating that it is possible for some organisations to avoid *"inevitable' accidents"*. By observing organisations which operate successfully in *"unforgiving environments"* (Weick and Sutcliffe 2007, p. 164) (aircraft carriers, air traffic control, and a nuclear power plant) the qualities of organisational mindfulness, which enable these systems to cope, were identified. Case studies have shown that high reliability organisations are characterised by their capacity to respond, learn, and feedback quickly through accurate communications, and their flexibility to improvise by recombining resources, skills and experience (Weick and Sutcliffe 2007). These traits demonstrate the presence of organisational mindfulness – *"a rich awareness of discriminatory detail and a capacity for action"* (Weick, Sutcliffe and Obstfeld 2008, p. 37) — which enables HROs to notice the unexpected developing, contain it, or act resiliently in the face of it. Theoretically, HROs respond to perturbations in ways that strengthen adaptability — increasing learning, flexibility, and experience — rather than reducing it by adding further controls (Sutcliffe and Vogus 2003).

One core principle of HRO is a commitment to *"resilience"*, a word which has recently appeared with increasing frequency in a variety of contexts — ecological, individual and

engineering (Bhamra, Dani and Burnard 2011). RE in relation to safety grew out of 'organisational resilience', a term which first appeared 20 years ago (Mallack 1998, Horne and Orr 1998), and described as the ability of an organisation to respond to change constructively, without introducing regression. RE has been described as the natural next step in OSH following a highly developed 'Interdependent' (DuPont 2015) or 'Generative' (Westrum 1991) safety culture, *"to overcome the limitations of existing approaches"* (Woods and Hollnagel 2006, p. 11). Its new perspective — seeing human adaptability as an asset — has been described as a significant step change (Hollnagel 2008); however, it can also be seen as a continuation of the work of human factors (HF) researchers to design systems around human attributes (Wilson 2014). This emerging field has yet to develop a clear definition of its theory and limits making it difficult to draw comparisons with the clear framework of HRO.

2.2.2 Perspectives on core concepts

In spite of their different origins, there are similarities between HRO and RE. Both emerged in response to the limitations of procedures and regulation to manage safety in complex systems, and both emphasise the human attributes — adaptability, imagination, mindfulness — which enable people to act resiliently and perform in circumstances where failure is expected. However, attempts to reconcile HRO with other high-risk safety approaches under the umbrella of RE (Hollnagel et al. 2006) have had limited success because of their different philosophical foundations.

One explanation for this disparity is their differing perspectives on what constitutes organisational resilience. In HRO's model of organisational mindfulness, 'commitment to resilience' is categorised as a principle of containment, not anticipation. 'Firefighting' (reacting to emergencies as they arise) in high reliability organisations is seen as a positive trait and evidence of resilience (Weick and Sutcliffe 2007) — something which, in other organisations, is seen as a symptom of poor planning and reactive management. Resilience engineers do refer to the work of HRO-scholars (Hollnagel 2014), incorporating organisational mindfulness, whether or not this is true to Weick's original concept, as one part of RE's toolset of safety measures which can *"facilitate the emergence of resilience"* (Hollnagel and Sundström 2006). Within RE resilience forms part of both anticipation and response — intrinsically linked as organisations adjust *"prior to, during, or following changes"* (Hollnagel and Fujita 2013, p. 13), whilst in HRO resilience is seen as the reaction to an incident, with a greater emphasis on 'bouncing back'.

2.2.3 Approach to measurement and validation

In terms of auditing resilience and HRO, measurement scales for HRO have been developed (Vogus and Sutcliffe 2007), but a literature review by the health and safety executive (HSE) (HSE 2011) criticised the lack of quantitative evidence supporting the predictive validity of organising in this way and safety performance. The majority of research was said to

be observational and qualitative, providing rich descriptions of the qualities of these organisations, but lacking a theoretical framework to justify why HROs succeed where other organisations fail.

Similarly for RE, research is needed in terms of real-world empirical methods to validate its constructs (Burnard and Bhamra 2011, Sutcliffe and Vogus 2003, Hollnagel 2018). Hollnagel and Woods (2006) state that resilience cannot be measured, only an organisation's capacity for it through variables such as buffering capacity, the flexibility of its structure, awareness of proximity to margins, and tolerances enabling graceful degradation (Woods 2006). The characteristics of a resilient organisation are less well-defined than high reliability organisations, but the RE community believes any organisation can become resilient, with different industries managing stability and flexibility in different ways (McDonald 2006). Therefore, RE could offer valuable opportunities to expand the well-intentioned ideas of HRO to suit other contexts, but as yet further work is needed to understand the factors that facilitate the development of both resilience and mindfulness.

The following sections will compare concepts of HRO and RE through the lens of the construction industry, focussing on three areas: Their approach to risk management; characteristics of the organisation; and individuals or workers.

2.3 Key principles

2.3.1 Risk management principles

Barriers

Construction accidents

One of the greatest barriers to adopting HRO in new sectors is the belief that HRO is only applicable in safety critical industries. In construction, workers believe that *"safety detracts from the primary production process"* (Swuste et al. 2012, p. 1333). This is true in some sectors such as rail, where unforeseen hazards frequently lead to delays or cancellations (Hale and Heijer 2006*b*); however, both RE and HRO emphasise maintaining performance and safety simultaneously — the key to safe performance without sacrificing reliability is resilience. Reason's Organisational safety model deliberately blurs the line between quality and safety, as safe operation is an integral part of performance as a whole (Reason 1997). This is particularly true in the safety-critical industries where HRO developed. The synonymous use of 'safe' and 'reliable' implies high-reliability is only attainable by organisations where safety is the primary focus — a view which underlies the conceptual barrier to applying this theory elsewhere and one which has kept HRO from integrating into construction (olde Scholtenhuis and Dorée 2014). However, Weick and Sutcliffe (2007) intend their work as a template for *"any institution that wants to better organise for high reliability"*.

Neither HRO nor RE promise zero accidents, but rather a reduced probability in terms of the number of encounters. In circumstances where the risks are high, it is possible for an

organisation to be described as resilient even if it has accidents (Hollnagel 2014). Similarly, if the risks are low, an organisation may be safe without needing to be resilient (Hale and Heijer 2006*a*). The high number and type of accidents faced by construction compared to ultra-safe organisations may explain one of the differences that prevent HRO and RE being applied more widely. Although construction is high-risk, the concern here is the high level of personal injury incidents, whereas HRO and RE have developed in safety-critical sectors — such as nuclear and aviation — with the potential to cause harm to third parties (Reason 1997). The prevalent causes of death in construction are falls from a height (30%), slips, trips and falls on the level, being struck by a moving vehicle (Haslam et al. 2005) and electrocution (HSE 2014*a*).

> Accidents therefore become intolerable on account of their consequences rather than their frequency … 100 isolated, singular deaths may have far less emotional impact than 10 deaths in a single event.
>
> (Amalberti 2006 p. 269)

The social amplification of risk (SARF) describes how some risks are amplified by social, psychological, and cultural factors (Kasperson, Renn, Slovic, Brown, Emel, Goble, Kasperson and Ratick 1988). Although the majority of occupational fatalities occur due to construction accidents, they are *"isolated"* events, so the risk is socially *"attenuated"* and research has been diverted to focus on sectors with greater risk of harm to the public and which generate more political and media interest. However, construction is not immune to causing collateral deaths: 4 members of the public died in UK construction accidents in 2014 (HSE 2014*a*), the collapse of the Rana Plaza textile factory in Bangladesh killed 1,134 people (The Guardian 2015), and corners cut in the renovation of Grenfell Tower led to the deaths of 72 people (Grenfell Tower Inquiry 2018). Reason (1997) argues risks to third parties are high across all sectors because, despite differences at the frontline, they are equally threatened by latent problems of planning, scheduling, and budgeting which contribute to major accidents. For HRO and RE to benefit construction, the similarities between accidents in safety critical sectors and those in construction need to be embraced.

Opportunities

Accident causation

Before the age of systems safety, accidents were believed to have a root cause — a technical malfunction or individual failure on which events could be blamed. This simplistic model is emotionally satisfying and has legal and financial benefits (Reason 1997), but can fail to appreciate the complex relationships between causes and consequences. Within construction this tendency towards simplifying situations to find a root cause can be seen in contemporary accidents (Clegg and Kreiner 2014). The prominence of the 'Zero Accidents' discourse also confirms this model. Using propaganda to manipulate workers' attitude

to safety demonstrates the belief that accidents could be prevented with more effort or care (Dekker 2015). Swuste et al. (2012) argue a better understanding of causal chains is needed to improve construction safety; however, given the loosely coupled structure of construction organisations, it can be difficult to identify and learn from causal links and to accept a lack of accidents as proof of good practice (Clegg and Kreiner 2014).

Accidents in HRO are described in causal terms, as the result of an unfortunate combination of a number of errors; hence, detecting failures as they develop through sensitivity to weak signals is advocated (Weick and Sutcliffe 2007). However, this simplistic understanding of accidents has been criticised for endorsing the idea that accidents can be prevented by paying more 'mindful' attention to precursor events (HSE 2011). Based on this interpretation, risk analysis depends upon the systematic identification of causal chains and implies safety is a static commodity that can be quantified, not a dynamic process. Projects, like those in construction, have been described as *"drifting environments"* (Kreiner 1996, p. 335), where the outcome changes over time, thus RE's notion of drifting accidents offers a different perspective on accidents investigation (Hollnagel 2009) which could be better suited to loosely coupled systems than exploring causal chains and looking for pivotal failures. For RE, safety is a dynamic process, human behaviour cannot be categorised in a bimodal way and the causes of accidents are far more subtle and complex — nothing worth reporting happens (Hollnagel 2009). Instead, accidents are caused by an undetectable *"drift into failure"* (Hale and Heijer 2006*b*, p. 37) which is a natural part of operations in resource-constrained environments.

RE scholars argue a causal model cannot cope with complex relationships (Hollnagel 2009) and unexpected failures (Hollnagel 2014) — only predictable cases where data can be reliably assessed — and is hindered by a form of confirmation bias Lundberg, Rollenhagen and Hollnagel call what you look for is what you find (WYLFIWYF) (Lundberg, Rollenhagen and Hollnagel 2009). The efficiency-thoroughness trade-off (ETTO) principle (the tendency to sacrifice thoroughness for efficiency) is key to understanding the 'drift' that means failure can develop out of normal behaviour. Humans have a natural tendency towards efficiency (Hollnagel 2009). Rational decision-making is also limited by context, subject to social and cultural factors (Perrow 1984), and constrained by finite cognitive resources so people *"muddle through"* making what they perceive to be *"sensible adjustments to cope with current and future situational demands"* P.149 (Hollnagel 2014). In many cases, this performance variability is a positive improvement, enabling more efficient ways of working, but the same variability can also lead to failures (Hollnagel 2009).

RE incorporates the ETTO into its understanding of accident causation, recognising that people instinctively make sacrificing decisions, or trade-offs, to cope with pressure; thoroughness is sacrificed for efficiency, safety is sacrificed for production. Instead, it is proposed that accidents are caused by functional resonance — an unexpected combination of everyday performance variability, or *"ETTOing"*, the consequences of which are emergent rather than resultant (Hollnagel 2009).

Reanalysing construction accidents through the lens of RE's functional resonance could provide a different perspective. Although trading off safety for production can lead to accidents, understanding that the workforce's natural adaptability has the potential to strengthen the system, as well as weaken it, highlights the opportunity to harness for the benefit of safety. These theories of drift within performance and its effects, which can reverberate unpredictably throughout a system, present an interesting challenge to construction and HRO's interpretation of accidents. Both these fields subscribe to the notion that accidents can be predicted and therefore prevented by promoting greater attention — or the vision of *"zero accidents"* in construction. However, according to RE, it is the efficient decisions which prevent accidents and maintain performance every day, as well as cause them when performance drifts outside the acceptable tolerance.

Anticipating accidents

Accidents in high reliability organisations are, by definition, extremely rare. They operate in environments which preclude learning by experimentation because of the dangers they face; therefore, little is said about how they learn from accidents. Instead, mindfulness encourages a focus on the present because — although past experience can be valuable — memory can draw attention away from current events and provoke generalised interpretations based on hindsight. This reactive approach to learning from accidents (or precursors of accidents), where feedback is immediately acted upon, could be beneficial in an industry like construction where factors needed for long-term learning — leadership, processes, infrastructure, communication, education and community (Chinowsky, Molenaar and Realph 2007) — are hindered by the dynamic and fragmented nature of temporary multiple organisations (TMOs).

HRO's principle of 'preoccupation with failure' encourages members of the organisation to imagine potential mistakes, elaborate on near misses, and articulate the consequences — however distressing — so mitigations can be expanded (Weick and Sutcliffe 2007). Similarly, RE advocates the use of 'Second Stories' — looking for other potential outcomes of the events to avoid bias, hindsight, and oversimplification caused by knowing the real outcome (Hollnagel 2014). It also warns of the dangers of *"distancing through differencing"* or the *"it would never happen to us"* attitude (Cook and Woods 2006) meaning people fail to see the similarities between accidents in other organisations and events in their own, and therefore cannot learn from them. Both these theories have potential to enhance safety in construction.

Recently RE has put forward an approach to safety management known as 'Safety II' (Hollnagel 2014). Traditionally, safety ('Safety I') has focussed on what went wrong following an accident; but under Safety II, a greater emphasis on the aspects that contribute to normal performance is encouraged; in order to learn from events they need to be frequent enough to make generalisations. In complete contrast with HRO, which advocates seeing the unique nuances of every event (Weick and Sutcliffe 2007), RE accepts that accidents

are difficult to learn from because they are rare, poorly understood, and difficult to make generalisations about. Instead, investigating everyday successes — such as human adaptability and positive performance variability — can be seen as an investment in performance rather than safety (Hollnagel 2014).

Accident research in construction, as well as many other sectors, is hindered by a mistaken belief that *"the potential for learning is proportional to the severity of the incident"* (Hollnagel 2014, p. 160). Hence, accident investigation is often confined to serious and fatal accidents (Hinze, Devenport and Giang 2006). Although it would be difficult to justify a shift in focus away from accidents (as advocated in Safety II) when they are a frequent occurrence, understanding accidents as emergent consequences of adaptations required to cope with pressure could reduce the propensity for blame, creating a just culture as advocated by both HRO and RE, and open up opportunities to embrace workers' flexibility — seeing it as a form of resilience as opposed to disobedience.

Key differences between HRO and RE have been identified in their approach to risk management and their applicability to other contexts. Underpinning these differences is their understanding of the way in which accidents develop. HRO, like construction, takes a view that accidents are the result of a causal chain of errors, thus the precursors to accidents can be detected by paying mindful attention to cues in the present. RE is founded on the belief that accidents emerge from adaptations made to cope with pressure and the *"drift"* towards failure is unnoticeable. This disparity is reflected in the ways the two schools advocate anticipating accidents.

Table 2.1 lists the new concepts for risk management from the Adaptive age, whether they arose from HRO or RE, and summarises the positive and negative points from the evaluation of their potential application in construction.

Table 2.1: Barriers and opportunities of Adaptive safety's management principles

Risk management principle	*From HRO or RE*	*Barriers to application in construction*	*Opportunities for application in construction*
Applicable to safety-critical industries where accidents are rare but catastrophic	HRO	Risks in construction are socially attenuated by high frequency and low fatalities-per-accident.	
Understand failures as the undetectable consequence of Functional Resonance (performance variability)	RE	The zero accident discourse and a culture of blame are prominent in construction, so constructs that challenge this are unlikely to be accepted	Could be better suited to a loosely coupled industry where causal chains are difficult to identify Could counteract confirmation bias and propensity for blame when analysing accidents
Accidents can be predicted and prevented by paying greater attention to precursors	HRO	Causal chains are difficult to identify in loosely coupled systems Implies workers are lazy, negligent, or careless	Could build upon 'zero accidents' which is popular in construction
Focus on everyday performance	RE	Difficult to justify when accidents are a frequent occurrence	Could promote sensitivity to operations Could enable investment in performance and strengthening the positive aspects of a system, rather than preventive methods
Focus on the present when responding to unexpected events	HRO		Could reduce the requirement for long-term learning in a temporary organisation

2.3.2 Organisational principles

Barriers

Applicability to construction

As with its theories about risk management, HRO's ideas about organisations have also meant it has not been readily embraced by construction. The type of organisation HRO is based upon is fundamentally different from construction work. NAT (Perrow 1984) arranges organisations onto two axes, forming 4 quadrants, according to their characteristics. *"Coupling"* (originally an engineering term) describes the capacity to absorb shocks and failures. If an organisation is tightly coupled its processes are time-dependent, sequential and invariable — leaving little slack — so perturbations have a rapid impact. *"Complexity"* describes the interactions between components. In linear systems it is easier to substitute people and materials because roles are less specialised, information is directly monitored, feedback is local, and control can be decentralised. In complex systems the interactions may be invisible, unpredictable, indirectly measured, and connect multiple subsystems; therefore, perturbations have a widespread impact.

In organisations which are both tightly coupled and complex, failures have a rapid and widespread impact. HRO describes the characteristics needed for safe performance in this type of organisation. According to the NAT framework, construction is low risk because raw materials are assembled, rather than fabricated, and their processes are visible and can be understood; thus there are opportunities to learn from construction accidents. However, the growing popularity of megaprojects as a delivery model for public services (Flyvbjerg 2014) means managers must coordinate numerous subcontractor organisations, work to a tight schedule, and keep agreements with local stakeholders to minimise disruption. For example, details such as the sequence in which deliveries have been loaded onto a lorry can mean a delay of a few hours but have widespread repercussions over several months for multiple other contractors who cannot begin their work until prerequisite stages have been built (Walsh 2015). Although the industry as a whole is loosely coupled, projects and their supply chains have become increasingly tightly coupled and complex — a structure which Dubois and Gadde (2002) describe as a two-layered pattern of coupling. In light of the recent changes to the industry, the applicability of HRO's principles in construction needs further consideration.

Structure

Under normal conditions high reliability organisations have an extremely hierarchical structure with clear roles and responsibilities; redundancy; high levels of accountability, and expectations for following procedures and performance (Roberts and Rousseau 1989).

The paradox of achieving high reliability is creating a strong hierarchy which can be dissolved rapidly in the face of adversity, allowing its empowered employees to manage local events. This transformation from centralised to decentralised control is only possible if organisations initially have a centralised control hierarchy (Glendon, Clarke and McKenna 2006). The importance of management has been well established in safety as a whole (Zohar 2010). Particularly within RE, the management's ability to diagnose potential problems, make-decisions, and act assertively, underpinned by their commitment (Flin 2006) and individual resilience (Hollnagel 2009) are all believed to contribute to resilient leadership among managers. In construction projects however, lines of authority and accountability become unclear due to the dynamic, transient nature of TMOs.

Culture

Developing adaptability through cultural change is an idea which has appeared in both HRO (Weick and Sutcliffe 2007) and RE (Reason 2000, Wrethall 2006). A just or reporting culture (Reason 1997) is required for 'sensitivity to operations' or understanding work as performed, not as imagined (Hollnagel and Woods 2006, Wrethall 2006). Construction, like many organisations, can be seen to take front line operations for granted. A recent inquiry exposed the practice of blacklisting construction workers for being vocal about OSH issues (House of Commons 2015). It is an industry highly vulnerable to economic pressure, employment fluctuates with recession and growth, hence the use of contracting to provide flexibility of labour and meet changing market demands (Manu, Ankrah, Proverbs and Suresh 2013). It has been suggested that, because HRO developed in non-profit organisations where safety is a primary objective, its constructs would be difficult to implement in sectors, like construction, with conflicting goals and pressures (Tamuz and Harrison 2006). A resilient response relies on contingency resources and experience within the workforce — a challenge in *"stretched systems"* (Hollnagel and Woods 2006) when workers are viewed as a disposable commodity.

Procedures

Although HRO classifies resilience as a principle of containment, it is recognised that a resilient response depends upon the *"structures that have been developed before crisis arrives"* (Weick and Sutcliffe 2007). Similarly in RE, maintaining control in the face of unexpected events depends upon both anticipation and response (Hollnagel and Fujita 2013). In spite of this, both HRO and RE are sceptical of formal planning: The limitations of foresight mean planning can never anticipate all the ways a system could fail. Planning can reduce the capacity for a resilient response because it imposes expectations on situations, promotes confirmation bias, and reduces improvisation (Weick and Sutcliffe 2007). RE also warns that an overemphasis on procedures could lead to *"work-to-rule"* where workers follow regulations so strictly it negatively impacts upon productivity and safety (Hollnagel 2009).

Despite its limitations, RE recognises that in some cases proceduralisation may be the most appropriate safety mechanism (Amalberti 2006). Perrow (1967) argues the degree to which organisational activity can be *"pre-programmed"* depends upon the activity itself. According to his framework, construction is classified as an industry well suited to procedures because its tasks are well structured and routine, exceptional cases are rare, and solutions to problems are easy to find. Thus, reducing proceduralisation is a concept from the Adaptive age that should be applied with caution in construction. Avoiding planning may encourage resilience to develop in some organisations, but in others it could reduce anticipation and lead to reactive management (McDonald 2006).

HRO recommends preparing for failure by building in contingency in the form of uncommitted resources or *"pockets of resilience"* (Weick and Sutcliffe 2007, p. 80). Rather than procedures or protocols, high reliability organisations plan by investing in systems that gracefully degrade and developing a broad range of employee experience; shared knowledge within the system; and training and drills to support 'deference to expertise'. In an industry like construction which is loosely regulated (Lingard and Rowlinson 2005) and averse to rules (Swuste et al. 2012), formal contingency plans are difficult to establish. The notion of uncommitted resources to help manage unexpected events is attractive, but unlikely in such a resource constrained environment.

Opportunities

Cultivating resilience

HRO's model of organisational mindfulness presents a 'one-size-fits-all' template which does not suit a fragmented, organic, transient organisation. However, RE recognises that *"spontaneous resilience"* (Amalberti 2006, p. 271) can be found in unsafe systems; hence, its stance is a more inclusive and holistic one. Resilience is seen as an emergent property so a top-down approach — forcing systems to adopt structures seen in successful organisations — shows an idealised understanding. A specific strategy for developing resilience is not prescribed; instead, RE methods should depend on the context and stage of development (McDonald 2006).

RE relies on organisations learning from experience how best to facilitate resilience in their own operations. Resilience is expressed differently in each system and at each stage, so to develop it requires an ongoing commitment to identify and invest in the factors that contribute. In other words, resilience is a proactive process a system does, rather than — as HRO suggests — a reactive mechanism a system has (Woods and Hollnagel 2006). This offers a more hopeful perspective, opening up the possibility of developing resilience in any organisation, providing the approach is suitable. The existing resilience within construction workers can be expanded to apply to safety, as well as production, without needing to adopt the structures of HROs; However, developing a strategy for cultivating resilience in a TMO — where feedback loops are not well defined and learning from experience difficult — is an area in need of further research.

At an organisational level, the services within which HRO and RE have so far been studied shed little light on how Adaptive safety might apply in a temporary project. Hierarchy, commitment to the workforce, reduced proceduralisation, and an unchallenged commitment of resources to safety are all concepts which do not transfer well into construction. However, it may be possible for construction to draw upon RE as its methods for 'engineering' resilience are not confined to a prescribed template and there is scope to develop a strand of RE specific to construction. Table 2.2 lists the organisational concepts for from the Adaptive age, whether they arose from HRO or RE, and summarises the positive and negative points from the evaluation of their potential application in construction.

Table 2.2: Barriers and opportunities of Adaptive safety's organisational principles

Organisational principle	*From HRO or RE*	*Barriers to application in construction*	*Opportunities for application in construction*
Applicable to complex and tightly coupled systems	HRO	According to NAT's framework, construction is not seen as a high-risk industry despite the recent growth in complex projects	Today's construction projects, which are far more complex and tightly coupled, indicate an opportunity to reconceptualise 'high-risk' industries
Control is simultaneously centralised and decentralised	HRO	Local-decision making and independence are encouraged Construction is loosely regulated Multiple subcontractors mean lines of authority and accountability are unclear	
Just culture	HRO and RE	Emphasis on zero accidents and identifying a root cause of accidents Workers rarely report accidents and have been blacklisted for being vocal about OSH issues	
Prioritise and invest in safety	HRO and RE	Resources are constrained due to economic pressure Production is prioritised over safety	
Avoid formal plans, and instead develop uncommitted contingency resources	HRO	Proceduralisation is widespread in construction due to the misconception that tasks are routine Transfer of experience is limited between temporary projects Resources are constrained due to economic pressure	
Management commitment to the frontline	HRO and RE	Production tends to be prioritised over safety Lines of authority and accountability are unclear	

2.3.3 Worker-centred principles

Barriers

Empowerment

At an individual level there are opportunities for workers to develop a resilient mind set which could allow construction to adopt Adaptive safety in spite of the barriers at the organisational and risk management strategy levels. However, a significant discrepancy still exists with respect to their stance on empowerment. The challenge for tightly coupled and complexly interactive systems is the need for control to be simultaneously centralised — to see the interactions between different parts of the system — and decentralised — so operators can act quickly and independently (Perrow 1984, Reason 1997). Both HRO and RE advocate empowering individuals to respond to unexpected events, but decentralised decision-making applied in a context like construction — where safety is not prioritised, regulation loose, and lines of authority unclear — leads to workarounds, and unsafe acts.

Herzberg (1987) found that performance could be improved if employees had greater autonomy, direct feedback, and an understanding of the significance and identity of their task — unlike the fragmented tasks of scientific management (Taylor 1911). To some extent this is similar to the principle of 'deference to expertise' in HRO (Weick and Sutcliffe 2007) — allowing leadership to migrate to the people with the most expertise, regardless of their rank or experience and RE which describes resilient organisations as *"empowered to be independent, involved, informed, and informative"* (Hollnagel and Woods 2006, p. 324). Weick and Sutcliffe (2007) say empowerment can be achieved by encouraging constant interaction between teams. Multi-disciplinary teams increase trust, prevent power struggles, and are better at coping because existing skills and knowledge can be recombined to deal with unique situations. They have greater diversity in their experiences — which can also be achieved through selection, job rotation, retraining — to increase awareness of the operational picture and prevent complacency. However, this is difficult in construction because the majority of work is subcontracted, allowing firms to engage specialists on a flexible basis. As a result, the organisation becomes fragmented into units with conflicting interests, ambiguous responsibilities, inadequate communication, and reduced teamwork (Manu et al. 2013).

An empowered workforce relies on communication, knowledge management, and opportunities for long-term investment and training, all of which are compromised in construction. To achieve the multi-skilled, self-managed teams seen in HROs, construction workers would need to be better educated and have higher expectations for job enrichment (Price et al. 2004). The existing literature on empowerment focuses on internal teams, and there is a lack of guidance as to how these could apply to outsource providers, highlighting a barrier to applying HRO to construction. For a TMO to empower workers in this way may not be possible, given that workers are employed for their specific skills, but it stresses

the need to foster relationships between contractor organisations to create a community of practice with a better understanding of the *'big picture'*.

Opportunities

Sensitive to the unexpected

Under the principle of 'reluctance to simplify', HROs encourage an understanding of error which sees the unique nuances of suspicious events to learn more rather than generalise about them. Their tendency towards efficiency means people are quick to name, categorise and stereotype phenomena; this helps to organise information and make it more sharable, but the use of rigid categories can mean its thorough exploration is brought to a premature end. Avoiding simple diagnoses based on superficial similarities affords HROs a clearer and more complete picture of situations (Weick and Sutcliffe 2007).

In intractable, high-risk environments it is impractical to be this thorough. Another concept proposed by Weick is that of *"sensemaking"*, describing how people cope with ambiguity by making sense of a situation through action and communication, and settle for a plausible explanation (Weick, Sutcliffe and Obstfeld 2012). This is similar to RE's ETTO: Rather than counteracting the natural tendency to simplify, the ETTO accepts that it is impossible for people find thorough, rational explanations for every event. To cope in dynamic situations people have learned to trade off thoroughness for efficiency and identify all the relevant information without being overwhelmed, rather than *"find the perfect response when it is too late."* (Hollnagel 2009, p. 55). HRO's sensemaking and RE's ETTO both describe the reality of coping with pressure in high-risk, ambiguous environments. Efficient or plausible explanations, rather than a complete understanding, can result in presumptuous decisions and lead to errors. Although it is impossible to avoid some simplification and routine, HRO's warning that this should be done *"slowly, reluctantly, mindfully"* (Weick and Sutcliffe 2007, p. 12) is nonetheless a valuable message and one that has not gone unrecognised in construction: Clegg and Kreiner (2014) suggest that one way to improve learning from construction accidents is to *"make learning harder, not to facilitate it"*. Where situations are complex and ambiguous, doubt and scepticism should be welcomed as they prevent complacency.

Imagination to anticipate

To avoid accidents, employees of high reliability organisations consciously maintain failure at the forefront of their mindset — the principle of 'preoccupation with failure'. HRO warns of the dangers of falling into automatic processing, and instead these organisations *"persuade all their members to be chronically concerned about the unexpected"* (Weick and Sutcliffe 2007, p. 62). Reporting is rewarded and a questioning attitude encouraged so employees remain sensitive to weak signals — acting on hunches that something might be going wrong. The same concept can be seen in RE, as Hollnagel and Woods (2006) also

advocate a *"constant sense of unease"* (p. 355) and Dekker *"keeping the discussion on safety alive even when everything looks safe"* (2006).

A similar concept has also been called requisite imagination (RI) (Adamski and Westrum 2003), *"safety imagination"* (Pidgeon and O'Leary 2000), and *"chronic unease"* (Reason 1997). RI — *"the fine art of anticipating what might go wrong"* (Adamski and Westrum 2003, p. 193) — is essential for resilience (Hollnagel and Woods 2006); It fuels a questioning attitude and enables designers to anticipate all the possible scenarios. Similarly, safety imagination (Pidgeon and O'Leary 2000) encourages a less rigid approach to anticipation in order to capture the failures outside expectations (Pidgeon 2010). Finally, chronic unease was first described by Reason (1997) as *"the assumption that every day will be a bad day"* and has more recently been broken down into five attributes — vigilance, pessimism, RI, flexible thinking, and the propensity to worry (Fruhen, Flin and McLeod 2013).

Developing a culture of chronic concern about safety issues is a fundamental part of resilience and organisational mindfulness, and its potential to improve safety in construction has been recognised — *"we need more theorising and imagination than facts and evidence"* (Kreiner 2009, p. 143). Mentally simulating the potential ways the operations could fail expands the *"complex tree of causalities"* (Kreiner 2009, p. 142) therefore increasing the number of precautions to be taken. Imagination also extends the potential of learning from accidents using imagination to avoid what Cook and Woods (2006) called *"distancing through differencing"*, and prevents *"overlearning"* from single-events by mediating experiences with an awareness of their complexity, randomness and ambiguity. In a masculine industry (Aulich 2013, Lindebaum and Fielden 2010) where risk as an integral part of work (Swuste et al. 2012), encouraging vigilance and lowering risk tolerance in this way presents an interesting opportunity. However, other than raising awareness that bringing attention back onto task when distracted requires conscious effort (Weick and Sutcliffe 2007), neither RE or HRO offer any empirical insights into how this 'preoccupation with failure' can be established or measured.

Initiative to respond

Their ability to transform between centralised and decentralised control means HROs could be described as both 'mechanistic' and 'organic' (Burns and Stalker 1961). Organic industries respond rapidly to changing market conditions, whereas mechanistic organisations, such as process industries, have a stable hierarchy. Construction is organic which provides one explanation for its poor safety record. OSH is far more difficult to implement in organic organisations than mechanistic because autonomy, responsibility, and the use of initiative to overcome problems are encouraged (Lingard and Rowlinson 2005).

In accordance with its philosophy that accidents can be detected as they develop, HRO encourages organisations to react to unexpected events with a contingency of uncommitted resources and diverse skills (Weick and Sutcliffe 2007). Ironically, construction workers are

adaptable — using initiative to work independently — but without clear lines of authority, regulation, and prioritisation of safety, the natural human tendency towards efficiency leads to unsafe workarounds and violations rather than resilient performance adaptations. This suggests high-reliability results from the combination of individual empowerment and hierarchical control. Therefore, for construction to be highly-reliable would require structural changes to improve regulation and management — an impossible challenge to implement given that construction projects are formed of multiple, temporary subcontractors (Stringer 1967). Imposing control and structure in this way is a major barrier to expanding HRO to other sectors, but cultivating workers' *"spontaneous resilience"* and channelling this capability towards safety, rather than productivity, could provide a useful opportunity. In contexts like construction, with complex organisational networks and high pressure, worker-innovated practices have been shown to be more influential than regulation; to improve safety the ways in which this knowledge exists and flows within the system need to be understood (Pink, Morgan and Dainty 2014).

The value of avoiding assumption, imagination, and initiative are all traits of Adaptive safety which could be adopted within construction. It could be possible for construction workers to develop resilience even in an industry where the structure and financial constraints do not support resilience at an organisational level. A research agenda is presented in Section 2.5 to outline how this could be achieved. Table 2.3 lists the worker-centred aspects of the Adaptive age, whether they arose from HRO or RE, and summarises the positive and negative points from the evaluation of their potential application in construction.

Table 2.3: Barriers and opportunities of Adaptive safety's worker-centred principles

Worker principles	*From HRO or RE*	*Barriers to application in construction*	*Opportunities for application in construction*
Empowerment	HRO and RE	Contract-based employment limits opportunities to invest in people Construction workers are engaged for their specialised skills Levels of education are low Expectations of job enrichment are low	
Understand the 'big picture'	HRO	Independent subcontractors work in silos Communication is fragmented Contractors are engaged on a temporary basis	Could improve relationships between organisations to create a collective community of practice
Multi-disciplinary teams and diverse experience	HRO	Construction workers are engaged for their specialised skills Contract-based employment limits opportunities for investment in people	
Adaptability	HRO and RE	According to HRO, centralised control is needed alongside adaptability, whereas construction is loosely regulated and lines of authority are unclear Production is prioritised over safety, so adaptability is applied to meet targets rather than respond to unexpected events	Could harness construction workers' natural adaptability Could improve safety without sacrificing productivity Could improve safety without introducing top-down structures
Avoid simplification (Sensemaking and the ETTO)	HRO and RE	Productivity is prioritised so efficient decisions are encouraged	Could enhance vigilance Could prevent the emphasis on efficiency/productivity overshadowing safety
Develop a culture of chronic unease	HRO and RE	Workers rarely report accidents In this masculine environment, risk is seen as an inherent part of construction work	Could lower risk-tolerance of workers Could heighten anticipation and response to unexpected events Could increase investment in risk management

2.4 Discussion

The findings will be discussed with reference to five characteristics of organisations which are managing safety in accordance with HRO and RE — continuously learning, well-resourced, flexible, chronically uneasy, and humanising — each of which poses specific problems for the construction industry.

Continuously learning

Learning from experience and feedback allows a resilient organisation to anticipate and prepare for unexpected events; however, construction is an industry particularly vulnerable to economic pressure: Employment fluctuates with recession and growth, hence the sector operates as a dynamic network of projects subcontracted to multiple organisations, allowing firms to engage specialists on a flexible per-task basis and cope with changing market demands. As a result, construction projects become fragmented into units with a silo mentality — conflicting interests, ambiguous authority, inadequate communication, and reduced teamwork (Manu et al. 2013). This is a very different picture to the empowered, multi-disciplinary, and constantly interacting teams which enable high reliability organisations to build up a complete risk picture (Weick and Sutcliffe 2007).

This transient structure impacts both workers' loyalty to the client and management's commitment to workers' professional development. While resilient organisations see the value of investing in training and drills to develop a wide range of employee experience and shared knowledge within the system, this long-term outlook is not prioritised for temporary workers on construction projects. Furthermore, the unique design of projects prevents knowledge transfer between projects and the specialised nature of the construction trades prevents multi-skilling, therefore limiting workers' awareness of risks outside their own role.

Well-resourced

Another feature of safety-critical environments which contributes to their resilience is that safety is prioritised and therefore invested in. The ability to respond to unexpected events without sacrificing performance relies on building up resources, both in terms of knowledge and physical assets. These can take the form of preparations, procedures, and competence to manage known threats, or a contingency of uncommitted resources —"pockets of resilience" (Weick and Sutcliffe 2007) — to tackle unknown threats.

Unfortunately, the structure and economic constraints of the construction sector make it difficult to prioritise safety by investing in resources in this way. Although the notion of uncommitted resources is attractive, in a temporary and financially pressured environment it is unlikely. It is known that for safety management to be most effective it needs to be incorporated into the project at the design phase; however, projects are often awarded to the lowest bidder and clients focus on the end service or infrastructure without considering

the implications of how this will be achieved. Production is prioritised over safety; efficient decisions (as opposed to mindful) are encouraged; and in order to cope in this dynamic industry workers are forced to take shortcuts and workaround issues to meet production targets.

Flexible

Ironically, construction workers and projects are adaptable, but their inability to cope with change without it resulting in incidents means they cannot be described as *"resilient"*. OSH is far more difficult to implement in organic organisations — those which respond rapidly to changing market conditions (Burns and Stalker 1961) — than mechanistic because autonomy, independence, and the use of initiative to overcome problems are encouraged (Lingard and Rowlinson 2005). Instead, it is the inflexible timescales and regulations which put pressure on workers to take risks.

Proceduralisation and compliance-based risk management are widespread in construction. Tasks are seen as routine and therefore they can be proceduralised, however each project is unique and so procedures, particularly if they are rigidly adhered to, can have a negative impact on workers' awareness and flexibility: Procedures can create a form of 'tunnel vision' known as Inattentional or Perceptual Blindness and can prime the wrong responses — reducing sensitivity to cues outside their expectations.

The difficulties of managing a dynamic project also means site-wide regulations, such as *"no hard hat no work"*, are implemented in situations where hard hats and other personal protective equipment (PPE) are unnecessary or even a hindrance. Rather than empowering workers to deal with risk, this inflexible approach to work practices shows a lack of sensitivity to operations and breeds cynicism among the workforce. Although this risk averse strategy protects against litigation, conventional approaches to OSH, including highly prescriptive procedures and legislation, limit innovation and professional judgment, hindering people's ability to assess and manage risk appropriately and the development of *"entrepreneurialism … resilience and self-reliance"* (Gill 2007, p. 18) — the types of thinking needed to adapt in response to unexpected events.

Chronically uneasy

Fruhen et al. (2013) categorised the sensitivity and suspicion within managers of HROs as comprising of *"pessimism, propensity to worry, vigilance, requisite imagination and flexible thinking"* (p. 969). Developing a culture of chronic concern about safety issues is a fundamental part of resilience: Maintaining the potential for failure at the forefront of their mind-set fights the complacency and automatic processing which allow errors surface. In contrast, construction is known for its 'macho culture': Physically demanding tasks undertaken in all weather conditions attract a workforce stereotypically seen as young, agile, males with low academic attainment, who therefore lack the vulnerability that motivates

a vigilant and proactive attitude to risk. Their inability to resolve *"distancing through differencing"* (Cook and Woods 2006) — also described as the 'it would never happen to us' attitude — makes it particularly difficult for these workers to learn from the mistakes of colleagues and other organisations.

Imagination is another trait which seems incongruous with construction work. RI (Adamski and Westrum 2003) has been identified as a component of chronic unease: Imagination can support an adaptive approach to safety by enabling those involved to anticipate more potential scenarios and capture the failures that fall outside the expected. It also encourages a questioning attitude and helps to prevent distancing through differencing by allowing workers to imagine themselves in an accident scenario and digest its consequences (Kreiner 2009).

Humanising

Managing risk in a humanising (as opposed to 'dehumanising') way can be subdivided into two aspects: Firstly, an approach to risk management which engages with workers and empowers them, and secondly an approach to investigating accidents which appreciates their complex causes and avoids hasty judgements of workers' incompetence or negligence.

As discussed in 2.4, organisational resilience relies on feedback, enabling the workforce to collectively learn from experience; this requires a just culture to support reporting of accidents. On the other hand, in construction there is a strong tendency towards explaining accidents with a root cause model. Pragmatic behavioural safety programmes have become increasingly popular in spite of their superficial understanding of psychology which promotes a simple 'reward-punishment' paradigm as a means to control unsafe behaviour. Rather than promoting a culture of trust and motivating learning, the unachievable goal of zero accidents breeds scepticism of OSH and reduces reporting for fear of punishment. Innovation and flexibility have also been shown to decrease, and rewarding successes (such as the number of hours since the last accident) worryingly promotes complacency (Long 2012). Similar rigid and centrally-determined targets — which are often skewed towards those which are easier to measure such as behaviour instead of culture, accidents instead of resilience — lack the sensitivity to operations needed to allow workers' the autonomy and responsibility to manage their own risks.

Behavioural safety programmes also demonstrate a superficial understanding of accident aetiology which causes blame to be placed on worker behaviour rather than systemic issues. In contrast, a view of accidents has been proposed from the Adaptive age which opposes a causal pathways altogether and instead sees accidents as an unfortunate and unpredictable combination of trade-off decisions, the consequences of which resonate throughout the system in a way that far exceeds the sum of the errors (Hollnagel 2009). Instead of seeing humans as inherently dangerous, and therefore firing those 'responsible' for accidents, this view challenges this approach and opens up opportunities to discuss and

learn from accidents by avoiding blaming individuals. A humanising approach, which sees people as part of the solution, is critical to managing safety adaptively.

2.4.1 Summary

This review presents a challenge for both construction OSH and the HRO and RE communities. Exploring the two side-by-side, has underlined the disconnect between OSH and systems safety, and the differences between HRO and RE. Further research is needed to understand how construction can reprioritise in order to adopt Adaptive safety approaches, and how HRO and RE can be extended and adapted to suit a network of subcontractors and temporary projects.

Adaptive safety requires management commitment, sensitivity to the frontline, prioritisation of safety, empowerment of workers, and a just culture; thus, it seems impossible to apply in an industry where contracting is ubiquitous, and investment in people is limited by the constrained budget and uniqueness of projects. Moreover, HRO and RE use multi-disciplinary teams to diversify skills and experience, while construction workers are engaged for their highly-specialised skill sets and work in 'silos'. RE relies on experience to inform how an organisation invests in developing resilience — a long-term strategy difficult to implement in a network of TMOs. These contrasts are summarised in Table 2.4.

Table 2.4: Contrasts between Adaptive safety and construction

	Characteristics of the Adaptive age	*Characteristics of Construction*
Structure	Tightly coupled and complex	Loosely coupled
	Empowered, multi-disciplinary teams	Sub-contractors paid per task
	Permanent organisations	Transient projects
	Strong hierarchy of control (HRO only)	Independent, local decision making
Organisation	Able to build in contingency resources	Vulnerable to economic pressure
	Safety is prioritised	Production targets prioritised over safety
	Open to change	Rejects innovation
	A just culture	Low levels of reporting
Accidents	Accidents affect 3rd and 4th party victims	Personal injury accidents
	Media attention	Accidents rarely reported in the news
Individuals	Sensitive to failure	Low risk perception
	Employees understand the 'big picture'	Workers work independently in silos

2.5 Research agenda

For construction to embrace Adaptive safety, in light of this evaluation the following areas of research show the most promise and should be made the focus of further research in both construction safety and the Adaptive age of safety.

This review has brought to light new ways accidents in the construction industry could be reframed to change the way they are approached. Hollnagel's (2009) theory of accidents as a result of drifting performance and functional resonance offers an alternative to the 'root cause' model which contributes to the culture of blame surrounding accidents. Models of drift could be well suited to temporary and dynamic construction organisations (Kreiner 1996) and need further investigation in this context.

Many of the challenges discussed have their roots in the fragmented and financially-constrained nature of construction, rather than its workers. In reality, construction workers are adaptable, demonstrated by their ability to work around problems, but at present the pressures on this sector channel workers' *"spontaneous resilience"* towards productivity rather than safety. A worker-centred, bottom-up approach to cultivating resilience by developing RI and chronic unease could help to increase vigilance and promote proactivity in the face of risk. Understanding these mechanisms — which have been proposed as antecedents to a resilient response to risk — presents a valuable opportunity to improve safety in construction. Chapter 5 investigates the role of leadership as part of this mechanism.

Finally, understanding the 'big picture'; focussing on responding to the present; and investing in maintaining everyday performance also provide areas where construction could incorporate Adaptive safety, but are hindered by the nature of the industry. However, there are examples of high-profile construction megaprojects where systems integration has been successful (Davies 2017, Bolt, Haslam, Gibb and Waterson 2012): These temporary yet well integrated megaproject organisations could provide a starting point for implementing Adaptive safety. This is the subject of Chapters 7 and 8.

Table 2.5 summarises the principles of the Adaptive age which offer the greatest opportunities for improving safety in construction, providing the barriers can be overcome. The novel approach to risk management and the worker-centred aspects of resilience show the most potential.

Table 2.5: Opportunities for construction from Adaptive safety

Approach	*Origin*	*Opportunity for construction*
Risk management	RE	Understand that failures emerge from performance adaptations to cope under pressure to reduce the propensity for blame
	RE	Focus on everyday performance to strengthen the system against accidents and reduce the propensity for blame
	HRO	Focus on the present when responding to the unexpected to reduce the requirement for long-term plans and learning from experience
Worker-centred	HRO	Enhance workers' understanding of the 'big picture' to build relationships between subcontractors and prevent silo working
	HRO and RE	Encourage adaptability among the workforce to support a resilient response
	HRO and RE	Develop a culture of chronic unease among workers to lower their tolerance to risk
	HRO and RE	Avoid simplifying unexpected events to maintain a vigilant and sceptical attitude
Organisational	RE	Cultivate resilience in a way that is appropriate to the unique context of each organisation

2.6 Conclusion

The disparities between construction OSH and the and Adaptive safety have been explored: The unique design of projects prevents the development of transferable experience; the project-based nature and transient workforce prevent continuous learning; temporary employment limits investment in diversifying workers' skills and experience; financial constraints do not allow for contingencies; rigid procedures hinder initiative and flexibility; the macho culture fights feelings of vulnerability; and a pragmatic approach to finding the 'root cause' of accidents has created a culture of blame and intolerance.

Applying principles advocated by the Adaptive age such as management commitment, sensitivity to the frontline, prioritisation of safety, empowerment of workers, and a just culture presents a significant challenge. Instead, it is proposed that construction could become more resilient by incorporating worker-level — as opposed organisation-level — aspects of the Adaptive age of safety. For this, further research is needed to understand how the social factors believed to underpin a resilient response to risk (chronic unease and imagination) can be developed. In response to this, leadership and how it is changing along with the changing landscape of safety is considered in Chapter 3.

Safety Leadership in Construction

3

Contents

3.1 Introduction

Chapter 2 highlighted the potential opportunity to apply Adaptive safety in construction through its individual or worker-centred aspects. Resilience is an emergent property of relationships and interactions between people and technology, not something which can be imposed from outside. Therefore, the role these actors play in constructing a resilient organisation is key to understanding how it can be adopted in a new context. As such, a focus on leadership was pursued because it is believed to have a significant effect on shaping the safety culture of an organisation (Zohar 2010, Clarke 2013, Lekka, Healey and Hill 2012) — although the ability to measure both culture and leadership are disputed.

Leadership paradigms have evolved over the past century from focussing on the draw of powerful characters towards leaders as facilitators; empathising, inspiring, and supporting followers to achieve organisational goals (Rowe and Guerrero 2018) — in this case the ability to withstand and respond to adverse events. This trend has also seen a movement towards leadership as plural, rather than limited to those in positions of authority, and hence an interest in how leaders can empower their followers to lead themselves (Huczynski and Buchanan 2007). Adaptive leadership (Northouse 2017) and Adaptive safety have emerged concurrently in their respective fields: Both are based on a contingency (rather than scientific) approach to management, and both aim to empower the workforce — either to manage risk or for a general purpose. Researching how the influence of leaders can foster

organisational resilience has the potential to further our understanding of this concept; how it can be translated to other contexts; and how it could benefit construction safety.

This chapter reviews the literature on leadership and safety, exploring how Adaptive leadership and safety leadership have evolved. In particular, the review focusses on 'Safety Intelligence' — a recently proposed framework for senior management in air traffic management (ATM) — and compares this with construction. A model of Adaptive safety leadership is proposed which is then evaluated against construction managers' experience of safety leadership in Chapte 5.

This work has been published as a conference paper (Harvey, Waterson and Dainty 2015) which was presented at the conference of the Association of Researchers in Construction Management (ARCOM) in Lincoln.

3.2 Leadership and safety culture

Supervisory practices have been shown to predict safety initiative and compliance (Simard and Marchand 1997 cited in Lingard and Rowlinson 2005) and high quality working relationships influence construction workers' performance: Encouraging positive emotions, job-embeddedness, voicing concerns, and participation (Chih, Kiazad, Cheng, Lajom and Restubog 2017). Leadership has also been well-established as a defining influence in organisational culture (Zohar 2010). A systematic review of 62 articles found a *"consistently positive association held between culture and outcomes across multiple studies, settings and countries"* (Braithwaite, Herkes, Ludlow, Testa and Lamprell 2017). Unfortunately, leaders' influence is not always a positive one: Lack of commitment to safety has been implicated as a cause in the investigation of several major accidents including the Deepwater Horizon oil spill, the Texas City Refinery explosion, and the sinking of the Herald of Free Enterprise (Fruhen, Mearns, Flin and Kirwan 2014*b*).

Workers' engagement with leaders shapes safety culture (Kines, Andersen, Spangenberg, Mikkelsen, Dyreborg and Zohar 2010, Conchie, Moon and Duncan 2013); their authority reinforces the social-learning process that takes place within exchanges, allowing members to recognise the values and behaviours that form the culture endorsed by the organisation. Cultivating workers' intrinsic motivation for safe behaviour is an appealing prospect, and the concept of safety culture has been utilised by many safety programmes such as 'Hearts and Minds' (Hudson et al. 2000), DuPont's 'STOP', ProAct Safety's 'Lean Behaviour-Based Safety', and Geller's 'Total Safety Culture' (Guldenmund 2010). Specifically in construction there has been a proliferation of behaviour-based 'Zero Accident Vision' (Zwetsloot, Leka and Kines 2017) programmes such as Crossrail's 'Target Zero' (Crossrail 2018) BAM[1]'s 'Beyond Zero' and Laing O'Rourke's 'Mission Zero' (see Chapter 7).

[1] Royal BAM Group

Programmes like these have deprived safety culture of its intangible and implicit nature and instead attempt to engineer a culture through behavioural and visible characteristics — tackling the outer *"layers"* of Rituals (such as processes, dress-codes, and slogans), Symbols and Heroes, rather than the beliefs which underpin them (Guldenmund 2010). Disillusionment with safety culture is growing (Guldenmund 2010). Rather than adopt ethnographic approaches traditionally used in anthropology, the majority of research into safety culture takes a functionalist approach, where culture is seen as a causal attitude and a variable subject to manipulation (Sileby 2009).

Given this backdrop, safety culture has been criticised for taking a Tayloristic view of safety. Attempts to change safety culture through propaganda to capture the 'Hearts and Minds' of the workers implies some form of moral deficiency or a lack of effort and is incompatible with the Adaptive age view that humans are an asset to systems because their abilities create resilience (Borys et al. 2009). Safety culture is a relative concept (Zhang, Pirzadeh, Lingard and Nevin 2018): Research has shown it is perceived in different ways at senior, middle and team levels (O'Dea and Flin 2001); young and older workers (Idrees, Hafeez and Kim 2017); and influenced by the norms of social groups over organisational identities (Choi, Ahn, Asce, Lee and Asce 2017).

There is a lack of research on how to worker engagement with leaders can support safety in construction (Bell, Powell and Sykes 2015). The following review explores how leadership theory has developed over time and existing models which could underpin Adaptive safety leadership in construction.

3.2.1 Defining leadership

The definition of leadership has changed significantly over the last century: Early research focused on characteristics that attract and influence followers — charisma, masculinity, intelligence, wisdom. Leadership was seen as an inherited trait possessed by individuals and fixed at birth. Contrary to this, today's definitions see leadership as a socially constructed process within relationships.

> The process of influencing the activities of an organized group in its efforts toward goal-setting and goal achievement.
>
> (Huczynski and Buchanan, 2007, p. 695)

Lekka et al. (2012) and Huczynski and Buchanan (2007) stress three components which characterise this contemporary understanding of leadership: Firstly, leadership is an interpersonal process involving influence; it is set within a social context (for instance, between leaders and followers); and lastly, it must be orientated towards a shared goal.

Leadership as a process

Consequently, contemporary leadership theories view leadership as a holistic process:

> Leadership is a two-way, interactive event between leaders and followers rather than a linear, one-way event in which the leader affects the followers.
>
> (Rowe and Guerrero, 2018, p. 1)

Traditional 'trait-based' leadership theories were challenged by this view: Rather than a characteristic a few *'Great Men'* were gifted at birth, newer theories advocate studying not only the leader as an individual, but their behaviour and that of their followers, transactions between leader and follower, the leader-follower relationship, and its context and purpose (Rowe and Guerrero 2018, Ladkin 2010).

As an emergent characteristic, leadership is therefore available to everyone — not just those born with particular traits — and not just a formally appointed leader (Rowe and Guerrero 2018). Similarly, good leadership is not automatically realised by those assigned a leadership position.

In spite of this, many studies focus only on the traits and characteristics of leaders and not the collective process of leadership as a whole (Pilbeam, Doherty and Denyer 2017). Furthermore, in terms of safety-specific leadership, most research has looked at team leaders and supervisors, yet the health and safety executive (HSE) provides most guidance for senior managers (Pilbeam et al. 2017). To counter these gaps in the literature, this thesis takes a social approach to studying leadership as a contextual phenomenon. This is discussed in detail in Chapter 4.

Leadership as shared

This view of leadership as emergent and accessible to all has been reflected in developing theories. Bennis-Nanus's (1985) model of '21st century leadership' (cited in Huczynski and Buchanan 2007) proposed a move from a few top leaders and many managers to many leaders at every level and fewer managers. This non-hierarchical model saw reduced power distances and increased sharing of information. It also distinguished between leaders and managers: Leaders, as opposed to managers, would be visionary and creative; inspiring, empowering, and anticipating rather than goal-setting, directing and reacting. The emphasis of leadership was as a coach, enabling change rather than managing conflict.

Pilbeam et al. (2017, p. 132) identifies three types of shared leadership: 'Plural' leadership is a collective responsibility; 'co-leaders' have different specialisms; and in 'distributed' leadership followers defer to expertise. Since 2008 there has been an emphasis on everyone's responsibility as a 'safety leader' (BSI in Pilbeam et al. 2017, p. 121), although this term is not well defined. Plural leadership is particularly relevant in networks temporary multiple organisations (TMOs) like construction, especially where the aim is to engage and empower rather than enforce rules and policies.

3.2.2 Leadership theories over time

Over time, the popular theory of leadership has developed from a trait to an ability, skill, pattern of behaviour, relationship, and influence process (Northouse 2017). Northouse's

(2017, p. 5) timeline (Figure 3.1) shows of how leadership research has moved through ages, some of which occurred concurrently. Lighter grey shading shows where interest in these approaches has waned.

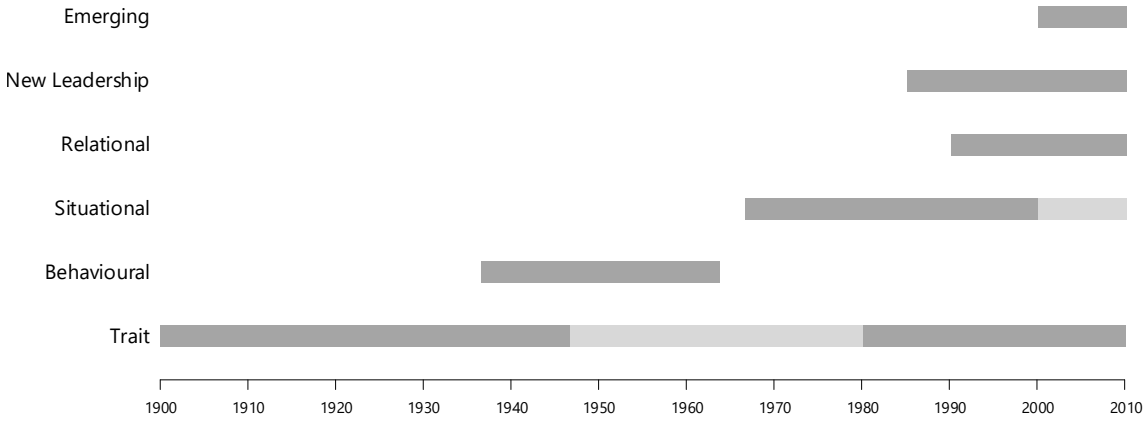


Figure 3.1: Leadership theories through history (Northouse 2017, p. 5)

Traits-based leadership

Prior to leadership research, 'Great Man Theory' provided an explanation as to why some individuals gathered followers more easily than others. This historical perspective argued leadership was innate, hence these leaders would become powerful regardless of social, historical, or organisational context (Huczynski and Buchanan 2007). In the early 20th century many attempts were made to define the characteristics of a leader or 'Great Man'; for example, Stogdill's (1948) survey of the literature on personal factors associated with leadership identified intelligence, alertness, insight, responsibility, initiative, persistence, self-confidence, and sociability.

Although typically regarded as an historical approach, a trait theory of leadership is still significant today. In the 1980s interest in psychometrics caused a resurgence of trait-based approaches: Of the 'big five' personality factors, extroversion, conscientiousness, openness are associated with effective leadership, agreeableness is weakly correlated, and neuroticism has a negative association (Judge, Bono, Ilies and Gerhardt 2002). A definitive list of traits has never been developed (Lekka et al. 2012) but the majority of models include intelligence, self-confidence, determination, integrity, and sociability (Rowe and Guerrero 2018).

Interestingly, some of the traits identified by early studies align with emerging models of Adaptive and Authentic leadership: Stogdill (1948, p. 81) identified *'venturesomeness and originality in problem solving'*, *'strong drive'*, and *'initiative in social settings'*. This proactiveness and anticipation are also supported by Steward (1963, cited in Huczynski and Buchanan 2007) alongside a more caring side of leadership — fairness, integrity, dedication, dependability, and co-operation.

The inability to develop a consistent list of leadership characteristics has been a major criticism of trait-based leadership, along with their vague description which limits generalisability. Its models are too reductionist, simplistic, and isolate leadership from its context (Glendon et al. 2006) — hence the move towards context-specific models in later years.

Behavioural leadership

The shift in leadership theory from traits to behaviours in the 1950s aligns with interest in, and the growing popularity of, behaviourism in psychology. Behavioural leadership focused on leaders' actions rather than their characteristics and showed leadership to be a cause-and-effect process (Lekka et al. 2012) but many of these relationships were inconclusive (Northouse 2017) and oversimplified (Huczynski and Buchanan 2007). The importance of consideration, participation, and democracy over an impersonal, autocratic, directive style for effective leadership was recognised.

Early research showed good or 'considerate' leaders focussed on building relationships, communication, and are attentive to followers, rather than task-orientated (Glendon et al. 2006). One example is the work of Rensis Likert (1961, cited in Huczynski and Buchanan 2007) who found supervisors in highly productive sections of an insurance organisation took a less prescriptive approach to supervision, enjoyed responsibility, spent more time focussing on employees not production. Throughout the 1950s and 1960s several continuum were developed from social-sensitivity to production-focussed; autocratic to democratic; and task-orientated to relationship-orientated (Huczynski and Buchanan 2007). One of these was Tannenbaum and Schmidt's 'Continuum of Leadership Behaviour' (1958, cited in Tannenbaum and Schmidt 2008) which places *"Boss-centred"* leadership at one end of the spectrum and *"subordinate-centred"* leadership at the other; between these there is a range of behaviour styles — tells, sells, consults, shares, and delegates.

Later research showed both task and relationship-orientation are important for effective leadership (Northouse 2017). Leaders need both employee-centred behaviours — supportive, trusting, approachable, encouraging participation — and job-centred behaviours — which deal with the practicalities — to balance productivity and workers' satisfaction (Huczynski and Buchanan 2007). Tannenbaum and Schmidt (2008) recognised leadership style depended on factors within the manager themself (their personality, values, and trust in workers); the workforce (their expectations, independence, tolerance of ambiguity); and the situation (the nature of task and team). This inspired the following era of Situational leadership research.

Situational leadership

A 'context-fitting' or 'contingency' theory of leadership was proposed to account for the way leaders adapt their style to suit different situations (Fieldler and Chemers 1974). This theory draws on Vroom's expectancy theory (1964, cited in Huczynski and Buchanan 2007) of motivation — the factors which determine how much effort someone will exert in a task.

Success depends not on particular traits or a behavioural style but on the ability to vary the approach depending on many contextual factors such as the structure of tasks; the leaders' position of power; and the relationships between leaders and followers. For instance, task-orientated leaders (as discussed in the previous section) were shown to be more effective in situations where tasks are highly structured but employee-centred leaders drive innovation and autonomy (Huczynski and Buchanan 2007).

House and Mitchell (1974, cited in Lekka et al. 2012) identified four types of leadership styles which leaders switch between: Supportive, Directive, Participative, Achievement-Orientated. Similarly, Goleman (2000, cited in Rowe and Guerrero 2018) identified six styles of leadership:

- Commanding. Driven and self-control. Goal is compliance.
- Pacesetting. Initiative and drive to achieve. Goal is high-standards.
- Affiliative. Empathy and communication. Goal is harmony.
- Democratic. Collaboration and team building. Goal is consensus.
- Coaching. Empathy and self-awareness. Goal is to develop people.
- Visionary. Self-confidence and change catalyst. Goal is mobilisation.

(Goleman 2000)

Commanding and pacesetting styles have been said to have a negative effect on commitment and flexibility in an organisation. In general, research suggests a considerate, empathetic, collaborative style is more successful: These styles draw on workers' expertise, bring them on-board with decisions, promote acceptance of change, build trust, and inspire creativity (Huczynski and Buchanan 2007). However, leadership style also depends contextual factors such as the nature of the task and the followers' preference; for instance, an authoritative style is needed when time is short, when the leader is most knowledgeable, and when those who participate will never agree — this may explain why such a style is preferred in construction.

Situational leadership has criticised for being too complex to provide a general, practical guideline for managers — it would be impossible to optimise these factors for every situation (Rowe and Guerrero 2018). The theory has not been tested in safety-critical contexts (Glendon et al. 2006), does not include leaders' technical competences; does not account for the impact of changeable style on trust in leader-follower relationships; and does not account for followers' needs — or *"psychological readiness"* (Hersey and Blanchard 1988, cited in Huczynski and Buchanan 2007), only leaders' goals. In spite of this, the situational model showed the importance of leaders' Adaptive Capacity, which enables them to perform in different contexts.

Relational leadership

A relational approach, also known as the 'power' or 'influence' approach, was introduced in the 1990s (Lekka et al. 2012). This type of leadership research aligned with the increasing popularity of modelling human behaviour in cognitive psychology and sociology. Rational choice theory (RCT) studied how humans optimise decisions by weighing the risks and benefits of relevant factors — a model which was also applied to the relationship between leaders and followers. One of the most notable theories from this period is the leader-member exchange (LMX) theory (Graen and Uhl-Biel 1995, cited in Huczynski and Buchanan 2007): According to this model, effective leadership is based on high quality social exchanges between leaders and followers (Rowe and Guerrero 2018).

LMX was the first theory to focus on the leader-follower relationships rather than seeing the leaders, followers, and situations as separate entities (Northouse 2017). Trust, respect, sense of obligation are key aspects of an effective LMX relationships, but the theory has been criticised as it lacked practical guidance on how to create such a relationship and downplayed the importance of situational aspects (Lekka et al. 2012). However, this approach is still relevant and used today (Northouse 2017).

New leadership

New leadership developed from Behavioural and Relational approaches (Lekka et al. 2012). This school focusses on visionary or charismatic leaders, the most well-known theory being 'Transformational Leadership'. Transactional leadership models (like LMX) study the exchanges between leaders and followers and how these motivate employees to perform in exchange for rewards. In contrast, Transformational leaders act as role models — inspiring, challenging, and mentoring employees (Bass 1985, cited in Northouse 2017).

> [Transformational leadership] is concerned with emotions, values, ethics, standards, and long-term goals. It includes assessing followers' motives, satisfying their needs, and treating them as full human beings.
>
> (Northouse, 2017, p. 171)

As well as a commitment to their followers, these leaders are committed to improving the organisation, motivating followers and inspiring them to go beyond contractual obligations and compliance (Burns 1978, cited in Huczynski and Buchanan 2007). This 'Inspirational Motivation' is one of Bass and Avolio's '4I' model of Transformational leadership — the others being *"Idealised influence, individualised consideration … and intellectual stimulation"* (Rowe and Guerrero 2018, p. 260) — describing how leaders act as role models, mentor followers, and stimulate innovation (Bass and Aviolo 1990, cited in Huczynski and Buchanan 2007).

A similar model the New school is Sims and Lorenzi's (1992, quoted in Huczynski and Buchanan 2007, p. 295) 'Superleaders' who *"lead others to lead themselves"*: These leaders

empower workers; stimulate motivation, creativity, and commitment; and develop informal leadership, reducing dependence on formal leaders.

Although this and other contemporary approaches to leadership research have moved away from a trait-based model, traits and behaviours are a convenient way to communicate aspects of leadership — providing practical guidance for managers. Alimo-Metcalfe and Alban-Metcalfe's model (2002, cited in Huczynski and Buchanan 2007), identifying 14 traits and behaviours which Transformational leaders exhibit:

> - Leading and developing others: Genuine concern, empowering, accessible, encouraging change.
> - Personal qualities: Transparency, integrity, decisiveness, inspiring, resolving complex problems.
> - Leading the organisation: Networking, achieving, focussing team effort, building shared vision, supporting developmental culture, facilitating change sensitively.
>
> (Alimo-Metcalfe and Alban-Metcalfe 2002)

Transformational leadership has also been described as a sequence of stages; for example, first empower subordinates and encourage innovation; then provide a strong example of morals which promotes trust; create an identity and goals for the organisation; shape the shared values and culture of the organisation; and finally reinforce success (Northouse 2017). Similarly, Kouzes and Posner (2002, cited in Rowe and Guerrero 2018) describe modelling the way, inspiring a shared vision, challenging current process, enabling others to act, and encouraging the hearts of followers.

Transformational leadership has been found by studies to correlate with increased satisfaction, decreased stress (Huczynski and Buchanan 2007), and increased proactivity among workers (Den Hartog and Belschak 2017); however, Lingard and Rowlinson conclude that *"the construction industry presents difficulties for transformational leadership because the prevalence of subcontracting means that value-based individualised relationships are difficult to foster"*(p. 382). Transformational leaderships has also been criticised because its focus on visionary leadership neglects the mundane side of management: Transformational leadership can intrinsically motivate employees but in some contexts workers need to be extrinsically motivated by transactional rewards (Clarke 2013). Visionary leaders can also have a negative influence, disrupting an organisation and confusing its goals (Huczynski and Buchanan 2007). Thus, situational aspects of leadership and leaders technical skills (as well as interpersonal) still need to be considered.

Emerging leadership

In recent years, Emerging theories of leadership have included 'Adaptive' and 'Authentic' leadership. Authentic leadership emphasises the importance of authenticity in leaders (Rowe and Guerrero 2018). The factors which influence trust, and subsequently influence,

in leader-follower relationships have become increasingly significant (Lekka et al. 2012). Workers value transparency, ethics, self-awareness, and *'walking the walk'* in leaders. Trust is built by leaders who value followers input and deliver on their promises (Northouse 2017).

Adaptive leaders *"don't solve the problems, but rather encourage others to do the problem solving and adapt to change"* (Northouse 2017, p. 4). This approach shares similarities with Transformational leadership, Goleman's Visionary and Coaching leadership styles, and even earlier behavioural concepts of social-sensitivity and subordinate-centred leadership. However, Adaptive leadership extends this to incorporate a plural concept of leadership — maximising empowerment. This model aligns with resilience engineering (RE) and Safety II in risk management; however, both these concepts lack research to verify the influence such a leadership styles could have on safety behaviour or organisational resilience.

3.2.3 Safety leadership

Over the past century, both safety and leadership research fields have moved from a technical or trait-based paradigm — in which these concepts are seen as properties — towards a view that these are emergent or socially-constructed dynamic capabilities (Simmons, Clegorne and Woods-Wells 2017). In the same way that Hollnagel described safety as *"something a system does, not something a system has"* (Hollnagel et al. 2006, Hollnagel 2009), contemporary leadership theory suggests leadership is not something leaders have, but something an organisation does. Both fields also now take a holistic approach with greater consideration for context.

Pre-2000, 'leadership' and 'safety management' were considered separate entities; however, since then the term 'Safety Leadership' has been introduced (Pilbeam et al. 2017), recognising their integral relationship and reflecting the growing emphasis on context and social construction in both fields.

> There is widespread agreement between industry, regulators, academics and the press that leadership is a key component of a safe organisation.
>
> (Lekka et al., 2012)

According to Pilbeam et al. (2017), safety leadership is integral to policy change, translation of knowledge from research to operations, and the implementation of informed practice. Safety management system (SMS), policies, and procedures will fail in the absence of leadership or if not embedded in a culture that supports and values safety (Kath, Magley and Marmet 2010); yet in spite of this recognition, the relationship between leadership and safety is not well-understood.

A recent review of the literature (Lekka et al. 2012) found the impact of Transformational leadership for safety has received the most attention, but aside from this the research field has been dominated by leader-centric trait and competence work. There is a

lack literature taking a situational or relational approach — both in construction (Simmons et al. 2017) and elsewhere (Pilbeam et al. 2017).

In terms of a trait-based or behavioural approach to safety leadership, studies have shown the importance of actively and visibly demonstrating a commitment to safety on safety culture (Luria, Zohar and Erev 2008) and consequently safe behaviour (Lekka et al. 2012). Behaviours associated with this are prioritising resources; involvement in occupational safety and health (OSH) activities; encouraging input from workers on safety matters; enforcing safety policies and safety behaviour (Lekka et al. 2012, Luria et al. 2008); and levels safety communication (Flin and Yule 2004). In particular, a participative approach — where supervisors encourage safety discussions and provide positive feedback — has been shown to have a positive effect on safety compliance (Flin and Yule 2004, O'Dea and Flin 2001).

Transformational safety leadership improves safety participation, compliance, and perception of safety climate, safetyrelated events, and injuries (Mullen and Kelloway 2009). Specifically in construction this has also been shown to be true: Conchie and Donald (2009) found safety-specific Transformational leadership was positively associated with safety citizenship behaviours; however, others have stressed the need to combine both Transformational and Transactional aspects of leadership (Lekka et al. 2012, Clarke and Ward 2006). Increasing the frequency of Transactional safety-related interactions between leaders and followers also improved perceptions of safety climate and reduced injury rates (Zohar and Luria 2003). On the other hand, organisations which take an overly controlling approach to management but lack strong leadership *"will stifle creativity and innovation and be very bureaucratic"* (Rowe and Guerrero 2018, p. 5). Balancing a Transformational approach — inspirational vision, modelling the way, and engaging and motivating employees — with more practical aspects of leadership — rational persuasion, goal-setting, and monitoring and rewarding performance — is key (Clarke and Ward 2006, Lekka et al. 2012).

One key finding of Lekka et al.'s (2012) review is the importance of trust as a mediating factor in leader-follower relationships.

> Mutual trust, respect and obligation between leaders and subordinates, is associated with positive safety outcomes, including higher levels of upward safety communication.
>
> (Kath et al., 2010)

The effectiveness of Transformational leadership is affected by trust and quality in relationships (Lekka et al. 2012, Conchie and Donald 2009). Being knowledgeable and likable affects power in relationships — the ability to influence others, which is integral to leadership (Rowe and Guerrero 2018). Interestingly, the openness and quality of these relationships relies on the more Transactional aspects of leadership — consistent behaviour, mutual respect, delegating responsibility (Lekka et al. 2012), two-way communication, prioritising safety (Kath et al. 2010), and valuing input from the frontline (Flin and Yule 2004, O'Dea

and Flin 2001). These basic management behaviours build trust which underpins a success of worker engagement and coaching-orientated approaches of Transformational safety leadership.

Much of the literature on safety leadership focusses on its leadership rather than safety component. Leadership has been extensively researched but there is a lack of work on understanding safety-specific leadership for high-hazard environments. Lekka et al. (2012) argues safety leadership requires not only interpersonal aspects of leadership that allow leaders to motivate and inspire workers, but also technical aspects of identifying and resolving risks.

One reason for this is that while the view of leadership as a fixed trait has been discredited, the notion of safety-consciousness or risk-perception as a trait remains popular (Wang, Zhao, Zhang and Wang 2015). Wang et al. (2015) recognised there are innate, learnt, and situational aspects to construction project managers' risk-propensity, but the relationship between this personal attitude to safety and their effectiveness as safety leaders is not yet known.

As yet, safety leadership lacks an agreed definition and direction (Pilbeam et al. 2017). Its research paradigm is also not clear — straddling safety science and organisational behaviour, both of which use mixed-methods. However, in light of the Adaptive safety movement, increasingly safety (like leadership) is seen as a cultural construct and thus should be studied as an emergent property of organising. This shift has also been seen other organisational sciences such as job and team design (Parker, Van den Broeck and Holman 2017). Like RE, which promises a means to 'engineer' organisational resilience, safety leadership faces similar challenges; how to develop effective safety leadership, both in a traditional sense of motivating compliance or to support organisational resilience, needs further research.

> One seeks not to create the perfect leader, but rather to develop a culture of better teammates and role players who pass off leadership and followership as needed when context shifts, thus creating a team more resilient to adversity of contextual shifts.
>
> (Simmons et al., 2017)

3.3 A framework for safety leadership

Leadership is an important aspect of organisational culture, therefore safety leaders are a powerful tool in influencing safety culture — especially if this can also engineer organisational resilience. Although studies have shown effective leadership can improve safety, safety leadership remains under-theorised. There is a significant body of existing research devoted to understanding interpersonal aspects of influencing, but little on the role of safety-specific traits and behaviours — like chronic unease, problem solving, and risk-perception — or the more managerial, Transactional aspects of leadership.

As well as interpersonal aspects, several models of leadership show leaders need visionary and technical skill. Katz's (1974, cited in Rowe and Guerrero 2018) Three-Skills approach to leadership includes Technical skills (subject matter proficiency), Human (or interpersonal) skills, and conceptual skills (developing and communicating a vision); Mintzburg (1975, cited in Huczynski and Buchanan 2007) saw the role of leaders as Interpersonal (leader, figurehead, liaison), Informational (monitor, disseminator, spokesperson), and Decisional (entrepreneur, disturbance handler, resource allocator, negotiator); and Shaw (1976, cited in Huczynski and Buchanan 2007) found effective leaders had high levels of ability (intelligence, technical knowledge, and verbal facility), sociability (participation, cooperation, and popularity), and motivation (initiative and persistence). With a view to understanding leadership for Adaptive safety, there is a need for a combined model of safety leadership which accounts for this mutlifaceted phenomenon — balancing leadership and management, interpersonal and technical aspects.

Fruhen, Mearns, Flin and Kirwan's (2014*a*) Safety Intelligence model brings these elements together into a combined model of safety leadership based on ATM — an industry which has embraced Adaptive safety. The following part of this chapter compares leadership in one industry which has embraced Adaptive safety (ATM) with construction which manages safety in a traditional way.

Existing studies of safety-related leadership competences in the US, UK, Australian, and Danish construction industries are reviewed in light of the Safety Intelligence model. These studies have explored specific competences including knowledge; communication; leadership style; emotional intelligence; and emotional expression. By comparing these competences with those of Safety Intelligent leaders within the ultra-safe, highly reliable environment of ATM, the differences between the leadership styles required to cope with the differing priorities of the two sectors are highlighted. Understanding how and why leadership differs between these sectors provides an insight into how Adaptive safety can be adapted and incorporated in construction.

3.3.1 Safety Intelligence

Safety Intelligence was first proposed by Kirwan in (2008) as a response to growing disillusionment with safety culture. It provides a *"way of helping top level management understand safety and react appropriately, rather than just giving 'lip service'"* (Kirwan 2008) — focusing on recruiting and equipping leaders with the personal attributes, skills, and knowledge required to positively influence safety in their organizations. It recognises the importance of chief executive officers (CEOs) and directors in shaping culture by influencing members' attitudes to safety and defines the combination of personal attributes, skills, and knowledge required for leaders have a positive influence. Just as leaders with higher intellectual, emotional and managerial intelligence are believed to be more effective (Müller and Turner 2010), Fruhen et al. (2014*a*) propose CEOs with these characteristics are more

Safety Intelligent and therefore better equipped to influence to safety culture in their organisations. Safety Intelligence offers a methodology to equip the top executive level of an organisation with a means to understand and drive safety as part of their business agenda (Eurocontrol 2013*b*).

The proposed Safety Intelligence model has remained undeveloped with the exception of a series of studies of senior managers in ATM (Fruhen et al. 2014*a*): Senior air traffic managers were surveyed through questionnaires and interviews about the ideal characteristics and behaviors of a CEO in relation to safety. The study focused on five characteristics: personality, problem-solving, motivation, safety knowledge and social competence, the latter two of which were found to be most significant and are shown closer to the 'core' in Figure 3.2.

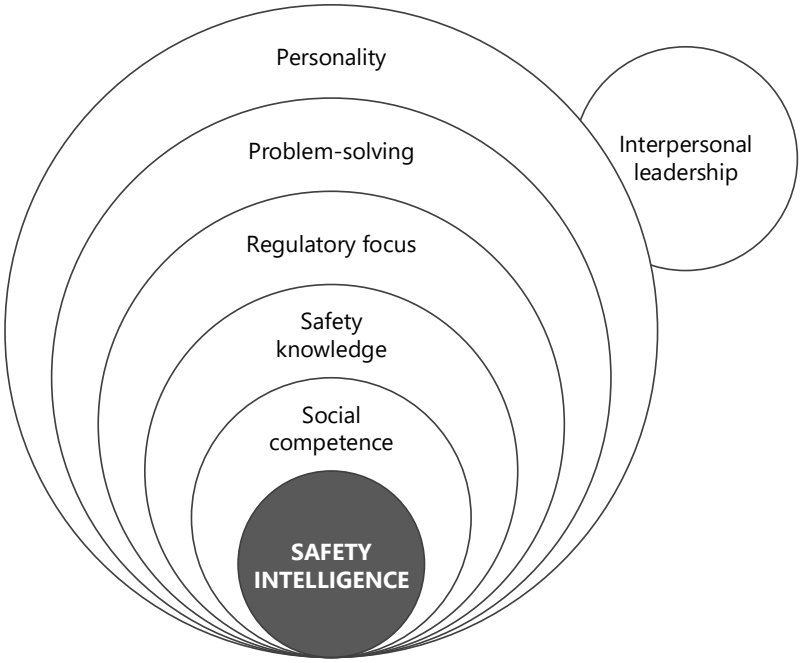


Figure 3.2: Conceptual model of Safety Intelligence (Fruhen et al. 2014*a*)

3.4 Comparing safety leadership between sectors

So far, Safety Intelligence has only been studied in ATM. This sector has very different characteristics to construction: Accidents are tightly-coupled, work is highly-regulated, and its approach to safety is progressive — being one of the first sectors to adopt RE (Eurocontrol 2009, Eurocontrol 2013*a*). The extent to which Safety Intelligence might have purchase within construction's project-based environments, and to which it can account for the multiple temporalities and fragmented delivery structure of this industry, remains unexplored. Opening up the construct and exploring its relevance to managing

complex and hazardous construction projects offers new theoretical directions for occupational safety and health research in the sector. It provides the most pragmatic method to introduce resilience and proactivity to construction.

Construction's pragmatic approach to safety leadership has focused on individual characteristics, indicating that the competency-based model of Safety Intelligence could gain greater acceptance and purchase than *"fuzzy"* cultural methods. Trait-based approaches have declined in popularity but 'person-centred' models which explain individual characteristics or conditions are still valuable (de Winter 2013). While there is not a universal model of a 'Great Man' there are characteristics and behaviours which help people lead more effectively — provided these takes account of the followers' needs, task, and context. Traits and behaviours are also easier to communicate, generalise, and have the potential to provide practical guidance for managers.

A competency-based approach to safety management in construction is not a novel concept. Accordingly, the author's search identified 18 studies from the construction industry which take a similar competency-based approach to influencing safety, although each focusing on a specific safety-related managerial competence — including knowledge; communication; leadership style; emotional intelligence; and emotional expression. However, a study by (Zou and Sunindijo 2013) used questionnaires and interviews to identify and rank safety-related competences and build a framework for construction similar to Safety Intelligence. Using this as a starting point, this paper discusses these studies in light of the Safety Intelligence model in order to open up the opportunities it offers and uncover the differences between these sectors. Zou and Sunindijo's (2013) and Fruhen et al.'s (2014*a*) models are presented in Table 3.1.

Table 3.1: Comparison of competences for influencing safety based on Zou and Sunindijo (2013) and Fruhen et al. (2014*a*)

	Competences for positively influencing safety in construction	*Safety Intelligence for ATM*
Highest priority	Self-awareness, Visioning, Sincerity	Social competence
	Scoping and Integration, Self-management	Safety knowledge
		Regulatory focus
	Relationship management, Social awareness, Social astuteness	Problem-solving
Lowest priority	Safety management tasks	Personality

3.4.1 Safety leadership competences in construction

Zou and Sunindijo (2013) describe four tiers of skills for construction supervisors: Their most significant priority or first tier competences are self-awareness, visioning, and sincerity, followed by scoping and integration and self-management; then relationship management, social awareness, and social astuteness; and finally safety management tasks. Parallels can be drawn between this model and that of Safety Intelligence; both list social, problem-solving and technical skills as important, although the definition and prioritisation of these skills differ. The differences between safety-management in construction and safety-critical sectors can be explained by exploring these in greater depth.

Safety knowledge

Behavioral competences without technical skill or knowledge are futile. Many studies have shown knowledge to be integral to authentic and committed leadership (Zou and Sunindijo 2013, Fruhen et al. 2014*a*). Hardison, Behm, Hallowell and Fonooni (2014) explored knowledge-based competences for construction supervisors with respect to safety, and found that *"knowledge of pre-job planning, organising work flow, establishing effective communication, and of routine and non-routine work tasks are highly important"* (p. 45). This suggests that safety knowledge, from the perspective of construction, is the technical understanding of business processes relating to safety.

In contrast, the Safety Intelligence model puts a greater emphasis on safety knowledge than Zou and Sunindijo, perhaps because its scope is considered to be broader than technical knowledge. Eurocontrol (2013*b*) advocates Safety Intelligent managers having a clear *"risk picture"* of the threats to their organisation and an understanding of how safety works. In accordance with Weick and Sutcliffe's (2007) concept of 'Organisational Mindfulness', Safety Intelligent managers are encouraged to respond to weak signals of failure, develop a 'Just Culture' (Reason 1997, Dekker 2007) where reporting is encouraged, and be sensitive to the human factors that are affecting operations. However, high reliability organising (HRO) has not yet been integrated into construction health and safety (Olde Scholtenhuis and Doree 2013).

A specific understanding of both safety processes within the organisation itself and *"how safety works"* (Eurocontrol 2013*b*, p. 8) in general is necessary for Safety Intelligence; thus, construction is hindered by its focus on technical aspects of safety which prevents new paradigms about how safety works, such as HRO and RE, taking hold.

Problem solving

Problem solving was ranked as the fourth priority (Fruhen et al. 2014*a*) by ATM CEOs — after interpersonal skill, technical knowledge, and motivation — and is vital for understanding problems and generating solutions (Eurocontrol 2013*b*). In construction, conceptual or problem solving skill is seen as a higher priority: The project-based, dynamic nature

of the construction industry, with its temporary workforce and extensive variety, presents challenges for safety management particularly in terms of coordinating subcontractors and keeping up with the pace of change (Biggs and Biggs 2013).

Construction is formed of TMOs *"where parts of several organisations — each with its own affiliations, its own goals and its own values — are all involved in the achievement of a plan or of an end-result"* (Stringer 1967, p. 106). Learning is limited by the uniqueness of outputs and the transient nature, so managing these projects requires conceptual skill to view these complex projects from a *"big picture perspective"* (Zou and Sunindijo 2013, p. 9). Visioning, Scoping and Integration were seen as fundamental to understand the dynamic relationships between stakeholders and components; ensure these are integrated as a whole; and influence safety (Zou and Sunindijo 2013).

In their study entitled *"Preparing project managers to deal with complexity"* Thomas and Mengel (2008) suggest training for this context requires a greater emphasis on continuous change; creative and critical reflection; self-organised networking; and coping with uncertainty. Similarly, Müller and Turner (2010) showed that construction project managers need greater propensity for Strategic Perspective and Developing.

In both ATM and construction, problem solving as a generic competence is important. However, in construction problem solving is considered more important than social skills as its dynamic, fragmented nature is a major barrier to implementing and influencing safety. The characteristics and pressures of the two sectors are very different, so the problem-solving approaches of the two types of managers are likely to be very different in reality.

Social competence

Social competence is key in influencing workers' behaviour, as leaders' commitment to safety is demonstrated by their interactions with others. Almost every study reviewed agreed that interpersonal skills are essential for successful leadership — both in construction and other sectors, and in safety or general management. The necessary competencies can be divided into Communication, Emotional Intelligence, and Leadership Style.

Communication

'Soft' skills of communication and consultation are often seen as incongruous with the uncompromising, methodical people needed to undertake complex construction projects (Aulich 2013). However, the need to strengthen health and safety coordinators' competence in communication and negotiation was highlighted by Antonio, Isabel, Gabriel and Angel (2013) and an intervention to train foremen in communication-based competences (such as mentoring and *"toolbox talks"*) increased safety behaviours on residential construction sites (Kaskutas, Dale, Lipscomb and Evanoff 2013). Similarly, Kines et al. (2010) found a significant, positive and lasting effect on safety levels though providing feedback and coaching to site foremen in daily verbal safety communication.

Communication needs to be systematic, understood by all stakeholders, and intelligently applied: A communication strategy must be designed with a thorough understanding of the principles of social dynamics in joint undertakings and cognitive learning theory (Aulich 2013). Sharing tacit knowledge within an integrated project team also builds connections between team members, leading to improved dynamic capabilities and ultimately, greater team flexibility (Zhang, He and Zhou 2013).

While some research demonstrates that initiatives directed at managers can be more effective (Zohar and Luria 2003), in construction the role of frontline supervisors has been shown to be more influential than that of senior managers (Lingard, Cooke and Blismas 2012) and safety competence at all levels of the hierarchy — workers, foremen, and managers — is equally important, because communication between these levels is critical (Hardison et al. 2014). As Safety Intelligence focusses only on senior management, this suggests its methods may not be as influential in construction.

Leadership style

Interviews with 41 construction safety leaders identified leadership as a key factor for positive safety culture in the organisation, with an emphasis on leaders' visibility and their demonstration of a commitment to safety (Biggs, Banks, Davey and Freeman 2013). This is supported by the findings of a study into the relationship between project managers' leadership style, teamwork, and project success (Yang, Huang and Wu 2011). The results show increased leadership communication and involvement can enhance relationships, fostering teamwork, which is significantly correlated with performance.

Emotional intelligence (EQ) is associated with many characteristics thought to underpin effective leadership: Improved self-awareness helps to develop effective relationships and understand others' emotions, thus enabling interpersonal skills such as communication, motivating others, resolving conflicts, and building teamwork (Sunindijo 2013). Specifically, Zhang and Fan (2013) found a strong positive correlation between six EQ factors (emotional self-awareness, emotional self-control, empathy, organisational awareness, cultural understanding and communication) and construction project performance.

Although EQ and a Transformational leadership style (Ramchunder and Martins 2014) were found to be significant in leaders from all sectors, the traits of managers in construction do not match those found in other industries. Power, urgency, proximity, competitive threat, opposing position and neutral attitude are shown by the most influential construction stakeholders (Yang, Wang and Jin 2014). Lindebaum and Fielden (2010) show how construction project managers quickly resort to anger in order to resolve issues, and felt this was necessary to raise their visibility, achieve the desired outcomes, and maintain their image and reputation because the trait is seen as *"role-defining"* for managers in the industry.

The need to assert authority reflects the other pressures on construction managers including organisational culture, turnover, job pressures, working relationships, budget and

safety communication which dictate safety performance (Kaskutas et al. 2013). Conchie et al. (2013) found that managers' engagement in safety leadership was hindered by workforce characteristics; role overload; production demands; and formal procedures.

Although managers in both sectors need to communicate strong messages, Safety Intelligent managers do this through engaging with others and listening (Fruhen et al. 2014*a*). The way in which social competence is enacted in these two sectors is very different, and Zou and Sunindijo (2013) rate this as a lower of a priority in construction.

Table 3.2: Comparing Safety Intelligence in ATM and construction

Air Traffic Management	
Leadership priorities	*Interpretation*
1. Social competence	Communication from management Just Culture Empower and collaborate Engage with employees and and listen
2. Safety knowledge	An understanding of contemporary and emerging safety constructs as well as technical processes
3. Problem-solving	To understand problems and generate solutions
Construction	
Leadership priorities	*Interpretation*
1. Problem-solving	Essential to cope with the fragmented and dynamic industry Emphasis is on a strategic perspective
2. Social competence	Communication at all levels to build integrated and flexible teams Power, Urgency and Anger are traits of good leaders Self-awareness and Sincerity Emotional intelligence supports effective management
3. Safety knowledge	A technical understanding of business processes relating to safety

3.5 Discussion

This literature review has highlighted the differences between these industries which limit the transferability of Safety Intelligence. As a TMO, it is more difficult for managers of complex construction projects to understand these fragmented and transient organisations. Problem-solving must take place between multiple contractors and stakeholders and reaching solutions is prioritised over their tactful delivery through developed interpersonal skills.

The dynamic nature of construction and production pressures also means leaders are required to deal with conflict in an assertive way, rather than collaborate as seen in Safety Intelligent leaders.

Despite the superficial similarities observed between the generic behavioural competences in ATM and construction, the *"job-task"* competences are highly industry specific (Cheng, Dainty and Moore 2005). To influence safety, the papers reviewed show construction supervisors need to be more assertive and astute in their relationships, cope with constant change, and grasp a more complex operational picture than air traffic managers.

In light of the differences between these two sectors, it is apparent that the ATM Safety Intelligence model would need to be adapted to construction before informing the selection and training of construction supervisors. However, whether the differences in leadership style are due to weaknesses in managers' competency-development, or the challenging environment in which they work, would need to be determined. Although the Safety Intelligence model provides an overview of management competences in an ultra-safe industry, a causal link between these competences and safe operations has not been explored. Validation is needed; in particular, testing a causal link between Safety Intelligence and safety in a more complex environment such as construction.

Risk is often accepted as an inherent part of construction work (Swuste et al. 2012) but the safe build of the Olympic Park challenged this, demonstrating that it is possible for construction to be a *"highly-reliable"* organisation. This unique success was underpinned by a culture of *"respect, trust, clarity, pre-emption, challenge, consistency, collaboration, motivation, empowerment, communication, openness, fairness and assurance"* (Bolt et al. 2012) — characteristics which are more consistent with Adaptive industries like ATM than construction.

3.5.1 Adaptive safety leadership for construction

Safety Intelligent leaders promote a just culture, empowerment and collaboration with members, proactivity, and communication; however, the challenges of implementing these in construction highlight where this model needs to be adapted. Taking account of this review, a model of Adaptive safety leadership for construction must account for leadership as distributed throughout an organisation, and its existence as a social construct within leader-follower relationships rather than the personality of leaders. It is also a multifaceted phenomenon — with visionary, technical and social components — and needs to be adapted to contexts and followers' needs. With this in mind, six components of Adaptive safety leadership are proposed:

- Vision and commitment. Prioritising safety, remaining vigilant, and being prepared to respond to the unexpected.

- Safety knowledge. As well as construction-specific processes, leaders should also have an awareness of events and aspects of the wider organisation which could impact on safety.
- Social competence. Empathy and mutual respect help to build high quality leader-follower relationships. Leaders should be open and approachable, and encourage change through coaching — explaining, supporting, and rewarding positive actions.
- Authority. Although studies suggest urgency and anger and key to influence in construction, knowledge and respect are important for effective leadership.
- Trusting and empowering others. This is an important difference between resilient organisations, where leadership is plural, and traditional management hierarchies. Trust mediates relationships and encourages proactivity and innovation.
- Collaborative problem solving. Engaging with workers, deferring to their expertise, and involving them in solutions which they own.

3.6 Conclusion

Safety Intelligent leadership poses a challenge for construction: Although the leadership style necessary to influence safety may be enacted differently in different sectors, the underlying principles of Safety Intelligent leadership — promoting a just culture, empowerment and collaboration with members, proactivity, and communication — have all been shown to contribute to the success of megaprojects. In spite of this, similar studies in construction have found site (or offshore installation) managers take a directive leadership style despite recognising the importance of participatory leadership practices — developing openness and trust, proactivity, and encouraging workforce involvement in decision-making (O'Dea and Flin 2001). This mismatch between perceived best practice and actual behaviour is not well understood.

Chapter 5 builds on the framework proposed in this chapter, exploring safety leadership and how it is enacted in construction. Chapter 6 then applies systems thinking to understand the mismatch in styles — why construction leaders prioritise problem-solving and authority over Adaptive safety leadership characteristics. Resolving this disparity could help to overcome the challenges to implementing Adaptive safety more widely.

Methodology

4

Contents

4.1 Introduction

The mechanisms of Adaptive safety are not well understood; however, Chapter 2 highlighted the value of researching how an organisation's potential to anticipate, monitor, respond, and learn is cultivated from the workforce upwards. If these resilience potentials are theorised as social constructs, they are best researched through social methods.

This chapter justifies the choice of qualitative methods in this research. Explaining how interpersonal skills, leadership, and culture contribute to Adaptive safety is key to unpacking this concept. An improved understanding the of role these constructs play is needed to guide other organisations wanting to grow their adaptive capacity — including construction.

To fulfil the research aim stated in Section 1.5 — *"To understand the factors which facilitate and hinder an Adaptive response"* — data collection was divided into two phases — an interview study followed by a case study. The interview study of safety leadership in construction explored which aspects could, or already do, align with Adaptive safety, and the barriers that prevent its adoption. Interview data were analysed by thematic, content, and soft systems methods to address the following research objectives:

1. Explore the role of safety leadership (Chapter 5)
2. Understand the challenges of construction as a system (Chapter 6)

The case study then used multiple methods (interviews, focus groups, document analysis, and observations) to evaluate Adaptive safety in practice within infrastructure megaprojects. This addressed the objective to:

3. Observe Safety Differently in practice in construction (Chapter 7 and 8)

In this chapter the research paradigm is discussed as well as the chosen methods of data collection and analysis; measures to ensure validity; and ethical considerations. The suitability of these methods to meet the stated aims is justified with reference to the theoretical perspectives and methodologies of the many disciplines this research intersects — risk management, culture, organisational sciences, human behaviour.

The following sections describe the differing research philosophies in the study of safety and risk through the lens of construction (as the context of this work) and Sociology, Psychology, and Ergonomics. The research design and qualitative methods are then proposed.

4.2 A social approach to risk research

In the age of enlightenment, scientific practice aimed to find the *"real nature of things"*(Bilton, Bonnett, Jones, Lawson, Skinner, Stanworth and Webster 2002, p. 414) by making abstract concepts visible and measurable (operationalisation). This rationalist approach is the foundation of positivism and natural science. Positivism says society and culture exist external to its members, and therefore the best means of study is as an objective observer.

With a positivist view of reality — *"that reality is external to self and can be observed using tools that produce information that can be understood and interpreted by others"* (Given 2008, p. 519) — society is seen as a system of interconnected parts that influence one another in functional and dysfunctional ways. This view emphasises how social problems are affected at an institutional level (Mooney, Knox and Schacht 2017). Positivism in sociology is now considered a classical tradition; however, there are many similarities between its holistic approach and that of systems ergonomics. For example the influence of ecological processes; describing society in mechanistic terms — inputs, outputs, and feedback loops — much like the systems theory. Similarly, sociologist Robert Merton described the functions of society as manifest (intended) or latent (unintentional) (Merton 1968) like Reason's Latent and Active Errors in complex systems.

Many social phenomena — such as aspiration, comfort, belonging, or morality — could not be operationalised or understood through rationalism or positivism (Bilton et al. 2002). After the 1970s, opposing the rationalism of Modernity, the Postmodern era disputed the existence of concrete concepts and instead promoted relativism (Rosenau 1992). Relativism says there is no neutral standpoint from which to view the world: All knowledge is constructed and mediated by language and culture (Rorty in Knight and Turnbull 2008).

With a relativist world view the guiding paradigm of research is interpretivism; the assumption *"that social phenomena are constructed or co-constructed by self and can be discovered by collecting and analysing conversations and texts"* (Given 2008, p. 519). Social

phenomena only exist as a result of social interaction and are best understood through empathy with actors and the gathering of qualitative data. According to this perspective social constructs can only be understood by studying definitions and meanings of communication or symbols (Given 2008).

The following sections discuss construction as a research domain and context for this work, and compares this with the fields within safety science that have contributed to the Adaptive safety movement: Psychology as the foundation of both 'traditional' safety and high reliability organising (HRO), and Systems Thinking and Ergonomics as the basis of resilience engineering (RE).

4.3 Ontology of risk and safety

Many phenomena, including risk, have both a rational and an relative component — experienced individually and in common with other people (Creswell 2007) — so a pluralist approach to methodology is key. Drawing on both these philosophies provides depth in the study of systems and safety culture. Safety science includes research from a breadth of fields including *"organisational sociology, semiotics and cultural studies, applied psychology, engineering, safety and risk studies"* (Pidgeon 1998, p. 97). This variety of approaches can be attributed to the disputed ontology of risk.

> Pathogens and injuries have a reality beyond individuals' beliefs, hopes and perceptions.
>
> (Williams 2003 in Clark, MacIntyre and Cruickshank, 2007, p. 519)

Risk is often used synonymously with other terms for unwanted events such as threat, hazard, loss, or damage (Zinn 2008). The health and safety executive (HSE) defines risk as *"a measure of the probability for an incident to happen and of the potential severity of the consequences"* (BSI 2018). This definition underlines the dominant objective, rationalist paradigm adopted by the majority of research in safety.

In contemporary risk management practice there is both a qualitative and quantitative dimension — probabilistic models of human reliability analysis (HRA) such as fault trees, HEART [1], and THERP[2](Kirwan 1994) — and deterministic models such as HAZOP[3] and HAZAN[4](Kletz 2001). Recognition of the social component of safety has grown in recent years as concepts of the social amplification of risk (SARF)(Kasperson et al. 1988), Safety Culture (Reason 1997), and safety leadership (Pilbeam et al. 2017) have been introduced, but these are often studied with a positivist lens (Guldenmund 2010). Zinn (2008) and

[1]Human error assessment and reduction technique
[2]Technique for human error rate prediction
[3]Hazard and operability study
[4]Hazard Analysis

Turner and Gray (2009) criticise current approaches to risk research which neglect socio-cultural and socio-structural aspects of risk, instead focussing overly on perception and propensity.

> Social scientific perspectives on occupational safety largely characterize it as a disembodied, tangible, and easily quantifiable phenomenon. Recent research efforts have focused on exploring organizational conditions that predict occupational safety outcomes, resulting in top-down, often de-contextualized prescriptions about how to control safety in the workplace.
>
> (Turner and Gray, 2009, p. 1259)

As a scientific discipline, much of Safety Science takes a positivist approach. Contrary to this, Haavik (2014) argues normal accident theory (NAT), HRO, and RE are all based on a constructivist ontology but the way these theories have been operationalised ignores this relational aspect and its philosophical underpinnings: He warns of the danger *"when key concepts of the approaches are decontextualised, black-boxed and adopted uncritically in a new context"* (Haavik 2014, p. 37). Beck (1992) on the other hand argues risks can be both real and socially constructed. They can be calculated formally, as a probability, or as part of everyday life in an *"intuitive"* or *"pre-rational"* way (Zinn 2008). This means, epistemologically, risk can be studied from the perspective of both realism and constructivism (Zinn 2008).

The resultant dichotomy is best defined by Hale and Borys (2013) who proposed two models of rules in occupational safety and health (OSH): A classical view of rules as rigid externally imposed limits to be complied with (rational), and another as flexible social constructions which draw on workers' expertise and allow them to respond to reality (relative). These two models work to different extents in different tasks (Gibb, Finneran, Cheyne, Dainty, Glover, Morgan, Fray, Waterson, Bust, Haslam, Hartley and Pink 2016) and different sectors depending on their degree of uncertainty (Grote 2012). This view of safety as simultaneously relative and rational means it must be studied accordingly. Further research is needed to understand rules in context — through the interpretations and values of those who enact them (Walliman 2011).

While in much social research there has been a shift towards postmodernism, Dekker (2018) describes the current state of safety as *"Authoritarian High Modernity"* — characterised by unfaltering confidence in scientific methods to better the human condition (Scott 1999).

Rationalism is, according to Weber (quoted in Zinn 2008), the belief that *"One can, in principle, master all things by calculation"*. In line with this, in pursuit of risk reduction many people are drawn to the power and prestige of numbers: The expectation in many high-risk domains is that interventions will be proven by a measurable reduction in injury rates. A calculative approach has invaded many sectors (social work, crime prevention, healthcare) transforming the social world into measurable factors with averages and probabilities (Zinn 2008).

This pseudo-scientific application of numbers in a subjective way (Porter 1995), or *"pseudo-positivism"* (Zinn 2008), has been criticised. A positivist paradigm can only be used to study repeatable, predictable aspects of nature (Walliman 2011). Risk is not one of these. Nascent research in safety is moving away from statistics, realism, and mechanistic models of behaviour and systems to understand risk (Dekker 2018): A scientific approach may work if accidents are linear, predictable, and not complex (Dekker 2018) but contemporary thinking says they are not.

Traditional models of accident causation are being challenged, proposing instead notions of emergence and resonance. Barry Turner described the study of accidents as *"shaking a kaleidoscope"* — unconnected components, but capable of combining in infinite possibilities of diverse outcomes (Pidgeon 1998). Risk cannot be completely understood as a product of nature and culture, but as an unpredictable and emergent property of both. Its intractability and subjectivity mean it needs to be studied as a social phenomena as well as a physical hazard. Similarly, Organisational Resilience (though not well understood) seems to emerge from systems in an irrational way, so does not suit a positivist research paradigm.

Whether risk is real or socially constructed, many phenomena which contribute to safety — culture, leadership, mindfulness, communication — are best studied from a constructivist perspective. Furthermore, a view of the world as discontinuous, emergent, and holistic underpins both Resilience Engineering and Social Science (Walliman 2011) — justifying the study of safety using social research methods.

4.4 Epistemology in construction, psychology, and systems ergonomics

4.4.1 Organisational research in construction

In construction management the majority of studies use quantitative methods, followed by mixed methods (11.2%) and qualitative (8.4%) (Dainty 2008). Similarly, an analysis of the methods used by papers published on construction safety and found that 24% of papers were qualitative (and 9% mixed methods) (Zou, Sunindijo and Dainty 2011).

In the mid-1990s, the *'paradigm wars'* divided opinions around the dominance of rationalism in many organisational sciences, including safety and construction management. Since then research has become polarised: The majority taking an *"engineering"* approach to studying phenomena as factual, generalisable and causative, while research into understanding their constructed reality is lacking (Dainty 2008). Zou et al. (2011) explains the drive for construction research to take a realist approach — in order to be fundable and generalisable — has meant quantitative methods have dominated past research – focussing on what, rather than why, construction accidents occurred. Relativism means there is no objective measure of research quality; so instead it is measured on its ability to achieve the

desired goal (Knight and Turnbull 2008). This has meant built environment research often takes a pragmatic approach (du Toit and Mouton 2012).

This rationalism has hindered our understanding of risk as data on accidents and injuries which fails to provide a *"detailed analysis of causes beyond the identification of the mechanism and agency of injury"* (Cooke and Lingard 2011, p. 279). Work by Oswald, Sherratt, Smith and Dainty into socially acceptable behaviour on construction sites raised questions about research *"approaches, which have traditionally focused in positivist roots, and have been unable to holistically capture social aspects that influence safety"* (Oswald, Sherratt, Smith and Dainty 2018, p. 294). Reductionism distances the findings from their social context; studies lack critical reflection and fail to provide a deep and nuanced understanding of practice (Dainty 2008).

> No matter the research subject — whether it is a new construction method, scheduling advances, lean construction, project delivery, information technology changes, or contracting techniques — the same inherent technical and social-technical issues abound.
>
> (Phelps and Horman, 2010, p. 58)

There are also practical reasons for the lack of qualitative research in construction: Difficulty sampling workers because of the temporary nature of their role (Fellows and Liu 2015); restricted access to sites; and unwillingness of participants to take part when they are paid per task (Eaves 2016).

There are several academics in this field who champion a qualitative approach to research:

> If the safety knowledge and practice are to be understood as enmeshed together … it may be prudent for [construction management] researchers to adopt more constructivist ontological and interpretivist epistemological positions.
>
> (Zou et al., 2011, p. 957)

> Qualitative inquiry has been strongly advocated for construction management … and with specific reference to construction H&S[5] studies.
>
> (Manu et al., 2013)

Like Hale and Borys (2013), Baarts (2009) argues construction workers' knowledge and skills are transferred through culture and practices on site. However, safety research in construction often assumes, like the mechanistic models of behaviour discussed in the next section (Section 4.4.2), knowledge and learning are resources that can be stored and transferred by an individual, rather than a social and cultural construct (Gherardi and Nicolini 2002).

[5]Health and Safety

Construction management research is dominated by pseudo-positivism and pragmatism (Amaratunga, Baldry, Sarshar and Newton 2002); drawing on a vast range of approaches and subjects rather than developing its own philosophy and methodology (Knight and Turnbull 2008). This lack of clarity around epistemology can be attributed to the contested ontology of risk, but also to the fact construction management is a field of application rather than enquiry. The same situation is seen in Safety (Shannon, Robson and Guastello 1999) and Ergonomics (Dekker, Hancock and Wilkin 2012, Waterson et al. 2015) — discussed in the following sections.

4.4.2 Behavioural psychology and safety

Behaviourism, or Behavioural Psychology, was a research field established by Watson in 1913 as a scientific alternative to introspection in understanding human thought (Huczynski and Buchanan 2007). It is based upon the principle that all behaviours are acquired through *'conditioning'* from the external environment. Rather than studying thought processes (which are not directly observable), behavioural psychology treats the human brain as a *'blackbox'* — only the stimulus and response can be studied. Behaviour Modification or Behavioural Safety Programmes in construction are based on these principles.

Behavioural psychology was superseded in the 1950s when cognitive psychology became the dominant paradigm. Cognitive psychology was influenced by technology: Mental processes such as learning, memory, and attention could be studied based on the premise that these could be modelled as systems with filters, biases, and feedback loops. This rational view of human behaviour has been endorsed in behavioural economics: Rational choice theory (RCT) provides a framework for understanding and modelling behaviour including risk taking; decisions are optimised based on preferences but 'bounded' by constraints like time and cognitive capacity (Kahneman 2012). RCT in cognitive psychology is used synonymously with Utilitarianism in sociology — the belief that all social constructs can be described by the individual actions that cause them.

Cognitive experiments have been criticised for their ideological stance and poor validity, yet their power, convenience, and flexibility mean their popularity has persisted to the present day. In the late 1980s these mechanistic models of behaviour were challenged by the introduction of naturalistic decision making (NDM): The work of LaPorte, Rochlin, Roberts, and subsequently Weick and Sutcliffe aimed to understand high-stakes decision-making through field research rather than laboratory experiments. This tradition spawned sensemaking, situational awareness and HRO.

Cognitive psychology has been fundamental in shaping many of the concepts of Adaptive safety — for example, NDM in HRO, and joint cognitive systems (JCS) in RE. However, behavioural psychology and older cognitive models still influence risk management in construction. These empirical branches of psychology assume knowledge, learning, and decision-making are individual processes whereas Adaptive safety sees them as emergent

social phenomena. In line with this shift, this thesis studies safety as a social phenomenon, rather than an individual trait.

4.4.3 Systems ergonomics

With the rise of automation, the value of humans in systems was identified in the 1980s — people provide *"thinking, decision-making, responsibility-accepting, behaviour-adapting, problem-identifying, innovating, information-processing, equifinality-capable*[6] *and multifinality-capable*[7]*, complexity-absorbing, goal-seeking, learning, and ethical entities"* (Siemieniuch and Sinclair 2015, p. 862). The corollary to this was that it was no longer considered appropriate to consider the person and technical system as separate, but rather as a *'Joint Cognitive System'* (Woods and Hollnagel 2005). This movement was a precursor to Cognitive Systems Engineering, and subsequently RE.

> We now acknowledge that work takes place in complex socio-technical systems, and that our models and methods necessarily must reflect that. Since work systems have changed, the descriptions we use must also be extended.
>
> (Hollnagel, 2012, p. 21)

Sociotechnical system (STS) thinking takes a holistic view of the system as a whole, evaluating behaviours as part of the system and explaining them as part of the whole (Walliman 2011).

> Systems thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static 'snapshots'.
>
> (Senge, 1990)

> Systems thinking is a rebellion against the objectionable habit of reductionist sciences to suppose that there is always some order hiding behind the disorder of the visible world
>
> (Vandenbroeck, 2015)

Within systems thinking there are two main schools: One taking a *'hard'* (Scholz and Tietje 2002, p. 120) mathematical approach to simulation and modelling — systems dynamics, agent-based, social networks — and the other a softer approach, similar to the way conceptual frameworks are developed in sociology. The soft and hard schools of systems thinking are divided by ontological position — whether an objective representations of these systems exists is disputed (Vandenbroeck 2015).

[6] Creating the same output from different inputs (Convergence)
[7] Creating different outcomes from the same outputs (Divergence)

> Usually this word [system] does not refer to existing things in the real world but, rather, to a way of organizing our thoughts about the same. The *constructivist* view of reality states that systems do not exist in the real world independent of the human mind.
>
> (Skyttner, 1996)

While hard systems thinking creates a model of reality, in soft systems thinking reality is socially constructed and therefore varies between individuals — much like relativism in Postmodern sociology. The social (human) and technical complexity are linked and embedded instead the aim of this discipline is to understand organisational learning and emergent phenomena. How system properties can emerge proved impossible for the more reductionist methods of hard systems thinking to explain, giving rise to Complexity Science which emphasises the complex, dynamic, emergent, and adaptive nature of systems as a whole (Braithwaite, Churruca, Ellis, Long, Clay-Williams, Damen, Herkes, Pomare and Ludlow 2017). From this developed the study of Complex Adaptive Systems — another precursor of Organisational Resilience (Braithwaite, Clay-Williams, Nugus and Plumb 2013).

Both hard and soft approaches use a mixture of methods to understand quantifiable (injury rates, absence, salaries) and unquantifiable (culture, communication, power, trust) aspects of systems. Ergonomics and STS have both been said to take an overly pragmatic stance on research methods (Dekker et al. 2012, Waterson et al. 2015) focusing on applications (Wilson and Sharples 2015). Thus, a pluralist approach to research design is advocated, giving researchers freedom to use any method justifiably appropriate for the context (Stanton, Young and Harvey 2014).

As an applied science, philosophical debates have not been a priority. Regardless of questions around the validity of systems research (Waterson et al. 2015) its methods are considered a truthful description of reality and powerful tools for improving safety (Salmon, Stanton, Lenné, Jenkins, Rafferty and Walker 2017). The key instead is to look holistically at systems, rather than take a reductionist stance (Wilson 2014), and to use multiple methods or models to validate constructs (Siemieniuch and Sinclair 2015).

Summary

Thatcher, Waterson, Todd and Moray (2018) criticise the preoccupation with *"micro-ergonomics"* in this field when a systems or macro- approach is has the potential to tackle global issues.

> Ergonomics already takes a transdisciplinary approach that combines theory from a number of other interrelated disciplines (notably combining theory from physiology, anatomy, biomechanics, psychology, sociotechnical systems, and design theory), more work is needed to engage with the other social sciences (e.g. sociology, political science, anthropology and philosophy).
>
> (Thatcher et al., 2018)

There is a tendency in applied sciences (including construction management, safety science and ergonomics) to focus on applications — pushing their theories to become *"too useful too quickly"* (Singleton 1994, p. 31). Concepts like safety culture and workload have been forced into oversimplified measurable constructs (Guldenmund 2010, Sharples 2018). To avoid reductionism, this work takes an interpretivist approach, allowing the depth and nuances of resilience to be fully understood before moving towards frameworks or models for its application.

4.5 Research design

4.5.1 Qualitative methods

Traditionally, qualitative methods were defined as text-based or, more broadly, any data other than numerical (quantitative) (Flick 2007, Robson 2011, Neuman 2014). However, many sociologists are sceptical of such a simplistic divide; Creswell (2007) describes a continuum between subjective (qualitative) and objective (quantitative) methods, and in practice most research uses a mix of methods guided by the phenomena in question, existing research, and the tendencies of their field (Bryman 2012, Bilton et al. 2002).

The difference between qualitative and quantitative research has also been described as taking a flexible, rather than fixed, approach to research design (Robson 2011): In quantitative research the theory or hypothesis leads the experimental design, but in qualitative studies the theory develops through reflection and iteration (Neuman 2014). What is key is that the choice of method should be driven by the aim of the study (Green and Thorogood 2010). Qualitative methods are useful for answering the and *"why"* and *"how"* questions quantitative research cannot (Hennink, Hutter and Bailey 2011). Its exploratory approach is best applied to tackling new problems and topics with little previous research, and attempting to understand how far the generalisations are valid (Walliman 2011, Bryman 2012).

Qualitative methods are best suited to studying the world *"out there"* rather than in a laboratory: Its methods are naturalistic — avoiding the use of artificial instruments (Bilton et al. 2002) — and both researcher and participant are involved as part of interpreting the findings (Flick 2007). This approach is therefore advocated where the aim is to provide an in depth understanding of social phenomena — in this case decision-making, risk-taking, and organisational change.

As discussed previously, risk, safety, leadership, and culture are socially constructed so lend themselves to an interpretivist research philosophy and qualitative methods. Not only are the social aspects of safety poorly understood, but this is approach is also justified by the lack of research in Adaptive safety and the lack of qualitative research in construction management.

Validity

One criticism often levelled at qualitative research is its questionable validity. Knowledge is developed via a researcher's reflection so always has their viewpoint imposed (Neuman 2014). Thus, the applicability of the terms often used in quantitative work — 'reliability', 'validity', and 'rigour' — is contested (Flick 2007, Noble and Smith 2015). In qualitative work, *"credibility"* and *"dependability"* instead become the measures of quality.

'Dependability' is the equivalent of reliability — the consistency or stability of a measure (Stanton et al. 2014). The dependability of qualitative work is demonstrated by a strong link between the data collected and the conclusions. To achieve this, consistent research housekeeping is required: Designing a case study protocol; maintaining records of audio recordings, notes, transcripts in a database; and ensuing transparency of analysis by applying a structured framework (Robson 2011, Noble and Smith 2015, Stanton et al. 2014). Pattern matching and explanation building are often used to link data to a study's proposition (Yin 2009). Stanton et al. (2014) recommends data collection is carried out by a single investigator for consistency whereas Noble and Smith (2015) recommends co-investigators should discuss the findings to challenge bias. These features would allow a study to be repeated just as reliability does for quantitative measures.

The 'credibility' of qualitative work is the equivalent of internal validity — the degree to which the findings reflect participants' experience of truth (Robson 2011). Good practice guidance recommends unbiased sampling of, and prolonged engagement to establish a relationship with, participants; achieving data saturation; and ensuring interpretation is free from bias by triangulating methods, considering alternative theories, giving equal weight to disconfirming cases, reflexivity on the part of the researcher, and validating findings with participants (Robson 2011, Noble and Smith 2015, Stanton et al. 2014).

Although mostly relevant for explanatory or causal studies, not exploratory or descriptive work, external validity or *"transferability"* should also be considered. The transferability of qualitative research can be improved by comparing the findings to theory; using multiple cases; and providing 'thick description' of the findings — for example, details of the organisation and supporting evidence (Robson 2011, Noble and Smith 2015, Stanton et al. 2014).

4.5.2 Interview study

Interview research aims to understand the *"universal essence"* (Creswell 2007) or a phenomenon or "object" of human experience — in this case the experience of safety leadership among construction professionals. Data is collected from a heterogeneous group, all of whom have experience of this phenomenon, usually in the form of interviews (Creswell 2007).

Interviews

According to an Interpretivist epistemological position, language is a fundamental part of how reality is created.

> Language does not mirror reality; rather, it constitutes it.
>
> (Fairhurst, 2011)

Interview research is based on the assumption that the social actors themselves define social phenomena best, providing the most genuine perspective (Bilton et al. 2002, Lewis-Beck, Bryman and Futing Liao 2004). Interviews provide an insight into how people consciously construct their own reality (Flick 2007) and are useful in gaining in-depth information about personal views and experiences, particularly around sensitive topics (Bryman 2012, Hennink et al. 2011). They are also well suited to exploratory research, when concepts are not well-defined (Walliman 2011).

In comparison to survey research, interviewing allows investigators to probe into participants' answers; offer reassurance and encouragement; gauge participants' understanding of new concepts; see logic or contradiction in their ideas; and ascertain a level of certainty or enthusiasm in participants' responses with cues such as tone of voice, speed, or body language (Haigh 2008). Interviewing in situ also allows the context to be observed, adding depth to the data — important in occupational research.

Interviews are the most popular method for qualitative research in the built environment (Dainty 2008, Haigh 2008). Where the population may struggle with a questionnaire due to low literacy or language barriers (Haigh 2008) interviewing is a preferable option.

One criticism of interviewing is that data is consciously constructed by the participants, rather than a reflection of objective truth. Participants' responses may be influenced by design of the study, or the interviewer's characteristics, opinions, or reactions (Hennink et al. 2011, Bryman 2012). Mitigating this potential for bias is largely dependent on the interviewer's skill and personality — *"casual and friendly, yet decisive and impersonal"* (Haigh 2008, p. 112). Researchers need establish a rapport with interviewees and be able to adapt the schedule to follow interesting leads. From a practical perspective, the time taken for transcription and analysis of data (Bryman 2012) is also a drawback to this method. Audio recording is recommended as it provides the best record of data. Where participants did not consent to being recorded, field notes were taken and written up the same day to ensure completeness and accuracy.

Design

Interviews can take a structured or unstructured format. Structured interviews use closed questions and gather standardised answers which can be quantified or generalised; however, they can be restrictive, cannot investigate issues in depth, and are not suited to complex issues. At the other end of the spectrum, unstructured interviews use open questions as

a general guide for exploring a topic. This style of interview is more sensitive to the participants' answers, allowing the interviewer to omit some questions, accommodate themes not included in the design, and discuss unanticipated topics. However, they are more time consuming and dependent on the researcher's skill to spontaneously question without leading (Bryman 2012, Haigh 2008). Unstructured interviews are said to provide *"genuine access"* (Bryman 2012) to what participants believe.

A semi-structured design provides the best of both of these designs: A level of standardisation while still supporting the follow-up of responses to understand their meaning (Given 2008) — important given the exploratory research question. Limiting the questions to a loose schedule also helps to achieve a 'rich' (dense and meaningful), saturated dataset focussed on these areas of interest (Guest, Bunce and Johnson 2006), which in turn maximises the potential to find meaning (Onwuegbuzie and Leech 2005). Semi-structured interviews were used as it allows a balance between gathering rich and focussed data and keeping the feel open and conversational; this builds rapport between the participant and investigator, encouraging them to share stories and examples from their own experience (Rabionet 2011).

In the design of interview questions it is important to carefully consider their potential for ambiguity, misinterpretation, and avoid introducing bias with loaded phrases (Haigh 2008). The interview study question protocol was informed by the emerging concepts in safety described in Chapter 2 and supported by a focus group with 14 participants who discussed the key issues facing safety and health in construction. A final semi-structured interview protocol was designed comprising of 11 questions. The first eight questions (included in Table 4.1) provide an in depth exploration of safety leadership, freedom, and resilience. The draft protocol was piloted with one participant to confirm the questions and probes were thought-provoking and the responses relevant and valuable. The findings from these eight questions are discussed in Chapter 5.

The latter three out of 11 questions (included in Table 4.2) explore the hazards of construction and worker attitudes. The questions were then chosen to gain an in-depth understanding the role of those managing risk in construction with each question focussing on a different facet of soft systems methodology (SSM) — issues, conflicts, and people. This ensured the scope of the questions would cover a sufficient breadth of human and technical factors at all levels of the system, in accordance with STS theory. The findings of from these questions are discussed in Chapter 6.

Phone interviews

Some evidence suggests phone interviews are shorter; gather inferior quality data; and have a lower response rate, engagement, and participant satisfaction compared to their face-to-face counterparts (Bryman 2012). Visual cues such as body language and context are lost, although this can be mitigated by the use of video conferencing tools. They are

Table 4.1: Interview questions

Background
1) Tell me about your role and previous experience. a. Current position b. Previous experience
Safety leaders' traits and behaviours
2) What traits would a safety-conscious leader have?
3) What behaviours would you see from a safety-conscious leader?
4) How do construction workers view risk? a. Describe their attitude b. What has given you this impression?
5) What does a 'healthy attitude to risk' mean to you?
6) What would a 'resilient workforce' look like? a. What would you see them doing on site?
The future of construction safety
7) Is there room to give workers more freedom?
8) What needs to be done next to ensure safety in construction continues to improve?

Table 4.2: Interview questions

Risk Management in Construction
9) What makes construction so hazardous?
10) What makes managing risk difficult?
Safe and unsafe workers
11) Why do some workers behave unsafely?

also less well suited to sensitive topics as participants may be conscious of their opinions being overheard in public.

Regardless of these concerns, phone interviews provide a convenient and cost-effective way to reach a busy and transient population of construction professionals. They enable a sample to be drawn from a wider geographic area and, because participants cannot see the Dictaphone, they quickly forget they are being recorded. Bryman (2012) also notes phone interviews are safer for the investigator and participants are less likely to be influenced by their appearance. Where is was not feasible within the cost and time constraints for this project to collect interviews in person, phone and Skype™ were used.

Sampling

Probability sampling uses randomisation to reduce bias by selecting a representative sample of participants from a wider population. This is common in quantitative research and is essential for its external validity — allowing the findings to be generalised to the wider population. Qualitative research on the other hand often uses non-probability sampling because its aim is to understand a particular phenomenon, event, or group (Bryman 2012) or provide in-depth insights into a selection of *'information-rich'* cases (Patton 2002). There are many potential criteria for non-probability sampling such as pursing typical or critical cases; emergent phenomena (theoretical sampling); or homogenous characteristics (intensity sampling) (Robson 2011); However, practical constraints mean the majority of qualitative research uses convenience sampling (Hancock, Windridge and Ockleford 2007).

To recruit participants the interview data was collected by purposive and snowball sampling — encouraging participants to pass the invitation on to relevant colleagues. Within the inclusion criteria, maximum variation (Hancock et al. 2007) — also known as 'dimensional sampling' (Robson 2011) — was sought to to draw on the views of a breadth of participants with differing roles and experience levels.

Data saturation

Rather than sampling a representative proportion of the population, a non-probabilistic sample is complete when data reaches 'theoretical saturation'. Unfortunately, there *"are no publicised guidelines or tests of adequacy for estimating the sample size required to reach saturation"* (Guest et al. 2006). Polkinghorne (1989, cited in Creswell 2007) recommends interviewing between five and 25 participants in interview studies. Instead, the guidance is that transcripts should be thematically analysed, iterating a coding structure until no novel codes, material, or insight are emerging (Glaser and Strauss 1967, Bryman 2012). Details of how the transcripts were analysed is included in Section 7.4.

The specific inclusion criteria increased the likelihood of reaching data saturation, but its internal diversity also ensured as many present themes as possible were captured (Guest et al. 2006). Furthermore, the use of a preliminary focus group helped to scope potential themes to be explored in depth through interviews.

4.5.3 Case study

The interview study investigated safety leadership as a general construct — exploring and the generating hypotheses about Adaptive safety and how it could be operationalised in construction. Following this with a case study provided an opportunity to study Adaptive safety in practice.

In the study of multifactorial organisational phenomena, experimental designs are often not possible because of the many factors involved and the inability to control them. Instead, a case study is a preferable method (Yin 2009). Yin (2009) advocates case study

research to answer *'how'* and *'why'* questions; in situations where the researcher cannot control behavioural events; and when the focus on the research is contemporary rather than historical.

> The central tendency among all types of case study, is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result.
>
> (Schramm 1971 in Yin, 2009, p. 17)

Case study research is used when the case itself is of interest (ideographic) rather than the generalisability of findings (Bryman 2012). Hence, the cases themselves are chosen for their importance as extreme, revelatory, exemplifying or critical examples of phenomena (Yin 2009). Laing O'Rourke (LOR) and its projects represent a critical case — an unexplored niche.

Like all qualitative research (as discussed in Section 4.5.1 case studies are often criticised for lacking rigour. Thus, it is important to analyse and report all evidence fairly to avoid bias. Although they can be used to generalise theories, they cannot prove a causal link as an experimental design can, so need to be used alongside other methods (Yin 2009).

Unlike ethnographic and grounded theory research, a case study has clearly defined boundaries. These are described in the following section.

Design

Case studies are typically exploratory or descriptive, but can be explanatory if they are sufficiently rigorous and repeatable. As Safety Differently is somewhat undertheorised and lacks an empirical evidence base (including other case studies), this case study took a descriptive approach, rather than exploratory or explanatory (Yin 2009). Descriptive cases are detailed and focused, scrutinising phenomena to inform theory development (Mills, Durepos and Wiebe 2010) — in this case the theoretical propositions about Adaptive safety in construction put forward in Chapter 2. The literature review and interview study provided a basis for the descriptive theory of this case study and ensured the investigator has a strong grasp of the concepts.

Case studies can be cross-sectional, where data is collected at a single time period, or longitudinal, where data is collected over an extended period (Mills et al. 2010). An extended data collection period is particularly useful in understanding organisational change. Longitudinal case studies draw on multiple sources to provide rich, contextualised data, improving the interpretation and validity of findings; however, the complexity, cost, and logistics of such studies mean they are rare. On the other hand, cross-sectional studies are easier to implement but can lack context and the validity of interpretation is limited (Fuller, Gibb, Jones, Dainty, Haslam, Bust and Pinder 2017). Due to time and access constraints it was not feasible to conduct a longitudinal case study; however, some questions included a longitudinal element — asking participants to reflect on change over time.

The final case study design compared Safety Differently in practice at two infrastructure megaprojects (Thames Tideway Tunnel (TTT) and Crossrail) at different stages of its implementation (first and third year respectively). These two projects represented embedded units of analysis within the contractor organisation (LOR). A vertical cross-section of the parent organisation and both projects was sought to understand its adoption from organisational — why and how the change has been implemented — and operational perspectives — how it affected the roles of safety managers and frontline workers. Figure 4.1 illustrates this cross-section, showing where documents and observations were collected from in order to understand the translation of Next Gear from an external risk consultancy to the frontline.

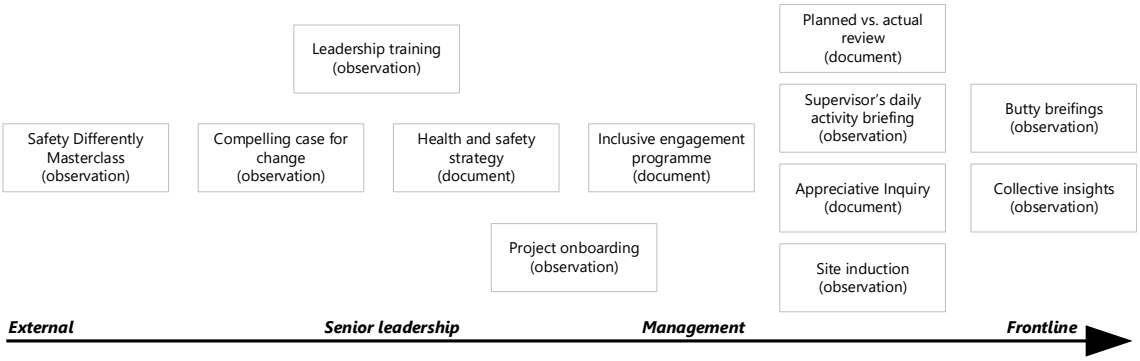


Figure 4.1: Documents and observations

Observations of these events totalled eight days and included any associated documents such as presentation slides, teaching materials, and joining instructions. This was in addition to two key policy documents regarding health and safety strategy and examples of paperwork as a 'naturally occurring' by-product of the risk management processes. Further information about these methods is included in the following section.

Methods

One key aspect of case study research is triangulation (Haigh 2008). This case study uses multiple data collection methods to create *"methodological triangulation"* (Denzin in Mills et al. 2010, p. 945). In addition to interviews (as described in Section 4.5.2), data were collected primarily by document analysis and observations for an organisational perspective, and interviews, focus groups, and observations for an operational perspective. These methods are detailed in the following sections.

Observation

The degree to which the researcher is embedded in the context of the research can vary: Bryman (2012) describes a continuum of *"complete observer, observer-as-participant, participant-as-observer, and complete participant"* based on Gold (1958). An increased level of involvement allows investigators to build relationships with participants and understand

meaning, but risks compromising the neutrality a detached observer would have. To understand how the concepts of Safety Differently were conveyed to the workforce through training courses, the induction process, and on site safety activities the investigator's role was as participant-as-observer.

One of the challenges of collecting observational data is that participants may change their behaviour as a result of being observed. Therefore, it is important for researchers to be discrete, allowing participants to be relaxed and behave naturally. Being a participant-as-observer also helped to mitigate this effect.

Document analysis

Documents are a useful source of data because they are a *"by-product of human activity"* (Mills et al. 2010, p. 318). These can be any written, visual, or physical materials — such as artefacts — that add depth to a case. In this case, safety reports, policy documents, and training materials contributed to the dataset.

Interviews

Most interviews conducted as part of the case study followed this semi-structured format, except those with frontline workers which were almost completely unstructured — based on a couple of open-ended questions. This less formal approach maintained an informal and trusting dynamic and allowed participants to lead with their experience and interpretation of the new safety measures. These questions are included in Table 4.3. Critical incident technique is a style of questioning which encourages participants to describe a specific incident rather than general opinions (Bryman 2012). The interviews for the case study included questions based on this method.

Focus groups

Focus groups — like group interviews — are a useful method to elicit large volumes of information over a short time and capture a range of viewpoints. The familiarity of this method (replicating social interaction) allows participants to speak freely about their views (Bryman 2012, Walliman 2011).

(Hennink et al. 2011) describes focus groups as either 'interactive groups' or 'moderator dominated'. An interactive group format allows participants to debate and challenge others, coming to a consensus, and highlighting unique perspectives. Moderator dominated focus groups require a skilful investigator to manage group dynamics and keep discussion flowing; this prevents minority views or quieter people being suppressed but can be less relaxed. The design of focus groups is important: Up to 8 participants is recommended, with similar status and experience; and acquainted with one another (Bryman 2012, Walliman 2011).

The focus groups in the case study were interactive groups or nine or less, all of whom were colleagues of the same status (supervisors, or workers from a particular trade). To

Table 4.3: Interview questions

Background
1) What is your role?
2) What responsibilities for health and safety do you have?
3) Who do you work for? How long have you been employed by them?
4) How long have you worked in construction? What is your background?
Awareness and understanding
5) Have you heard of 'Next Gear'?
6) Next Gear sees *"people as the solution"*. Is this true here?
7) Next Gear is about *"positives not negatives"*. Is this true here?
8) Next Gear sees safety as about *"ethics not bureaucracy"*. Is this true here? Have you seen a reduction in paperwork?
Evaluation
9) What do you like about safety here?
10) What has been the biggest change from previous projects?
11) Have you seen a change in people's attitudes? Or in your own attitude?
12) Can you give an example of a situation when Next Gear made a big difference?
Implementation
13) Has your role changed since introducing Next Gear? Do you feel supported in this?
14) What have been the most challenging aspects to change?
Future projects
15) Could you have got to this point without previous safety programmes?
16) Would you find it difficult to move to a non-Next Geat site or company?
17) What would you like to see happen next?

counteract the logistical challenge of organising a focus group, they were arranged around times when groups were already meeting for briefings. Like interviews, transcription and analysis of focus group data is time consuming and complex (Bryman 2012, Walliman 2011).

Sampling

According to Yin (2009) use of the term 'sampling' in case study research is incorrect as it implies the participants are representative of a wider population.

> Sampling while collecting data for qualitative research is not the same as sampling in quantitative research because researchers are not interested in being able to generalise at a statistical level — instead the key is purposive or strategic sampling.
>
> (Hancock et al., 2007, p. 21)

The aim of case study research is to seek information from specific groups and subgroups within a population, or describe a particular case — such as an event or organisation — in detail (Yin 2009, Hancock et al. 2007). Therefore, unlike quantitative work, where external validity is paramount, it is the intensity of analysis in case studies that is of interest (Bryman 2012). Case study units of analysis are typically too small or unique to be representative of similar cases of used for statistical generalisation; however, they can be useful to corroborate, modify, reject, or advance the findings of other research as part of informing policy (Hancock et al. 2007, Yin 2009) — in this case the rhetoric of Adaptive safety which lacks a strong evidential or theoretical basis.

For the case study in this thesis, a stratified framework was designed to capture a cross-section of participants from all levels of the projects and parent company — from senior management to frontline operatives. Within this convenience sampling was used.

4.6 Ethical approval

The design of both studies was approved by Loughborough University's 'Ethical Approval (Human Participants) subcommittee'. This ensured they complied with the university's 'Code of Practice on Investigations Involving Human Participants' and 'Data Protection Policy'.

In line with these policies, participants gave their informed consent; were made aware they could withdraw at any point during or after the study; and provided a point of contact for 'Research Misconduct and Whistle Blowing'. Data about interviewees has been kept confidential and information included in reports or publications used anonymously.

Audio recordings and interview transcripts from the interview study will be archived at Loughborough University for ten years after creation and then destroyed. Those for the case study will be combined with the dataset for the *'Tideway Tracer'* longitudinal case study of TTT and managed within this.

4.7 Conclusion

Ergonomist Donald Taylor criticised mechanistic models of human behaviour and their application of accidents and safety, instead advocating a hermeneutic approach to interpreting and understanding accidents through their meanings for the humans involved (Taylor 1981). This view has become increasingly important in safety science as language shapes culture, including safety culture (Pidgeon 1998). The importance of organisational culture in safety has been recognised since the 1990s, yet the majority of research in this field takes a functionalist approach rather than, as seen in the anthropological study of culture, an ethnographic one (Sileby 2009).

Organisational culture is often wrongly thought of as an external phenomenon acting upon the workforce (Bryman 2012). Studying 'organising' as a social process rather than the organisation as an entity (Tsoukas and Chia 2002) aligns with Hollnagel's notions of safety as a system process rather than a property and Weick's push for High Reliability *Organising*, rather than Organisations. These shifting views towards understanding of risk and safety as emergent social phenomena means there is a need for research which takes a qualitative approach. A methodology has been proposed that aligns with, or addresses gaps in, the current research landscape of the disciplines that intersect this multi-disciplinary work.

Safety Leadership for Resilience

5

Contents

5.1 Introduction

Adaptive safety has emerged in response to a changing understanding of the ontology of risk and how risks result in accidents. Alongside this, safety is shifting from being seen as an externally imposed control to a dynamic social process. In the preceding chapters, the role of leaders has been theorised to be a significant factor in this; thus, the following work focusses on leadership as a means to foster a more Adaptive culture in organisations with a view to creating a framework to guide the implementation of Adaptive safety in construction and other sectors (Objective 1 — *"Explore the role of safety leadership"*).

Chapter 3 compared a model of Safety Intelligence from air traffic management (ATM) (a sector which has embraced Adaptive safety) with research into safety leadership in construction. There are many similarities between these two sectors: The importance of a just culture, communication, empowerment, collaboration, and proactivity has been demonstrated, but leadership styles need to be adapted to suit different tasks, industries, and relationships — accounting for the needs of followers. The six components of Adaptive safety leadership proposed are therefore all necessary in both ATM and construction, but to differing degrees and are manifest in different ways to suit the work of the sector.

In light of this, it is not possible to create a universal model of safety leadership that could apply in all sectors; instead, the aim of this study is to unpack the relationship between leadership and resilience — understanding the social factors that underlie organisational resilience. Replicating Fruhen et al.'s (2013) method used with ATM leaders, this study uses interviews to create an exhaustive taxonomy of safety leadership traits and behaviours that constitute effective safety leadership in construction. It sheds light on the extent to which safety leadership in construction does, or could, align with an Adaptive approach. Attitudes to risk, and the potential for freedom and resilience are also discussed.

A panel of expert interviewees contributed their views on best-practice in safety leadership. The findings show range of opinions, from those who were convinced a traditional control and compliance approach is best, to those who were open to interpersonal risk management, softer leadership styles, collaboration, and empowerment. Many participants discussed the importance of learning, trust, vigilance, and proactivity in construction safety. However, even those who saw the benefits of the latter approach had reservations; the pressures and trade-offs of the industry mean this best-practice is not always possible in reality. The reasons for this mismatch are explored in Chapter 6.

5.1.1 The organisation of this chapter

This chapter presents the findings of interviews conducted with safety managers, consultants and experts as part of a study of safety leadership. Participants' responses are explored in light of theories from the era of Adaptive safety to identify existing elements of, and the potential for, Adaptive safety in construction.

The findings are presented as four sections based on the themes of the interviews: Best-practice in safety leadership, attitudes to risk, understanding resilience, and the potential to give workers more freedom.

5.2 Method

5.2.1 Participants

The sample included predominantly safety managers working for (or having previously worked for) construction, infrastructure, architecture, and civil engineering companies. These were global or multinational tier-1 contractors (in direct contact with the client) headquartered in the UK, US or EU, and employing between 4,000 and 48,500 employees. All the participants had at least five years' experience working on or researching large projects with a strong commitment to safety. The mean experience of participants was 22.5 years with a standard deviation of 13.2. This did not include previous experience working in health and safety in sectors other than construction which they drew on for comparison. Participants' roles are included in Table 5.1.

Participants were recruited through the researchers' contacts and snowballing the invitation to participants' colleagues. Judgement sampling was applied (based on occupation

Table 5.1: Study participants and their roles

Role	*Pilot Focus Group*	*Pilot Interview*	*Recorded Interview*
Health and safety manager or director	9		10
Health and safety training coordinator	1		1
Construction manager	1		1
Self-employed risk consultant	2		3
Academic with previous employment in construction	1		6
Academic researching construction safety		1	4
Total	14	1	25

and experience) to create a sample of construction safety experts with maximum variation within this inclusion criterion; this included those involved in different roles within the risk management process — such as research, policy-making, training, and consultancy, as well as frontline managers — from a range of organisations.

53 potential participants were contacted yielding 25 recorded interviews (Response rate 47%). Eight participants from the pilot focus group went on to participate in a recorded interview; they were not counted twice, leaving six plus 25 and one pilot interviewee, giving a total of 32 individuals contributing to the dataset.

5.2.2 Data collection

Interviews were conducted between October 2015 and January 2016 by telephone ($n = 15$), Skype™ ($n = 1$), and in person ($n = 9$) depending on the most convenient method for the participant. All the interviews were conducted by a single investigator. The duration of the recordings ranged from 20 min to 60 min, with an average of 37 min. The recorded interviews were transcribed verbatim and the complete dataset contained 140,000 words. All coding was completed by the same investigator to ensure consistency. The process of thematic analysis used to analyse this dataset is detailed in Chapter 4.

5.3 Data analysis

There are three main types of analysis used in social research: Grounded theory, thematic analysis, and content analysis (Bryman 2012). Grounded theory takes an inductive (bottom-up) approach to building theory so is best suited to unresearched territories (Bryman 2012, Walliman 2011). Content analysis, on the other hand, is deductive (top-down) so suits research where a hypothesis to be tested exists (Bryman 2012, Walliman 2011). Thematic analysis sits between these two approaches (Braun and Clarke 2011).

As the concepts of Adaptive safety are not well-defined, neither an entirely deductive or inductive approach was suitable. Retroductive (Bryman 2012) or Abductive (Dubois and Gadde 2002) reasoning describes a process whereby empirical data are used to refine a

proposed framework, thus resulting in the coproduction of knowledge (Green, Kao and Larsen 2010). This approach was used in the thematic analysis of interview transcripts.

Following Bryman's (2012) guidance on thematic analysis, a theme (or more) was assigned to each sentence — coding examples of concepts, local terminology, similarities and differences, and theory-related material. The identified codes were then reduced by grouping similar and redundant themes into an axial or tree structure (Braun and Clarke 2011). Interpretive coding (Miles and Huberman 1994) was also used to break down codes in further detail. The coding process can be either deductive, if a coding structure has been predetermined, or inductive, if based on the data itself. In an abductive approach, the coding structure remains fluid and is constantly compared with the data and theory until saturation is reached (Robson 2011, Mills et al. 2010). A sample of the final coding structure developed by this method is included in Appendix A.

Content analysis was also applied to the interview study data. This consists of structured searches to count the number of times particular works for phrases are used (Mills et al. 2010). Miles and Huberman (1994) suggest the frequency of data can provide verification and guard against anecdotalism (or a *"main informant"* (Robson 2011)) but Braun and Clarke (2011) warn more instances of a theme does not equate to significance. In Chapter 6 the number of respondents who spoke about each theme is used as a form of quantitative validation. This prevents participants who spoke extensively on one topic skewing the results (as coding by word count, percentage coverage, or number of references can) yet provides another dimension to the analysis — demonstrating the dominance of certain themes.

5.4 Findings

5.4.1 Safety leadership

Participants were asked to describe the traits and behaviours they felt a safety-conscious leader should display — drawing on examples of best-practice from workers and colleagues and their views of an idealised safety leader. In response to both questions on traits and behaviours, participants provided a mixture of both traits and behaviours illustrating the breadth of skills needed for leadership and the weak distinction between what participants perceived as traits or behaviours. This difficulty extracting behaviours from the traits that underpin them, and vice-versa, also supports criticisms of trait-based leadership theory which ignores the social-process and situational context of leadership as discussed in Chapter 3.

There was widespread recognition that safety leadership should not be limited to those in a leadership role; however, if this was unclear prompts were used to widen the investigation beyond safety managers' best-practice.

> You [workers] can all be, and I want you to all be safety leaders, to lead each other and help each other.
>
> (Safety Manager)

Traits

The traits of safety-conscious leaders are shown in Figure 5.1. This figure displays the trait nodes from the dataset as proportional circles, sized according to the aggregated number of references, and segmented into subcomponents. Where these could be broken down further these are shown in an overlapping circle.

Traits of leadership (influencing and interpersonal competence) and traits of safety-consciousness (experience, qualifications, high-standards, careful working, and proactivity) were brought up as expected. However, participants gave almost equal weight to discussing the softer aspects of care and humility — traits which seem out of place in construction's macho culture.

> They actually think of the people, not just as employees but they think of them as kind of a family unit, so they will go beyond what they have to do to keep them safe.
>
> (Academic)

Social skill

Many participants' responses focussed on interpersonal skills: Communication dominated this theme, including being able to create a rapport as well as listen to and direct others. The other social traits (personality and reasoning capability) fall into two main themes: being good-natured — approachable, likeable, patient, polite, and having a sense of humour — and being charismatic — engaging, enthusiastic, persistent, and persuasive. These two themes are supported by other traits which have been grouped under *Integrity* and *Agency* respectively.

> They have to have good personal qualities and these sort of interpersonal skills, you know, to listen, articulate … to somehow empathise with the individuals to make the safety part personal.
>
> (Safety Manager)

Agency

For a minority, success in leadership was about being authoritative; leaders need to be brave and thick-skinned, but many others saw a softer side to the role: From their perspective this required support from seniors, and being relatable, respected, and trusted. The success of safety interventions is *"based on the trust, and their openness, and communication"* (Academic) that exists within the leader-follower relationship. Proactivity, or self-motivation to

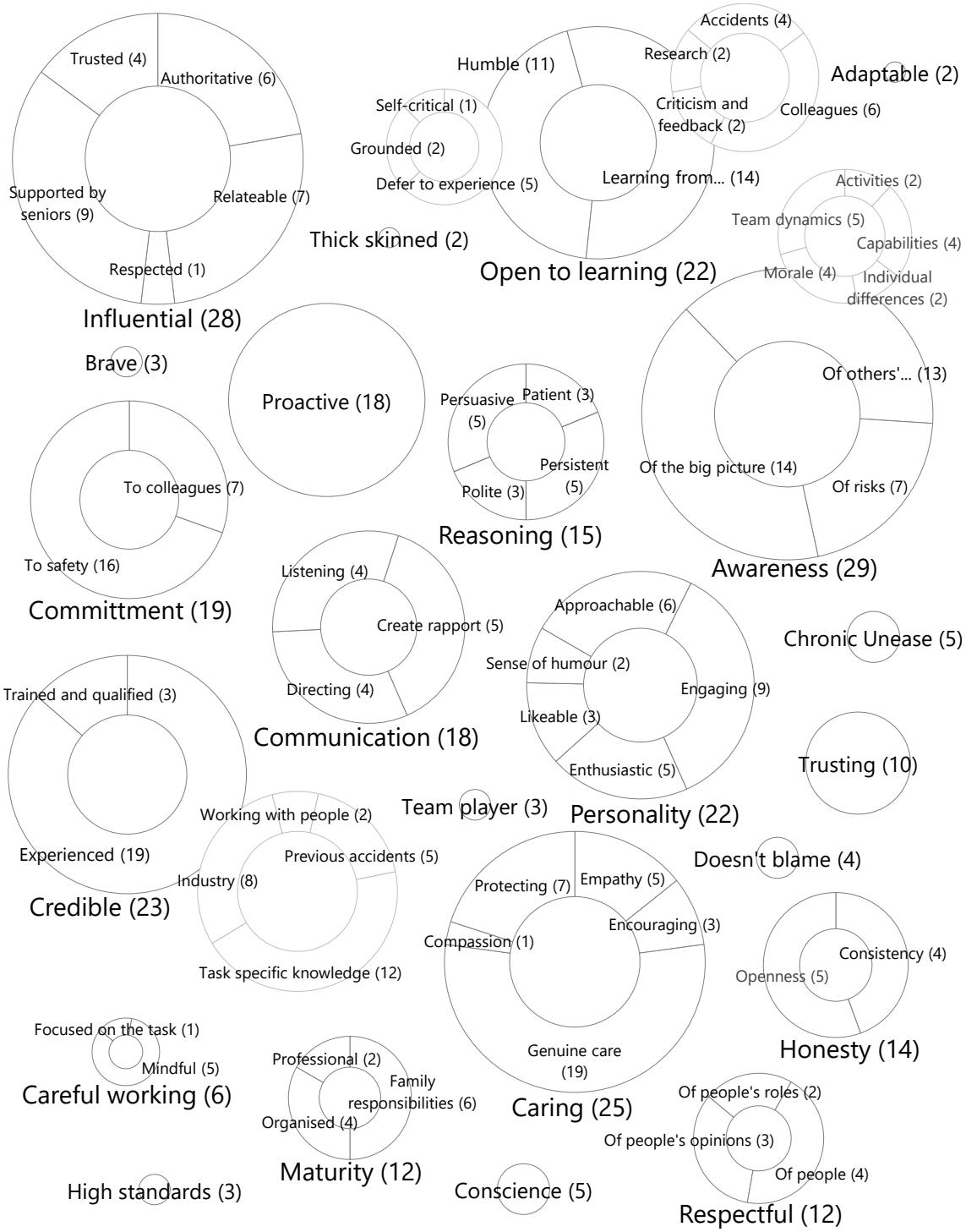


Figure 5.1: Traits of safety-conscious leaders

anticipate and resolve problems, was also seen as an important trait and is explored further under 5.4.1.

Expertise

Technical competence was a key theme raised by participants: Their credibility is based on previous experience — including task-specific knowledge and having gained appropriate qualifications and training as well as experience of the construction industry, accidents, and working with people. They were said to have high standards and work carefully, finding a balance between mindfulness and focus on the task.

> It's about believing in what you do and how you then project yourself out to others that you're doing it in the correct, mindful, safe, articulate, and proper manner.
>
> (Safety Manager)

Expertise was also displayed through the level of maturity, organisation, professionalism, and commitment to both safety and their colleagues. Six participants spoke of those with family commitments as being better safety leaders because of their experience of responsibility.

Openness

An important aspect of safety leadership was a heightened awareness of team dynamics and morale, and others' activities, capabilities, and individual differences. Alongside this, leaders need to be open-minded; learn from colleagues, accidents, research, and criticism or feedback they receive; and make adaptations accordingly.

> It's about going in with an open-minded approach, that you're willing to … try and understand other peoples' views, people that are more capable than you, you know, understand their views, appreciate their views.
>
> (Risk Consultant)

This requires safety leaders to remain humble: *"Competent to know when they need support and help, so whether something's out of their knowledge zone, or their comfort zone"* (Safety Manager) — they remain grounded, self-critical and can seek assistance or expertise.

Integrity

As mentioned, many participants felt being good-natured was an important part of safety leadership. This should be underpinned by values of genuine care, protection, empathy, encouragement, and compassion. They put other's needs before their own (team player) and worry about the potential for harm (chronic unease). Many participants used analogies of family ties to describe this trait such as *"mother hen"*, *"brotherhood"* and *"parent-child relationship"*: Not only does experience of responsibility make people better leaders, but also their ability to care.

> The people that they're looking after is almost their immediate family, their children, almost, but we've lost that I feel, and it's a big issue with me that we've lost this family ethic to how we care for and look after people at work.
>
> (Risk Consultant)

Other traits that showed integrity were honesty, respect, trust, a strong conscience and not blaming colleagues.

> [Workers] feel they can approach you for anything and they're not going to be chastised for anything, you know, the open door policy, no blame culture look at things.
>
> (Safety Manager)

Behaviours

The behaviours which participants felt a safety-conscious leader would exhibit are shown in Figure 5.2 as proportional hexagons. Sub-nodes are shown by overlapping shapes. These themes were arranged into a hierarchical framework — from 'Personal conduct' to 'Influencing safety policy' — based on models of a safety culture continuum from pathological to generative (Westrum 2004); safety compliance to safety participation (Neal and Griffin 2006) or citizenship (Hoffman, Morgan and Gerras 2003); or safety leader practices as *"controlling-caring-coaching"* (Pilbeam et al. 2017).

Participants tended to focus on one or other end of this spectrum: A minority believed being safety-conscious was about unquestioning obedience and taking ownership of safety on an individual basis, whereas most participants saw safety-consciousness as a workforce-wide activity, focussing on proactivity and collaboration.

Personal conduct

At the bottom of the framework, the foundation of being a safety leader is first to be safety-conscious on a personal level. This includes not only technical competence in following rules and best-practice guidance, but also attitude. Workers should be obedient, prioritise safety and conform to the safety climate. At this level, the leadership element is passive (i.e. leading by example). However, several participants said that for truly safety conscious workers, their commitment went beyond the workplace — where safe working is expected and rewarded — and their exemplary practice continued in their home life. This shows an intrinsic motivation for safety.

> If the walkway is showing that you go from this point to that point, that person should do that, if it says reverse park you should do that, you know, so it's following the same rules, can't be like one rule for one and one rule for the other.
>
> (Safety Manager)

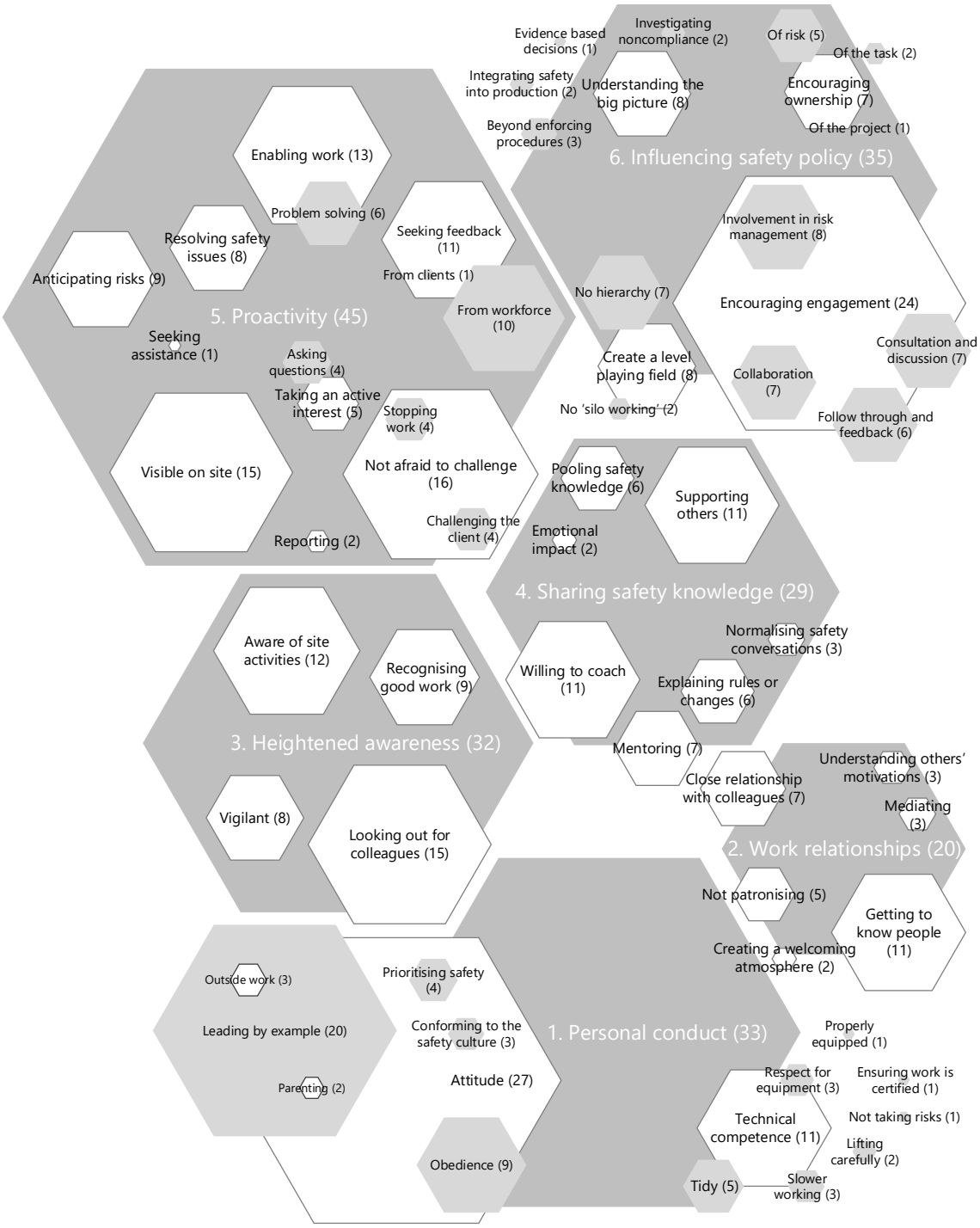


Figure 5.2: Behaviours of safety-conscious leaders

This is supported by traits listed under *Expertise*, but also *Openness* and *Integrity* as leaders need to stay grounded and humble, respectful, consistent, and genuinely committed to their colleagues' welfare.

Work relationships

Many interpersonal skills are discussed in the previous section; however, participants also raised particular behaviours within work relationships which display safety leadership. This included creating a welcoming atmosphere, and getting to know people as people, what motivates them, and building close relationships with them.

> Does the supervisor know the workers? Do they know how many kids they have? Do they know what they get up to afterwards? It's that sort of interest in somebody outside of work which then you would expect to overflow into a care and concern of them as individuals.
>
> (Academic)

These work relationships are supported by interpersonal traits but also underpinned by genuine care, commitment to colleagues and respect for others.

> How much does it cost to be respectful? Nothing … I mean I've worked on sites where I think *"Boy! Do you realise that that's actually a human being?"*
>
> (Academic)

Interestingly, at this level of the hierarchy the behaviours are neither influencing nor explicitly safety-conscious, yet participants felt they were important for a safety leader to exhibit. This confirms their recognition that for safety leadership or interventions to be successful requires a foundation of good relationships between leaders and followers.

Heightened awareness

Building on these foundations — being committed and knowledgeable about safety, and having good relationships with colleagues — participants spoke about being vigilant of site activities, looking out for colleagues, and recognising good work. One participant said the growth of this approach was something he had noticed over the past five years:

> It was never macho to go out on a construction site and say *"well done, you're doing a grand job there"* because you'd be looking round thinking *"well, I hope somebody ain't seen me"* and they saw that as weakness in management.
>
> (Safety Manager)

This requires leaders to be vigilant and observant, but also caring, humble, open and respectful. As with work relationships, heightened awareness is an important aspect of safety leadership without specifically relating to safety or leadership.

> You mustn't be lazy, you've got to be on your guard all the time and living- living safety, not just talking about it, living it!
>
> (Safety Manager)

Sharing safety knowledge

Levels four to six show increasingly aspirational safety leadership behaviours — impacting others on an individual, workplace, and organisational level. Sharing safety knowledge by supporting, coaching and mentoring others, and being willing to explain why policies and procedures are as they are. This requires leaders to have technical knowledge, experience, and authority, but also the interpersonal skills to influence behaviour without patronising or embarrassing — patience, empathy, and persuasiveness, underpinned by commitment and care.

> I try and do that [influence behaviour] through talking to people first of all, giving them the benefit of my experience, trying to show them how it can be done the right way, and giving them practical solutions as well.
>
> (Safety Manager)

Participants felt the best safety leaders were able make safety conversations a normal part of everyday work and convey the emotional impact or *"horror stories"* (Training Manager) of previously experienced accidents.

Proactivity

Being proactive dominated many responses on safety leadership and included proactivity to prevent unsafe work and enable or encourage safe work. At the baseline, proactivity was seen as supporting compliance by reporting, stopping or challenging circumstances which could lead to an accident: This included not only challenging peers about unsafe practices, but also those more senior.

In addition to preventative interventions, heightened levels of proactivity were shown by those who went above and beyond enforcing compliance.

> It's better to be prudent and try and prevent an event occurring than acting after the event has occurred … it's about being proactive and making sure that we can possibly foresee what might go wrong and try and put it right before it does.
>
> (Safety Manager)

These safety leaders actively engaged with site safety, asking questions, and seeking feedback from the colleagues and the client. The most proactive safety leaders were those who anticipated risks, planned well, and actively resolved safety issues. Particularly in the case of figures of authority, safety leadership was demonstrated by their visibility on site and engaging with workers.

> Actively spending time on the site, prioritising that time, planning, and building the workers- what the workers need into their plans on an ongoing basis, making sure that everyone's got what they need to be doing the next stage.
>
> (Academic)

Proactivity requires leaders to be open and humble, enabling them to know their capabilities and seek assistance, and to learn from criticism and feedback. To challenge unsafe behaviour they need experience, maturity, tactful communication skills, courage, and a thick-skin and sense of humour if interventions are scorned. This is the first instance where influence is a trait underlying the behaviours of a safety-conscious leader.

Influencing Safety Policy

The final level of the framework was reserved for behaviours which saw safety leaders not only influencing their colleagues or workplace but the wider safety policy or climate. Primarily, this was through encouraging a collective approach to risk ownership and management — engaging, consulting, and collaborating with workers. While proactivity is often a one-way activity, the perceived importance a two-way collaborative relationship validates the social construction of safety and leadership.

Highly safety-conscious leaders have a deeper understanding of risk and its implications which is evidenced by going beyond enforcing compliance, fully understand why procedures are not adhered to, making evidence-based decisions, and integrating safety into primary operations.

The need for a collaborative approach was supported by many participants who spoke of breaking down hierarchical or trade-based organisational structures to create a culture where anyone, junior or senior, can openly discuss risk. This is underlined by many of the traits found under 'Integrity' — trust, respect, honesty — alongside expertise in risk management, and the interpersonal and communication skills needed to engage and influence others. Commitment is also a key trait: As well as asking for feedback, it is important to follow through with suggestions and communicate back the changes that have been made to build credibility and relationships.

> If they've got a complaint, deal with it! And actually follow it through! Doesn't matter how small it is, deal with it and carry it out because you'll get the biggest respect from them.
>
> (Safety Manager)

5.4.2 Construction workers' attitudes towards risk

Participants felt workers' attitudes varied significantly both between and within individuals depending upon the activities or circumstances, but overall were improving with time. Brace, Gibb, Pendlebury and Bust (2009, p. 194) categorised attitudes to risks as 'Sensation Seekers', 'Deniers', 'Acceptors' or 'Avoiders'. These are expanded upon based on participants'

descriptions: A distinction was made between sensation deniers who are genuinely oblivious to the risks, and those who are aware yet deny a risk's potential for harm; a further distinction between sensation acceptors for whom this acceptance made them either more tolerant or more mindful of the risks; and the addition of a 'risk appreciators' category. These categories are described in Table 5.2 and Figure 5.3.

Table 5.2: Construction workers' attitudes to risk

Attitude to risk	*Participants stating workers hold this attitude*	*Quotation*	*Description*
Risk Averse	3	You've also got people who- perhaps towards- later in their working careers are much more risk-averse. (Academic)	A few construction workers, particularly older workers, are risk averse. They are seen as a memorable exception to the norm given the nature of the work.
Risk Respecting	6	Some accept it's just part of the environment, but it can be managed effectively. (Risk Consultant)	Workers are aware of the risks and are pragmatic about risk management.
Risk Accepting	6	The workers themselves are pretty aware of the risks. Whether they do anything about it I'm not quite sure! (Construction Manager)	Workers are aware of the risks but these are normalised as part of construction work. They become desensitised and are unlikely to challenge unsafe conditions.
Risk Denying	10	Whilst these guys appreciate that there are risks, he thinks *"Hey, I can make £25 more for less time!"* and so that- so the risk in a sense is almost carted[a]. (Safety Manager)	Workers are aware of the risks but deny their potential for harm because their judgement is influenced by complacency or conflicting priorities.
Risk Oblivious	11	I honestly don't think that they see the risk out there. (Safety Manager)	Workers are unaware of the risks they face. This could be due to a lack of experience, competence, or training, and particularly regarding the work of other trades which could interact with their own.
Risk Appreciating	4	Construction workers actually like and embrace risk, 'cos it's exciting, it's innovative, it's dynamic. (Risk Consultant)	The risks and challenges of construction work are a significant factor in workers' job satisfaction: They enjoy working in new and varied environments, thrive on problem solving, and take pride in facing challenges others might think too difficult.
Risk Seeking	3	My biggest worry would be with our young people is that they do they think they're immortal and they will try things. (Training Coordinator)	Some construction workers were actively 'risk seekers', but these attitudes predominantly occurred among younger workers and rare *"mavericks"* (Risk Consultant).

[a]Dismissed or put to one side temporarily

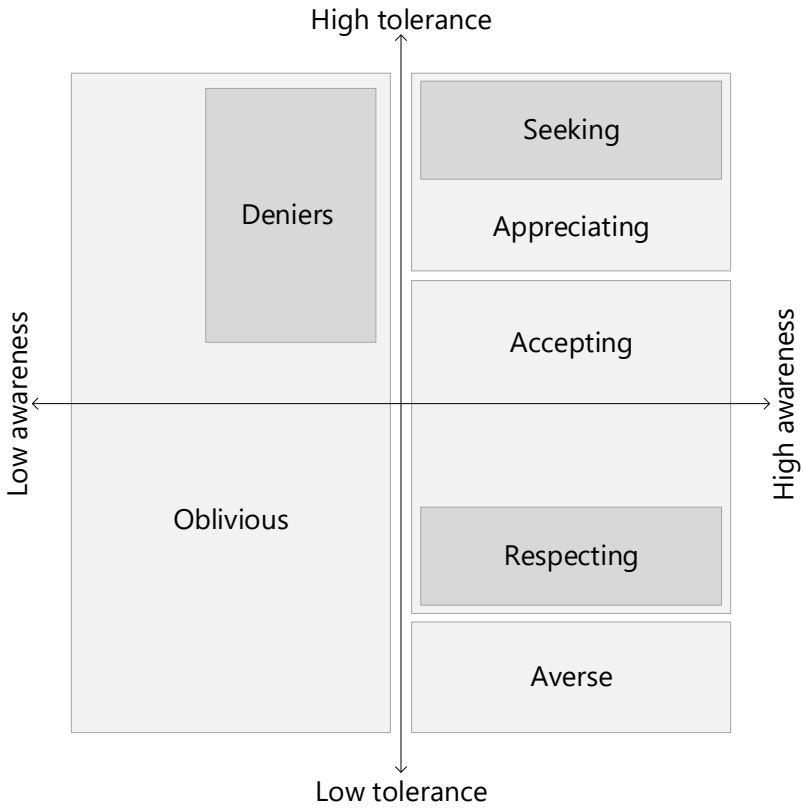


Figure 5.3: Risk-tolerance versus risk-awareness of different attitudes

The dominant view of workers attitudes as either oblivious to or denying risk highlights the importance of training to raise awareness of risks and the pressures workers face to balance safety and production. Complacency was often blamed, either because of over-familiarity with dangerous tasks and environments; distancing others' experiences — *"it would never happen to me"*; or the assumption risks had already been dealt with.

> They almost rely, rightly or wrongly, on the engineer and project management that set it up accordingly, and the main contractor, and hope to walk onto a safe site, which is no bad thing, but can be slightly utopian!
>
> (Risk Consultant)

5.4.3 A healthy attitude to risk

In terms of a healthy attitude to risk, participants discussed how this applied to both how risks are perceived (Detecting risk) and how they are dealt with (Responding to risk). Some participants also discussed a healthy attitude to risk as an organisational phenomenon rather than an individual one — Managing risk. These components of a healthy attitude are broken down further and presented in Figure 5.4.

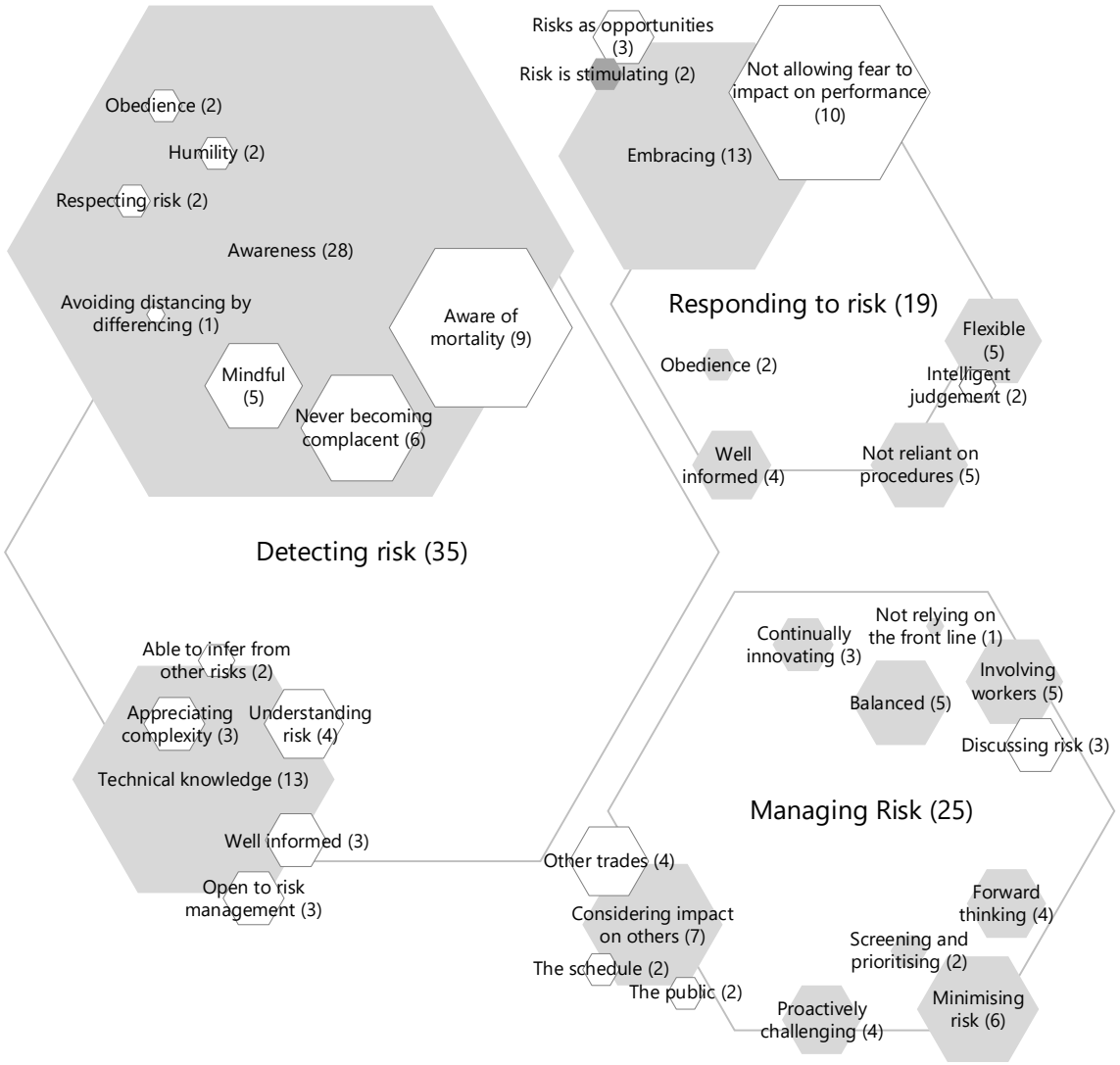


Figure 5.4: A healthy attitude to risk in construction

Detecting risk

Worker's ability to detect risk is dependent on a technical knowledge of construction processes, but also an abstract awareness of risk similar to that described by Fruhen et al. (2013) as chronic unease. According to participants, a healthy attitude to risk is one which is fully informed of risks and their potential severity; how risks develop, often unexpectedly, from hazards; and how risks can be controlled. Other participants also said those with a healthy attitude would be attentive, open to learning about risks, and able to extrapolate their knowledge to other risks — applying "common sense" rather than needing specific information on every scenario.

On the other hand, the majority of the responses concerned the less tangible aspect of risk detection.

> They keep that consciousness level up … make sure that they're thinking about the possibilities of what can happen around them.
>
> (Academic)

Participants described a heightened level of engagement, vigilance, respect, and mindfulness of risks as an important aspect of a healthy attitude. Key to this was avoiding complacency — never taking any situation for granted and continuously checking for hazards in a changing environment.

Unlike technical knowledge which is developed through training and experience, this mindfulness is more likely to have developed from previous experience of poorly managed risks and their consequences. One risk consultant described the stark difference between those who had had such *"an epiphany"* (Academic) and those who had not.

> You can always tell straight away … they have more morals than most. They've been either prosecuted or investigated or they've had something happen to them, or on their site, because they tend to ask for a more questions, and the right ones.
>
> (Risk Consultant)

Responding to risk

This awareness of risk reflects the concepts of chronic unease and organisational mindfulness which feature in Adaptive safety — in particular in high reliability organising (HRO). However, in contrast, there were also some participants who felt a healthy attitude to risk was one of unquestioning obedience and rigid adherence to procedures. This view was mostly held by those working in high-risk construction environments (such as off-shore or tunnelling) but shows a traditional model of safety-by-compliance is still prevalent.

Responses on a healthy manner to respond to risk were similarly divided between those who felt this was to follow procedures as instructed, and those who saw the value of flexibility, intelligence, and judgment. Aligning with an Adaptive model of safety, some participants highlighted the need for risk response to be sensitive to the context.

> A healthy attitude to risk is to be not just reliant on procedural knowledge … a healthy acknowledgement that plans can be improvised upon.
>
> (Academic)

In responding to risks, most participants agreed a healthy attitude was one that embraced risks — ensuring they are safe but not allowing risk aversion to compromise performance. Excessive risk aversion is not only expensive but takes the enjoyment out of work and degrades the relationship with the workforce. Participants stressed the importance of risk as an opportunity: A degree of risk keeps workers focussed, and overcoming hazards stimulates innovation; improves processes; impresses clients; builds teams; and gives workers a sense of pride and job satisfaction.

Managing risk

Although most participants discussed a healthy attitude to risk as a personal value, many also discussed the concept as an organisational strategy. This reflects the shift towards a systemic view of accidents — rather than seeing individuals as responsible — and the social construction of safety. These participants saw managing risk is a collective process, stressing a healthy attitude as one where responsibility is shared between designers, clients, and the supply chain.

A healthy attitude to managing risk is primarily the belief that risk should be minimised and mitigated as far as possible; proactively challenging processes and *"seeking to innovate our way out of risk"* (Academic). However, opinions were divided between traditional and Adaptive approaches. Some felt the best way to manage risk was through thorough planning: Carefully scheduling work to consider the impact on other trades and the public, prioritising high-risk activities, and responding proportionately to events. On the other hand, others saw risk management as dynamic and interpersonal — engaging workers in *"a real active discussion around risk"* (Risk Consultant).

Finding a *"sweet spot"* or balance was recurring theme in responses to this question. Just as Lekka et al.'s (2012) and Fruhen et al.'s (2014*a*) frameworks show safety leadership requires interpersonal leadership skill alongside technical knowledge of risk management, a healthy attitude to risk includes the technical and social competence to manage it appropriately. Overall, a healthy attitude to risk was described as a desire to reducing risk, while sharing responsibility; balancing autonomy and control (which is still seen as important in construction); and not compromising production.

5.4.4 Resilience

Although many participants were not familiar with Adaptive safety or resilience engineering (RE), responses to the question *"What would a 'resilient workforce' look like?"* provided valuable insights — promoting discussion around their interpretation of this term and its applicability to construction. Figure 5.5 illustrates participants' perceptions of 'resilience behaviours' ordered from least to most aligned with the literature from left to right. As with previous figures the shapes are proportionally sized to the number of participants speaking on this theme.

This diagram shows their differing views and divided opinions: For some, resilience was synonymous with compliance and discussions revolved around traditional aspects of safety — for example, a workforce which is stable, healthy, competent, experienced, well-briefed, and projects exhibiting good planning and housekeeping. There was also a tendency to discuss resilience as an individual or psychological construct rather than from an organisational perspective. Workers themselves are determined to *"stand up to adversity"* (Risk Consultant), but this 'resilience' actually causes them to put themselves at risk.

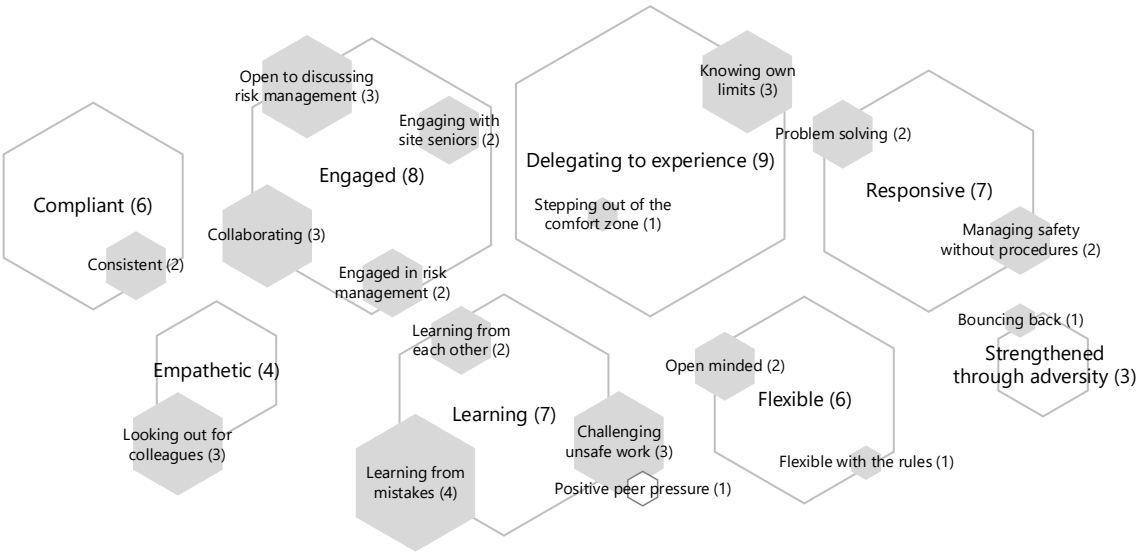


Figure 5.5: Behaviours of a resilient workforce

> A construction workforce is resilient in terms of being macho and tough, and they will work in whatever weather and things like that.
>
> (Safety Manager)

At the other end of the spectrum, participants discussed aspects of resilience such as flexibility, responsiveness, and strengthening through adversity. Interestingly, the risk consultant quoted below felt construction had become less resilient over time, with larger projects tending to take a 'one-person-one-job' approach rather than multiskilling.

> So they could bend and twist and be flexible to accommodate the business needs … I think [in the past] we had a resilient workforce that could be flexible and take on several tasks, within their comfort zone.
>
> (Risk Consultant)

Other participants recognised the regulator's drive towards a more resilient approach, *"trimming back on all the legislative plethora of documents … to make it more workable and understandable"* (Safety Manager).

> I think there has been that shift- I mean if you think about construction legislation, there is very very few rules which say *'you absolutely have to do this'* or *'have to do that'*. The point is that you a have to judge for yourself what the harm is and the hazard is.
>
> (Safety Manager)

Several responses did see resilience as a team-based capacity. Many spoke about the value of worker engagement, an active dialogue around risk, mutually asking questions,

problem solving collaboratively, and providing feedback. Their answers showed parallels with an interdependent safety culture, the resilience capacities to learn and respond, and deference to expertise — focussing on a team's ability to learn and self-organise based on its members' strengths and expertise.

> Ultimately sort of a climate of interdependency so workers have the ability to work on their own without having to be overly supervised, companies with a workforce that trains itself and self-regulates itself as well.
>
> (Safety Manager)

> They'd have this ability to manage without process, they didn't need the written word, they didn't need rules, they have a natural process going on where capability and competency was coming to the fore, in terms of how those teams were managing the delivery of that project.
>
> (Safety Manager)

These managers described how a resilient organisation would deal with the unexpected without rigid processes or management, instead drawing on capabilities and experience within the team. This organic vision (whereby resilience is a bottom-up capacity driven by the workforce) was only described by a small number of participants. Most saw resilience as a result of good leadership and organisation — top-down rather than emergent.

Although some saw the potential for resilience, particularly on smaller projects, almost all the participants were sceptical about applying it to construction: Reasons given for this were its legal implications; construction's orthodox approach to occupational safety and health (OSH); the challenge of getting buy-in from senior management and the workforce; the macho culture; and the untrustworthy and untrained workforce. The idea of giving construction workers more autonomy and ownership of risk was difficult to accept. This is discussed further in the following section.

5.4.5 Freedom

In line with Safety Differently's philosophy of *'people are the solution'*, the idea of giving construction workers more freedom over how safety is managed was discussed with participants. Many participants had a negative initial reaction — non-compliance is a major cause of accidents; however, after elaboration 17 were in favour of freedom provided this was within certain parameters. In general, participants spoke of a restrained level of freedom: Rather than *"let them loose on the site"* (Academic), they discussed freedoms in terms of engaging workers' expertise in planning work and managing risks. Even the participants who strongly disagreed with the notion were in favour a collaborative approach to risk management. Only a small minority took the concept to the extreme of using a 'common sense' approach or choose their own personal protective equipment (PPE).

> We have this compromise or this balance of giving them sufficient freedom to feel that they're in control of their own work and that they are contributing and that they're overcoming individual problems, but we also want to shield them from making bad decisions and putting themselves and others at risk.
>
> (Safety Manager)

For increased freedom

The majority of participants spoke of at least one potential benefit of giving workers more freedom: Primarily, this was because they felt workers' should be *"respected and recognised for the talent that they bring to the project, and their diversity as well"* (Safety Manager); their expertise should be appreciated as a valuable asset and integrated as early as possible in the design phase.

> I think the freedom we should give them is upfront, sitting down thinking about planning the job, and we can really draw on and use their experience to the utmost at that stage.
>
> (Safety Manager)

From an operational perspective, participants recognised that freedom could help the workforce to respond to problems and cope with change, and had the potential to improve productivity (albeit at the expense of safety) by harnessing workers' creativity and problem-solving skills. It is also a more efficient way of managing people on projects without the resources to *"micromanage"* (Safety Manager) and in situations where plans must remain flexible.

> We're relying upon the decision making on an hourly basis of the people who work for us, in order to get the work done.
>
> (Safety Manager)

Furthermore, participants felt workers appreciated freedom because it enhanced feelings of empowerment, respect, responsibility, commitment, and self-expression, and promoted communication and cooperation.

> The beauty of that as well is that if the workers have been involved in that they're much more likely to buy into it because they've helped design it.
>
> (Academic)

Against increased freedom

Although the majority of participants agreed workers should be given more freedom, all of them specified caveats. It should be implemented carefully, on a case-by-case basis —

depending on size, type of project, sector, cost, and level of safety integration at the design phase — and consider boundaries set by corporate policy, work standards, and clients' expectations. It is also only suited to situations where workers are competent, supervised, aware of the risks and working within a good safety culture.

Arguments against increased freedom focused on the practicalities of implementing such a policy within an industry which is project-based and resistant to change. Construction relies on the standardisation of processes and the skills of specialised trades: In large multi-organisational projects these need to be meticulously coordinated. The risks change quickly making them difficult to manage, and construction often takes place within hazardous domains (such as live process plants) where not only construction risks need to be controlled but those of the host environment. From a management perspective, participants felt safety-by-compliance would be easier to manage and defend in court should an accident occur. The influence of the litigious culture of construction was clear as participants found the idea of a laissez faire approach to safety challenging.

> What happens if there's an accident and we haven't put all of these things in place? … People are scared of [change] because you don't know what's going to happen. So I think it's around this- there's fear around the unknown.
>
> (Academic)

Participants also cited problems of giving freedom to workers whom they felt did not have the competence or risk perception to cope with increased freedom. Four participants felt workers could not be trusted; they would push the boundaries of safe operation, fail to wear appropriate PPE, and cause accidents through non-compliance.

In contrast to those who felt workers appreciated the empowerment and self-expression that came with increased freedom, three participants said workers who chose a career in construction did so *"because they don't have to answer questions, they don't have to stand up in front of people, they don't have to make suggestions, they just have to do what they're asked to do that day and get on and get it done"* (Construction Manager). Increased uncertainty and responsibility, and a requirement to think, engage and communicate with others would not be welcomed by the construction workforce.

Finally, one participant felt workers already had a great deal of freedom in the sense that they were about choose their employment and the projects they worked on because of the flexibility of the industry. They have freedom to engage in risk management but don't take up this offer.

5.5 Discussion

The findings of this research provide an insight into the work of safety managers, exploring how they perceive and influence workers' attitudes to safety. For some, safety-consciousness was unquestioning compliance, but others showed an appetite for a less

forceful rigid approach. In line with Adaptive safety, most interviewees felt that workers would benefit from greater autonomy but tempered this with a firm caveat about competence and experience. Trust and ownership are important factors in risk management but, given the unique nature of construction and its challenges, a traditional approach to safety is still seen as valuable. Despite this, participants suggested more could be done to reduce the reliance on paper-based safety; integrate safety into primary processes (as opposed to seeing it as a separate activity or department); cross-skilling of trades to increase risk awareness; and engaging frontline workers in risk management activities.

Discussing the traits and behaviours of safety-conscious leaders with experts in construction allows the different aspects of successful safety leadership to be conceptualised. Safety Leaders need both power and safety expertise to build relationships and influence culture, but other factors such as trust, respect, authenticity and humility have also been proposed as significant. Interviews found leaders in construction should possess expertise, integrity, authority, open-mindedness, and interpersonal skills — empathy, charisma, communication, and likeability. These traits underlie the behaviours shown at the top of Figure 5.2 which contribute to safety-by-resilience rather than safety-by-compliance. This model is simplified in Figure 5.6 which illustrates the continuum of safety behaviours becoming increasingly engaged and collaborative with improved worker engagement and safety culture (Westrum 2004, Neal and Griffin 2006, Hoffman et al. 2003, Pilbeam et al. 2017).

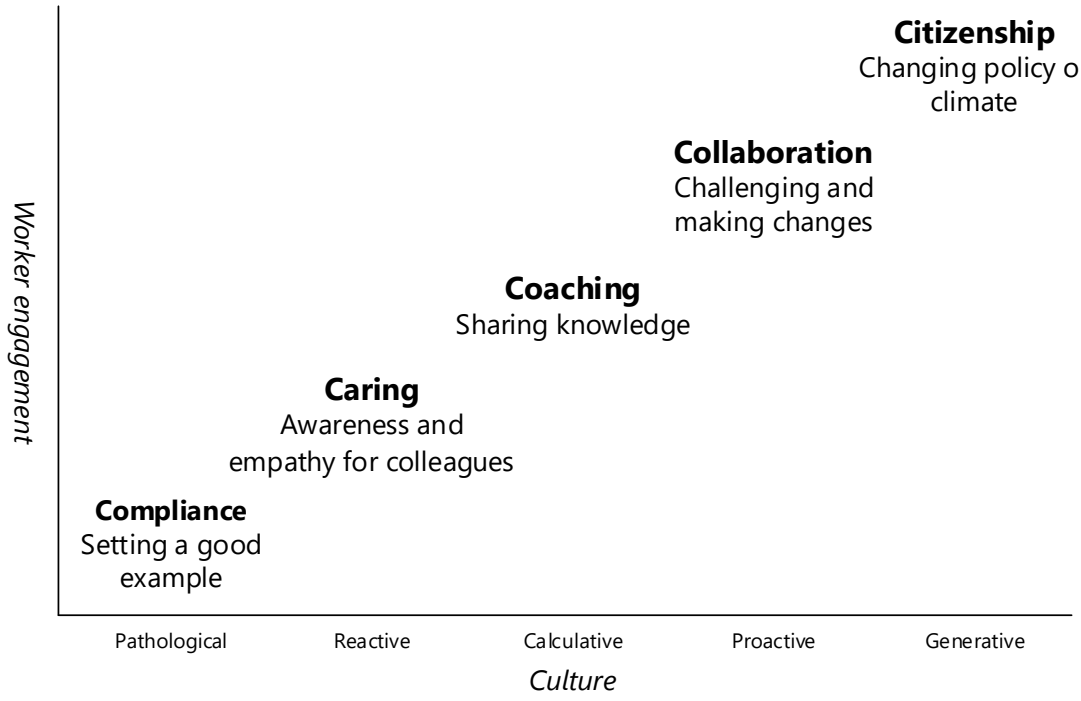


Figure 5.6: Safety leadership and culture maturity model

The levels show safety behaviours shifting from prevention to promotion and then influence an increasingly wide sphere — from coaching others, to collaborating on processes,

to changing organisational and industry-wide policies. Showing safety leadership as a continuum in this way illustrates that it is not a fixed trait; different styles of leadership are required in different situations and types of work. Furthermore, safety leadership is not only a product of safety knowledge and authority: While these support the lowest (Compliance) and highest (Citizenship) levels, other degrees of safety leadership are also underpinned by empathy, integrity, and openness to new ideas.

> They need to ask us what we need, not tell us what to do. Ultimately, to understand how work actually gets done, they need an open mind and a big heart.
>
> (Dekker, 2018)

While research in safety leadership has been dominated by its 'leadership', rather than 'safety' component, this conceptualisation highlights other aspects of safety leadership besides these. It also emphasises safety leadership is not limited to those in a position of authority as influence is only one aspect of this phenomenon.

A key theme from the interviews which marks the transition from preventative to generative safety is proactivity. Interest in proactivity has grown in recent years, paralleling interest in resilience: Beyond occupational safety, modern work is increasing in uncertainty and interdependence — requiring an agile and innovative workforce (Parker and Bindl 2017, Curcuruto and Griffin 2017). Proactivity is defined as *"taking control and making things happen rather than watching things happen. It involves aspiring and striving to bring about change in the environment and/or oneself to achieve a different future"* (Parker, Bindl and Strauss 2010, p. 828). Therefore, to be described as proactive actions must be change-orientated and self-starting: This could be to either bringing about change within an organisation itself; strategic changes to improve the organisation's performance in its environment; or individual changes to 'craft' (Slemp, Kern and Vella-Brodrick 2015) a role (Parker and Collins 2010).

Early research in the 1990s explored proactivity as a personality trait (Crant, Hu and Jiang 2017), but contemporary perspectives see the concept as a pattern of behaviour in individuals, teams, organisations or societies (Parker and Bindl 2017). Curcuruto and Griffin (2017) define the prerequisites for proactive behaviour as both 'proximal' and 'distal': The proximal component includes an individual's capability and commitment — also described as *"can do"* and *"reason to"* (Parker et al. 2010) — which is supported by distal aspects of their role (knowledge, competence, skills, expectations, and definitions) and the organisation (values, climate, routines, social exchanges, leadership, job design, supervision, and team design) (Curcuruto and Griffin 2017).

Likewise, the findings of this study have highlighted the importance of considering Adaptive safety as a product of distal and proximal antecedents: Neither safety leadership nor proactivity can be considered as individual traits, so focussing on individuals as a means to cultivate organisational resilience neglects its organisational prerequisites. Engaging

and empowering workers is not only a consequence of good leadership, but enabled by the culture, resources, and structures to support it.

5.6 Conclusion

An engaged workforce is an important aspect of Adaptive safety. This work sheds light on the role of leaders to support worker engagement: In terms of safety leadership as a tool for fostering resilience, participants advocated individualised relationships, trust, coaching, and collaborating with workers — paralleling best-practice in leadership generally. These leadership behaviours are recognised as exemplary by construction professionals, yet construction is not safe or resilient. Questions therefore remain about why this type of leadership is difficult to implement in construction, and other factors which play a part in organisational resilience. The role of systemic factors or 'distal antecedents' which support resilience are explored in Chapter 6.

Construction as a Complex System

6

Contents

6.1 Introduction

Chapter 5 explored safety leadership in construction and the aspects of this which align with an Adaptive approach. Many of the participants interviewed recognised the importance of authenticity and trust, engaging with workers, building relationships and encouraging proactivity. Furthermore, most agreed there was scope to give workers more freedom to manage their own tasks and safety. Contrary to this, many participants felt obedience, control, and compliance were still key to safe operations in this sector. This chapter uses soft systems methodology (SSM) (Checkland 2001) to describe the complex, systemic challenges of construction with a view to explaining why these barriers make it more difficult to take an Adaptive approach (Objective 2 — *"Understand the challenges of construction as a system"*).

This work has been published as a journal article in Applied Ergonomics (Harvey, Waterson and Dainty 2018*a*) and as a conference paper (Harvey, Waterson and Dainty 2018*b*) which was presented at the Congress of the International Ergonomics Association (IEA) in Florence.

6.1.1 Systems thinking in construction

There have been calls for construction to move away from a 'root cause' mentality towards accidents since the turn of the millennium (Gibb, Hide, Haslam, Hastings, Abdelhamid and Everett 2001). Many studies looking into the factors affecting performance on construction sites emphasise managing safety at every level of the system (Sawacha, Naoum and Fong 1999); In particular, the contributing factors in construction accidents (ConCA) model promotes a holistic view of incidents (Haslam et al. 2005). The impact of the ConCA model has been widespread in academia, industry, and government. 13 years after its original publication the article continues to attract more attention year-on-year, confirming its position as a seminal paper in construction safety.

Haslam et al.'s model shows the importance of considering relationships between the immediate circumstances causing an accident, and the factors which shape and originate it — following in the footsteps of Reason's 'Swiss Cheese' metaphor (Reason 2000) (Figure 6.1). The research highlighted the contribution of political originating influences — such as education and economic climate — and as such went on to inform a government inquiry which said:

> The HSE[1] cannot succeed in eliminating fatalities without the support of the population as a whole and the Government. This is a social issue and is too important to be confined to the narrower focus of health and safety.
>
> (Donaghy, 2009)

Donaghy's report not only recognised the need for change to be driven from outside the industry, but also the breadth of causal factors. It includes an extensive list of recommendations — from equipment and working conditions to unions and directors' responsibilities.

ConCA demonstrated the need for a collaborative effort to own and manage risk from the client team, concept designers, project management, preconstruction planners and the industry as a whole, and to ensure risk management robust, integrated and participatory (Gibb, Haslam, Gyi, Hide and Duff 2006). An integrated approach has been shown to support project success (Franz, Leicht, Molenaar and Messner 2017), organisational learning (Behm and Schneller 2013), the relationship between designers and constructors, (Atkinson and Westall 2010), teamwork between trades (Baiden and Price 2011) and safety leadership, by developing trust and communication throughout the system (Donovan, Salmon and Lenné 2016). Systems thinking has been applied to demonstrate the emergence of events, such as why safety outcomes are often inconsistent with inspection results (Saurin 2016) or supposed leading indicators (Lingard, Hallowell, Salas and Pirzadeh 2017). However, a need for further research into systems thinking in construction has been recognised (Love, Ding and Luo 2016); While in other sectors systems models have progressed and developed, ConCA remains the best fit for construction.

[1] Health and Safety Executive

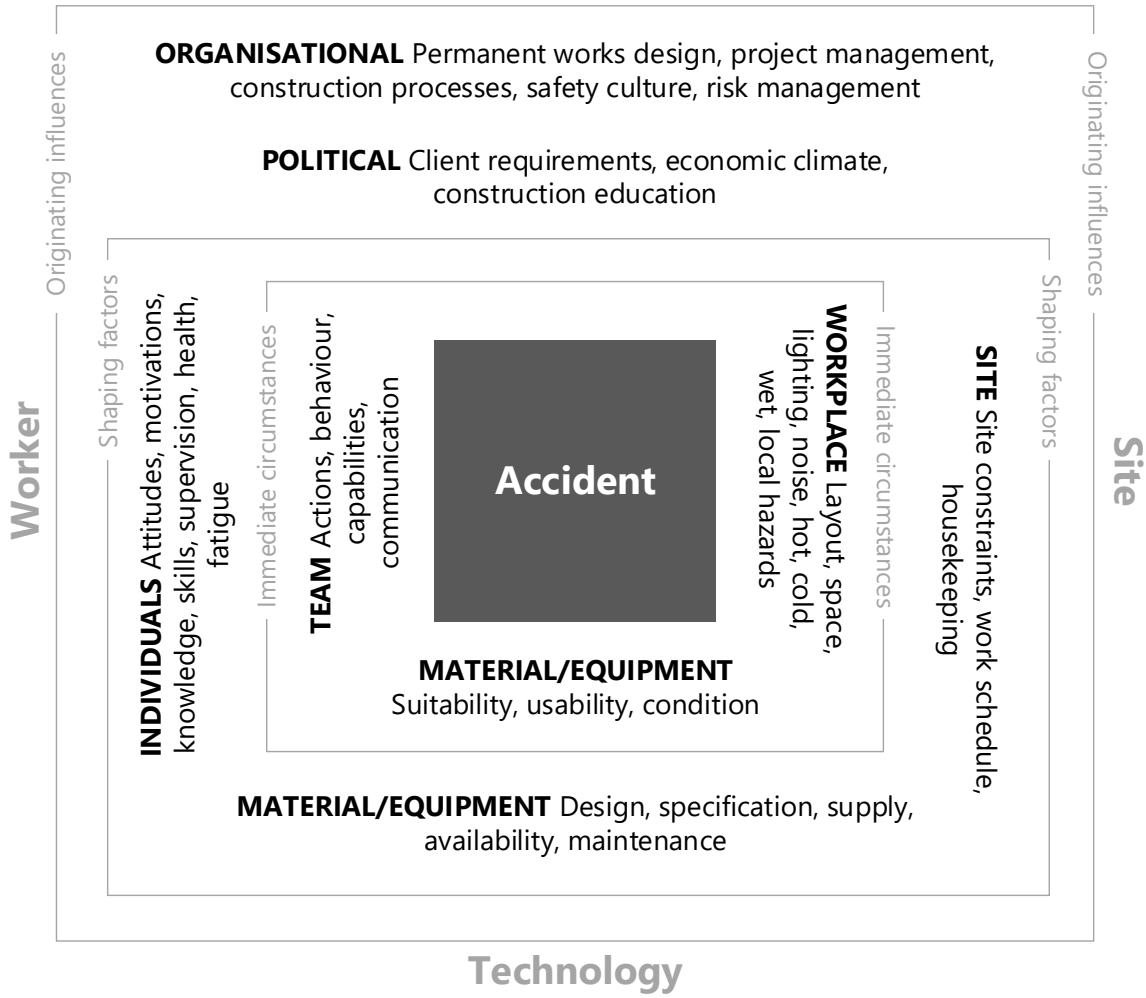


Figure 6.1: The ConCA model (Haslam et al. 2005)

The existing literature on systems dynamics modelling in construction often takes a 'hard' (Scholz and Tietje 2002, p. 120) or objective approach to modelling the complexity of construction organisations and performance, based on data mining of accident reports (Chi and Han 2013), existing literature (Shin, Lee, Park, Moon and Han 2014), or simulations (Goh and Askar Ali 2016). Conversely, literature on risk management and risk-taking focuses on the range of proximal and distal factors which predispose workers to these behaviours (Choudhry and Fang 2008, Oswald, Sherratt and Smith 2014) but rarely explore the relationships between these and where they originate from (Asilian-Mahabadi et al. 2014).

6.1.2 The organisation of this chapter

The aim of this study was to review the credibility of the ConCA model with a panel of expert interviewees. Their perception of the system, the pressures they face, and the factors which shape their decision-making and leadership style were discussed and mapped onto the original framework. This included the intrinsic hazards of the building process, the

workforce, and the wider system. These data were used to crystallise relationships between these factors and substantiate the systemic nature of accident causation.

The findings are presented as two sections. First looking bottom-up at the nature of work and the workforce, then looking top-down at the organisational and industrial challenges. The discussion brings these together drawing out five key themes, or common perceptions of workers, and exploring their systemic origins. Finally, a developed and updated version of the ConCA model is proposed which gives a fuller picture of accident causation.

6.2 Method

The participants and data collection for this study were the same as in Chapter 5, see Section 5.2 and for details. In addition to thematic and content analysis described in Section 7.4, this study used SSM: This approach enabled relationships between the wider industry and its workers' traits to be explored and provided evidence to support why leaders' traits and behaviours are successful or unsuccessful in the context of construction.

6.3 Data analysis

This latter part of the interview study uses SSM (Checkland 2001) to explore construction as a complex system, managers' priorities, and the challenges of risk management with a view to explaining why an Adaptive approach to safety would be difficult in this sector. The 'Rich Picture' method facilitates visual communication and holistic thinking about messy problems, situated in the context of complex systems within which they exist. Checkland's (2001) method advocates exploring the structures, processes, climate, people, issues and conflicts, and the relationships between these.

Having already analysed the data thematically for the previous Chapter, rich pictures or conceptual models were developed from the data in accordance with the principles of SSM (Figures 6.4, 6.5, 6.6, and 6.7). These are not 'hard' quantitative models, but describe construction as a complex system — revealing the relationships between factors that contribute to construction's problems, with a view to understanding and resolving them.

6.4 Findings

6.4.1 Hazards in construction

The initial questions sought to extract the problems and pressures of the construction industry which make risk difficult to manage. Participants' responses to these two questions often provided overlapping content, demonstrating the interwoven nature of hazards and validating the use of sociotechnical system (STS) analysis to understand this complex system. The interaction between the intrinsic hazards of construction and the risks caused or exacerbated by poor management was most clearly demonstrated by the participants who

questioned whether describing construction as hazardous was correct and instead felt poor management (of risks and the project as a whole) was at fault.

> I don't think construction is dangerous, I think what's dangerous about construction is not truly understanding the hazards that construction presents, and therefore not evaluating the risks associated with those hazards, not properly designing out hazards.
>
> (Safety Manager)

Intrinsic hazards of construction work

17 themes were extracted which relate to the intrinsic hazards of the construction process, as opposed to management issues which interact with these or introduce their own risks. These are illustrated as a tree diagram in Figure 6.2. The number in brackets following each subject in the figures show the number of responses including that theme. These numbers are aggregated into high-level themes, where the same participant is only counted once, but which also include responses from other participants about the overall topic that could not be subcategorised.

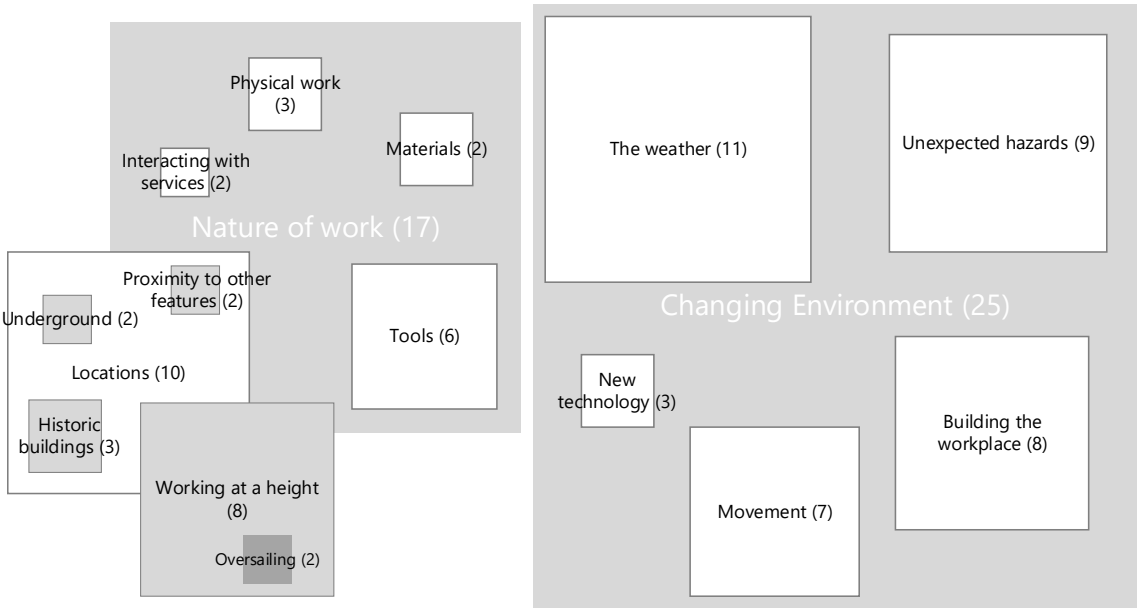


Figure 6.2: Tree diagram of the intrinsic hazards of construction processes

Features of construction process such as dangerous materials, tools and the physical nature of work were identified, as well as the hazards of building within a context of physical geography and existing infrastructure. Working at a height was also a recurring theme which reflects its importance as one of the major causes of fatalities (HSE 2014*b*). Nevertheless, these physical hazards were overshadowed by the changing nature of construction projects, the effects of which were universally recognised. This included both external

changes, such as weather and unanticipated hazards of the site, and internal changes as the workplace grows and materials are transported.

> The biggest thing about construction is that it's permanently temporary until the day we finish, and everything changes all the time, even the things you've done the same are different.
>
> (Safety Manager)

> Walls go up and so all of a sudden our fire escape routes need to change, or we've dug a trench across the- the ground and now we have to change our whole traffic management system.
>
> (Risk Consultant)

As well as physical hazards within a changing environment, many participants chose to discuss the way these hazards are exacerbated, and other risks introduced, by industry and workplace factors. These are explored in 6.4.2.

The construction workforce

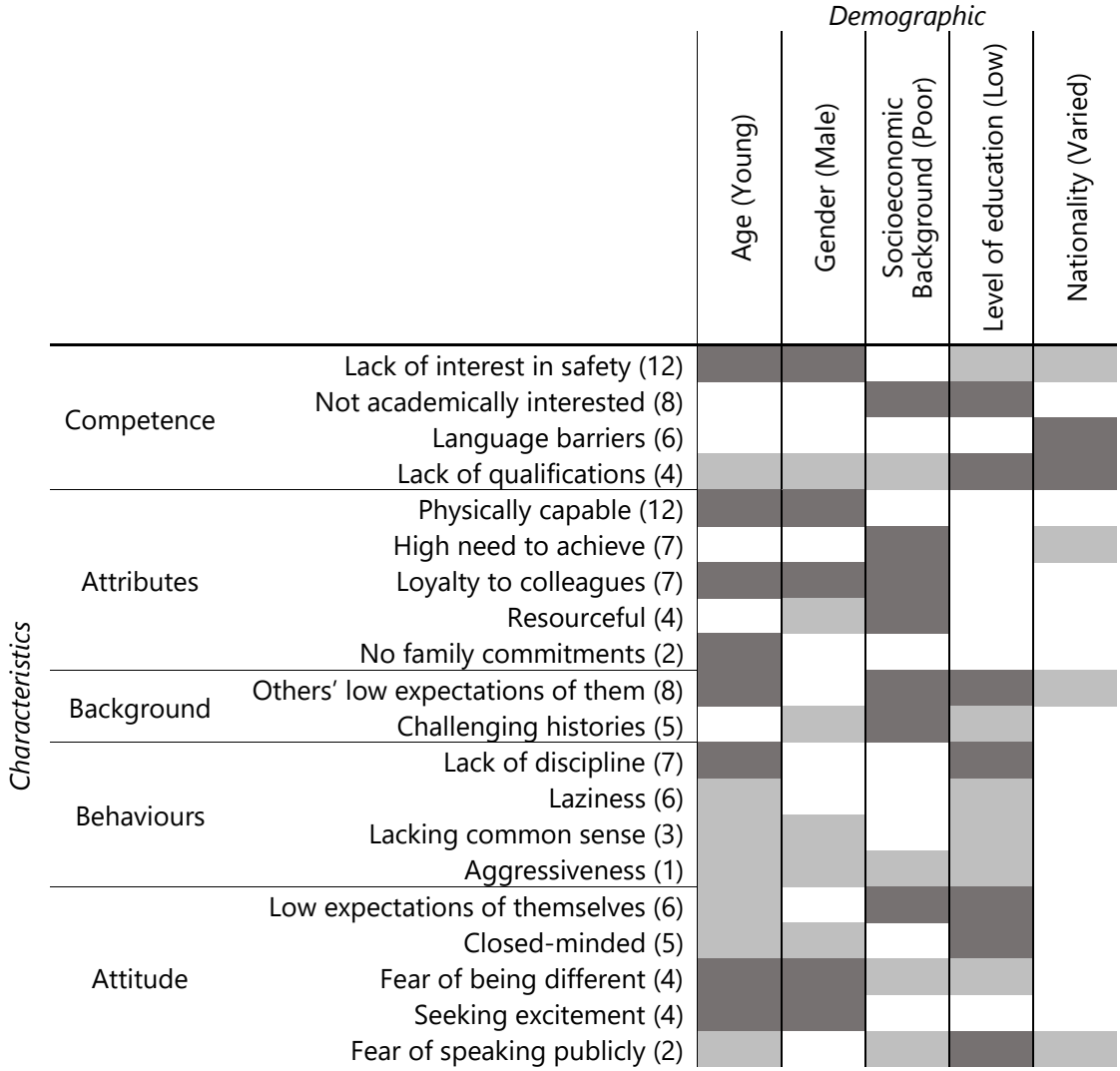
The intrinsic hazards of the construction process would not have such potential for harm if not for the proximity of the workforce within these activities.

> You've got machinery and humans together which as we know is a terrible mix … in a factory hopefully either the machinery's moving and the people are stood still or vice versa, we've got both happening at the same time!
>
> (Construction Manager)

Undoubtedly, people play a role in creating risk in construction; it is human nature to be variable, unpredictable, prone to error, and to struggle with change, but there are many factors which make those attracted to work in construction — typically young, agile, men — particularly susceptible to unsafe acts. Table 6.1 is a matrix which compares demographics of the construction workforce with common traits that were seen to increase their propensity to take risks. The shading shows where participants drew links between the characteristics of the workforce and these demographics — dark for a strong association, and light for possible. As with Figure 6.2, the numbers in brackets represent the number of respondents who spoke about each characteristic.

The requirements for education and language skills are low, and the short-term contracts provided by project-based work are appreciated by workers who are young and free from responsibilities, and therefore able to work long hours and travel. Construction workers are known for being tough and physically capable, but this can cause workers to push themselves beyond safe (and healthy) limits because they believe they are fit, strong, flexible, and have good balance and stamina enabling them to cope with the tasks.

Table 6.1: Demographics of the construction workforce seen to exacerbate risk-taking



Many of the factors in Table 6.1 lead workers to engage in risk denial: The male-dominance of the industry pushes workers to show they are able to cope with its risks; economic disadvantage means workers act to cut-corners and save money; age can mean workers are complacent based on their physical capability (young) or experience (older); and workers with low academic attainment are less likely to fully understanding the risks. The diversity of nationalities working in construction is also a demographic of the workforce which exacerbates risk-taking behaviours, although rather than the denial of risk, this can be attributed to misunderstandings due to language barriers, different expectations of occupational safety and health (OSH), and a lack of standardised international qualifications.

Unfortunately, the type of work attracts workers with traits which, while desirable from a production perspective, mean they can be unpredictable, complacent and prone to risk-taking. Positive attributes such as being hardworking, innovative, and free from commitments can have a negative impact on judgement.

> One worker actually said to me: *"If I die, my parents are the only ones that are going to miss me."*
>
> (Academic)

This recklessness suggests workers lack an appreciation of their worth and their impact on those around them. The desire to be seen as a hard worker can be partially attributed to the importance of reputation for securing work in the industry, but can also be interpreted as a product of workers' backgrounds — low academic attainment and economic disadvantage. The low expectations held by others and of themselves fuel a strong need to achieve and be seen as helpful and resourceful.

> In [area] we tend to be a bit poorer and we think a bit more creatively … because they're trying to save money and we've got to tell them that their safety- well we do tell them that their safety is much more important than any amount of money in the world.
>
> (Safety Manager)

> Another reason why construction is risky is some people are very keen- which is an admirable trait- very keen to help others, and almost jump in when they can't- when they haven't got the competence to do that particular task, to try and help out.
>
> (Training Coordinator)

Another trait mentioned by participants was a fear of speaking in public — a skill which is not important for construction work — but which, alongside peer pressure, can contribute to an unwillingness to report unsafe incidents. This lack of confidence combined with the low expectations, low sense of personal value, and a strong need to achieve suggest one factor contributing to construction workers' cavalier attitude to risk is a desire to prove they are capable.

Factors shaping the acceptability of risk

The significant numbers who felt that construction workers were oblivious to risk, and many more who said they had a high tolerance or poor understanding of risk, prompted an in-depth analysis of the factors participants felt influenced this.

Complacency was a prominent theme, said to be caused by either experience or previous positive outcomes; familiarity with such situations; or distancing — an 'it would never

happen to me' mindset. Other significant negative effects were attributed to a lack of competence or training about risk, and a poor or macho safety culture. Conversely, participants felt workers perceived the risks as less acceptable if they had experience of previous accidents, had commitments to family or friends and colleagues, management were committed to enforcing safety, and the location of work felt dangerous (e.g. underground or at sea).

> They've all sort of seen something they'd prefer not to … they turn round and think *"Well hang on, the ambulance isn't going to come toddling up the road, there isn't one"* you know? So whatever happens you've got to survive it for at least- well if you're off shore at least an hour.
>
> (Risk Consultant)

There were several factors which have potential to have either a positive or negative effect, such as peer pressure and previous experience of the construction industry, national culture, and age. Participants were evenly split as to whether older workers became more or less tolerant to risk with experience, and similarly participants felt younger workers were either aware of their lack of experience or thought they were invincible. Variability can also be seen within the international demographics of the construction industry: Workers who have been exposed to poor safety attitudes in other countries may have no concept of formal safety management systems, making them difficult to control, whilst other cultures take a rigid approach to rules meaning their obedience is advantageous for safety.

When the magnitude or consequence of a risk is perceived as high and uncontrollable, workers were said to be more cautious; however, this could also have a negative influence as serious risks such as high voltage current or working at a height can overshadow smaller risks making these seem more acceptable. Workers were thought less likely to perceive a risk if it was relevant to their trade, and they had therefore become complacent about it, or it was not relevant to their trade, and they did not understand it. This also meant workers were likely to only take ownership of risks relevant to their trade and compartmentalise their management.

Communication about risk management meant workers were more vigilant, but 4 participants said risk management measures had the potential to encourage tolerance because, in accordance with risk homeostasis theory (Adams 1995, Wilde 1982), workers feel the risks have been adequately controlled. Finally, if workers felt valued by management, that their skill was valuable, had recent training, or were trained in multiple trades they were less tolerant to risk. As seen in the previous section, attitudes to risk in construction are highly varied and subject to the complex interaction of many factors.

Factors leading to unsafe acts

Factors such as experience, training and culture, influence the acceptability of risk; however, participants also spoke of the pressures and distractions that could cause workers to behave unsafely, regardless of whether they felt the level of risk was acceptable.

Whether or not a worker chooses to accept a risk depends upon its perceived benefits whether these are worth the risk (Adams 1995, HSE 2004). Figure 6.3 shows that participants felt workers were often motivated to take risks by money, peer pressure, time pressure, and concern for their reputation. As well as these trade-offs, some participants mentioned dissatisfaction as a motivation for unsafe acts, particularly where they felt restricted or patronised by safety measures, and a few said they would act unsafely if distracted by a mobile phone or personal issues.

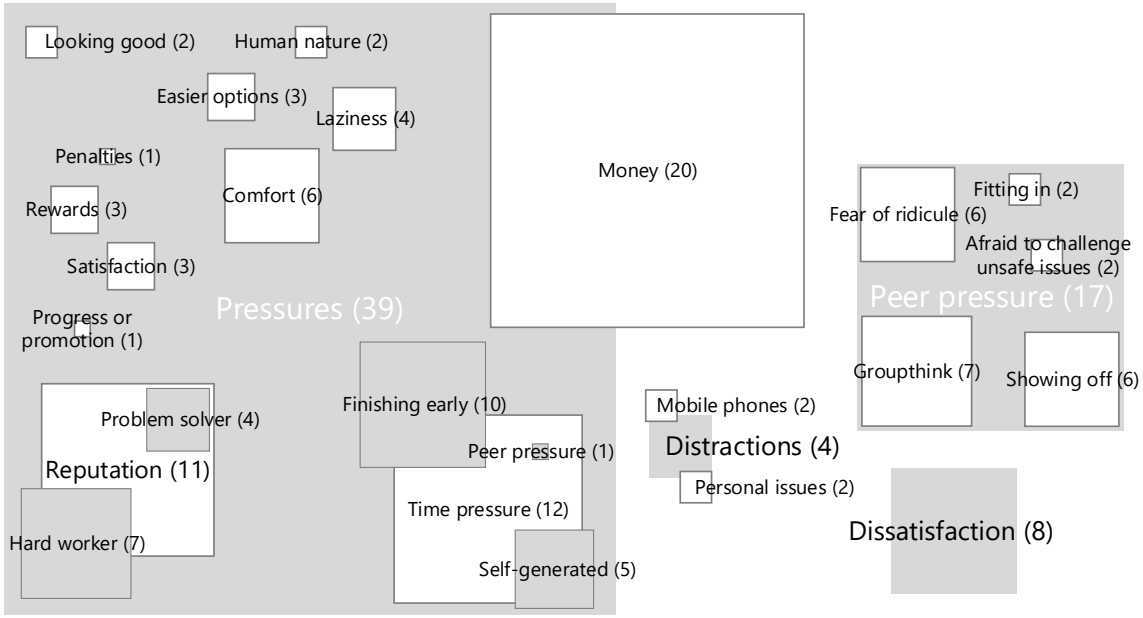


Figure 6.3: Tree diagram of factors which can cause workers to trade-off safety

> The trouble is the workers will latch onto this [inappropriate safety measures] and see this as an inability of the management to be flexible, in what they're doing, and then they sort of rebel against that, and there is resentment and a negative attitude.
>
> (Academic)

Workers took unsafe actions because they were not aware of the risks themselves or their impact on others. In particular, workers were more likely to behave unsafely if they were not aware of the consequences of the risk and lacked knowledge or experience around it. More complex risks, where the hazard develops from combination of causes, and those outside a worker's trade were also likely to be missed.

Attitudes towards risks are an important consideration, but one of many factors which contribute to the decision-making process of weighing up knowledge and awareness of risk against pressures, priorities, and distractions. So far, unsafe acts have been discussed from an individual perspective – the factors that affect the acceptability of risk and decision-making – however, these should be seen in the context of the system: Participants also spoke

about many team, workplace and organisational influences which can affect someone's propensity to act unsafely and show the importance of not placing blame at the frontline.

To some extent the conflicting factors in Figure 6.3 can be seen as products of both the workforce and the industry: Time pressure may stem from a desire to finish early but also the client or poor planning; reputation is important to secure work in a competitive industry; poorly designed personal protective equipment (PPE) is bulky, uncomfortable, and interferes with operations; showing off shows a desire to be accepted into a transient community; and being motivated by money is not only an individual trait but one which reflects the sector as a whole and companies' desire to stay in business. It is clear that sacrificing safety is not an individual's choice but a complex decision based on many pressures and issues.

6.4.2 The wider challenges of managing risk

Thus far, the intrinsic hazards of construction have been extracted, and aspects of the construction workforce which participants felt increased workers' propensity for risk-taking behaviours. The remaining data related to other issues which made managing risk difficult in construction. These codes were grouped into a tree structure, ordered into a hierarchy of distance from the frontline based on ConCA ('Originating Influences', 'Shaping Factors', and 'Immediate Circumstances') and ranked according to prevalence (Table 6.2). The relationships between these factors, and the site and workforce challenges already identified, are discussed in the following section.

Table 6.2: Originating, shaping, and immediate factors which make managing risk difficult

Originating Influences (75)

Client (41)	Conflict of interest (32)	Cost (22)
		Speed (19)
		Reputation (4)
		Supply chain (2)
	Underinformed (12)	About construction (8)
		About safety (5)
	Lack of buy in (9)	Ownership of risk (6)
		Compared with other sectors (4)
	Intimidation (1)	
	Varied (1)	
Subcontracted structure (35)	Transient workforce (24)	Lack of loyalty to tier-1 (8)
		Varied levels of experience (5)
		Disposable (4)
		Unstable culture (4)
		Loss of local knowledge (2)
		Difficult to implement safety strategy (1)
	Standardisation (10)	
	Mistrust (6)	
	Coordination (5)	
	Communication (5)	
Variability between projects (19)	Size (12)	
	Lack of transferability (8)	Knowledge transfer between projects (2)
		Pushing boundaries (3)
	Domain (2)	
	Type of construction (2)	
Unregulated (11)	Lack of standardisation (5)	
	No need for formal qualifications (4)	
	Companies (3)	
Financial risk (2)		

Shaping Factors (74)

Accountability (32)	Shirking safety responsibilities (15)	To the health and safety team (8)
		To the sub-contractors (7)
		To the client (2)
	Compartmentalisation (12)	Silo working (7)
		Separating safety from primary activities (5)
	Fear of litigation (10)	
	Blame culture (4)	
	Blurred chains of responsibility (2)	
Poorly designed policies (32)	Unsuitable rules (25)	Lack of sensitivity to the task (17)
		Not done by an expert in the task (9)
	Lack of review (4)	
	Reactive (3)	
	Disproportionate (2)	
	Measurable (2)	
	Not evidence based (1)	
Planning (26)	Not integrating safety at the design phase (13)	
	Coordinating a complex project (8)	
	Unpredictable (6)	
	Undesignable workplace (6)	Unlike a factory (5)
Attitude towards risk (20)	Acceptance of risk (7)	
	Lack of new ideas (5)	Awareness (3)
	Minimum compliance (5)	
	Cost and time for change (4)	
	Conservative (2)	
	Focus on safety not health (1)	

Immediate Circumstances (59)

Worker buy in (35)	Lack of interest (19)
	Cynical about safety (7)
	Intimidated by professionals and paperwork (5)
	Lack of loyalty or responsibility (4)
	Demonising health and safety staff (3)
	Resolving issues at the frontline (2)
	Patronised (2)
Lack of training (20)	Not informed about risk (8)
	Lack of cross-trade skills (1)
Poor integration of management staff (17)	Lack of consultation (10)
	Lack of trust in workers (3)
	Not engaging (1)
Communication (16)	Lack of live discussion (7)
	Difficult to enforce safety (4)
	Changing attitudes (3)
	Failure to stop and revise plans (3)

6.5 Discussion

The findings show the range of challenges that influencing decision making: Construction work is high-hazard in combination with constant change making risks difficult to control; the demographics of the workforce (young, male, international, and with low levels of education and economic privilege) are associated with characteristics that exacerbate risk-taking behaviours; and the project-based, client-driven structure of the sector is competitive, unregulated and litigious.

Primarily, workers were seen as oblivious to the risks or tolerant and willing to deny the risk in the face of other priorities. However, a holistic or systems thinking approach to analysis helps to reveal the complex relationships between this and other immediate, shaping and originating causes of accidents — challenging the tendency to blame workers and look for a "root cause". The systemic origins of five worker attributes that were seen to cause accidents — low engagement with safety, 'silo working', lack of competence, 'cutting corners', and a high risk-tolerance — are explored in the following section. The industry-wide factors which cause, attract, and exacerbate these behaviours demonstrate the value of systems thinking to address construction risks.

6.5.1 Worker traits and their systemic origins

Low engagement with safety

On the surface workers are seen to lack interest in safety and therefore fail to engage in risk management. However, this is a relationship which goes both ways: not only do workers fail to engage with management, but management fail to engage with the workforce. Although the workers are the experts in the task, it is presumed they are risk-takers who need to be controlled and this limits collaboration; thus, because their expertise is not valued, they disengage from the project. Many of the participants recognised the need for enhanced collaboration, but the project-based nature of the industry makes this difficult: Learning is disrupted in temporary organisations and there is limited time built into the schedule to gather input from the workforce during the design phase.

This lack of engagement means safety becomes an afterthought and policies are ill-suited to the context, making sweeping generalisations about the nature of construction work. Poorly designed procedures and equipment cause workers to become cynical and, again, disengaged because they feel they have little influence or value. They become disobedient (either as a pragmatic reality of getting work done or as an act of animosity), resentful of their employers, and demonise OSH — perpetuating the disconnect between workers and safety which is perceived as their lack of interest. This emphasises the importance of integrating safety into primary work activities so they suit the context and support, rather than hinder, efficient work. These relationships are summarised in Figure 6.4.

It is clear some effort is needed to break the vicious cycle of managements' mistrust and rigid rules leading to workers' disengagement and disobedience. Although workers appear

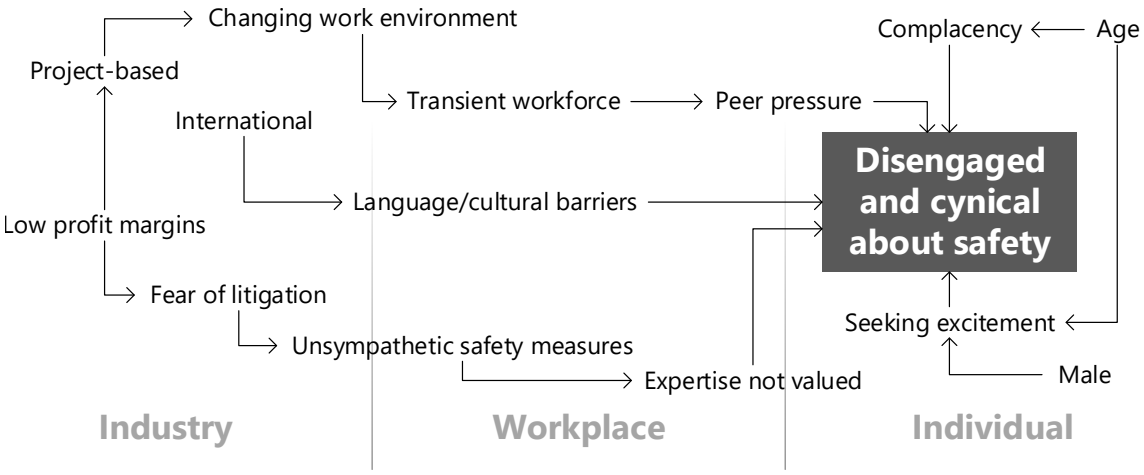


Figure 6.4: Factors contributing to construction workers' lack of engagement

uninterested in safety, this could be because they are not given timely opportunities to engage, do not expect to be engaged with, or have become cynical about safety because their input is not valued. Rather than blaming workers' lack of interest, it is important to recognise the impact of this as well as peer pressure, fear of school-like situations, intimidation from professionals, cynicism, and a misperception of OSH staff as enforcers. Acknowledging these reasons for low engagement shows where interpersonal skills and guidance for engaging with workers could be developed and improved in light of this.

'Silo' working

Similarly, as a result of low engagement between workers and management, workers are seen to work in silos — compartmentalising their role and the risks associated with it.

> When they're just treated as a part in a much bigger picture- jigsaw, and your part isn't that important- or that's how they perceive it perhaps, then their interest in that project and that organisation, and risk, is diminished.
>
> (Academic)

Workers contracted to do a specific task for a specified price rarely appreciate the significance of their role in relation to the project. Accidents can happen because they fail to see the 'big picture'; how their work might interact with other trades on site or the wider impact the risks they take could have. On one hand this could be seen as a lack of competence, but it is also indicative of problems within the project-based nature of construction: Projects need specific skills for certain periods of time and work to a tight schedule. Brief temporary contracts allow little time or incentive to invest in training, and workers are under pressure to finish their tasks and move on. The system is not set up to allow relationships between trades to develop and instead they become inward-looking, defensive, and isolated, which narrows their perception of risk. These relationships are summarised in Figure 6.5.

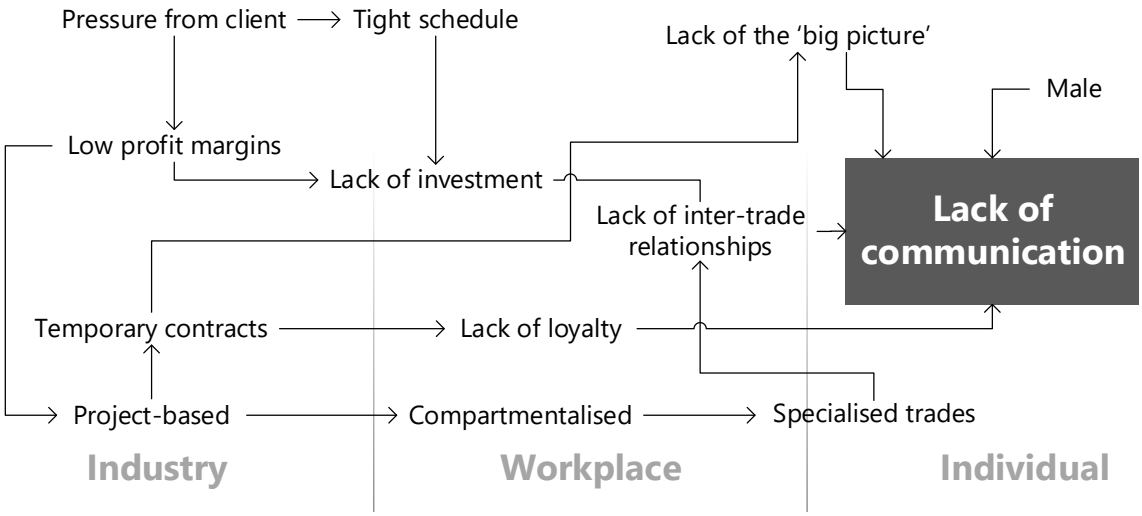


Figure 6.5: Factors contributing to construction workers' lack of communication

Several participants felt that workers' perception of risk was higher if their trade was valued, particularly if their work was visible in the finished building, and they had an awareness they were contributing to something they could be proud of. Projects are more likely to be safe and successful if workers understand their role as part of a larger project, particularly if the project is high-profile (Bolt et al. 2012). Some participants also felt training workers in skills other than their own would help them to identify the hazards of other trades. However, although autonomy and job rotation have been shown to improve job satisfaction (Parker and Bindl 2017, Waterson et al. 2015), it would be difficult to justify and implement this in a transient environment where the skills required are highly specialised.

Lack of competence

Under the broad term of competence, participants referred to not only a lack of technical competence in one's own trade, but an awareness of safe practice, the work of other trades, and the interactions between site activities. This highlights the breadth of skills and traits needed to manage risk successfully and the tendency of managers to oversimplify and dismiss an incident as a 'lack of competence'. To improve workers' competence there is a need for further training; however, the lack of investment in workers due to specialised trades, project schedules, and temporary contracts has already been discussed. There is also a lack of regulation of construction companies which fails to prevent a lack of competence leading to incidents.

> You could set up a construction business tomorrow … it's a low level of entry into the market, and that exposes people to risks and hazards that they're not capable of controlling.
>
> (Safety Manager)

This is exacerbated by a lack of resources and low profit margins. The role of the construction sector, as a provider of engineering solutions within other domains, means profit must be reaped from the supply chain and building processes. By engaging the cheapest workers construction firms can reduce their outgoings, but these are often those with the lowest competence levels. Several participants spoke about the difficulties of resisting pressure from clients who were determined to keep costs down at the expense of engaging, competent, qualified and safe personnel.

A more general lack of competence (for example, academic and social attainment) can also lead to risk-taking behaviours. Participants said workers chose construction because *"they're well down the food chain when it comes to where they're going in life"* (Safety Manager) and were incapable of doing anything else. From a systems perspective, it is important to understand why construction work attracts these workers: Although some trades are highly-skilled, the requirements for general labouring are quickly learnt; physical agility is prized over mental; and good social and language skills are rarely necessary. These relationships are summarised in Figure 6.6.

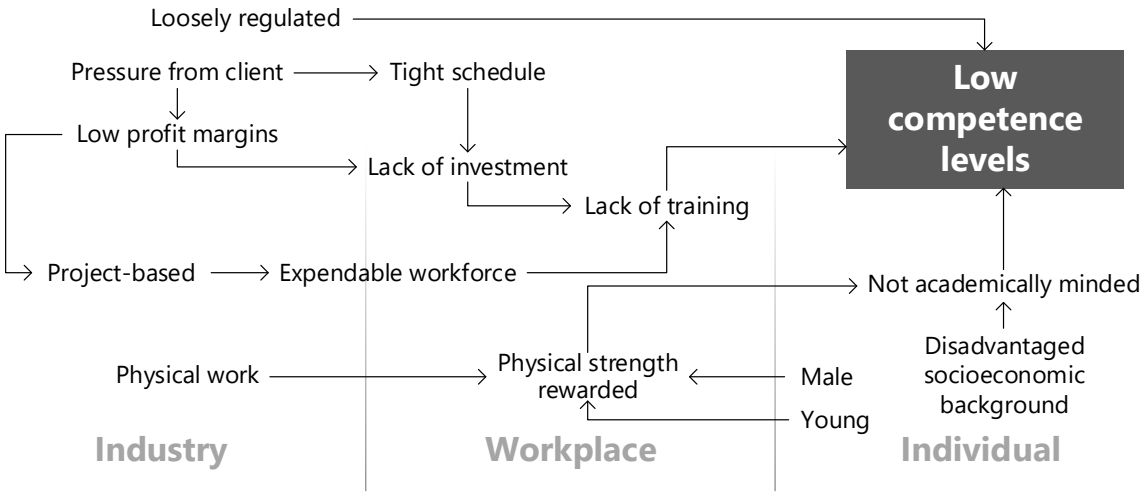


Figure 6.6: Factors contributing to construction workers' low competence levels

Construction suits workers with these traits, but this introduces management problems for those in charge. Again, these issues are embedded within the nature of construction work and the project-based industry, but to improve safety it is important to understand why construction workers lack the necessary competence so training and regulation can focus on addressing these.

Taking shortcuts

Cutting corners to save time and money were often seen as driven by laziness, but also symptomatic of a culture among construction workers to solve problems and prove themselves to be resourceful, capable, and productive.

> What we want people to do is stop and reflect, what they tend to do is to go in to automatic problem solving … you know, *"What would I get congratulated for, would I be congratulated for stopping work? Or would I be congratulated if I solve the problem?"*
>
> (Safety Manager)

Participants felt workers had been conditioned by the customary lack of resources to rush and improvise, and there was a widespread expectation that prioritising cost and schedule over safety would be rewarded. Even in cases where projects were well-managed and safety budgeted for, it was difficult to change the attitudes of workers who were not used to work being open for discussion, projects being planned well, and companies being committed to workers' well-being.

Pressure from clients — who were said to be more concerned with cost, schedule, and reputation than safe operation — was seen as the source of this: Participants provided examples of clients who appointed the cheapest firms, imposed penalties for contractors who took longer than planned, and sacked those involved in accidents to the dismay of the safety managers who could no longer learn from and improve upon the situation. These actions show a limited appreciation of construction processes, especially safety, and an unwillingness to take ownership of risk or invest in anything other than the end product. The subcontracted structure also creates opportunities for clients to pass the blame down to subcontractors, who in turn look to blame the primary contractor or client.

Low profit margins, compounded by a fear of litigation, can be seen to underpin corner cutting at all levels of the industry. Risk management is based on meeting the minimum standards for compliance: Safety policies were said to be reactive, disproportionate, not evidence based, rarely reviewed, and taking a broad-brush approach to cope with constant change. The extensive use of PPE, signage, and site rules to keep workers safe shows a reliance on the *"the last line of defence"* (Risk Consultant) rather than good planning and design. This profit-driven, and hence corner cutting, culture is inevitable in a competitive sector, and the most fundamental of the systemic issues it faces.

High risk-tolerance

Most participants agreed construction workers had either an accepting or denying attitude towards risk, and some said they enjoyed the thrills and challenges of the work. In part, this is due to the potential for varied, physical, outdoor, and exciting work which attracts individuals with a risk tolerant personality. Often, these are young men who are flexible, hardworking, and problem solvers, and, although these traits are desirable for production, they tend to coincide with unpredictability, complacency and risk-taking. As discussed in the previous sections, the construction workforce is also known for its low levels of academic attainment, social skill, and economic privilege: Their low expectations can be seen to drive a need to achieve — cutting corners and saving money.

This is another clear example of the connection between risk-tolerance and risk-taking at the frontline and the nature of construction as a distributed system which attracts unskilled and uncommitted workers who are difficult to manage. Risk-tolerance is not a fixed trait but dependent upon pressures and incentives such as time, comfort, money, and reputation. These factors motivate workers to sacrifice safety and appear to have a high tolerance for risk, but in fact, these are initiated by systemic issues: Poor planning, tight schedules, poorly designed equipment and insensitive procedures; fear of litigation, and an expendable view of the workforce are all brought on by a lack of resources and stability. A high tolerance for risk can also be attributed to a lack of awareness, due to insufficient training, or disobedience, due to dissatisfaction, as already mentioned. These relationships are summarised in Figure 6.7.

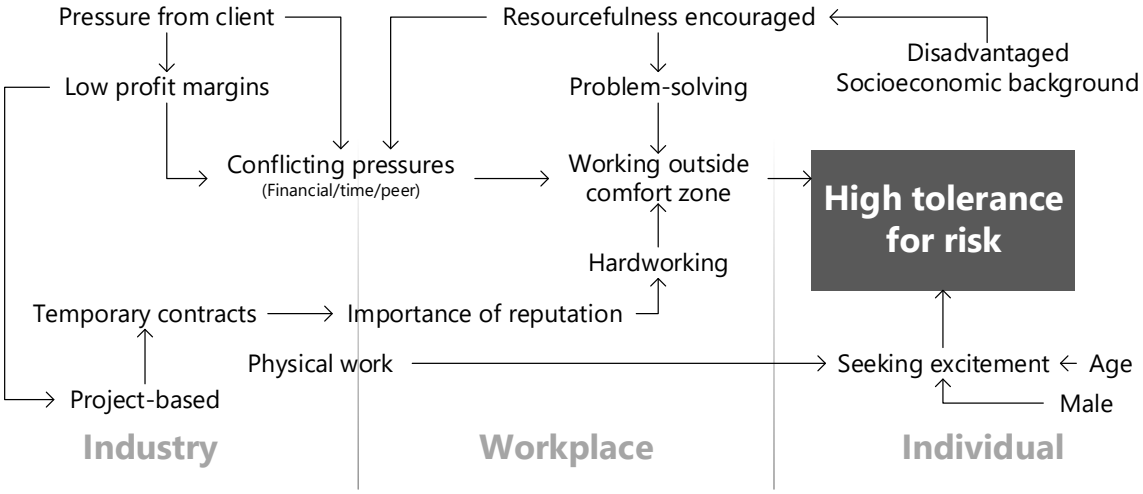


Figure 6.7: Factors contributing to construction workers' high risk-tolerance

An improved understanding of the type of worker attracted to construction, and the pressures they face, can support safety managers' strategy to tackle unsafe acts. Greater empathy and autonomy could combat dissatisfaction, a balanced safety policy to maintain elements of construction which inspire workers and provide job satisfaction, and training to enhance risk awareness could all help lower workers' risk-tolerance. However, more difficult to tackle are the organisational pressures which influence the culture of the organisation. Proving the roots of these problems identified here would provide evidence to challenge the view that workers are rebellious, negligent and complacent, and instead show they are scapegoats in a flawed system.

6.5.2 Summary of findings

The findings provide an insight into the work of construction safety managers. It is clear they face not only the intrinsic hazards of a physical, dynamic work in challenging locations, but also managing a difficult demographic of workers, and competing with the pressures of an unstable and financially squeezed industry.

> Construction is just a big game of risk, companies go under all the time, because tender decisions are taking a risk- it's what we're kind of used to.
>
> (Academic)

All three facets of the problem were explored - the work itself, the workforce, and its management. Construction is unstable, not only in terms of the workplace they are building, but its finances, workforce, and the systems in place to manage these. Its dynamic nature prevents the transfer of knowledge between projects and the implementation of consistent and well-designed safety measures (policies, training, culture, quality standards etc.). Lines of accountability become unclear in temporary organisations, leading to the shirking of safety responsibilities — by both the client and subcontractors — and a culture of blame and litigation. By exploring the wider organisational or industry-wide challenges it is possible to see the shaping influence these factors have on the structure and workforce of construction and the difficulties influencing safe behaviour.

6.5.3 Systemic causes of risk in construction

There is a clear need to tackle the roots of unsafe acts embedded within the construction industry; however, it is difficult to know how to approach change and who to hold responsible.

By using an STS lens on construction, the relationships between the issues which safety managers expressed have been explored to disentangle hazards from poor management, and poor worker attitudes from the industry-wide factors which attract and exacerbate these. This analysis provides evidence to challenge blame at the frontline: Many of the complaints about workers' poor attitude (such as silo working, cutting corners, high risk-tolerance and a lack of ownership, competence and engagement) can all be traced to systemic issues around the nature of construction work and pressures from the wider sociotechnical system. In light of this, the ConCA model (Gibb et al. 2006, Haslam et al. 2005) has been redrawn (Figure 6.8) to show how the site, technology and worker factors which combine to form accidents are framed within managerial and industrial originating and shaping influences.

Quantitatively, when asked about the causes of risk in construction, participants were more inclined to discuss the difficulties of managing a complex project — dealing with clients, subcontracting, and accountability — and worker attributes — a macho and complacent workforce. When the data is displayed as a tree diagram based on ConCA framework (Figure 6.9) the number of nodes and references demonstrates this. This contrasts with the original ConCA model (Figure 6.1) which elaborated more on the site and technology. Unlike accident reports which are reductionist and can be vulnerable to hindsight bias (Dekker 2002) (and which the original ConCA was based on), this study shows many managers are aware of the influence of a wide range of distal factors in the causation of accidents.

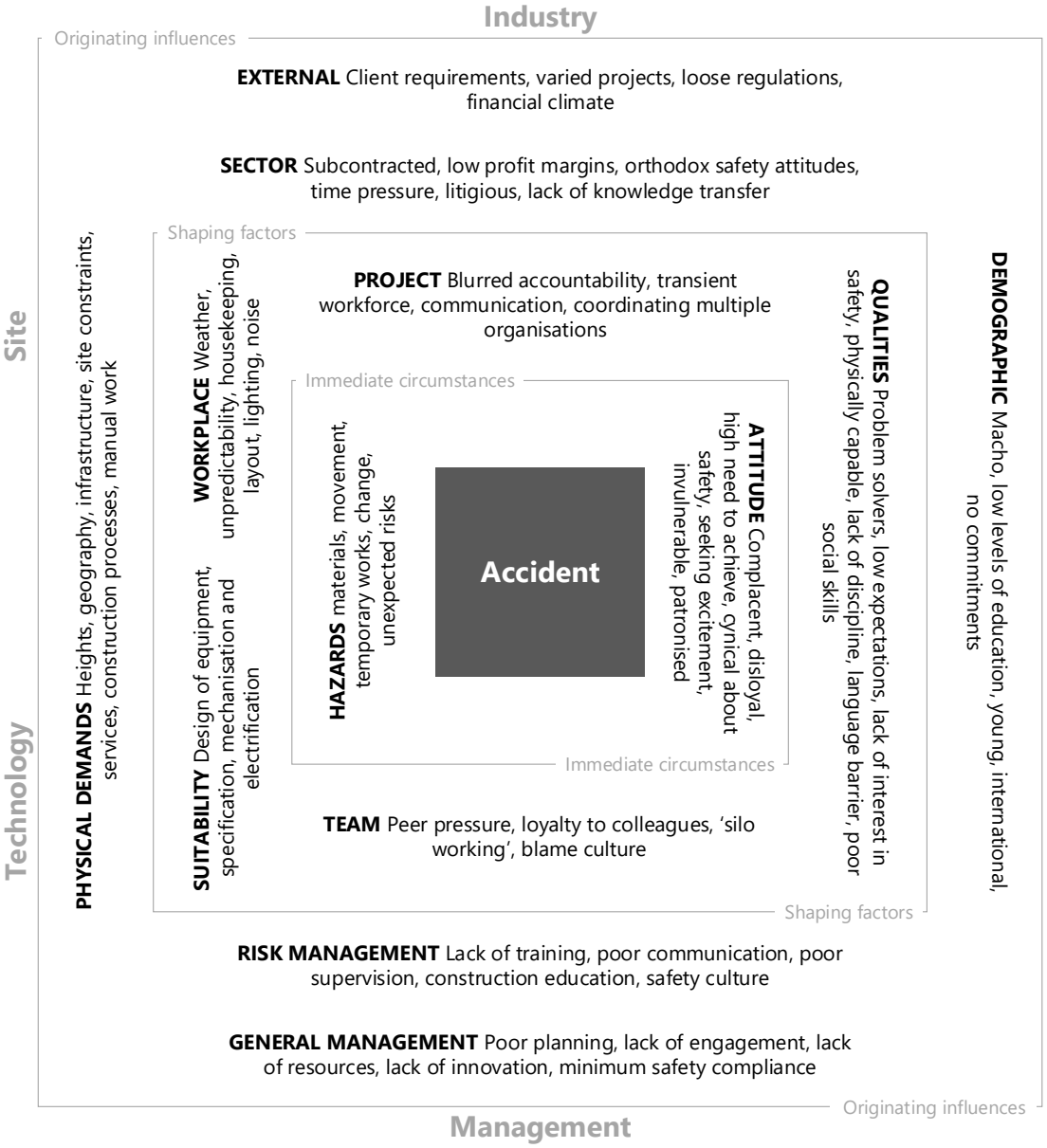


Figure 6.8: ConCA+

Taking a systems approach to interview analysis also provided an opportunity to explore the relationships between poor attitudes at the frontline and the industry-wide factors which attract and exacerbate these. While workers are often blamed for causing accidents because they lack interest in safety, work in silos, lack competence, cut corners, and have a high tolerance for risk, these traits can be traced to interrelated aspects of organisations and the industry. This approach generates new avenues for improvement which are explored under Section 6.5.4.

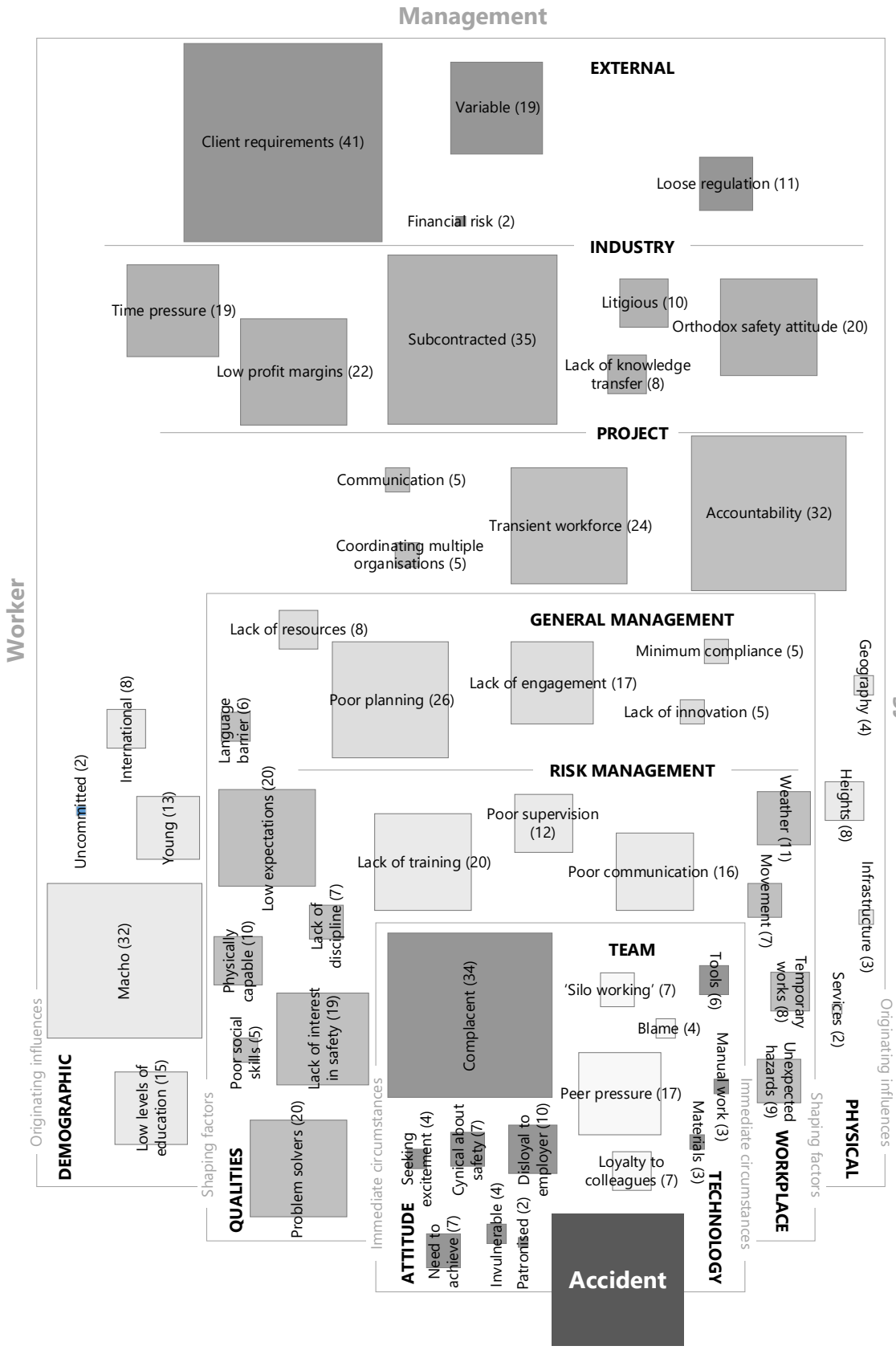


Figure 6.9: Tree diagram of the ConCA+ data

6.5.4 Recommendations and future work

The following research agenda summarises the opportunities highlighted by taking a systems thinking approach, going beyond increasing regulation, qualification, training, resources and length of contract which are often called for but difficult to realise effectively. It provides guidance for implementing and shaping some establishing safety methods and refocussing the way forward.

- Job enrichment research has shown that enlargement and rotation of roles can improve performance (Parker and Bindl 2017). Diversifying roles in construction could increase empathy, awareness, community, and the 'big picture' perspective, thus emphasising the value of each workers' roles in the project as a whole and inspiring pride in their work. Cross-trade training could provide increased competence at minimal expense to the company; however, it could reduce quality as skills are highly specialised and may be unpopular as workers are unlikely to want more information and responsibilities.

- "Learning legacy" programmes should be developed to improve transfer of knowledge between projects and awareness of innovation. These exist in high profile public sector projects in the UK, but there is a lack of support for smaller projects. Therefore, the programme should be extended to include a wide variety of projects; information must be brief and accessible; and manpower (particularly from architects, designers and engineers) allocated to seeking out and applying relevant innovation.

- Empowering and valuing workers is an underestimated aspect of risk management. Engaging with workers on risk management and respecting their expertise is particularly important in light of their low expectations and lack of loyalty. Collaboration would build vertical relationships, communication, trust, and protect against peer pressure.

- Risk management should involve workers on the frontline and be integrated into operations. Effort is required to change the perceptions of health and safety executive (HSE) staff as an enforcer of rules to a facilitator of ideas. Collaboration can help to combat dissatisfaction with insensitive procedures and equipment, but must be initiated in a way informed by the traits of workers — e.g. not academically minded, intimidated by professionals, not inclined to speak publicly, limited fluency and comprehension of local language, and influenced by peer pressure.

- Peer pressure could potentially be a powerful force for good given the need to build relationships quickly in a transient environment. Cultural programmes need persistence and repetition to account for constant change and counteract the pressures to prove their reputation or show-off to fit in.

- Adaptive safety has so far been touted as a solution for intractable industries; however, although the successes of well-managed projects prove construction is tractable (Bolt et al. 2012) it is not the most efficient to manage safety in a squeezed industry. Although the hazards are manageable the rate of change and unpredictability is not; thus, an adaptive approach could benefit an environment which — for reasons of time pressure, language barriers, low literacy levels, context on site, unstable processes, and change — does not cope well with paperwork.

6.6 Conclusion

The hazards of construction are embedded within building a physical output, both in terms of the practical processes needed to accomplish this and the temporary, undesignable nature of the workplace. This constant change makes managing risk difficult, not only within a project, but across the industry: The nature of the work — providing infrastructure for other businesses — means designs are unique, profit margins are extremely low, and work is suited to a dynamic network of specialist organisations contracted to specific aspects of the build. It is inevitable therefore that the physical nature of work and style of contract attracts workers who are uncommitted, physically capable, unafraid of hard work and seeking a career with plenty of variety. Unfortunately, these traits coincide with risk-taking. Building for a client also means profit must be squeezed from the supply chain and building processes, leaving construction firms with little resource to invest in technologies which could improve processes, no time for change or learning, and no inclination to change because of the widespread acceptance that construction is risky. These top-down pressures from the client and bottom-up challenges from the workforce show why it is important to take a holistic approach to the system when managing safety.

Construction workers are perceived as having a high risk-tolerance: This has been unpacked by exploring how and why attitudes vary within and between workers. Risk-taking behaviours depend firstly upon whether they are aware of the risk, secondly whether they perceive that risk as tolerable, and thirdly whether they feel the rewards are worth taking said risk. Many factors contribute to these, including the traits of the workforce; influences on their decision-making; and the pressures of the industry. In terms of supporting the managers this study shows a disparity between those who saw workers as negligent and disobedient and those with more enlightened views about distal or originating influences.

A systems thinking analysis of managers' perceptions lends support to the view that many of construction's problems are rooted within distal factors such as its transient workforce, financial constraints, and temporary organisations — products of a structure which is vital to providing unique outputs for a range of clients. Although this would be difficult to challenge, this paper provides advice for training and risk management which takes

account of workers' traits and the pressures they face from the system. It also provides supporting evidence for emerging concepts in safety management: Collaborating with workers to show they are valued; integrating risk management in operations; increasing transfer of knowledge though 'learning legacy' programmes; cross-trade training to improve their 'big-picture perspective; and looking to Adaptive safety to reduce paperwork and increase empowerment.

Chapters 5 and 6 have explored the phenomenon of Adaptive safety leadership; how this compares with leadership styles in construction; and the systemic barriers which underlie construction's leaning towards a more traditional compliance-based approach to safety — limiting the adoption of an Adaptive approach. So far this research has only studied this concept based on individuals' experiences rather than organisationally: Further research is needed to understand the practice and reality of becoming an Adaptive organisation and the role leaders play in this.

In spite of the barriers discussed in Chapters 2 and 6, some construction companies are pushing forward with implementing the Adaptive paradigm. The successes and shortcomings of this venture are explored in a case study of two infrastructure megaprojects in Chapters 7 and 8.

7 Adaptive Safety in Practice I

Contents

7.1 Introduction

In the previous chapters, the systemic challenges of construction that conflict with Adaptive safety have been identified and discussed. Despite these concerns, Adaptive safety has attracted attention from construction and has recently been introduced to the sector by pioneering companies. The question remains whether Adaptive safety can be successfully translated into this new and different context. These pioneers provide a unique insight into this theory of safety and an opportunity to improve our understanding of its mechanisms and prerequisites.

Laing O'Rourke's (LOR's) 'Next Gear' safety programme is the first in UK construction to publicly incorporate Adaptive age principles — namely Dekker's 'Safety Differently'. The transition to Next Gear began in LOR's Australian business, two years ahead of the UK. Following this, in 2015 two sites (Tottenham Court Road and Liverpool Street stations — both Crossrail) became pilots for Next Gear based on having a supportive client; being sole-ventures; the high-risk activities involved; and the timeline of the build. The programme was officially launched across all UK sites and business areas in Summer 2017.

The aim of the final study in this thesis is to document LOR's transition to Next Gear with a view to explaining its successes and challenges. Two infrastructure projects are compared: Crossrail, which was the pilot for the scheme, provides the most mature version of Next Gear, and the Thames Tideway Tunnel (TTT) where Next Gear has more recently

been implemented as part of a joint-venture with Ferrovial Agroman. Chapter 7 explains how LOR interpreted, adapted, and implemented Safety Differently, and Chapter 8 discusses its impact on stakeholders and vice versa - addressing Objective 3 — *"Observe Safety Differently in practice in construction"*.

7.1.1 The organisation of this chapter

The following sections describe how the Next Gear programme was designed and rolled-out by LOR. It discusses the rationale behind their decision to pursue Safety Differently; the development and implementation of the programme; the uptake of the changes; and its impact on the business.

The next chapter (Chapter 8) explores its reception by stakeholders (frontline workers, safety leadership, clients, and the wider industry) and evaluates their influence on the effectiveness of the programme. Chapter 9 concludes by discussing Next Gear's fidelity to the concepts of the Adaptive safety movement, and whether this truly is a more ethical and safer way to manage risk.

7.2 The projects

Similarities between the TTT and Crossrail projects make them well-suited for comparison. Both are tunnels which traverse central London meaning both have multiple sites dispersed across a crowded city. Both also face similar challenges as they update the capital's Victorian infrastructure to cope with a growing population: The first London Underground line opened in 1863, and the London Sewer System was completed between 1859 and 1865. However, unlike the Underground which has been constantly expanded and modernised since the 1800s, a sewerage project on the scale of TTT is unprecedented. TTT is larger in diameter (7.2 m, compared to Crossrail's 6.2 m) and the longer of the two — 25 km of continuous tunnel compared to Crossrail's five twin tunnelled sections totalling 8.3 km of the 22 km Elizabeth Line. Despite this, TTT is estimated to cost £4.2 billion compared to Crossrail's £14.8 billion.

The major difference between these projects is their delivery organisations. 'Crossrail Ltd' is part of London Underground, known as an experienced and domineering client, while TTT's client (Thames Water) has commissioned a consortium of four investors (Bazalgette Tunnel Ltd, commonly known as "Tideway") as the infrastructure providers. As such, Crossrail is publicly funded through the government's Department for Transport but TTT is a private venture funded by Thames Water's customers. Public-private partnerships (PPPs) such as Crossrail — where risk is retained by the public sector — have been criticised as poor value for money, inflexible, and lacking transparency (HM Treasury 2012); the financial and environmental costs are underestimated and benefits for the local area exaggerated (Flyvbjerg, Bruzelius and Rothengatter 2003). On the other hand, private ventures (like TTT) are known to be more agile and innovative, but face greater pressure to maximise

profit (Robinson, Carrillo, Anumba and Patel 2010). Despite these challenges, megaprojects (in excess of £1 billion) continue to grow in popularity (Flyvbjerg 2014).

Typically, PPPs contract out smaller work packages while private investors give their contractors a larger jurisdiction and greater autonomy in its delivery. Delivery of Crossrail involves 17 organisations with LOR fitting out of three of 41 stations but not involved in tunnelling. Only eight principle contractors are involved in TTT forming 3 joint-venture partnerships: Ferrovial Agroman and Laing O'Rourke (FLO) will deliver one third of the tunnel and eight out of 17 combined sewer overflows (CSOs) — where the new tunnel connects with the existing sewer. Information about the two projects is from their respective project websites (Crossrail 2018, Tideway 2018).

Construction in London is a *"thriving megaproject ecology"* — a dense and multi-layered network of project-based organisations and their supply chains (Davies 2017, p. 124). Project ecologies serve as the memory for these organisations (Grabher and Thiel 2015, Schwab and Miner 2008) where 'project capabilities' (Brady and Davies 2004) develop, hence it is important to consider these projects in context. LOR is one of several major construction firms which have cultivated relationships and capabilities that support them in winning large government infrastructure contracts. Having been involved with Heathrow Terminal 5 and London 2012 Olympics, these firms were the natural choice for Crossrail and Tideway — their chief executive officers (CEOs) becoming 'project nomads' (Davies 2017) moving from project to project transferring their knowledge and staff along with them.

7.3 The case study

The case study is a cross-sectional multiple case design with three embedded units of analysis: two at TTT — the Central tunnelling shaft site and Blackfriars Bridge Foreshore (a CSO), and one at Crossrail — Tottenham Court Road Station. The scope of the case study is illustrated in Figure 7.1.

These two London tunnels allow Adaptive safety to be studied in practice in construction. Many 21st century management innovations — lean, quality management, six sigma — have been less successful in projects (Davies 2017); however, the capabilities LOR has developed from past megaprojects combined with the freedom of a private venture should mean TTT is fertile ground to test this new concept. Furthermore, by comparing the two projects, Crossrail provides an opportunity to compare and explore the influence of joint-venture partners, public verses private clients, and cultures from different sectors.

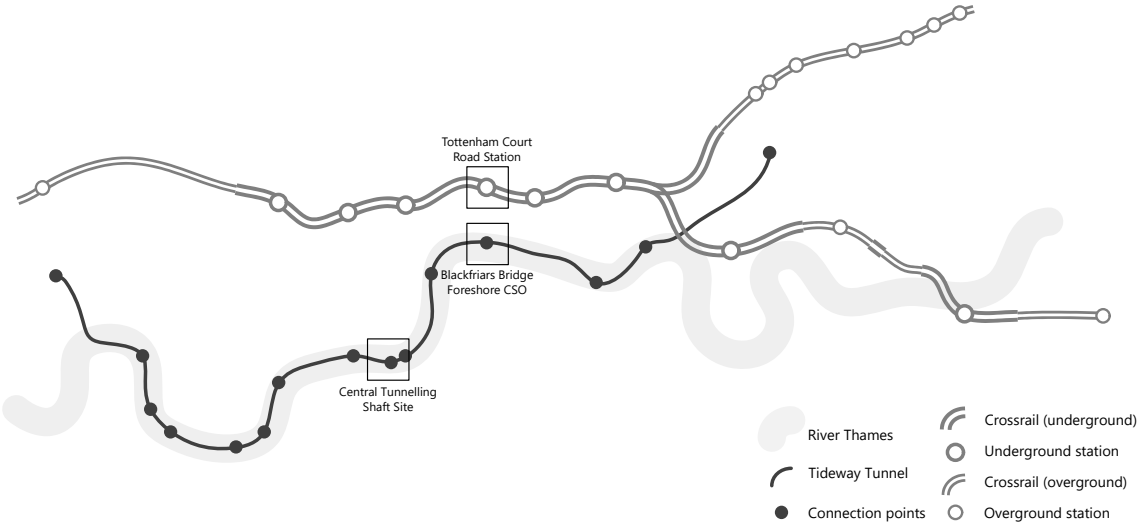


Figure 7.1: The cases and units of analysis in relation to the River Thames

7.3.1 Data collection

Data were collected at eight locations between July 2017 and February 2018 in the form of interviews, focus groups, documents, and observations which were thematically analysed. 21 interviews and three focus groups were conducted, the roles the interview and focus group participants held are illustrated in Figure 7.2.

The mean construction experience of participants was 18.4 years with a standard deviation of 15.2. Mean number of years with their current company was 6.8 years with a standard deviation of 7.7. Most were employed directly by LOR and subsidiaries, but others by the client, Ferrovial Agroman, sub-contractors, and themselves. As discussed previously, of the participants working on TTT almost all had worked on Crossrail previously.

Interviews and focus groups were triangulated with core policy documents outlining how Next Gear would be implemented; observations of risk management processes — inductions, briefings, and workforce engagement; and observations of other events to provide a complete picture of how Safety Differently is communicated by an external risk consultant to LOR's management and then to site. These documents and observations are detailed in Figure 4.1.

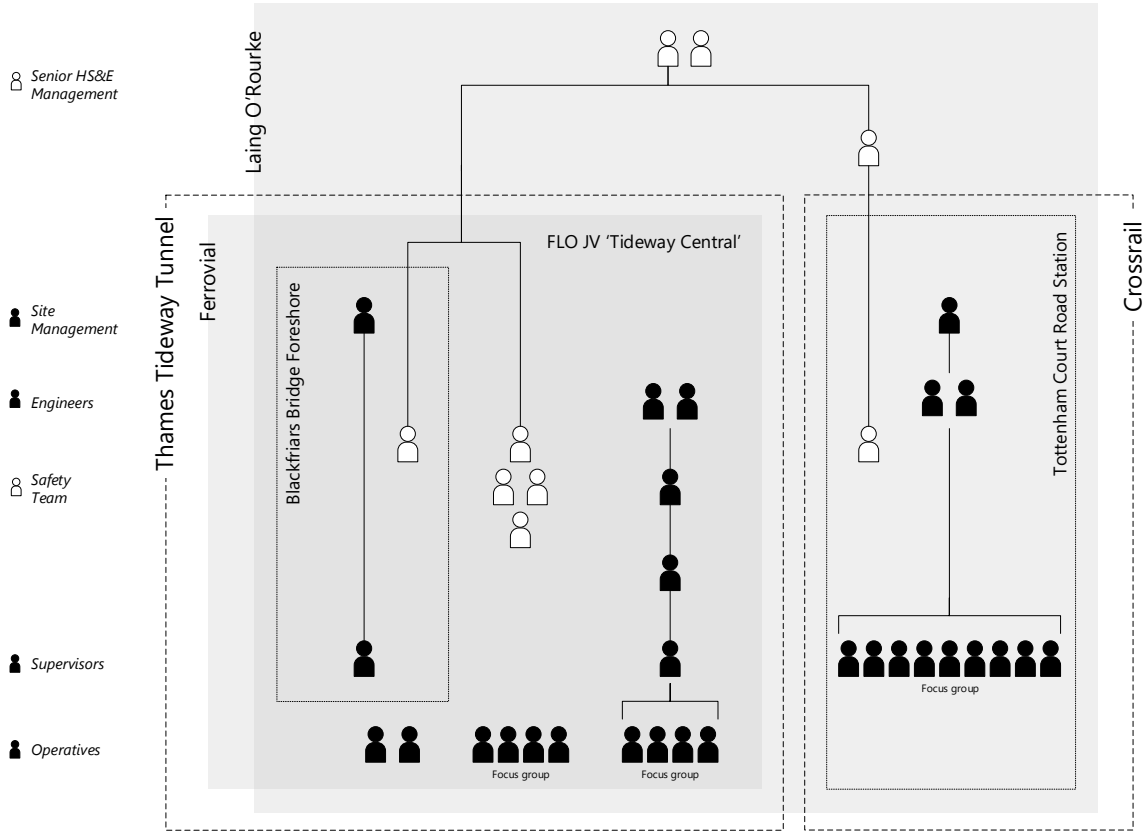


Figure 7.2: The roles of case study participants

7.4 Data analysis

Case study researchers need to be adaptive — making the most of the available data — meaning the importance of rigorous and intelligent analysis is even more significant (Yin 2009). As with the interview study (Chapters 5 and 6), thematic analysis was used to identify themes and the relationships between these within the data. This process is described in Section .

Observations and documents cannot provide a complete picture because participants are the expert in their own reality (Lewis-Beck et al. 2004); instead they need to be combined with other methods as it is difficult for an investigator not to overlay their own values when interpreting observed behaviours. Comparing multiple sources and methods (observations, documents, interviews and focus groups) validates the findings and helps to build a robust theory of Next Gear's operationalisation.

7.5 Findings and discussion

To structure this section, key relationships found in the case study are illustrated in Figure 7.3 with the relevant section numbers where these are discussed in Chapters 7 and 8. The arrows show how Next Gear has influenced stakeholders, and where they have shaped this

organisational change. Some factors which have helped and hindered its implementation are also shown.

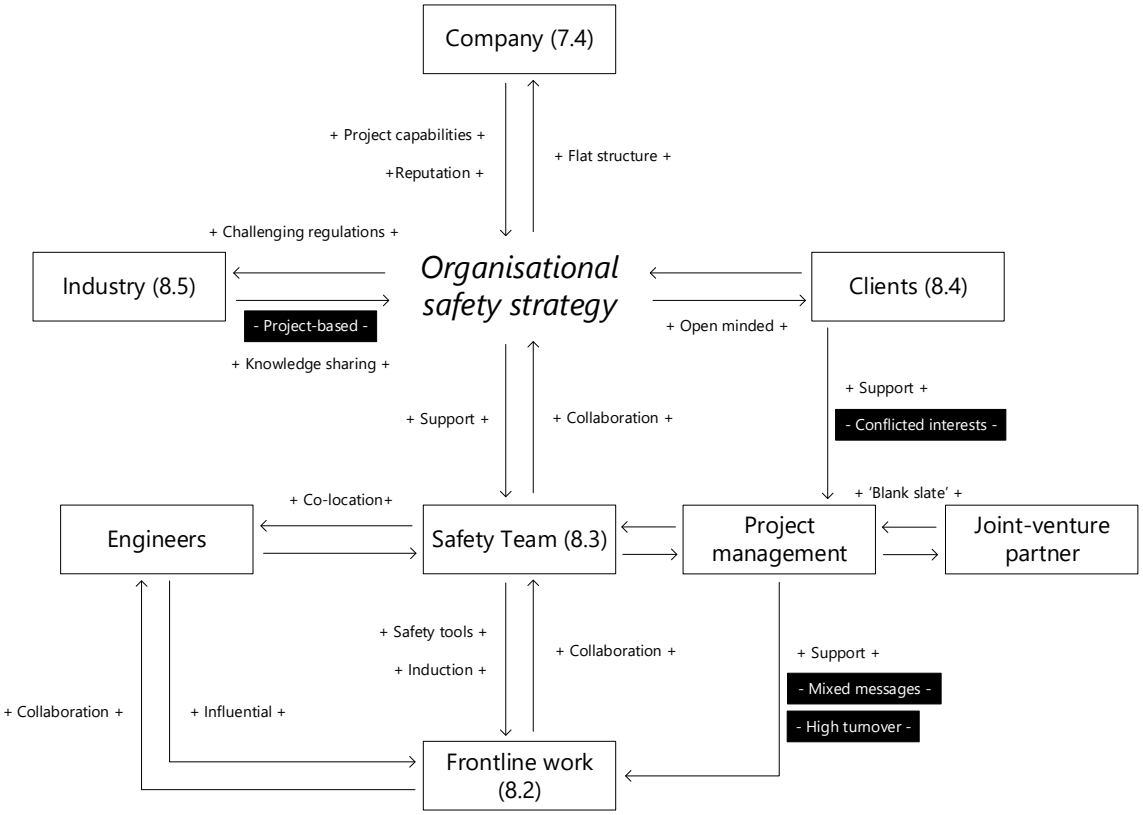


Figure 7.3: A conceptual framework illustrating how safety strategy influences stakeholders

7.5.1 Why 'Safety Differently'?

Consistent with the research which gave rise to Safety Differently, one factor which prompted LOR to find an alternative to 'Behavioural Safety' was plateauing safety metrics. Alongside this, the move was triggered by three unprecedented fatalities over 18 months on sites with an exemplary safety record. Existing safety systems and their foundations were called into question as high-consequence accidents had become more frequent and more difficult to predict. Safety Differently was described as a *"Road to Damascus*[1]*"* (Senior Safety Management) moment which explained their experience and offered a welcome *"breath of fresh air"* (Construction Manager). Past methods — *"dogmas of* [Bird's and Heinrich's] *triangles and* [Swiss] *cheese models"* (Senior Safety Management) — were stifling progress and no longer fit for today's industry.

> But when you look at an AFR[2] graph it doesn't include any of the potentials, it doesn't include any of the things that actually have the potential to kill people

[1] A conversion or religious experience
[2] Accident Frequency Rate

> … We're looking at the wrong indicators, we're looking at the wrong picture of what good looks like.
>
> (Senior Safety Management)

As well as its underlying philosophy, Safety Differently appealed to this pragmatic sector as an opportunity to address some of the other challenges of construction safety: Ethical responsibility (Dekker 2017*b*, Long 2012), bureaucracy (Bieder and Bourrier 2013, Dekker and Nyce 2014), and relationships that exist within the workforce characterised by conflict, confrontation, and blame (Lingard and Rowlinson 2005).

Industrialisation in Western society promoted science, rational planning, and quantification as the key to progress (Dekker 2018); however, some believe this *"trust in numbers"* is misplaced (Porter 1995). Porter challenges the pseudo-scientific utilisation of numbers in social, and specifically risk, research. Quantifying safety creates a burden of compliance (Bieder and Bourrier 2013) which does not equate to reducing risk (Manuele 2013) and places legal defensibility above rationality and morality (Rae, Provan, Weber and Dekker 2018). The need to 'prove' the safety of an organisation has been recognised as an industry-wide obsession by academics (Amalberti 2013, Dekker and Pitzer 2016) and LOR's managers — feeding complacency, suppressing reporting, tempting fraud, and drawing focus from potential high-consequence events

> There's just a whole industry hiding the reality of what's happening on sites and it's all built around the pressure that we've racked up.
>
> (Senior Safety Management)

The pressure to do this does not come from any legal requirement but is driven by competition to win contracts; misinterpretation of the law; and fear of litigation. One safety manager described how construction companies have become *"choked with these initiatives and programmes"* (Senior Safety Management) over the past 15 years because of the attention health and safety has received from the government, clients, and keeping up with competitors. Research has shown the *"irony of tremendous efforts that are being devoted to safety"* which foster a false sense of security (Amalberti 2013, p. 114); unpreparedness for situations that do not fit the rules (Dekker 2018); and increased liability as companies run the risk of failing to comply with their own high standards (Hale and Borys 2013).

Provan et al. (2018) describe how the professionalisation of safety means practitioners need to validate their own existence by creating safety-specific activities outside primary operations: There is a contagion of new ideas; lack of validation; and dogmatic implementation. This professionalisation and subsequent segregation of disciplines involved in construction has been increasing since the 1700s, and is not unique to safety — a similar trend has been seen in architecture, engineering and the building trades (Davies 2017). Rather than replacing existing measures, these activities contribute to a growing paperwork burden which fulfils an anxious need to look busy, even when these activities have *"no direct line of site to the risk"* (Senior Safety Management).

Safety clutter is defined as *"the accumulation of safety procedures, documents, roles and activities that are performed in the name of safety, but do not contribute to the safety of operational work"* (Rae et al. 2018). Rae et al. warn subcontracted organisations (where multiple contractors' processes overlap) are particularly vulnerable to clutter, resulting in cynicism and 'surface compliance'; hindering innovation; perpetuating harmful beliefs about safety; and undermining trust and adaptability.

As part of the move towards Next Gear, safety managers recognised this clutter was not intended or supported by regulators and began to challenge it, streamlining processes to those which add *"real risk management, not liability management and paperwork"* (Senior Safety Management).

> Collectively we've all given up on aligning the method statements, the task sheets, the way we said we're going to do the work, with how it's actually done, and that just creates a whole world of problems because it creates a culture where actually management's completely divorced from reality.
>
> (Senior Safety Management)

Paperwork has tied management to their desks, fuelling operatives' view that they are uncaring, ignorant about construction work, and afraid to be on site. Instead, Next Gear responds to risk on site, accepts adaptation, and aligns policy with practice. This has the potential to improve productivity both directly, though innovation, and indirectly through improving the relationship with the workforce. This approach also appealed to health and safety professionals who had become disillusioned with their role and its reputation.

> I've always known from when I started in health and safety, in tunnelling, that the best way to get something out of somebody is to engage and listen and involve people.
>
> (Safety Manager)

This 'Compelling Case' for Next Gear was put forward to senior management: Safety Differently offered an explanation and hope in light of troubling trends and on a practical level, it was an opportunity put safety back in touch with reality — reducing bureaucracy, increasing productivity, and improving worker satisfaction.

7.5.2 The 'Next Gear' vision

Next Gear is headlined by three principles based on Safety Differently: *"People are the solution, not the problem"*, *"safety is the presence of positives, not the absence of negatives"*, and *"safety is an ethical responsibility, not a bureaucratic activity"* (Policy Documents). Alongside these, Next Gear renews LOR's commitment to Just Culture (Dekker 2007, Reason 1997) and challenges the norm with its focus on high-potential over minor risks, and lack of 'Zero Accident Vision' (Zwetsloot et al. 2017).

To support this, changes have been made throughout the risk management process: The safety programme has been rebranded from 'Mission Zero' to 'Next Gear'; all safety processes are implemented at the discretion of each project, in collaboration with the workforce; and procedures have been redesigned to prioritise worker involvement, high-potential risks, and positive events. These three key areas are expanded on in the following sections.

The rebranding

The most apparent change to the identity of LOR's safety strategy is the removal of 'zero' from its brand name. However, the more significant changes have been in the way this identity is communicated to the workforce: Recognising that heavily brand-orientated programmes can be a hindrance for frontline operatives, their approach avoids using the Next Gear name, logo, slogans, and jargon on site.

> When you go to the project, you might not see Next Gear logos anywhere. It's not about the posters and the spin, but it's about the ethos and the values … it's business as usual as opposed to it being some kind of campaign thing.
>
> (Senior Safety Management)

This *"softer approach"* (Senior Safety Management) emphasises and aligns with Next Gear's ethos that safety should be led by the workforce, not imposed top-down by management. The brand is also less rigidly enforced than its predecessors; for example, at Tideway, Next Gear's principles have been incorporated into the joint-venture's 'Integrated Engagement Programme' — but neither this term nor 'Next Gear' are used on site.

This new identity (or lack of identity) signifies efforts to distance Next Gear from past Behavioural Safety where strong brands overshadowed and undermined progress. Rhetoric is a powerful tool for influencing safety mindsets (Waterson 2017): A safety campaign which trivialised risk and dehumanised victims as 'dumb' lead to an increase in fatalities (Long 2014); the word 'zero' is laden with connotations of reductionism and minimalism, not learning (Long 2012); and 'behavioural' emphasises human behaviour as the cause of accidents, encouraging blame (Long 2017). Instead, Next Gear's aim is to communicate its philosophy and culture to the workforce *"subconsciously"* (Safety Manager) through the inclusive processes used on site conducted in natural, familiar language.

> You've got to be careful how far down the chain you want this [brand] communicated … [Labour suppliers'] senior leadership won't have to know much about Next Gear because their people will be involved in all the tools we have, they'll be absorbed into the project culture.
>
> (Safety Manager)

In line with this, when asked if they had heard the name 'Next Gear' most engineers were familiar with the term, but only a minority of supervisors and no frontline operatives

were aware of its existence. Contemporary perspectives on safety leadership see it as a relational and participatory process (Pilbeam et al. 2017, Simmons et al. 2017). Fairhurst argues language is key to identity, relationships, power, and hence leadership: Leadership is not a trait but a process, socially constructed in context through interactions (Fairhurst 2011). Discourse analysts believe words and symbols communicate values which shape the attitudes and culture of an organisation (Long 2017). Their power to frame and prime responses has been carefully considered in renaming the programme as a whole and the tools. These tools are discussed later in this section under *Developing the toolset*.

Suppressing safety as a 'brand' helps to integrate it with primary operations and increase engagement on site. However, there is still an expectation for principle contractors to have a strong safety brand as part of their business and tenders. Rather than being demanded by government, bureaucratic accountability for occupational safety and health (OSH) has become part of business-to-business relationships, and accepted as the norm (Dekker 2018). As such, Next Gear was viewed as needing a new brand, but this is applied selectively above the frontline.

> Safety's become commodified in a way that we need to have a brand … I can't just say *"We're just going to do safety in a more simple, straightforward way with greater honesty and integrity and have a proper relationship with our workforce"* it doesn't sell, you know, it doesn't win work.
>
> (Senior Safety Management)

Another downside to Next Gear's low-key branding is that without an obvious new identity many workers have not noticed the changes, so their scepticism towards safety remains.

> Every construction company has their own- so I used to work for BAM[3] they have 'Beyond Zero', every company has it, it's just with a different badge and a slightly different slogan.
>
> (Engineer)

This is especially true at Crossrail where Next Gear competes with 'Target Zero' (the client's safety brand) which dominates the visual identity of the site, and LOR's 'Mission Zero' persists on logoed personal protective equipment (PPE). Without the symbolic commitment of site-wide rebranding, Next Gear's impact is somewhat lost. Conversely, by avoiding creating yet another more prominent safety programme, LOR hope to combat many damaging effects of Behavioural Safety discussed in Chapter 1 (Innovation fatigue; safety's divorce from operations; suppressed reporting). Next Gear is primarily communicated through personal encounters within *"business as usual"*; although this means cynical attitudes and past expectations will be slower to change, the change will be meaningful.

[3] Royal BAM Group

Adjustment to fit sectors and projects

As Safety Differently emerges, consultants promoting this to industry emphasise the need to tailor the concept to each context, experimenting and cultivating practice to be shared with a network of like-minded organisations. The need to manage organisations in a way which accounts for context or environmental factors has been recognised by contingency theorists since the 1960s. This school counters Taylor's 'Scientific Management' and its mechanistic view of organisations: Rather than 'one best way' to manage, 'Contingency Theory' sees organisation as open systems which need to adapt and respond to threats (Burns and Stalker 1961, Lawrence and Lorsch 1967). In the same vein, Turner's (1978) seminal book, which paved the way for a sociotechnical approach to risk, was inspired by Burns and Stalker's work (Weick 1998). While traditional safety takes a mechanistic or reductionist approach to finding the 'best way' to minimise risk, Adaptive safety — having branched out of sociotechnical system (STS) — recognises the need to adapt and construct safety in context.

Unlike previous Behavioural Safety programmes, which were described as *"an off-the-shelf solution"* (Senior Safety Management), Next Gear was introduced gradually as a small-scale pilot — allowing time to test the new tool set and refine it with input from the workforce. LOR were able to develop their own version of Safety Differently, sensitive to the needs of the sector and its history with safety. As part of this, LOR took a bold step to make all safety policies discretionary for each project — including the '5-point PPE rule' although this was controversial and only adopted on half their sites: For traditional thinkers PPE epitomises safety, and not enforcing its use was likened to heresy. Sites which did experiment with a 'carry-and-use' PPE policy found this to be a breakthrough with the workforce. It sets forth LOR's ambition to fundamentally challenge safety in construction and clearly demonstrated their commitment to *"people as the solution"*.

Where previously conversations about risk had been dominated by complaints about poor-quality ill-fitting equipment, making these optional paved the way for authentic and constructive dialogue. One construction manager described how optional PPE raised workers' awareness of the risks and urged them to take responsibility for their own safety.

> **Participant:** You might never have to wear a hard hat again … if you thought that you could manage your health and safety on site that was the freedom we were going to give you, and people said *"This is great, we're not going to wear helmets-"* and then they took a step back and thought about it, and said *"Actually I do need to wear a helmet, I'm being a fool here!"*
>
> **Interviewer:** Sort of realising it for themselves?
>
> **Participant:** Yeah, we're giving you- the ball's in your court to look after yourself, we're not going to tell you what to do, you've got to look after yourself, and it came through that way.
>
> (Interview with a Construction Manager)

Increased flexibility supports a response to risk on site which is proportionate, as opposed to blanket bans and rules. As another example of this in practice, one participant explained previously contraband short trousers and radios have been allowed on some sites for activities where these do not expose workers to increased risk. Safety can be customised to the reality of risk on site: Discussion is encouraged, and workers are invited to challenge rules and paperwork, collaborating on more efficient and evidence-based procedures.

> We're happy to manage our risk on a day-to-day, like person-to-person, on the role-that-they-do basis, rather than, you know, being unnecessary, do you know what I mean? Being over- OTT, over the top
>
> (Safety Team)

Different versions of Next Gear have developed on different projects and different sites. At Tideway, the Integrated Engagement Programme combines Ferrovial Agroman's and LOR's safety policies with the client's requirements and input from the workforce, but also allows for these guidelines to be refined in context. As such, each of the CSO sites is unique; keen to share good practice with each other, but equally willing to dismiss something that does not work — acknowledging the individuality of each site's culture. One CSO site was praised for its family dynamic which would be impossible to recreate through any top-down initiative.

Expressions of Next Gear also vary throughout the business because of the services they provide and industrial sectors they are involved with. LOR owns many subsidiary businesses, some of which are used to *"more of a command and control type approach"* (Senior Safety Management); nevertheless, they have drawn upon Next Gear to create their own *"blend"* of Safety Differently. Similarly, both Crossrail and Tideway's versions of Next Gear have been blended with requirements from their exacting clients.

> We [infrastructure] have clients sometimes who restrict us being this free … in construction they have developers who don't really care.
>
> (Senior Safety Management)

Finally, as a global business, safety strategy needs to adapt to suit national cultures: In Australia, Next Gear began with a grand public launch, but in the UK low-profile *"drip-feeding"* (Senior Safety Management) was favoured for many of the reasons in the previous section . According to Hofstede's 'Cultural Dimensions' theory Australia has a lower 'Power Distance' score than the UK, meaning hierarchy and the establishment are held in low regard. This aligns with Next Gear: Their culture of decision-making in business is collaborative with management expected to consult the expertise of their employees (Today Translations 2018); modesty, brotherhood, and equality are valued; and communication is ubiquitous, informal, direct and participative (Hofstede Insights 2018). Australians are also open to new ideas (Today Translations 2018) and the nation is recognised as a world

leader in the safety research community; thus, they have been more readily accepting of the changes. By comparison with the UK — where great care has been taken to introduce change gradually — these traits have allowed the Australian branch of LOR to rapidly embrace Next Gear.

Increased flexibility *"gives projects the ability to come up with local solutions, to local challenges and local risks"* (Senior Safety Managers), empowering them to respond to hazards and innovate. Participants have seen relationships with the workforce improve, particularly with sub-contractors who become frustrated with overly restrictive principle contractors.

> A happy workforce is an efficient workforce, right? And that's the most important thing, so if you can do that safely it doesn't create a problem and it keeps their morale happy for what they do, it's better for all the project, that's what I like about it.
>
> (Safety Team)

Through their efforts not to *"brainwash everybody"* (Senior Safety Management) — allowing Next Gear to colonise and evolve naturally — has meant some of LOR's subsidiary businesses have developed quite differently compared to the core: For example, the organisational structure of sub-businesses is leaner and involves less supervisors and managers, so people are busier and workers' attitudes more *"gung-ho"* (Safety Manager). The discretionary approach to safety policies means some projects have not been as proactive in implementing Next Gear as others; sites have become more varied and some feel safer than others. Concerns were raised that this lack of consistency could cause problems for those managing multiple sites or for staff transferring between projects.

Developing the toolset

Compliance-based processes have been replaced with a new suite of tools reflecting the ambition for a more positive, people-focused, and less bureaucratic approach. The changes to the *Planning*, *Monitoring*, and *Reviewing* phases of risk management are outlined below. It should be noted that, as discussed in the previous section, the tool set is only a guideline; everything is optional and can be adapted according to each project's needs. The following describes how these have been implemented at TTT and Crossrail. Other LOR sites may use their own variants of these processes.

Planning

Fatal and severe risk (FSR) reviews are the Next Gear equivalent of a 'Deep Dive Audit' or Hazop[4] (Kletz 2001). Although some participants were flippant about this rebadging, they also understood its significance: The new name emphasises the gravitas of 'fatal' hazards and severs the punitive and bureaucratic connotations of audits. Furthermore, at TTT the

[4]Hazard and operability analysis

FSRs are known as 'workshops' which invites collaboration more than its generic title — 'review'.

> Particularly from my team, they love the fatal and severe risk workshops, and- they like it that- that everybody gets involved in those, the workforce as well.
>
> (Safety Manager)

The new identity has made a positive difference to how safety audits are perceived alongside changes to the way these are conducted: The FSR review is high-level — *"your top risks that could kill or severely hurt someone, so work at a height or lifting operations, if they go wrong someone's going to get badly hurt"* (Safety Manager) — not task specific, but detailed enough for client approval. The workforce is also involved in the process, and positive language gives emphasis to what is *"missing and needed"* to support the task, rather than what could go wrong. Another difference is that the output is to brief the workforce not to protect against litigation: 'Visual Task Sheets' are favoured over impenetrable 'Risk Assessment Method Statements', because ensuring information is accessible and the workforce well informed is seen as an ethical responsibility. Both these changes reduce time spent on paperwork. Lastly, these procedures are open to change and can be updated throughout the build through 'Operational FSRs' and other processes outlined in the following section.

Monitoring

While safety audits and inspections only view non-compliance in a negative light, Next Gear's planned versus actual (PvA) sees divergence from process in a unbiassed way. The 'actual' method may reveal adaptations which can be incorporated into improved plans. Where workers' adaptations could potentially introduce risk, the PvA is used as an opportunity to clarify the process and learn, not punish.

This underlines *"people as the solution"* by honouring their ideas, incorporating their expertise, and developing processes together. It also upholds their ethical stance on safety: For example, unmarked services at Blackfriars led to costly delays of three weeks[5] while procedures were revised to mitigate the risk of cable strikes. By listening to workers' concerns and responding to the reality on site, the expected attitude of *"we're doing everything we should be in the procedure so … that's alright, just crack on"* (Safety Manager) has been challenged.

These reviews are far less formal than their traditional counterparts — described as a simple, humble, open-minded conversation, conducted on site to review the task in situ. Their approach draws on 'Humble Inquiry' — *"The fine art of drawing someone out, of asking questions to which you do not know the answer, of building a relationship based on curiosity and interest in the other person."* (Schein 2013, p. 2) — and 'Radical Candor' — balancing criticism and empathy in leadership (Scott 2017).

[5] At the time of data collection

> Those conversations are very open and very trusting, and they're done at the workface.
>
> (Safety Manager)

To maintain this open and trusting dialogue, PvAs are not intended to be led exclusively by health and safety staff (although at present most are until the process becomes embedded); paperwork is updated off site; changes are communicated visually; and the new process replaces intimidating 'Method Statement Assurance Checks' — at supervisor level and below PvAs are not known by anything other than a 'chat'. Most participants were positive about these changes to the assurance process, they have been welcomed by the frontline and are considered the *"biggest success"* (Senior Safety Management) of Next Gear.

Participants also praised the 'Collective Insights' tool. These are *"a brainstorming session"* (Senior Safety Management) led by a site engineer with everyone relevant to the task. They are more structured than PvAs and conducted off site, but in the same way their aim is to collectively update the procedures, either as an interactive briefing before a task or in response to concerns raised by workers. Acknowledging workers' expertise in problem solving has been a key part of participatory management's 'quality circles' (Ishikawa 1985) and participatory ergonomics since the 1980s (Gyi, Shalloe and Wilson 2015), but this style of management is rare in construction.

> The guys on site found that [Collective Insight] really valuable because it's not just me telling them what they're doing, they also know what's expected of everyone else, and where everyone else needed to be at the time.
>
> (Engineer)

The method statements are simplified, broken down into daily or weekly packages, and discussed step-by-step allowing workers to ask questions, clarify their own and others' roles, and contribute lessons from their experience. Participants found this method improved buy-in and communication — especially with sub-contractors — and helped to integrate safety and quality into operations. They are a powerful problem-solving tool, but critics warned against these becoming a substitute for proper planning.

> For me the striking thing- and I think the guys round the table felt the same- within half an hour of all the relevant people being round there, there's your solution … I just wish we'd spent the half hour prior to putting people out there, then we wouldn't have had all the drama that went along with it.
>
> (Safety Manager)

This open-minded approach is reinforced by the metrics used to monitor safety.

> It's all about the narrative. Tell us the story of your project, how active are you in the space of Next Gear? How many positives have you got?
>
> (Senior Safety Management)

Conventional safety metrics and their associated punitive measures have been removed. Instead, positives are measured such as engagement tours, training, and use of the new risk management processes mentioned above. Hollnagel argues efforts to measure Safety II are futile: Quantification introduces certainty and complacency to a construct where uncertainty and responsiveness are essential (Hollnagel 2018). Avoiding this temptation has been a challenge for construction but, although many of the traditional performance metrics are still recorded to satisfy the client, these are kept internal to the health and safety team and no longer seen as targets they are under pressure to meet.

Reviewing

The introduction of 'Positive' or 'Appreciative Investigations' is a significant step in an industry for which, in the past, tight schedules have limited opportunities for learning.

> Why don't we [debrief] in construction? Well, because it's onto the next task. But not only do we not get to practice before we start, we also don't get to debrief. There's not enough time, we've got to get on and pour the next wall.
>
> (Senior Safety Management)

Appreciative inquiry (AI) was first proposed as an alternative to problem solving: Rather than focussing on the negatives or problems, AI aims to encourage social innovation by evaluating the 'positive potential' of a situation and how this can be developed and prioritised (Cooperrider and Srivastava 1987). Optimism and positive emotions support individual and organisational resilience; promote creativity; and strengthen the relationships needed to sustain change (Bushe 2012). AI has not only been adopted as part of Safety Differently's toolset, but been expanded to underpin its trademarked 'Appreciative Safety®' (Art of Work 2018) — acknowledging the role of people as the solution in creating safety.

In accordance with Safety Differently, *"it is easier to study how things go right than to study things that have gone wrong"* (Positive Investigation Report); therefore, LOR aims to prioritise understanding *"all of those activities that happen every single day, on every single site, where we actually do do what we said we were going to do"* (Senior Safety Management), investing as much time in this as investigating reportable incidents. The positive aspect of their investigations is two-fold: Firstly, it focuses on successful tasks, and secondly it looks for good practice and innovation. The review process is led by a member of the health and safety team who collects feedback from all parties involved in the task. This is summarised into a short, visual, report to share this knowledge and improve this process, and others, in the future.

Achieving positivity in construction is a challenging prospect; workers are quick to criticise, and, despite being a positive investigation, much of the analysed report focused on

difficulties and frustrations. Changing this negative culture will take time, but these investigations are a tool to accelerate progress: They fulfil a need to acknowledge not only workers' ideas and good practice, but their efforts to fill the 'gap' — overcoming challenges to bring about a successful outcome in spite of these.

Although some participants alleged the new tools were simply a renaming of old processes, they recognised the significance of changing the way these are conducted. Many safety requirements are still dictated by the client and regulators, restricting what can be changed; however, in contrast with their predecessors, these new tools involve frontline staff and take place on site where appropriate — integrating safety as part of primary operations. As Next Gear matures and reaches its 'critical mass' (Rogers 1995), more of these processes will be initiated and led by people at the sharp end.

> The way these things are designed, it's all about- it's about people getting involved, it's not about safety-people doing safety, it's about a project leader, and his team, and the project, they're doing safety.
>
> (Senior Safety Management)

Changing the rhetoric of safety has been significant step in Next Gear: Using a positive and familiar vocabulary, rather than accusatory and corporate, has made safety accessible to the workforce. The names of the tools have been changed to align with this, and investigations ask 'what' rather than 'who' to deter blaming individuals. The safety team were observed on multiple occasions speaking calmly and candidly about risk on site, sharing stories of incidents at both TTT and Crossrail and how they have been managed. They avoided speaking in a way which would blame or ridicule the victim; raised awareness of risks through empathy rather than fear; and welcomed discussion.

7.5.3 Impact on the business

Two years in, LOR's leadership and staff driving the change remain enthusiastic about Next Gear's collective and people-centric approach. Its principles can be adapted to any issue, project, or country and participants were keen to see these extended beyond safety to other areas of the business such as procurement and recruitment.

Several participants provided examples of times when Next Gear's processes improved productivity — either directly through changes to the procedures, or through improved coordination and engagement of the workforce. Where previously safety and productivity had been incompatible, an openminded attitude towards 'workarounds' deploys workers' creativity for the benefit of the business.

> Why didn't you set the walkway up in that way in the first place? If that's the most efficient way to do it. We're all about efficiency and improving productivity. Why penalise him because he hasn't stuck to the walkway?
>
> (Senior Safety Management)

Rather than competing, safety, quality, and productivity are addressed simultaneously through collective processes that bring together expertise and voice concerns from all aspects of the build. Subsequently, in the face of deadlines, safety was less likely to be sacrificed: *"If you're working safely … then that's going to be the quickest and most efficient way to do it"* (Safety Team). Next Gear's streamlined methods also meant there was more time to invest in designing out risk, preventing *"hideously dangerous"* (Site Engineer) rework and its associated costs.

> Cutting down the bureaucracy allows me to focus more on the engineering issues which is my speciality, which in turn prevents safety issues.
>
> (Engineer)

Although Next Gear's approach sees safety integrated into primary operations, prioritising it is still difficult — especially in light of recent *"major commercial challenges … when it becomes matter of survival for a business … the focus [on safety] drops"* (Senior Safety Management).

> If it's not feasible in terms of business and we're going to lose money, then we won't do it.
>
> (Safety Manager)

> Unfortunately, like everything it comes down to *"how much does it cost?"* at the end of the day, which is alright when times are good, but of course then it's a race to the bottom when money's tight.
>
> (Engineer)

Next Gear's streamlined, integrated processes should reduce expenditure on safety in the longer term, but some investment is required initially to support the new tools, substantiate the philosophy, and demonstrate their commitment through fair wages and quality equipment. Contrary to this, many operatives complained about budget PPE and low wages; the safety department was understaffed for what was required; and the several engineers provided examples of times when where a more expensive version of a product could have prevented an incident or additional work which put workers at risk. Privately and publicly funded projects face financial pressure to maximise profits and provide value for money for taxpayers respectively (Robinson et al. 2010), competing with the necessary increase in safety spending to initiate this change. Procurement departments were demonised as a barrier to Next Gear — prioritising targets to reduce spending and diluting Next Gear's message. To reinforce to the workforce the value of engagement it is crucial to listen and respond, but delays in responding to workers concerns because of cost have weakened this feedback loop.

Operatives had noticed the projects' and LOR's efforts to make health and safety visible and accessible.

> You see a lot more of the health and safety [team] out and about on the job actually- like they're asking you if everything's- if everything's working sort of how it should be and if people are working safely and things like that. On my last job they'd just let you get on with it, but- yeah. It is- they are on top of their game here.
>
> (Operative)

This visibility is helping to normalise health and safety as part of everyday work; increasing workers' positive interactions with it; helping Next Gear to spread 'virally'; and changing the reputation of OSH. This process is supported by feedback to the workforce which demonstrates their input is making an impact — incentivising further engagement.

7.5.4 Enabling factors

As a business LOR have been well-positioned to make this change — known for being progressive and innovative. In the 1990s several major tunnelling projects (Jubilee Line, Heathrow Express, and Channel Tunnel) suffered significant delays and cost overruns leading to an investigation concluding *"British clients and contractors were incapable of managing large-scale infrastructure projects"* (Davies 2017, p. 104). Following this, the construction of Heathrow Terminal 5 introduced a new agile contract with greater collaboration, client accountability, and co-located integrated project teams leading to its success (Brady and Davies 2010). Involvement in this project meant LOR acquired 'project capabilities' which have continued to develop at London 2012, Crossrail, and TTT strengthening their world-leading position. Their respect within the industry which has helped to gain support from regulators and sub-contractors.

> We've got quite a lot of prominence in the industry, so when someone like Laing O'Rourke does something a bit differently, then the industry kind of looks at that.
>
> (Safety Manager)

Once the support of senior management was gained, the flat management structures of this family-owned company have enabled rapid change.

> It's a family run business with very- very senior leadership … a very direct approach to leadership, it's a very flat management structure … the benefit of the way our business is if [the CEO] says- just says one sentence it all happens immediately.
>
> (Senior Safety Management)

There were also benefits to the project-based structure of construction: the streamlined processes suit sub-contractors; changing project partners compels review and continuous improvement of policies; and the complexity of projects prevents complacency because *"the*

slower pace of work drives the safety up … being forced to have more time to think about it does drive out good solutions." (Site Engineer)

> Here [Crossrail] almost every single pour requires an entirely separate method statement, whatever … because of the very nature of the job you have to stop and plan, otherwise you can't physically do anything, which requires the safety to be revisited each time.
>
> (Engineer)

Characteristics of the innovation itself and the way it has been implemented have also enabled its success. Research shows innovations are more likely to be adopted if they offer a significant relative advantage or 'utility' — particularly if it makes life easier; have the potential to be developed and customised; a shallow learning curve; and are compatible with existing systems (May and Finch 2009, Rogers 1995). In line with this, frustrations with the previous systems meant Next Gear's advantages provided motivation for change, and its non-prescriptive approach to co-creating safety processes also supported its adoption.

> It is seen as radical by many, but when you think about it, it makes sense. It does make sense, and I think everybody gets that- everybody gets that it makes sense.
>
> (Senior Safety Management)

Previous iterations of Behavioural Safety programmes and the progress seen with each has reduced the learning curve. Participants agreed the transition would have been more difficult without these stepping stones — *"standing on the shoulders of giants"* (Senior Safety Management).

Finally, Next Gear has also been surprisingly compatible with other aspects of the industry. It does not compromise their ability to meet the client and regulators' requirements or protect against legal action; instead, it addresses legislation in its intended form, and challenges misconceptions which have built up through fear and market-pressure. Moreover, the programme has won awards from major safety regulatory bodies as the construction industry is becoming convinced this is the way forward.

> People were really worried about these [auditors], because they thought, *"Are they going to be asking for all these pieces of paper we've shredded?"* And we got an 'excellent' and several 'noteworthy efforts' for the kind of things we're doing, so we must be doing something okay.
>
> (Senior Safety Management)

In terms of communicating the philosophy, participants said it was important to go through the right authority when engaging with sub-contractors. Until Next Gear realises a constant open dialogue on risk between trades, sub-contractors respond best to their own

management, rather than the project's. This is consistent with research which show internal factors, such as communication and social networks, are more important in the diffusion of safety innovations in construction than external drivers, such as regulators (Esmaeili and Hallowell 2012). LOR have been able to use this to their advantage; relying on word-of-mouth to spread Next Gear through frontline-led interactions reduces the disparity between individuals, enabling them to share knowledge more effectively (Rogers 1995). Anecdotes and stories of successes are powerful and Next Gear is creating a buzz which attracts talent to the company.

7.6 Conclusion

LOR are changing the culture of construction through relational encounters which empower workers to create safety at the frontline. Next Gear has been a shift towards making safety relevant and accessible to the workforce and away from litigation management. As well as increased collaboration, the processes are more streamlined, simplified, and flexible, and the language of risk has been refreshed to emphasise positivity, participation, and the human (not legal) cost. Safety is communicated informally and integrated into everyday activities.

The effect is to break down barriers with the workforce, increasing communication, trust, buy-in, and morale, and for the business greater coordination between trades, efficiency, and productivity. Their progress has been supported by LOR's previous experience of London-based infrastructure megaprojects, agile project management, and past safety innovations; clear motivation for change; and the sympathetic way the programme has been designed and implemented. However, the journey has not been without difficulties. The next chapter discusses how Next Gear has been received by stakeholders: The barriers which have diluted its impact, and the factors which strengthen the case for operationalising Adaptive safety in construction.

8 Adaptive Safety in Practice II

Contents

8.1 Introduction

Chapter 7 discussed Laing O'Rourke's (LOR's) rationale behind introducing Adaptive safety in construction and the benefits they have seen as a business. While most have embraced the Next Gear philosophy, undertaking any organisational change is known for its challenges and its reception has been mixed. Rogers' 'Diffusion of Innovation' describes how the adoption of new technology or ideas varies throughout a population, with some 'Early Adopters', followed by the majority, and some 'Laggards' (Rogers 1995).

> Some people have an epiphany moment and think *"You know what, I'm going to change"* … Some people it's *'Oh I've been doing that- this is the way I've been all the time anyway'*, and some people are *'What a load of bollocks, I'm not going to buy into it'*."
>
> (Safety Manager)

Some of the quickest to embrace Next Gear have been project leadership — because of its efficiency emphasis on production — and engineers — because they value the increased buy-in from the workforce. Next Gear has made significant progress with cynics in the past few years: Some took time to be persuaded of its advantages *"slowly but surely"* (Safety Manager), but the Early Adopters have pushed forward aggressively putting themselves in a *"risky situation"* (Senior Safety Management) as they rush into uncharted territory.

8.1.1 The organisation of this chapter

This chapter describes how Next Gear has been received by different stakeholders, its impact on them, and the factors which have challenged and facilitated the transition at each level of the system. Aspects of the workforce (both operatives and health and safety professionals), the projects' clients, and the industry (regulators, structure, and culture), have all influenced the change. These are evaluated in the following sections with a view to determining Adaptive safety's compatibility with construction.

8.2 Frontline operatives

When asked about the differences they had noticed between Thames Tideway Tunnel (TTT) and their previous project, operatives primarily commented on the enthusiasm for, and visibility of, health and safety. Many also praised the good organisation which meant it felt unrushed — *"no roaring and shouting"* (Operative) — and the inclusive atmosphere.

> There's no friction, there's no bitchiness, we all know what we have to do, and that's it basically.
>
> (Operative)

This visibility is helping to normalise health and safety as part of everyday work, increasing workers' positive interactions with it and spreading Next Gear *"virally"*. Those who had been involved with Next Gear's processes quickly saw the value of these new methods that aligned with the reality of their work and had potential to address many of their concerns — excessive paperwork, inappropriate procedures, and poor communication. At Crossrail, where Next Gear has been running for more than two years, operatives and engineers were increasingly taking the initiative to lead safety processes themselves.

Unfortunately, not all workers had noticed a difference between this site compared with previous ones. They complained it was just as litigious, bureaucratic and pressured as any other site. This view was mainly held by operatives from sub-contractors so may have been influenced by their brief time on site and limited interactions with Next Gear: Its low-profile dissemination means workers have no reason to expect this project to be different, and instead assume these long-standing issues remain.

The extent to which Next Gear is achieving its goals to increase communication, collaboration and trust within the workforce are explored below.

8.2.1 Communication

The effects of a more collective approach to risk had been noticed at all levels of the organisation: For example, senior safety management found workers who in the past would have avoided them were now less fearful and even proactive about speaking to them; a safety manager observed workers were less inclined to blame engineers for failure of a task; an

engineer said he now made a conscious effort to speak up *"and most of the time people listen, which- which is quite nice actually"* (Site Engineer); one supervisor had been pleasantly surprised to be asked his opinion on *"everything"*, even tasks outside his sphere; and operatives felt able to give feedback to others which in the past they would have avoided because of the potential for argument.

> I think the operatives are a lot more vocal now … I think probably before they were kind of *"Oh, if I'm seen to be causing a fuss then, you know- then I'll cause a problem"*
>
> (Engineer)

Although this shows Next Gear has increased communication on site, operatives needed reassurance of support, with some saying they would prefer to speak to management than confront another worker directly — past arguments and bullying taking time to be forgotten. Some were reluctant to challenge others as they wanted to avoid being a nuisance or causing confrontation. Several workers liked the anonymous observation cards as they saw them as an alternative to challenging directly — misinterpreting the purpose described in the induction to firstly to speak to those involved (*"Sort it"*), and then to *"Report it"* as a final action. These cards are one of TTT's initiatives which blur the message of Next Gear as many frontline workers were not aware they would be encouraged and supported to challenge directly.

Other operatives did feel able to challenge, but felt the need to be defensive and, on occasion, hostile. There were also practical difficulties engaging the workforce in the new processes: Some were shy and needed encouragement to get involved in discussions and maintaining the attention of workers in a meeting room of a busy site — even for a thirty-minute Collective Insight — was a challenge.

Next Gear has been supported by factors which promoted dialogue throughout the workforce. At TTT's smaller combined sewer overflow (CSO) site (Blackfriars Bridge Foreshore), health and safety management found — compared to the Central tunnelling shaft site — teams developed better working relationships with each other and the client.

> Working on this [CSO] site, it's an entirely different beast, because here I've found there isn't really the us and them mentality … it's a smaller team and we are all over a couple of floors, we see each other when we're in here making tea and coffee et cetera.
>
> (Safety Manager)

Co-location of teams has been shown to have a significant impact on cooperation, trust, and communication (Allen 1984) hence some safety managers at TTT chose to sit with the engineers to facilitate Next Gear. Other participants confirmed the importance of building these relationships: An engineer found workers more willing to engage with her when

part of a smaller team or working on the smaller CSO, and a supervisor found teams that had moved from Crossrail to TTT (bringing their experience and existing relationships with them) were easier to work with. Having moved from another tunnelling megaproject, these teams benefited from a reduced learning curve at TTT — already being familiar with the high-expectations and organisational processes associated with this type of site.

8.2.2 Collaboration

Many had noticed the positive effects of empowering workers, drawing on their experience and listening to their concerns. The emphasis on respect, recognition, praise, and engagement is improving workers' job satisfaction and overall well-being.

> The lads feel more involved, that they're actually building what they've planned, not building what we've planned.
>
> (Construction Manager)

> Even today, I'm still learning stuff … it's good, because then they feel a bit motivated, *"Oh, look! He's asked me what I'm going to do!"*
>
> (General Foreman)

Workers also fed back about benefits of Next Gear's processes for sharing workload and integrating new workers — particularly in engaging a multicultural workforce — and subcontractors who appreciate the autonomy, improving their relationship with LOR's managers. Those who had been involved in collaborative problem-solving found this built trust and lasting relationships which teams would draw on in the future to share knowledge.

> They'd understood their problems, and they worked together, and that team now are very close … they'll come back and talk to some of our team, if there are problems with any job because they learn from each other.
>
> (Construction Manager)

Next Gear's processes have also resulted in productivity gains and quality enhancements:

> I'm not stupid, the boys out there have been doing what they're doing a hell of a lot longer and have got far more experience in what I'm asking them to do than I have … they'll tell you exactly how you can get round [a problem].
>
> (Engineer)

Not everyone at the frontline had seen the benefits of Next Gear, particularly at TTT where the Next Gear way of life is less established. Many workers were cynical about safety;

bored of *"the next new drive'* (Supervisor); and uninterested in the changes — *"I've done like loads of them, they're all similar"* (Supervisor). Some were confused by the subtle branding which had appeared on bulletins and emails without a formal launch, and why 'Mission Zero' (for the few who had noticed its absence) had been removed without any explanation of whether or why they had failed to achieve zero accidents. The workforce has become weary of constantly changing safety interventions: Initiative or Change Fatigue reduces energy, productivity and commitment; can leave a workforce overwhelmed and fearful of instability; and breed pessimism and cynicism towards management (Shapiro 2017). In line with Shapiro's recommendations safety leaders recognised the need for persistence — explaining messages, involving workers, and incentivising the new processes. However, he also recommends 'recovery-time' to allow workers to buy into change, but LOR's safety leaders felt the names and branding would need to be changed again in the future to keep them *"fresh"*. Complacency is a threat which worries many safety managers in construction, hence their search for novelty (Shapiro 1996) and dogged enforcement of overlapping interventions (Johansson and Lundberg 2010, Rae et al. 2018, Swuste et al. 2012).

Workers were disdainful of management's legal *"arse-covering"* (Supervisor), lack of experience, sympathy, and humility, and several used the interview as an opportunity to implore management to listen to them.

> I'm not saying all of them, but there is a lot of them who've never actually physically worked on the ground with the likes of us ... you can't really talk to them because they think they know best.
>
> (Operative)

Although participants from Crossrail said the new tools helped to integrate sub-contractors, only some at TTT felt part of the project; instead feeling the need to compartmentalise their responsibilities.

> We're in charge of our little world, and obviously a lot of management like to think they're in charge of everything, but when it boils down to it, it's only me, because if it all goes wrong it's me who goes to prison.
>
> (Supervisor)

Many workers were fervently risk-averse, clearly aware of their responsibility for their peers; they did not trust the organisation to keep them safe and did not feel, or want to be, integrated into the wider project — *"I look after my little area."* (Supervisor). This desire to protect what Dekker describes as their *"discretionary space"* is an attempt to retain some pride and meaning in their work (Dekker 2018, Dekker 2007).

8.2.3 Trust

Some frontline workers who had encountered Next Gear were disappointed that it had not lived up to expectations and grown sceptical.

> **Participant A:** We were told that with this Next Gear that they was empowering people and, you know, wouldn't shove- all this health and safety wasn't shoved down your throat … they were going to say *"Well, OK, we can relax our- our rule on [PPE]"* but it's not panned out yet, it's just words.
>
> **Participant B:** And I don't- personally I don't think it ever will.
>
> **Participant C:** I don't see how that would really work, if they say that *"Well some tasks don't need safety glasses, some do-"*
>
> **Participant B:** There'd be too much confliction wouldn't there?
>
> **Participant C:** There'd be too much room to abuse it to be honest.
>
> (Crossrail supervisors' focus group)

Despite efforts to engage with the workforce, their distrust for management was still evident. Several argued it was not their attitude that needed to change but that of management — rarely had they noticed that it had. Moreover, some had misinterpreted Next Gear's methods: Asking open questions — intended to involve and listen to the workforce — enforced the perception *"they don't know what we're doing"* (Operative), and using photographs was seen as *"spying"* (Operative).

> It's a lot of us and them … [management] come and they stand at the top of the shaft looking down at you- wouldn't look at you or say hello or nothing, they'd just look at you and walk away … They're not confident enough to ask questions. They don't know anything about shovelling.
>
> (Operative)

Engaging with workers has been complicated by safety's negative reputation. Workers were on their guard around management, wary of the new processes — *"they're here to catch us out"* (Senior Safety Management), and they feared losing their jobs so would bow to pressure to *"just get it done"* (Supervisor). The expectations not to challenge or be consulted have become so ingrained in the industry workers no longer speak out.

> **Participant:** These days I don't even bother arguing now, it's pointless because they just go *"Do it!"*, so you just think *"Fine, I will do it."*
>
> **Interviewer:** So that's come from 20 years of experience?
>
> **Participant:** Yeah, and I don't mind doing anything, but there's got to be a reason why you're doing it … they can't give me reasons, it's just because that's what's written down in their book, and that's what we've got to do. And they won't listen to- like I said, 20 years' experience of doing a job-
>
> **Interviewer:** So even if it were to be different here you probably wouldn't try and challenge it?
>
> **Participant:** No, no.
>
> (Interview with a Supervisor)

Management interpreted workers' compliance as a fear of thinking for themselves or, at worst, incompetence; but in fact, having worked under the authoritarian rule of safety for many years, they have become demoralised and apathetic. These characteristics — submission, resignation and cynicism — have also been seen in people kept under totalising regimes (Arendt 1967 cited in Dekker 2018). Next Gear recognises the industry's role in workers' oppression and challenges it, but their trust in the system will take time to rebuild.

8.3 Safety leadership

Traditional mindsets at every level of the organisation — focussed on accidents, trends, targets and certainty — have been difficult to convert, especially among safety professionals and engineers. Accepting safety based on trust, well-being and anecdotes has been a struggle, and it is a constant fight not to slip back into old habits.

> People struggle if there's nothing to measure … if we haven't got a chart that says there's this many happening, then nothing's happening, and my worry with Next Gear is we're starting to slide into that.
>
> (Safety Manager)

The scheme needed an identity *"to get any traction with senior management"* (Senior Safety Management), reflecting how safety has become commodified, quantifiable, and normalised as part of business relationships (Dekker 2018). Some were sceptical of the abstract concept of 'Safety Differently' as initially presented, without any proof or tangible plan and tools to implement it. Concerns were also raised about how occupational safety and health (OSH) professionals — with their strong preferences for detail, order, and control — would cope with such a significant change to their role. They would be fearful the legal implications and concerned that (should Next Gear be successful) they would ultimately make themselves redundant.

> [They feel] that unless there's a massive turnover of activity, inspections, observations, meetings, briefings, inductions about actually- somehow they're- they're deficient.
>
> (Senior Safety Management)

As well as those whose pro-bureaucracy tendencies meant they struggled with Next Gear, there were also critics who reacted defensively to the plans — assuming any new safety intervention would mean increased paperwork and refusing to engage.

> Trying to get people's mindset around the bureaucracy, although we're introducing new tools which on the surface appear to be more bureaucracy … we are introducing these new tools to move us in a different direction, and therefore we can remove some of the other tools.
>
> (Senior Safety Management)

Some could not see past the short-term increase in paperwork to long-term plans for its reduction. The cluttered and liability-driven past of safety bureaucracy has scarred the sector, stifling innovation.

Contrary to this, most OSH professionals have embraced Next Gear. Participants were positive about the changes; genuinely committed to its principles; and increasingly convinced by its philosophy as it proved itself on site. Not only has it been effective in identifying safety issues but has changed their role for the better — improving job-satisfaction and relationships with the workforce.

Next Gear has seen the role of health and safety shift *"away from being a policeman and more into being the conscious of the organisation."* (Safety Manager)

> We're enablers, we're not restrictors … [leaders] who ask better questions, who facilitate the environment so that the team can succeed.
>
> (Senior Safety Management)

In the past, many safety managers had found themselves bored and disillusioned with their role — unpopular, office-based bureaucrats — which did not match their reasons for joining the profession. Rather than traditional stereotypes of policeman, bureaucrat, or priest, OSH professionals regard themselves as *"upholders of justice, making sure the capitalist objectives of the modern corporation don't come at the expense of the safety of those on the frontline"* (Provan et al. 2018, p. 31). Some participants had even joined LOR because of Next Gear's promise of a role which better fit these values.

> You don't need any skills for it, it's a mindset, that's what it is … if you don't think that way then you're not going to be- you won't have any skills in it, do you know what I mean? It's not a- it's not something to learn, it's something to believe.
>
> (Safety Manager)

There was a widespread view among safety managers that Next Gear's ideas were *"preaching to the converted"* (Safety Manager). They had recognised through their own past experience the value of an inclusive, relational approach, but this was now validated and supported explicitly with *"additional tools to help push it along … it does help having the same message because on a big job I guess it allows everyone to be aligned and moving in the same direction."* (Safety Manager)

> I've always enjoyed the engagement side of it, so I've always enjoyed engaging people and empowering people. It gives me a lot of satisfaction if you've got a good site with feedback coming from the workforce.
>
> (Safety Manager)

Most had enjoyed the challenge and opportunities it had brought to gain new soft-skills and experience in other areas.

> It is an interesting challenge because it's a very counter-intuitive place to be as a health and safety expert, to be telling people to do less to get more! And I've enjoyed that.
>
> (Senior Safety Management)

Focusing on collaboration has reduced the dependence on safety managers to provide the answers. There is less expectation for them to understand the technical aspects of construction (although it does help) and instead they support and empower workers to solve problems themselves. This was especially reassuring for newer members of the team who found the collective processes enhanced their own learning, as well as the operatives'.

> You don't need to be an expert just to ask questions, you could learn something new. And you might just be right, you might spot something they've overlooked.
>
> (Site Induction)

Practically, only some said they had seen a reduction in paperwork; however, they had noticed they spent more time on site, were better informed, and had better relationships with the workforce. Next Gear's goals to focus on high-consequence risks, reduce bureaucracy, and involve the workforce frees up time for safety staff and engineers to spend on activities that add value, and should continue to do so as more safety responsibilities become part of frontline work. Although not under any less pressure, safety managers felt liberated from pointless and punitive work that had hampered them previously.

> I don't get that feeling the world's fallen apart because somebody's cut their finger from our business, which is great really, because it used to be an absolute nightmare.
>
> (Senior Safety Management)

As well as confidence in its philosophy, Next Gear leaders were outgoing, curious, open-minded, enjoyed problem solving, embraced challenge, and were proactive — taking the initiative to create opportunities for conversations and lead the new processes. Leaders were supported by from interpersonal and leadership skills — such as accommodating different personalities — as well as a technical knowledge of construction processes which gained the respect of the workforce and increased engagement. Respect and trust were key to the relationship between leadership and operatives. Finally, an individual's health and wellbeing support effective decision-making, including judgement around risk. Many of these traits align with the interpersonal aspects of leadership discussed in Chapter 5.

> I'm quite a confident person, I'm not intimidated or phased by new people or different situations, I think that's why it's good that I'm in the role I am.
>
> (Safety Team)

Initially, the responsibility for leading Next Gear has fallen to health and safety management, but this is shifting towards operations — hence these characteristics apply to anyone wanting to drive the Next Gear agenda. However, changing the negative reputation of safety and the view that safety is the responsibility of the safety department are both ongoing struggles.

> I think it's still very much seen as it's a safety function, and we go and do it to people, and I think we need to- for it to work really really well and really embed it, it needs to be the construction teams, and the management teams.
>
> (Safety Manager)

8.4 The client

Balancing Safety Differently with the client's requirements has been one of the greatest challenges. Both Crossrail and Tideway are supportive of Next Gear, but need the reassurance of more traditional safety measures alongside it, resulting in confusion and conflict. Despite the drive to the reduce paperwork, the safety team found themselves duplicating processes — running a parallel *"ghost system"* (Senior Safety Management) to satisfy the client. For instance, the Crossrail and LOR's Next Gear inductions are presented back-to-back at Tottenham Court Road station (TCR); workers at TCR received safety alerts and initiatives from other non-LOR Crossrail sites; and at TTT a multitude of contradictory safety interventions send mixed messages to the workforce — diluting the impact of Next Gear.

> **Participant:** If you think about it you could have, in essence, three health and safety systems. You have Ferrovial and Laing O'Rourke and the joint-venture.
>
> **Interviewer:** And Tideway's?
>
> **Participant:** Yeah. Which in essence are all going to say exactly the same thing, right?
>
> (Interview with a Safety Manager)

The intentions of these four safety systems may be the same, but the ways they try to achieve this outcome are incompatible. Both clients were inclined to pay more attention to minor injuries than the potentially fatal incidents which are the focus of Next Gear.

> One of the things about Crossrail is that they sometimes look for easy wins, picking up on [minor hazards], but when it comes to *"Oh we want you to do*

> *this lining a wall, this big form work, this big complex lift, whatever- just do it!"* Show us the method statement and as long as it looks sound it's fine.
>
> (Engineer)

Both clients required key performance indicators (KPIs) to be reported, going against the move away from metrics; both reacted to incidents by restricting freedom and carrying out conventional investigations, making it difficult to prioritise Next Gear initiatives such as investigating positives or engaging with the workforce; and both enforced mandatory personal protective equipment (PPE) so there has not been an opportunity to trial a discretionary policy.

Tideway's 'transformational' ambition has seen many positive initiatives such as its outstanding welfare facilities, immersive induction course, and emphasis on long-term holistic physical and mental health. Being privately funded, TTT is not as tightly regulated as publicly funded projects allowing greater scope for innovation (Robinson et al. 2010). However, safety managers condemned some of these initiatives as *"unnecessary"* (Safety Manager): They felt workers were inundated with interventions, some of which were perceived as trite or superficial (e.g. giving out gift cards at Christmas) and hindered Next Gear's attempts to depose the transactional management of 'Behavioural Safety'. Some of the safety team admitted to paying lip service to the client's initiatives which did not align with Next Gear.

Safety managers also criticised Tideway's 'Leadership Tours', which on one hand could provide perfect opportunities to engage with the workforce, but instead were used by the client as inspections — reinforcing the *"us and them"* culture which many operatives felt was present despite LOR's efforts to open up communication between workers and management. The client's interference and hypocrisy led to additional work and frustration, degrading their relationship with the contractor.

> I was going to say strangled, but that's not the right word, by Crossrail … we're man-marked by Crossrail so they're not like our previous jobs that I've worked on … We had a lot more freedom.
>
> (Site Engineer)

> The problem with being a client is you get to know less than half of what actually goes on … we have a client here based on the job integrated with us but there's still that clear divide.
>
> (Safety Manager)

The success of creating an integrated project team of client and contractors has been limited, and clients were often seen to be obstructing health and safety; unfortunately, their blue sky ambitions and promises made at the induction created expectations which could not be met on site, resulting in resentment among the workforce.

> We talk a good fight but we don't necessarily deliver … and you do get people saying *"Well, what- I heard this on EPIC*[1]*, I heard that on EPIC, and I'm still stuck here with all this"*. So I think on some- on some issues, we're over stretching the reach.
>
> (Safety Manager)

This was compounded by cost-cutting measures on the project which complicated recruitment and retention.

> All the labour out there is agency, it's ridiculous because there's no commitment from them, you know, there's no commitment from them, *"Oh you've finished up, oh alright off you go."*
>
> (Supervisor)

The quoted supervisor had seen a 300% turnover in his team in less than two years on the project, and was among several operatives who complained that pay at TTT was below the market level. It was hypothesised that LOR's high proportion of directly employed workers would aid the transition; however, this factor was not raised by any participants. Instead, its effect was overridden by pressure to maximise profits on this private venture, driving the use of agency labour. This high turnover will be costly long-term and compromise safety: Agency workers lack commitment, skills, and — as discussed in the previous section — the transient workforce makes it more difficult to communicate Next Gear through personal encounters.

Despite this, those who were able to compare the two clients said Tideway were more supportive than Crossrail. Rail clients, including London Underground are known to be ultra-conservative, quick to blame, and have a knee-jerk reaction to incidents. Described as *"confrontational"* and *"stuck in the dark ages"*, several participants felt fighting uncompromising clients would hold Next Gear back.

> [Clients are] absolutely obsessed with AFRs[2], Lost Time Injuries, and they always will be, they won't change that principle … there's a lot of bonus attached to that, in- in their world.
>
> (Senior Safety Management)

Although in their own ways both Tideway and Crossrail have been challenging clients, they have also been supportive of the scheme. Ideally, a client needs to be either fully aligned with Next Gear, or happy to give the principle contractor complete freedom — as seen more often in construction as opposed to infrastructure. Tideway has been influenced by Safety Differently, including *"people are the solution"* as part of their mission statement, which explains why many of their initiatives align with Next Gear. They have ambitions to

[1] Tideway's immersive and experiential induction course
[2] Accident Frequency Rates

"raise the bar" for the industry, experimenting with new ideas and concentrating on health and well-being which demonstrates their commitment to people.

> We've got kind of a client that just wants to be different, they'll embrace, you know, anything new, the innovation side of it is- is very well supported, and yeah in a sense they're a breath of fresh air themselves.
>
> (Safety Management)

Next Gear has been supported by Tideway initiatives which emphasise the 'big-picture' (for example, an induction video about the tunnel, a viewing platform over site, and photographs of the build throughout the offices). A goal-driven approach motivates performance and encourages innovation (Dekker 2018): By showing workers their contribution is a valuable part of the project these initiatives stimulate ideas and discussion. Engagement has also been encouraged through interactive and scenario-based elements throughout the induction process and technology (BIM[3] and VR[4]) which is used to support training and discussions on risk.

Having an opportunity to influence safety from the outset of the project has been beneficial for LOR at TTT. This is consistent with research which shows a project is more likely to be successful if the client is involved at the front end to define goals, understand risks and opportunities, and engage with stakeholders (Morris 2013). In contrast, Crossrail is seen as the more difficult of the two clients, but Next Gear was introduced four years in to a seven-year project so difficulty changing their established safety practices was to be expected. Having proved its value over the past two-year pilot, as they reach the final phases of the project Crossrail are becoming more amenable.

> But what's happening now is Crossrail is, now it's drawing to a close they're not as forceful as they used to be- we still have to comply, but they're not- they're not as forceful.
>
> (Senior Safety Management)

8.5 Industry

8.5.1 Regulators

Initially, convincing an industry which so staunchly advocates traditional or Safety I values was a battle. The Union of Construction, Allied Trades and Technicians (UCATT) launched a scathing attack, accusing LOR of slipping standards and neglect which would *"erode the very foundations of the UK's health and safety culture"* (UCATT, 2016).

[3]Building Information Modelling
[4]Virtual Reality

> We needed to counter this myth that floats around that we've stopped doing safety.
>
> (Senior Safety Management)

LOR was criticised in the media yet risked their reputation to pursue the scheme. Safety management showed determined faith in the theory, defending themselves against unions and regulators who had taken it *"out of context"* (Safety Manager), and ultimately, their risk has been rewarded as they lead the industry into this new era.

Construction has struggled to relinquish its *"endless bureaucracies"* (Senior Safety Management): As discussed in 7.5.1, companies have set progressively ambitious targets and tighter controls to impress clients and regulators, creating pressure for themselves and competitors. Turning against this prompted uncertainty and criticism.

> The traditional perception would be that if you're not focusing on traditional health and safety anymore, then you're not doing very well in the eyes of the regulators, and you're not doing very well in the eyes of the assurance companies.
>
> (Senior Safety Management)

Some felt the move would need a supportive change in government legislation to be successful. Qualifications enforced by the regulators (National Examination Board in Occupational Health (NEBOSH) and Construction Skills Certification Scheme (CSCS)) conflict with the Next Gear philosophy meaning from the start of their careers both safety professionals and workers and not trained for a Safety Differently organisation. For example, Next Gear aims to break down barriers and support a ubiquitous discussion of risk, whereas the CSCS reinforces the correct procedures for challenging another worker — via your supervisor unless the situation is safety-critical. On the other hand, misrepresentation of the law has led many to believe it is more restrictive than it is. Rather than rigid compliance and bureaucratic processes, regulators advocate *"sharing and learning"*, *"active participation"* (BSI 2018) and *"strengthening leadership and worker engagement"* (HSE 2018) — key components of Next Gear.

8.5.2 Structure

As a network of project-based temporary multiple organisations (TMOs), the influence of the wider project ecology on TTT and Crossrail needs to be considered. Growing numbers of infrastructure megaprojects (Flyvbjerg 2014) has created competition for workers and TTT has struggled to recruit and retain qualified workers, jeopardising the project.

> Now we shouldn't just be going out to anybody to do any sort of job, we should be getting the best … but the trouble is the best guys are either still on Crossrail

> or they've been taken to HS2[5], or they're going down to Hinkley Point, Northern Line Extension."
>
> (Supervisor)

Research is ongoing into the 'trickle across' effect in construction meaning project capabilities are transferred to subsequent megaprojects; however, this supervisor raises concerns TTT may be left out of this 'cascade' because of its timing and its poor reputation which deters workers. On the other hand, TTT's leadership has created a knowledge sharing partnership to pass on learning from Crossrail. The infrastructure industry innovation platform (i3P) aims to foster industry-wide collaboration, accelerating and directing innovation towards key challenges (I3P 2018, Kemp 2017). Learning or capability development is key to Adaptive safety but project-based industries struggle with a *"doing versus learning dilemma"* (Davies 2017, p. 109) — whereby work is focussed, rapid, and seemingly unique which restricts the transfer of knowledge. Systems like i3P build relationships and trust between organisations to share explicit knowledge, but the tacit knowledge workers have gained may be lost.

Infrastructure megaprojects are often led by a partnership of principle contractors. Initially, implementing Next Gear in a joint-venture was expected to be a challenge — hence Crossrail, a sole-venture, was chosen for the pilot — however, TTT strengthens the case for its suitability to any context. Ferrovial Agroman and LOR both brought ideas to a *"blank canvas"* (Safety Manager), forcing them to review their processes, combine their expertise, and decide a way forward together based on the needs of the project. Designing this joint strategy was initially painful, but compared to other joint-ventures the tension between the partners was said to have been minimal: Ferrovial Agroman were soon convinced of Next Gear's potential and committed to this experiment. Partners on subsequent projects have also been quickly converted and more willing align their policies than expected.

However, at the frontline supervisors did feel there was tension between LOR and Ferrovial Agroman, and the complex organisational structure was a hinderance.

> Crossrail to me was an easier project and not as frustrating, here is very very frustrating … we're waiting 6 weeks to get plastic zip-ties, we're waiting 6 weeks to get lifting tackle- you know.
>
> (Supervisor)

Compared to Crossrail (the sole-venture), TTT's layers of management and lengthy processes resulted in delays in procurement and allocating permits. While Next Gear tries to encourage engagement by showing workers they are valued and listened to, these delays and frustrations mute its effectiveness. The structure of the organisation is further complicated as work is sub-contracted; trades compartmentalise their work, limiting communication, trust, and engagement. These sub-contractors are also only on site temporarily —

[5] High Speed 2

perhaps as one of several projects they are working on — making it harder to reinforce Next Gear's message.

> If you were in a manufacturing company or- oil company probably it's easier because you're going to have the same staff … but during those 7 years [of this project's duration] it's amazing the number of people we have on site so that's very- it makes it very challenging just making this philosophy more effective.
>
> (Safety Manager)

The temporary workforce and organisations in construction also mean the sector struggles to allow interventions to reach maturity. Shapiro critiques the tendency for organisations to 'fad-surf' between panaceas which are *"applied blindly across a business, without attention to where they might be useful, why, with what other techniques they are being combined, and how, if at all, they should be modified to meet the needs of the company"* (Shapiro 1996, p. xiv). This trend is seen in construction with safety culture and behaviour-based safety programmes, each promised breakthrough but was soon replaced by the next fad.

In such a dynamic and pragmatic industry waiting for long-term results is challenging. Some saw Next Gear as one of many fads that had come and gone and were worried it too would not come to fruition.

> I think as a sector we're quite good I think at sharing and communicating, so what tends to happen is, the latest- someone has a success with something, or it gathers some positive publicity, and then the next company wants to do that because they want to be on that bandwagon.
>
> (Senior Safety Management)

> You see in construction, especially in this project, it's very difficult to- for us to have these kind of strategies because we have people everyday coming to sell you new stuff, new practice, agencies, so it's very difficult to create a strong culture about it here.
>
> (Safety Manager)

Having a strong 'safety brand' has become an important part of the tendering process. Clients' requirements for contractors are based around traditional safety metrics, putting LOR at a disadvantage beside competitors who spoke the language of the industry. This included Tideway whose works information for the project originally specified a contractor with a zero-based safety programme. To counter this, extra time and effort was needed to convince potential clients of the benefits of Next Gear, persuading them to take a risk and let LOR experiment.

> It's a slight risk because some clients are still measuring us like for like with other competitors, and they might be saying *"AFR*[6] *this, and AFR that"* and we're saying *"Next Gear, engagement, trust."*
>
> (Senior Safety Management)

8.5.3 Culture

Finally, LOR faces a challenge changing the culture of construction which is dominated by negativity and blame. Past safety policies have been built around controlling a minority of apparent risk-seeking, undisciplined, and incompetent workers. Senior Safety Management explained the key to Next Gear is not to let this minority limit the respect and autonomy the workforce deserves, instead fostering sympathy with the workforce — understanding their actions in order to learn and improve. However, there was a widespread acceptance that occasionally there would be *"idiots"* and *"mavericks"* on site that caused accidents.

> We work in an industry where [accidents are] just inevitable, we can do as much as we can, but we can't- you can't teach out stupidity.
>
> (Engineer)

According to Safety Differently, accidents are impossible to predict, and people are the strength in the system, yet even participants who were fervently committed to and engaged in Next Gear were inclined to see accidents as someone's fault. There were examples of instances where Next Gear's privileges had been openly abused.

> We've had some guys on construction sites saying: *"Where's your permit?"*, *"We don't need a permit, we're 'Safety Differently'!"* and you can see how it can start to be abused.
>
> (Senior Safety Management)

This limits how true Next Gear can be to the Safety Differently philosophy: While there is still a perception that these *"malicious people"* indulge in *"rogue behaviours"* there will be pressure to balance Safety Differently with traditional discipline and rules.

Negative attitudes also compromised the Next Gear tools; collective insights could be dominated by questions about accountability and appropriate permits, and worker engagement often unleashed a barrage of complaints.

> It's trying to get people- people will very readily complain, but they won't very readily praise, you know? Everybody's happy when they're moaning … unfortunately it's a construction site and if you're too nice, people will just take you for a ride.
>
> (Engineer)

[6] Accident Frequency Rate

8.6 Conclusion

There have been many challenges which threaten Next Gear's ambition at every level of this complex system: The industry is reliant on compliance-based safety; clients dictate safety processes; projects are constantly changing; and the workforce has learned not to engage. These discourage collaboration — reinforcing the culture of cynicism, blame, fear, and the divorce of management and the frontline. Any organisational change is challenging, and construction's persistent culture means workers' trust in management, and subsequently willingness to engage, will take time to rebuild.

The case study also identified aspects of construction which mean Next Gear is well-suited, and factors which have facilitate the transition. By comparing the two projects, the importance of a supportive client; alignment with the Safety Differently philosophy from the outset of the project; and time to allow the ideas to embed and relationships to mature were discovered. Construction's dynamic organisational structures can also be advantageous as changes can be made quickly, processes reviewed, and iterations trialled.

Chapter 9 draws together the factors which have supported and hindered Adaptive safety at LOR. These findings, together with those from previous chapters, are discussed to determine its compatibility in construction.

9 Discussion

Contents

9.1 Introduction

This chapter summarises the findings of the case study presented in Chapters 7 and 8 and reflects back on the theory behind the Adaptive safety movement to evaluate this attempt to apply its ideas in construction. Its compatibility (or incompatibility) with construction is discussed, questioning whether resilience is suited to a dynamic network; if empowering workers addresses construction's blame culture; and the degree to which a more traditional version of safety — procedures, competence, experience, and compliance — is better suited to this sector.

The chapter concludes by proposing a model of systemic antecedents which underpin organisational resilience and a continuum between traditional and Adaptive safety.

9.2 Challenges and facilitators of Safety Differently

The findings of Chapter 8 indicate that — based on the early stages of Next Gear's development and implementation — construction can incorporate Adaptive safety, and benefits from its ideas. To summarise these factors which have affected Laing O'Rourke's (LOR's) transition to Next Gear they have been presented in a modified decision matrix. Table 9.1 shows how the 'SWOT-TOWS' decision matrix has been modified for this purpose.

This framework is typically used to explore the Strengths and Weaknesses of an organisation, and Opportunities and Threats of the external environment in a future venture (hence 'SWOT'); however, here it is utilised to assemble the strengths and weaknesses of

Next Gear and the factors which have challenged and facilitated its application in these infrastructure megaprojects. Instead of making a strategic decision, the SWOT-TOWS analysis has been applied on reflection to evaluate the mechanisms that support and hinder Safety Differently. The inverse 'TOWS' element uses four quadrants to identify where the strengths of Next Gear are supported by aspects of construction (lower left) and where the weaknesses of Next Gear are exacerbated by construction's flaws (upper right). The upper left and lower right quadrants show where features of Next Gear can overcome the challenges of construction and features of construction which can overcome the weaknesses of Next Gear respectively. These quadrants have been subdivided — as the analysis is retrospective — to also include areas where the construction's challenges undermine the benefits of Next Gear and where the weaknesses of Next Gear mean it fails to take advantage of construction's strengths. The findings are presented in Table 9.2.

Table 9.1: The modified SWOT-TOWS pro forma

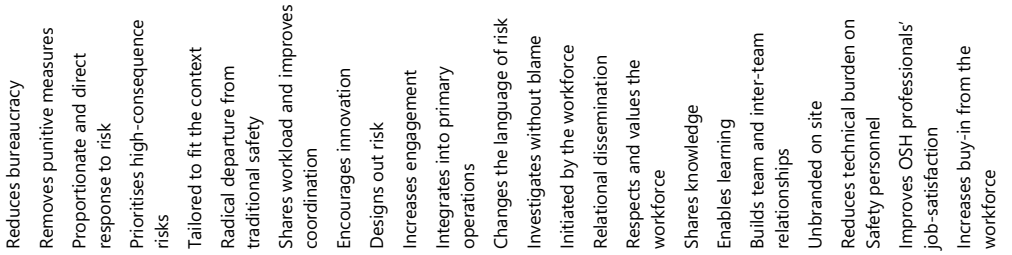
		Weaknesses of Next Gear		*Strengths of Next Gear*	
Challenges of Construction	**SECTOR** **ORGANISATION** **PROJECT** **SAFETY LEADERSHIP** **WORKFORCE**	Challenges of construction which **aggravate** the weaknesses of Next Gear (and vice versa)		Strengths of Next Gear which **overcome** the Challenges of construction	Challenges of construction which **undermine** the strengths of Next Gear
Positives of Construction	**SECTOR** **ORGANISATION** **PROJECT** **SAFETY LEADERSHIP** **WORKFORCE**	Positive aspects of construction which **overcome** the weaknesses of Next Gear	Weaknesses of Next Gear which **undermine** positive aspects of construction	Strengths of Next Gear which **complement** positive aspects of construction (and vice versa)	

Table 9.2: The strengths and challenges of Next Gear at LOR

Weaknesses of Next Gear

Challenges of Construction	Cost to implement	Abstract concepts	Compromises defence against litigation	Slow to maturity	Lack of identity or brand	Difficult to measure 'success'	Reliant on traditional safety to set boundaries	Not suited to traditionally-minded safety leadership	Relational dissemination	Optional	Inconsistent across projects	Misunderstood by the workforce	Open to abuse	Failed to meet employees' expectations
	Aggravating													
SECTOR - Litigious, traditional safety mindsets, existing qualifications, low-profit margins, blame culture, market-pressure and competition	Difficulty convincing the sector and its clients to overcome their fear of litigation. Requires investment to make changes. Changing the culture of the industry is difficult and slow. Risky to go against industry expectations.													
ORGANISATION - Unionised, constant change, compartmentalisation of trades, low wages	Public reputation is crucial in a competitive market. Change makes communicating Next Gear's message more difficult.													
PROJECT - Demanding clients, interfering project management, joint-venture partners, cumbersome processes	Clients dilute Next Gear and confuse the message with contradictory initiatives. Reliant on traditional metrics. Difficult to bring all stakeholders on board.													
SAFETY LEADERSHIP - Pragmatic, fearful of litigation, negative reputation, separated from primary operations, preference for control and busyness, significant change to their role	Difficulty understanding Safety Differently as a concept. Struggle to let go of a traditional model of safety. Difficulty moving between projects because of inconsistency.													
WORKFORCE - Transient, cynical, fear of confrontation, apathetic, distrustful of management, low calibre of workers, defensive, initiative fatigue, fear of losing their job, shyness, stubbornness, short attention span	Broken promises reinforce cynicism. Some only briefly encounter Next Gear and have not noticed the changes. Not open to change. Worries about 'idiots' who need to be controlled by conventional safety measures. Expectation to be told what to do.													
Positives of Construction	***Overcoming*** (Positives over weakness)													***Undermining*** (Weakness over Positives)
SECTOR - Open to change, communication between companies, dynamic	Construction has become cynical about traditional safety. Constant change stimulates review and improvement.													Change prevents initiatives reaching maturity. Change means versions of Next Gear diverge.
ORGANISATION - Flat management structure, progressive, influential within the industry, previous behavioural safety programmes, supportive leadership, project capabilities	Willing to invest in innovation. Most are familiar with Behavioural Safety and its flaws.													
PROJECT - Well-organised, aligned or laissez-faire clients, influenced decisions from the outset, joint-venture partners, smaller sites or teams, 'big-picture' perspective, pace and complexity of the project														Some partners may be less on-board than others. Pace and change mean some lack time to understand the philosophy.
SAFETY LEADERSHIP - Aligns with experience, outgoing, open-minded, proactive, embrace challenges and problem-solving, technical knowledge of construction, health and wellbeing, authority, leadership skills, visibility														Relies on knowledge of safe construction processes to set boundaries. Workers expect formal risk processes led by safety leaders. Some safety leaders lack skills or mindset for engagement.
WORKFORCE - Resourceful, experienced, risk-averse, experience of megaprojects, existing team relationships, open-minded, appreciate autonomy, trusted														Many still feel restricted and have become sceptical about whether Next Gear will deliver. Some workers misunderstand or abuse the new policies.

Strengths of Next Gear



Overcoming (Strengths over challenges)	***Undermining*** (Challenges over strengths)
Challenges unethical litigation management. Challenges insensitive, unworkable policies and bureaucracy. Language is accessible and not accusatory. Aligns productivity, safety, and quality. Improves efficiency. Supports a just culture.	Existing training discourages engagement and communication between trades.
Greater empowerment and job satisfaction for workers. Encourages inter-trade collaboration and coordination.	Sceptical of changes. Change reduces the effectiveness of knowledge transfer. Relational approach relies on open communication. Undermines value of the workforce.
	Brand is overshadowed by the clients'. Undermines value of the workforce's input. Limits knowledge transfer.
Improved wellbeing. Improves safety's reputation. Safety is created by the workforce for the workforce. Embracing a more collaborative approach to safety.	Poor relationship with the workforce compromises engagement.
Significant change challenges long-standing expectations. Increases engagement. Supports open communication throughout the site. Informality makes safety accessible. Opens communication. Improves relationships between 'us and them'	Difficulty changing attitudes of those only briefly involved. The workforce has learnt not to expect to be consulted. Attitudes and expectations are ingrained.

Complementing
Able to adopt radical ideas quickly. Flexibility suits diversity of the sector. Successes and challenges are easily shared. Communication is enhanced by the involvement of the workforce. Supports learning and innovation.
Direct involvement of management to support change. Open to new ideas. Demonstrates the workforce is valued and supported from the top.
Provides time for consultation and collaboration. Reduces pressure. Supportive of new initiatives, particularly reducing bureaucracy and monitoring. Develops a safety policy which meets the needs of the project. Builds relationships which support communication. Stimulates ideas and learning. Time to reflect and share ideas.
Enjoy engaging with the workforce. Facilitate collaboration, communication, and relationships. Welcome innovation. Changing the reputation of safety. Increasing involvement on site. Respected by the workforce. Not judgemental. Normalising safety as part of everyday work.
Empowered. Embraces their creativity. Draws on their experience. Supports engagement with other teams and the project organisation. Eager to improve productivity, safety, and working conditions. Increased job satisfaction. Improves relationships with management.

9.3 The role of safety leadership

Safety leaders have been integral to the shift towards Adaptive safety in construction. Figure 9.1 shows how negative attitudes to workers — 'people are the problem' — perpetuate a vicious cycle (Zimmermann, Raab and Zanotelli 2013) driving the division between workers and management. Strong leadership skills are needed to break these cycles, changing attitudes to workers and encouraging engagement.

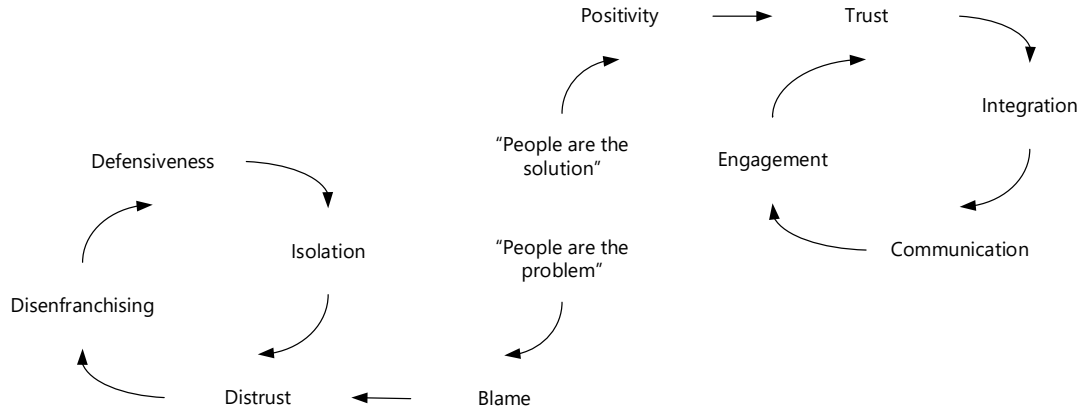


Figure 9.1: Vicious and virtuous cycles in management and worker attitudes

While safety leadership is key to worker engagement, this research has shown there are many other factors that contribute to organisational resilience. Change at LOR has been driven top-down, first changing the organisational strategy, in order to facilitate the emergence of resilience from the bottom-up. Many of the challenges they have faced confirm the industry-wide factors that conflict with Adaptive safety — lack of investment, lack of stability, and lack of communication.

In addition to its incompatibility with construction, these explorations have revealed potential flaws in the philosophy of Adaptive safety which need to be addressed: Namely, the ethics of experimenting with safety; its overemphasis of worker engagement; leaving the frontline vulnerable to blame; and its reliance on traditional safety to provide boundaries. These are discussed in Sections 9.4 and 9.6.

9.4 Challenges

9.4.1 The ethical concerns

Key academics in the field of resilience engineering (RE) have been clear there is no one best way to engineer resilience, but a multitude of methods which depend on an organisation's context and progress (McDonald 2006). Instead, an approach is advocated focusing on the factors unique to each sector which *"facilitate the emergence of resilience"* (Hollnagel

and Sundström 2006) and conducting 'microexperiments' to test changes in procedures (Dekker 2017*a*, Dekker 2018).

'Safety Anarchism' proposes an ecological model of learning by *"self-correcting feedback loops"*(Dekker 2018); however, with so little known about the mechanisms and antecedents of resilience, the ethics of such a trial-and-error approach are questionable. In many sectors changes to safety management are unthinkable unless evidenced by a quantifiable reduction in injury rates.

9.4.2 The substitution of engagement for safety

Similarly, if resilience is cultivated in a unique way depending on context, organisations are free to pick and choose aspects of this multi-faceted phenomenon. LOR have adapted Safety Differently to suit the challenges of this unique sector, so the extent to which Next Gear reflects the original theory of organisational resilience is debatable. Without an in-depth understanding of the antecedents or mechanisms underpinning organisational resilience, in construction this concept has been reduced to 'maximising worker engagement'. Although focussing on this has been a significant step forward for construction, a link between engagement and resilience or safety has yet to be proven.

This thesis set out to discuss how the philosophy of Adaptive safety could be modified to suit construction, focusing one particular aspect — safety leadership. Instead, this work reveals the need for a thorough and holistic understanding of the construct.

9.4.3 The responsibilisation of workers

Behavioural Safety has been criticised for endorsing worker-blaming, giving rise to the era of Adaptive safety and vision of 'people as the solution'. Unfortunately, without a shift in culture, empowering workers could actually fuel the tendency to blame them. In the past, workers have been blamed for errors, for a lack of attention, and now for a lack of engagement, mindfulness, and flexibility.

This contradiction highlights a significant research gap in Adaptive safety: Construction workers are problem-solvers; they are determined to continue work in spite of adverse conditions; they are dynamic to keep up with constantly changing sites and projects. All these are key to Adaptive safety, yet here are more likely to cause accidents than prevent them. Adaptive safety is more than freedom and proactivity at the frontline — without cultural change, training, resources, and restructuring to provide support at an organisational level their resilience will not result in safety.

9.5 Antecedents of Adaptive safety

Figure 9.2 proposes a model for the industrial and organisational factors that underpin organisational resilience. These factors at different levels of the system interplay horizontally

and vertically, but most importantly they stem from a top-level commitment to facilitate and support resilient response at the frontline.

Figure 9.2: Industrial and organisational factors that support a resilient frontline response

Collaboration

One of high reliability organising's (HRO's) defining principles is *"sensitivity to operations"* (Weick and Sutcliffe 2007), or in RE examining *"work-as-done"* (Hollnagel 2014). LOR have demonstrated the value of this in Next Gear, but this would not have been possible without top-level support.

Culture

Safety culture has developed a bad reputation due to its oversimplification in manipulative behavioural programmes (Sileby 2009, Guldenmund 2010) and vague utility (Cox and Flin 1998). Nevertheless, the collective values of the workforce, organisation, and industry continue to play a significant role in risk management. Here the term culture is used specifically to mean an organisational commitment to reducing risk — reflecting Chronic Unease (Fruhen and Flin 2015) and the *"preoccupation with failure"* (Weick and Sutcliffe 2007) component of Adaptive safety.

Competence

The workforce needs to be equipped, as well as empowered, to respond — Parker et al. (2010) call this the *"can do"* and *"reason to"* of proactivity. Workers need appropriate training and availability of resources to support *"deference to expertise"* (Weick and Sutcliffe 2007) and their potential to respond (Hollnagel and Woods 2006). In this way, resilience is underpinned by a traditional approach to safety.

Communication

Traditional safety processes and systems also underpin communication — an integral aspect of risk awareness and the potential to learn. Adaptive safety promotes agile, interdisciplinary teamwork, but the structure of construction (as projects and specialised trades) limits the flow of knowledge.

9.6 The interdependence of traditional and Adaptive safety

So far, Adaptive safety has primarily been explored in ultra-safe industries wanting to add resilience as an additional layer of defence. It is not yet understood to what extent Adaptive safety relies on these sectors' traditional foundations. Safety II is often promoted as a replacement for Safety I (Art of Work 2018, Dekker 2018), but its founders argue the two are complementary (Hollnagel 2014). The danger here is that seeing resilience as a state of 'mindfulness' — a sort of "sixth sense" for risk — emphasises responsiveness over preparation and prevention. As well as responsibilising workers, it offers construction a superficial substitute for addressing the problems of the industry at their source.

Gibb et al. (2016) propose a continuum between formal top-down risk control and the bottom-up social construction of safety knowledge. The appropriate type of risk management varies along this scale depending on the individual, task, and environment. This 'Third Way Continuum' has been adapted (Figure 9.3) to show how traditional and Adaptive safety are not mutually exclusive: Some work can allow a greater degree of freedom within specified boundaries, but other tasks must be rigidly controlled.

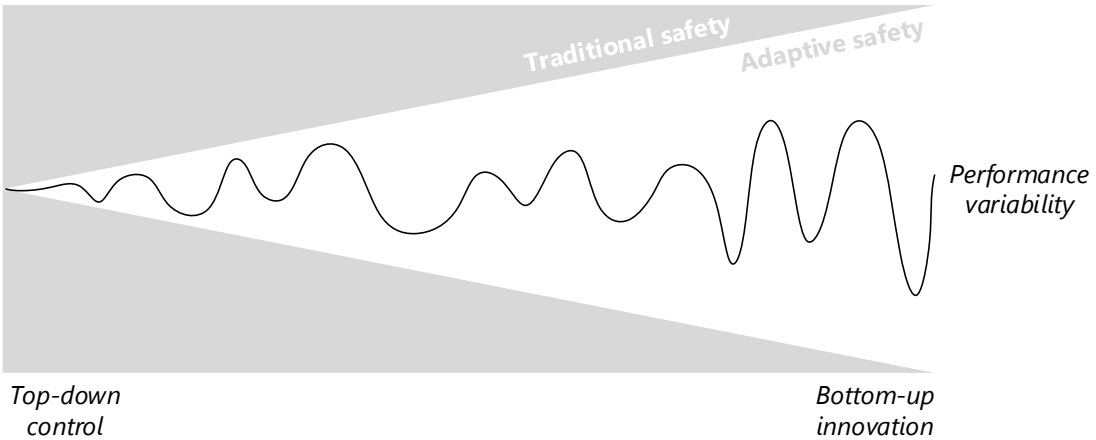


Figure 9.3: A continuum between traditional and Adaptive safety based on (Gibb et al. 2016, Hollnagel 2009)

At the far left are industries which are best managed with a traditional approach to risk; the grey areas show the extent to which rules and procedures are needed to set boundaries, establishing an envelope for performance variability (shown in white). Industries on the right of the spectrum can allow their workforce to manage risk adaptively with very few hard rules. Construction sits somewhere between the two extremes of Safety I and Safety

II: Depending on the nature of the task, some rules are necessary, but there is scope for adaptation within these guidelines. Further research is needed to understand where different types of construction and other industries would sit within this continuum.

9.7 Conclusion

This research has shown that Adaptive safety in construction depends on organisational, as well as individual factors. Culture, communication, and competence provide the Safety I foundations and, within these tangible boundaries, workers can be allowed the freedom to indulge in Safety II. Thus, there is a need for a context-sensitive balance of new and old safety paradigms. However, balancing Adaptive safety with more traditional aspects of safety poses a challenge: Lindland (2018) found encouraging autonomy from the top-down can send mixed messages, weaken trust, and alienate workers: Too prescriptive a 'recipe' compromised employee driven innovation. This paradox suggests autonomy needs to be initiated from the bottom-up and top-down in collaboration — drawing on both traditional and new philosophies of safety. Chapter 10 concludes with the impact of these findings and a way forward.

10 Conclusion

Contents

10.1 Introduction

This final chapter summarises the findings and contribution of this thesis; critiques its limitations; and puts forward an agenda for future research in the short, medium, and long-term.

10.2 Summary of thesis findings

10.2.1 Adaptive safety and construction

Initially, Chapter 2 reviewed contemporary literature on emerging concepts in safety (principles of high reliability organising (HRO) and resilience engineering (RE) from the Adaptive age) and contrast these with construction. Differences between occupational safety and health (OSH) and systems safety were highlighted in terms of the types of accidents; understanding of causation; and the way in which accidents are investigated and learnt from. The type of industry, structure, power dynamics, culture, low investment in safety, cost constraints, and disposable workforce pose potential barriers, hindering the application of this philosophy in construction: This brings to light the sector-specific challenges and gaps in our knowledge of Adaptive safety.

Instead, it was proposed that focussing on the worker-centred or social aspects of safety offered the greatest potential for progress in spite of these industrial barriers. Cultivating

mindfulness and chronic unease could help workers' better anticipate accidents. Diversifying workers' skills and improving communication could empower them to respond. In view of this, the first study examined safety leadership as a means to enhance the Adaptive capacity of the workforce.

10.2.2 Safety leadership to cultivate resilience

Chapters 3 and 5 examined safety leadership best-practice for engaging and collaborating with the workforce (proposed as a means to cultivate resilience) in construction and how these differ from industries like air traffic management (ATM) which have embraced Adaptive safety.

Fruhen et al.'s (2013) model of Safety Intelligence was developed to suit construction: Adaptive safety leaders need vision and committent; safety knowledge; social competence; authority; to trust and empower others; and to solve problems collaboratively. These traits were explored with an expert panel of interviewees confirming such a leadership style is favourable, but not always possible, in construction. The findings exemplify what is known about best-practice safety leadership generally; however, nothing distinguishes this from a model of Generative (Westrum 2004) or Interdependent (DuPont 2015) safety culture.

The results of this study suggest, while safety leadership may be an important factor in a resilient response, alone it is not enough to overcome the challenges of construction. This prompted an in-depth exploration of these barriers to Adaptive safety, as hypothesised in Chapter 2.

10.2.3 Compatibility with construction

In chapter 6, soft systems methodology (SSM) was applied to the interview data to explore the challenges of construction with a systems thinking lens. Although some construction safety managers recognised the value of ownership and autonomy to manage risk, others' views remained rooted in a traditional model of predicting harm, defining rules, and complying to them.

The dominant perception of workers' attitudes to risk is as denying or oblivious. Understanding the characteristics and pressures of this sector helps to unpack why such attitudes are drawn towards and instilled by work in construction. The culture of worker-blaming in construction is challenged: Workers are often seen as rebellious and complacent, when in reality their propensity for 'unsafe behaviour' is shaped by peer pressure, job insecurity, inadequate schedules and funding, poorly designed and maintained equipment, lack of training, and low awareness of risk. All these factors can be attributed to cost-cutting in a competitive and fragmented industry.

These findings cast doubt on the suitability of Adaptive safety to a dynamic network, highlighting the importance of organisational stability to learn and to develop resilience capacities. Construction does not fit the template of a complex adaptive system

(Braithwaite, Herkes, Ludlow, Testa and Lamprell 2017): Its risks are predictable and activities plannable — even if they do not always go to plan.

10.2.4 Implementing Safety Differently and its impact

Chapter 7 and 8 present a case study of Adaptive safety in practice in construction. Laing O'Rourke's (LOR's) safety strategy has been redesigned around 'people as the solution'. Their organisational rhetoric is positive and accessible; investigations transparent; and risk management processes collaborative, streamlined, and flexible.

The response to these changes has been encouraging: Communication, collaboration, proactivity, and job-satisfaction have shown improvements as the programme is refined and developed with input from the workforce. Safety leaders have been instrumental in implementing this change; however, their efforts have been hindered by the persistence of construction's culture, interfering clients, and a lack of stability in the workforce — diluting their message of engagement.

There are questions about whether this success could be replicated on other projects and in other areas of construction: LOR is a capable, reputable, and progressive principle contractor, and working at Thames Tideway Tunnel (TTT) with an enlightened and innovative client may be a one-off winning combination. These megaprojects also provide a degree of longevity and stability in which to study the emergence of resilience. Elsewhere in the sector the pace of change may have a greater impact on these organisations' capacity to learn.

10.3 Final conclusion

This thesis rethinks traditional construction safety in light of new theories from the nascent era of Adaptive safety. Adaptive safety takes a less prescriptive approach to risk control, instead endorsing the view that safe operations emerge from workers' capability to adapt and respond. The applicability of this concept in many industries has yet to be explored; thus, the aim of this research was to identify ways this philosophy could advance safety in construction.

Giving workers more autonomy proved a challenging concept for managers in this Safety I dominated sector. They saw its potential in valuing workers' expertise, promoting communication, building respect and trust in relationships, and fostering responsibility and commitment; however, construction's litigation culture, affinity for traditional safety, project-based network structure, and transient workforce were seen as barriers to this. These challenges suggest Adaptive safety is not compatible with all contexts, drawing attention to its unknowns and the weak evidence in support of this concept.

In practice, where companies have moved towards Adaptive safety, they have incorporated engaging workers in shaping practice as part their organisational strategy. Increasing worker engagement has been a positive step for the industry; improving buy-in, satisfaction,

ownership, relationships, and challenging its obsession with workers' 'unsafe behaviour' as the root cause of accidents. However, it does not fully represent RE and HRO's vision for a spontaneous self-organising frontline response to safety-critical scenarios.

Organisational resilience is often described as as an emergent property of systems, cultivated from the workforce. This work demonstrates the significance of systemic factors that underpin a resilient response. Worker engagement and collaboration is undoubtedly an important aspect, but without competence, communication structures, and a culture committed to reducing risk it will not necessarily result in safety.

10.3.1 Original contribution

This work sheds light on the applicability of Adaptive safety in construction. Its incompatibility raises questions about the challenges of construction as an industry which prevent the adoption of new constructs, perpetuating the disconnect between OSH and systems safety. Exploring these challenges with a systems thinking lens revealed the relationships between workers' 'unsafe behaviours' and aspects of the industry which compromise competence and communication; attract a workforce with a higher propensity for risk; and put pressure on workers to trade-off safety. These factors highlight new ways of thinking about construction safety and new directions for future progress.

These explorations also reveal many research gaps in this field which need to be clarified before Adaptive safety can applied more widely. The mechanisms and methods of Adaptive safety are poorly understood, raising questions about its prerequisites at all levels of the system; compatibility with different types of work; and suitability to networked organisations.

On the way to this conclusion, the findings have also contributed to theories of safety leadership; expanded Brace et al.'s (2009) categorisation of workers' attitudes to risk; updated Haslam et al.'s (2005) contributing factors in construction accidents (ConCA) model; and discussed the challenges of methodology in applied sciences. The temptation to rush into applications — as seen with many constructs in safety science — could deprive organisational resilience of its depth and potential. Section 10.5 proposes an agenda for future research needed to prove the value of Adaptive safety before taking risks in unknown territory.

10.4 Limitations

Interview study

In the first phase of this work, the applicability of findings is limited by the sample and study design. The data were based on a modest sample of experts, and as such a degree of caution is required when generalising these to construction as a whole. This type of exploratory expert panel study alongside sociotechnical system (STS) analysis proved to

be an effective method in generating new theories and identifying new opportunities to improve OSH; however, further research is needed to validate the proposed models.

Another limitation of this study is that is focuses on the views of managers and policy-makers; it does not include the views of workers which would help to validate their perception of risk-taking and evaluate the quality of the decision-making based on these influences. This is outside the scope of the study and is another area where future work is needed.

Case study

Research is construction is complicated by project timelines and access to sites. The projects used for the case study were at the extreme ends of their lifecycles: At TTT tunnelling had not yet begun and at Crossrail the station was nearing completion. Thus, there was not an opportunity to evaluate the suitability of 'Next Gear' on a project running at full capacity.

Construction is also a varied sector, of which this work has only focussed on infrastructure megaprojects. The scale and domain of these projects has clearly been a factor in Next Gear's dissemination; further research is required to explore its applicability in smaller companies and other types of project.

10.5 Future work

Qualitative methods have provided valuable insights into this undertheorised concept. Prematurely reducing resilience or Adaptive safety into a measurable construct or framework that can be applied elsewhere should be avoided. This has been the downfall of many promising concepts in safety such as culture (Guldenmund 2010) and workload (Sharples 2018). At this early stage, research in this field should focus on observing and understanding the mystery of how safety is socially constructed (like the original research in HRO) rather than developing reductionist surveys or methods and toolkits to 'engineer' resilience.

Many questions about an Adaptive approach to safety remain, both in construction and other sectors. Below, a research agenda is proposed to guide future research in the short and long term.

Short term

- **Continuing to study Next Gear at LOR**
  Having implemented the programme for less than three years, it is too early to draw definitive conclusions about its success. Neither of the projects case studied provide a view of Safety Differently at the height of construction: Questions remain about whether it can cope with this pace of work; the effect of a serious incident; and proving its long-term impact on accident rates. A longitudinal case study is needed to follow the progress of this strategy throughout a project.

- **Other types of construction**
  As mentioned in Section 10.4, this work only studied infrastructure megaprojects. Further work is required to explore the compatibility of Adaptive safety in other types of construction — project types, domains, scales, and locations. For instance, the case study findings suggest Adaptive safety is better suited to construction (rather than infrastructure) projects where there is less interference from the client, and on smaller sites where teams are co-located. Both these hypotheses could be tested in future studies. This work could be used to expand Figure 9.3, comparing where different types of work fit within the continuum from traditional to Adaptive safety management.

Medium term

- **Applicability to other sectors**
  Adaptive safety has been studied most extensively in healthcare (Sutcliffe and Weick 2013): Studying it in another context has revealed barriers where its ideas need to be adapted and many gaps for further research. Similar sectors — such as mining or agriculture — may confirm these findings or provide insights of their own. There are many sectors where the potential for Adaptive safety has not been explored. This could also contribute to the development of Figure 9.3 and look towards a general model defining the types of work which are best suited to differing degrees of Adaptive safety.

Long term

- **Organisational change in construction**
  Studying how Next Gear has been developed and rolled-out across LOR has highlighted the challenges of changing culture and diffusing innovations across this dynamic sector. This is one reason safety interventions are often ineffective, so research to understand address this would be valuable.

- **Mechanisms of Adaptive safety**
  This thesis contributes to our understanding of Adaptive safety, but there are still many questions about how resilience emerges and how to cultivate it. Work is needed to confirm the model of systemic antecedents proposed in Figure 9.2 of this thesis and understand how to balance new and traditional methods of risk management.

Positioning the researcher

In social research it is important to consider the work in light of a researcher's position. My background as an Ergonomist is an unusual one in this field: Fundamental to Ergonomics is the principle of understanding and redesigning the system rather than blaming and condemning its users. This perspective is a refreshing one in OSH, and even more so in a litigious sector like construction. Another unusual aspect of my position is as a female researcher in a male-dominated sector — although having previously worked in engineering and defence this has become familiar.

Following my undergraduate degree in ergonomics, I worked as a Human Factors Engineer developing designs for what will become the Dreadnaught Class of ballistic nuclear submarines. The first of these boats is expected to begin sea trials in 2023 and enter active service in 2030 — more than 15 years after my involvement in the project. As a new graduate, this project provided an ideal opportunity to tackle many ergonomic challenges from classic anthropometry and HMI to organisational issues of training needs and crew resource management; however, what fascinated me more than life onboard the submarine was the lifecycle of this complex megaproject and its social and economic impact on the local area.

Winning and managing this contract well is critical to sustaining the isolated shipbuilding community of Barrow-in-Furness. Living in this town for a year also challenged my stereotypes about manual workers and I chose a PhD topic in construction — a sector passed over by human factors specialists in favour of 'sexier' ultra-safe domains, yet one in need of the most help. Based on this background, my interpretation of the data in this thesis are unavoidably influenced, but in a way which I hope brings original insight.

Appendices

Coding structure sample

A

Figure A.1: An example from the coding structure developed during interview analysis

Nodes	***References***
Risk management difficulties	581
Industry	229
Client	99
Conflict of interest	64
Cost	26
Reputation	8
Speed	23
Supply chain	3
Intimidation	4
Lack of buy-in	13
Comparison with other sectors	4
Ownership of risk	9
Underinformed client	17
About construction	8
About Safety	9
Varied clients	1
Financial risk	2
Subcontracted structure	74
Communication	5
Coordination	5
Mistrust	6
Standardisation	18
Company policies	12
Competence	6
Transient workforce	40
Difficult to implement safety strategy	2
Disposable	5
Lack of loyalty to principle contractor	8
Loss of local knowledge	2
Unstable culture	5
Varied levels of experience	5

Nodes	*References*
Unregulated	20
Companies	7
Lack of standardisation of safety	6
No need for formal qualifications	6
Variation between companies and projects	29
Domain	2
Lack of transferability	8
Lack of knowledge transfer between projects	2
Pushing boundaries	3
Size	17
Type of construction	2
Organisational	211
Accountability	67
Blame culture	7
Blurred chains of responsibility	2
Compartmentalisation	19
Separating safety from primary operations	7
Silo Working	12
Fear of litigation or claims culture	14
Shirking safety responsibility	22
Client	2
Health and safety team	11
Subcontractors	8
Attitude towards risk	33
Acceptance of risk or not challenging risk	8
Conservative	2
Focus on safety not health	1
Lack of new ideas	11
Awareness of innovation	3
Minimum compliance	6
Time and cost of change	5
Planning	57
Coordinating a complex project	10
Not integrating safety at the design phase	16
Undesignable workplace	7
Unlike a factory	5
Unpredictable	10
Poorly designed policies	54
Disproportionate	2
Lack of review	5
Measurable	2

Case study participants

B

Table B.1: LOR management participants

ID	*Crossrail or TTT*	*Years with company*	*Years in construction*	*Role*
1	Both	20	20	Senior safety manager
2	Neither	1.5	25	Senior safety manager
3	Crossrail	5	38	Senior safety manager

Table B.2: Crossrail Tottenham Court Road station (TCR) participants

ID	*Employer*	*Years with company*	*Years in construction*	*Role*
4	LOR	30	40	Construction manager
5	LOR	2.5	9	Section engineer
6	LOR	13	13	Section engineer
7	LOR	13	25	HSE manager
8–16	Subcontractors			Supervisors

Table B.3: TTT participants

ID	*Employer*	*Previously on Crossrail*	*Years with company*	*Years in construction*	*Role*
17	Ferrovial	Yes	4	23	Head of HSE
18	LOR	No	0.5	0.5	HSE graduate
19	Ferrovial	No	2	2	HSE manager
20	LOR	Yes (client)	2	13	HSE manager
21	Subcontractor	No	2	20	Crane supervisor
22	Self	Yes	11	13	Appointed person
23	LOR	Yes	1	5	Section engineer
24	LOR	Yes	3.5	3.5	Section engineer
25	LOR (Expanded)	Yes	7	10	Crane supervisor
26	LOR	Yes	1.5	25	HSE manager
27	Client	Yes	7	17	Site manager
28	Subcontractor	Yes	7	60	Stores
29	Ferrovial	No	5	5	Stores
30–33	Subcontractors	Yes			Slingers
34–37	Subcontractors	Yes			Carpenters

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