Centre for
Construction Work Health and Safety Research

Final Report

The impact of supervisors' and site managers' behaviour on work health and safety in the construction industry

June 2017

RMIT UNIVERSITY

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Centre for Construction Work Health and Safety Research

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About the Centre for Construction Work Health and Safety Research

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

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Executive summary

The supervisory leadership and work health and safety (H&S) communication practices of 20 workgroups engaged in rail construction work were investigated.

A survey of workers was undertaken to examine supervisors' leadership styles, perceptions of the workgroup H&S climate and self-reported H&S-related behaviour. An analysis of communication network patterns within workgroups was also undertaken. Site-based observations and conversations with supervisors and workers were used to supplement survey data and gain deeper insight into supervisors' H&S leadership practices and their impact.

The research showed significant variation in supervisors' leadership style, workgroup H&S climate and workers' self-reported participation in discretionary H&S activities between workgroups. Further, supervisors' leadership style was statistically significantly linked to workers' self-reported H&S behaviour. Workers' perceptions of the workgroup H&S climate fully mediated the relationship between leadership style and H&S behaviour. This indicates that supervisors who adopt certain leadership practices influence workers' behaviour by creating a workgroup climate in which H&S are consistently understood to be of high priority relative to other project goals.

Both transformational and transactional leadership were positively related to the H&S climate and workers' self-reported H&S behaviours. However, consistent with research in other industries, components of transactional leadership (e.g. providing contingent reward for H&S-related behaviour/performance) were more strongly linked to workers' self-reported H&S compliance, whereas components of transformational leadership (e.g. providing a positive role model) were more strongly related to workers' self-reported H&S participation.

While much research into leadership and H&S has focused on the benefits of transformational leadership, in safety-critical contexts any deviation from H&S standards can have serious consequences. Previous research in such contexts has found that an active (not passive) transactional leadership style is effective in reducing ambiguity, maintaining a clear focus on H&S, and monitoring performance to identify and resolve any H&S issues before incidents occur. Our research indicates that a transactional supervisory leadership style is linked to H&S compliance in the rail construction context.

On-site observation and conversations with supervisors and workers confirmed the importance of a variety of supervisors' leadership practices. The following leadership behaviours were identified as having a positive impact on H&S:

- being organised and planning work in advance to anticipate and manage H&S hazards,
- setting a good example by maintaining high standards for H&S,
- establishing a consistent approach and fostering a sense of shared purpose with regard to H&S within the group,
- understanding individual workers' circumstances and responding to individuals' needs,

- eliciting respect through being experienced and demonstrating practical technical capability,
- creating a trusting environment in which workers are listened to and are able to voice concerns,
- being loyal and protecting the interests of workgroup members, and
- recognising and reinforcing good H&S practices.

Communication practices were also identified as an important component of supervisory leadership. In particular, when supervisors play a central role in both giving and receiving H&S-related information, the workgroups they lead have more positive H&S climates and workers report higher levels of H&S compliance.

The site-based observation and conversations with supervisors and workers identified different communication practices. Of particular importance were:

- pre-start meetings to focus attention on issues of particular relevance to the working day ahead,
- informal H&S-related interactions between supervisors and workers throughout the working day, and
- ad-hoc H&S-related discussions conducted by supervisors when required (for example following a near miss).

Participants identified that some supervisors use ‘hard’ influence tactics to enforce H&S standards. These tactics (e.g. the use of threats) were perceived to be ineffective and have a detrimental impact on H&S.

Effective supervisor-worker communication in relation to H&S was identified as involving:

- regular and frequent informal interactions,
- authenticity of messages,
- behaviours consistent with words,
- two-way communication and active listening to workers,
- respectful, open and honest exchange of information and ideas, and
- the delivery of personalised H&S messages to convey the relevance and importance of working in a healthy and safe way.

The results suggest that supervisors’ H&S leadership practices vary from workgroup to workgroup. Participants identified opportunities to improve H&S performance through developing supervisors’ H&S leadership capability. The results also suggest that leadership development programs should focus on a range of styles and practices.

Part 1: Introduction

The *Australian Work Health and Safety Strategy 2012-2022* sets the following targets to be achieved by 2022:

- a reduction in the number of worker fatalities due to injury of at least 20 per cent,
- a reduction in the incidence rate of claims resulting in one or more weeks off work of at least 30 per cent, and
- a reduction in the incidence rate of claims for musculoskeletal disorders resulting in one or more weeks off work of at least 30 per cent.

The Strategy identifies construction as a priority industry and states that leaders can play an important role in developing a positive culture for health and safety.

This report presents research undertaken in the Victorian construction industry. The research examined leadership and communication in relation to occupational health and safety (hereafter referred to as H&S) in major transport infrastructure projects being delivered by the Level Crossing Removal Authority and the Melbourne Metro Rail Authority.

The research investigated the way in which H&S messages are communicated within construction projects. Specifically, the research investigated:

- the leadership style and behaviours of frontline supervisors,
- the frequency and structures of H&S-related communication within workgroups,
- the perceptions of the safety climate within participating workgroups, and
- the self-reported safety behaviours and involvement of members of participating workgroups.

The research used a mixed methods approach, combining quantitative (survey) and qualitative (observational) data collection approaches.

Research questions were as follows:

1. How do site managers' and supervisors' actions influence H&S in construction projects?

2. What supervisory actions have a positive (or negative) impact on H&S?

3. What can be done to maximise the positive H&S impact of site management/supervisor behaviour?

4. What are effective ways for site managers/supervisors to communicate H&S expectations and information to workers?

5. What communication methods maximise the retention and application of H&S knowledge?

6. What site management/supervisor behaviour motivates workers to comply with H&S procedures and/or participate in H&S activities?

7. What tools and methods can be used to improve H&S communication and worker engagement in H&S?

8. What can be learned about H&S leadership from other industries and contexts?

The research was completed in three stages (see Figure 1.1).

Stage one involved undertaking a review of relevant academic literature. This is presented in Part 2 of this report.

Stage two involved the collection of data at participating worksites. In total, 73 workers belonging to 20 workgroups participated in the research. Approximately 100 hours were also spent on-site undertaking observation and conducting informal conversations with workers and their supervisors.

Stage three involved undertaking statistical analysis of the quantitative data and undertaking thematic content analysis of field notes collected during site-based observation. The results of this analysis are presented in Parts 4 and 5 of this report.

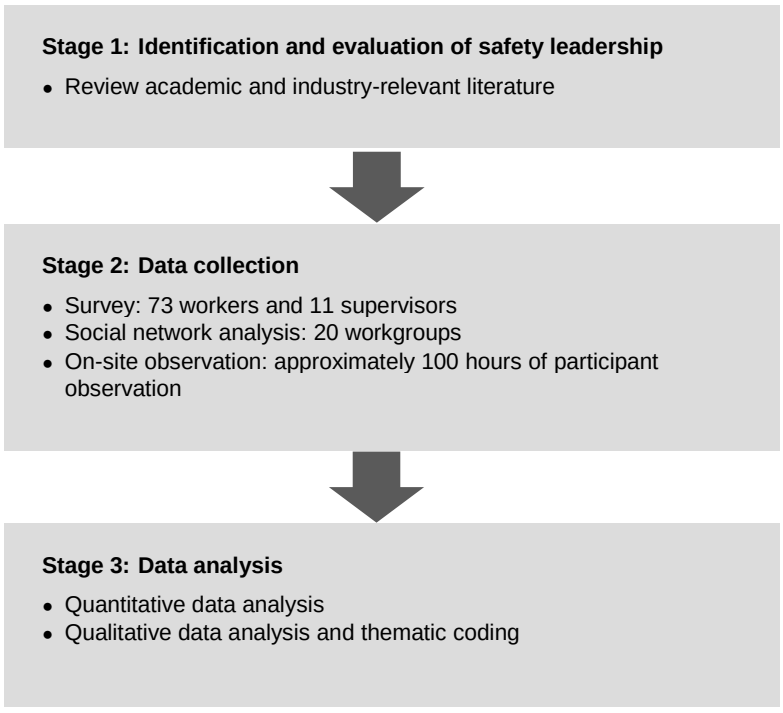


Figure 1.1: Research stages

The remainder of this report is structured as follows:

Part 2 presents the literature review. The review presents a synthesis of previous research dealing with issues of leadership styles, supervisor and coworkers' influence, organisational and workgroup climates, communication and trust. Much of this research was conducted outside the

construction industry but, studies undertaken in the construction industry are dealt with in a specific sub-section of the literature review.

Part 3 presents a description of the research methods adopted in the research. A description of the quantitative and qualitative methods used to collect data is provided. Data analysis methods are also described.

Part 4 presents the results of the quantitative data analysis. The relationships between leadership style, group H&S climate and self-reported H&S compliance and participation are examined. Communication patterns within workgroups are also described.

Part 5 presents the results of the qualitative analysis of supervisors' and workers' interactions and H&S-related communication and behaviour. This is based upon the observation of workers and supervisors during the course of their working day.

Part 6 presents a discussion of the results in response to each of the research questions. This discussion links the findings back to themes and findings documented in previous studies in the construction industry and other industrial contexts. Conclusions and suggestions are drawn from this discussion.

Part 7 lists the academic literature that has informed the study.

Part 8*, the* ***Appendix,*** presents the survey instruments used to collect data in the study, a glossary of social network analysis terms, and details of the social networks examined in this research broken down by workgroup.

Part 2: Literature review

2.1 The decentralised structure of construction

Construction projects are subsystems of an organisation's larger portfolio of work (Blismas et al., 2004a; Blismas et al., 2004b). Each project is delivered through a temporary organisational structure in which professional services are brought in under a variety of contractual arrangements. Construction work is typically outsourced to a principal contractor and a multiplicity of trade contractors. Work is often non-routine and is undertaken by semi-autonomous (usually subcontracted) workgroups. Most manual, non-managerial work takes place in locations away from the construction organisation's head office. The reliance on subcontracting means that there is a relatively weak connection between the majority of construction workers and principal contracting organisation engaged to deliver a project (Meliá et al., 2008). The decentralised and distributed industry structure means that construction workers rarely interact with senior leaders in client or principal contractor organisations. Thus, frontline leaders in site-based supervisory roles play a key role in influencing performance. Supervisors effectively act as the conduit through which organisational and project health and safety (H&S) directives, goals and priorities are communicated to workers.

In this literature review we consider the issue of leadership and its impact on H&S. The review is structured as follows:

- First, we describe theories of leadership in general terms. We describe different ways of viewing leadership, different leadership styles and the concept of leader-member exchange.
- Second, we discuss the relationship between leadership and H&S in organisations. We present research evidence supporting the link between various aspects of leadership and H&S and consider the mechanisms through which leadership can drive H&S performance.
- Third, we discuss the role of organisational and group-level H&S climates, suggesting climate is a linking mechanism between leadership and H&S performance.
- Fourth, we discuss the role played by supervisors and coworkers in driving H&S performance, linking this back to aspects of leadership and H&S climate.
- Fifth we consider the relationship between supervisory leadership and issues of communication, trust and engagement in workgroups.
- Finally, we present the evidence supporting links between supervisory leadership and co-worker support for H&S performance in the construction industry context.

2.2 Leadership in general

2.2.1 What is leadership?

Leadership has been described as the action of influencing a group of individuals to achieve a common goal (Northouse, 2013) and is assumed to be an important determinant of

organisational effectiveness (Yukl, 1989). Yukl (1989) summarised four distinct approaches to leadership as follows:

- a power-influence approach, which explains leadership effectiveness in terms of the type and the amount of power possessed by a leader, and how power is exercised,
- a behaviour-focused approach, which emphasises the actions of leaders on the job, and the relationship between behaviour and effectiveness,
- a trait approach, which emphasises the personal attributes of leaders and their impact on followers' behaviour, and
- a situational approach, which recognises the importance of context and the environment in shaping leaders' behaviour an effectiveness. For example, the leadership context includes the industry and type of work being performed, the organisational environment and/or workforce characteristics.

Graen and Uhl-Bien (1995) suggest leadership involves three domains, i.e. the leader, their follower and the dyadic relationship between leader and followers (Figure 2.1).

In the leader domain, the focus is on the combination of personal characteristics and leadership behaviour to achieve desired outcomes. Leadership is understood to involve establishing and communicating a vision and inspiring followers to pursue organisational goals.

In the follower domain, leadership is focused on engaging followers to make the most of their capabilities and use their knowledge, skills and abilities to achieve high levels of performance. A follower-focused approach recognises leaders' role in empowering or coaching workers and enabling them to perform at a high level.

The relationship domain focuses on the relationship leaders and followers. The emphasis is on developing relational characteristics (e.g. trust, respect, mutual obligation) that promote desired outcomes.

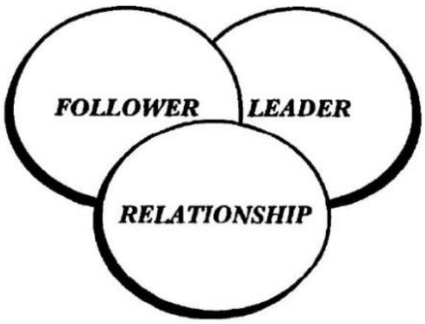


Figure 2.1: The domains of leadership (Graen and Uhl-Bien, 1995, p. 221)

2.2.2 Leadership styles

A great deal of work has sought to categorise different styles of leadership and understand the links between these styles and various aspects of organisational performance.

Bass developed a leadership model that categorised various leadership styles, including transactional and transformational leadership (Bass, 1985).

Transactional leaders identify actions subordinates need to take to achieve desired outcomes and clarify role and task requirements. Transactional leaders set appropriate goals, monitor workers' performance in relation to these goals, and provide rewards (when results are positive) or corrective feedback if improvement is required.

Transactional leadership comprises two main components:

- contingent reward, and
- management-by-exception (Bass & Riggio, 2006).

Contingent reward describes the clarification of expectations and provision of rewards in exchange for satisfactory performance.

Management-by-exception can be active (MBE-A) or passive (MBE-P). MBE active describes leaders actively monitoring followers' performance and taking corrective actions as required before problems arise or become serious. MBE passive describes leaders monitoring followers' performance but waiting for deviances, mistakes, or errors to occur before taking corrective action.

Transformational leadership is more relationship-oriented and evokes changes in followers' value systems such that their values are aligned with organisational goals (Clarke, 2013). Transformational leaders engage followers by making them more aware of the importance and value of task outcomes, by activating their higher-order needs, and by inducing them to transcend self-interest for the sake of the organisation (Bass, 1985).

Transformational leadership comprises:

- idealised Influence (II): leaders behave in a manner that makes them serve as role models for followers. Leaders are admired, respected and trusted by their followers.
- inspirational motivation (IM): leaders motivate and inspire their followers by providing meaning and challenge to their followers' work. Strong team spirit is presented and enthusiasm and optimism are displayed.
- intellectual stimulation (IS): leaders stimulate their followers' efforts to be innovative and creative, and expand their followers' abilities to improve performance.
- individual consideration (IC): leaders pay attention to each individual follower's needs for achievement and development as a coach or mentor.

Podsakoff et al. (1990) reported the way that leadership behaviour impacts on workers' performance varies depending on whether they display predominantly transactional or transformational leadership behaviours. For example, workers' trust in their leader and job satisfaction were positively linked to transformational leadership behaviour but not to contingent reward behaviours (i.e. transactional leadership).

Outcomes also differed between components of transformational leadership. Thus, trust was positively linked to some transformational behaviours (e.g. articulating a vision, providing an

appropriate model and fostering an acceptance of group goals and the provision of individualised support), but negatively related to leaders' high performance expectations and intellectual stimulation (Podsakoff et al.,1990).

Similar results were found for workers' satisfaction, which was positively related to core transformational leadership behaviours and individualised support, but negatively related to leaders' provision of intellectual stimulation.

There is a growing interest in other positive forms of leadership and work performance. For example, authentic leadership has been reported to improve or amplify the ability of transformational leaders to create positive worker performance (Yammarino et al. 2008). Authentic leadership is defined as "a pattern of leader behaviour that draws upon and promotes both positive psychological capacities and a positive ethical climate to foster greater self-awareness, an internalised moral perspective, balanced processing of information, and relational transparency on the part of leaders working with followers, fostering positive self-development" (Walumbwa et al. 2008, p. 94).

According to Aviolo et al. (2004) authentic leaders are "those who are deeply aware of how they think and behave and are perceived by others as being aware of their own and others' values/morale perspectives, knowledge, and strengths; aware of the context in which they operate; and who are confident, hopeful, optimistic, resilient, and of high moral character" (p. 802-804).

Walumbwa et al. (2010) present evidence to suggest that positivity in leaders influences followers' behaviour and performance through increasing their levels of hope, efficacy, optimism, and resilience (or psychological capital). Thus, when leaders demonstrate these positive psychological states, followers will also experience positivity about their work, which will produce improved performance.

In contrast to the positive forms of leadership described above, relatively less attention has been paid to negative or destructive leadership characteristics and behaviours, despite the impact these can have on organisational performance. Ashforth (1994) describes the behaviour of 'petty tyrants' as self-aggrandisement, undermining of subordinates, demonstrating a lack of consideration, adopting a forcing style of conflict resolution, discouraging initiative and using non-contingent punishment. Tepper (2000) also describes abusive supervision, in which supervisors engage in sustained hostile verbal and nonverbal behaviour towards subordinates. Another form of negative leadership that is more passive, and therefore less obvious, is laissez-faire leadership (Skogstad et al., 2007). Laissez-faire leadership has been described as "the absence of leadership, the avoidance of intervention, or both. With laissez-faire (avoiding) leadership, there are generally neither transactions nor agreements with followers. Decisions are often delayed; feedback, rewards and involvement are absent; and there is no attempt to motivate followers or to recognise and satisfy their needs" (Bass and Avioli, 1994, cited in Skogstand et al., 2007). Laissez-faire leadership creates high levels of role ambiguity, role conflict and interpersonal conflict between coworkers. Further Skogstad et al. (2007) describe how these stressors are highly destructive and can ultimately contribute to bullying.

2.2.3 Leader-member exchange

Leader-member exchange (LMX) refers to the quality of relationships between workers and their supervisors. Research shows that subordinates reporting high quality relationships with their supervisors assume greater job responsibility, contribute more to their workgroups, and are rated as higher performers than those reporting low quality relationships (Liden & Graen, 1980).

Although supervisors are representatives of an organisation, worker-supervisor exchange relationships are distinct from exchange relationships between workers and their employing organisations. This distinction is likely to be even more apparent in decentralised and distributed organisational environments, such as construction.

Gouldner (1960) explains the link between LMX and workers' performance in terms of a social exchange relationship that is underpinned by a norm of reciprocity. Leaders develop an exchange relationship with individual workers, and the quality of these exchange relationships affects workers' attitudes, behaviours and performance (Liden & Maslyn, 1998). The exchange relationships range from those based strictly on fulfilling the basic expectations of an employment contract (i.e. in conditions of low LMX) to an exchange that is based on mutual trust, respect, affection, and reciprocal influence (i.e. in conditions of high LMX) (Liden & Maslyn, 1998). Thus, workers typically perform specific job duties regardless of the quality of their relationship with their supervisors but with high quality LMX relationships, workers are motivated to engage in work-related behaviours that they believe to be are beneficial to their supervisors and extend beyond the scope of their formal job duties (Wayne et al., 1997).

Graen and Uhl-Bien (1995) describe how the investigation of LMX has evolved through at least four stages, as follows:

- **Stage 1 – Discovery of differentiated dyads**: Research revealed that leaders do not use a uniform leadership style but develop differentiated relationships with individual workers within workgroups.
- **Stage 2 – Focus on relationships and outcomes**: Researchers investigated characteristics of LMX relationships and analysed relationships between LMX and various organisational outcomes.
- **Stage 3 – Description of dyadic partnership building**: Emphasis was placed on how leaders work with individual workers on a one-on-one basis to develop unique partnerships.
- **Stage 4 – Expansion of dyadic partnership to group and network level**: Research has used LMX to evaluate systems of interdependent relationship networks within workgroups, rather than just looking at independent dyads between individual supervisors and workers.

Graen and Uhl-Bien (1995) suggest that LMX is independent of leadership style. That is, LMX can involve both transactional and transformation leadership. This is because LMX begins with a transactional social exchange that is primarily based on material rewards exchanged for fulfilling requirements of an employment contract. However, in circumstances where more positive relationships are developed, LMX evolves into transformational social exchange, in which the social exchange involves psychological benefits (e.g. trust, esteem, support, satisfaction, approval).

2.3 Leadership and H&S

2.3.1 Leadership style and H&S

The important role played by leaders in promoting H&S at work has been noted (Flin & Yule, 2004). Management commitment to H&S and management approaches are frequently identified as critical drivers of H&S. For example, O'Dea and Flin (2001) identified participative management as important in driving excellent H&S performance in an organisation. There are some overlaps between their description of participative management and transformational leadership. Thus, participative management comprises a number of interrelated activities that:

- indicate the managers' concern for H&S,
- contribute to a closer relationship between managers, supervisors and workers, and
- may serve as a frame of reference for the workforce to guide the appropriate task behaviours.

Table 2.1 shows four facets of participative management that can impact H&S.

Table 2.1: Four facets of participative management

1. Visibility	Participative managers: • are visible, • participate in H&S activities at the workplace, • consistently apply H&S policies and rules, • model good H&S practices, and • lead by example.
2. Relationships	Participative managers: • form open, honest relationships with the workforce by engaging in two-way communication, and • listen and respond to workers' suggestions for H&S improvements.
3. Workforce involvement	Participative managers: • actively involve workers in work planning and decision making.
4. Proactive behaviour	Participative managers: • proactively seek to improve H&S, and • promote an environment in which hazards and incidents can be reported without fear of reprisal.

Research has most frequently focused on the positive influence of transformational leadership and H&S (Barling et al., 2002; Conchie & Donald, 2009; Zohar & Luria, 2004; Kelloway et al., 2006). Some of this research has examined the influence of generalised transformational leadership (i.e. leadership behaviour that is not specific to H&S) on H&S-related performance and outcomes. Inness et al. (2010, p. 280) argue that exploring the extent to which generalised transformational leadership affects workers' H&S performance reflects "the lived reality of supervisors whose daily priorities reflect a range of issues, and not safety alone".

Inness et al. (2010) conducted a survey among ‘moonlighters’ (i.e. workers who have more than one job) to investigate the relationships between supervisors’ generalised transformational leadership behaviours and workers’ H&S performance. Following the recommendation of Griffin and Neal (2000) they measured two aspects of H&S performance:

- H&S compliance, which is concerned with the behaviours of meeting H&S standards at work, e.g. complying with H&S rules and procedures, and
- H&S participation, which describes the voluntary behaviours in improving and promoting safety, e.g. help to promote H&S programs at workplace.

Inness et al. (2010) report that supervisors’ transformational leadership positively predicted workers’ H&S participation but not their H&S compliance. Further, transformational leadership in one work context (job) was unrelated to workers’ H&S performance in other contexts (jobs). This suggests that the motivational effect of transformational leadership on H&S participation is leader-specific and does not transfer between employment contexts, unless supervisors remain the same.

Research has also examined the effect of safety-specific transformational leadership on H&S-related performance and outcomes. Leaders demonstrating safety-specific transformational leadership “take an active and inspirational approach to safety issues, serving as good models of safety behaviour and encouraging others to work in a safe manner” (Kelloway et al., 2006). Barling et al. (2002) modified a commonly used general transformational leadership measure, derived from the Multifactor Leadership Questionnaire (Bass & Avolio, 1990), to make it safety-specific. For example, item wording was changed from “My supervisor talks about his/her most important values and beliefs” to “My supervisor talks about his/her values and beliefs about the importance of safety”.

Barling et al. (2002) studied the effects of safety-specific transformational leadership on young workers’ perceptions of safety climate, safety-related events, and occupational injuries. They found that safety-specific transformational leadership positively predicted perceptions of safety climate which, in turn, mediated the negative relationship between perceptions of safety-specific transformational leadership and employee self-reports of safety-related events. Similarly, Mullen and Kelloway (2009) provided evidence that training managers in safety-specific transformational leadership enhanced workers’ H&S climate perceptions and H&S outcomes.

Conchie and Donald (2009) also reported that safety-specific transformational leadership had a positive association with the H&S-related behaviour of workers. They particularly examined the combined effect of safety-specific trust with safety-specific transformational leadership to influence workers’ safety citizenship behaviours. They found that in conditions of high safety-specific trust, safety-specific transformational leadership strongly influenced workers’ H&S behaviour. However, as safety-specific trust in leaders reduced, leaders’ effectiveness at promoting workers’ H&S citizenship behaviour declines.

Mullen et al. (2017) examined the moderating effect of safety-specific transformational leadership on the link between the provision of a basic level of H&S protection (e.g. H&S training, PPE, equipment maintenance, etc) and worker H&S compliance, participation and attitudes. Safety-specific transformational leadership was reported to strengthen the positive

effect of providing these basic H&S measures, by increasing workers' H&S self-reported levels of compliance, participation and attitude. They argue that provision of basic H&S measures is more effective when accompanied with transformational safety-leadership behaviour (Mullen et al., 2017).

Zacharatos et al. (2005, p. 80) suggest four ways in which transformational leadership would enhance H&S performance. These are summarised in Table 2.2.

Table 2.2: The influence of transformational leadership on H&S

Leaders high in idealised influence convey the value of H&S through their personal experience.
Leaders high in inspirational motivation convince their followers that they could attain levels of H&S not previously considered possible.
Intellectually stimulating leaders help followers think about H&S and develop new ways to achieve high H&S levels.
Individualised consideration is evident through leaders' real concern about their followers' H&S at work.

Although transformational leadership has been linked to a range of H&S outcomes, it has generally been reported to exert a stronger impact on discretional H&S behaviours, such as extra-role behaviour, safety citizenship and participation (Christian et al., 2009; Clarke, 2013).

Clarke (2013) suggests that transformational leadership evokes changes in subordinates' systems of values and can align these with organisational H&S goals. However, transformational leadership is also based upon a social exchange framework and elicits a personal identification with the leader and a social identification with the workgroup. Clarke (2013) argues that while some aspects of transformational leadership, e.g. idealised influence, inspirational motivation and individualised consideration can positively impact H&S through affective processes, the final aspect of transformational leadership (i.e. intellectual stimulation) is enacted through cognitive processes. Thus, when leaders provide intellectual stimulation to workers, these workers are encouraged to develop new ways of solving problems and/or to question the H&S status quo.

Compared to the focus on transformational leadership, links between other leadership styles and H&S have been less widely studied and are less well understood (Clarke, 2013). However, the transactional leadership component of contingent reward has been linked to positive H&S outcomes (fewer injuries) (Zohar, 2002). A strong positive association has also been found between the contingent reward component of transactional leadership and workers' H&S compliance behaviours (Kapp, 2012).

Consequently, Zohar (2002) argues that both transformational and transactional leadership are important to ensure optimal H&S performance.

Clarke (2013) examined the differential impacts of transformational and transactional leadership on workers' H&S participation and compliance behaviours. She reports that active management-by-exception leadership can be effective in relation to H&S, depending on the leadership context. Thus, in work environments in which there is a strong emphasis on error management,

including in safety-critical organisations, active management-by-exception is likely to have important positive impacts on H&S. In particular, active leaders:

- monitor workers' behaviour,
- anticipate problems, and
- take proactive steps to implement corrective actions.

These are all key features of creating an organisational culture that supports the correction of errors and learning from mistakes. Further, in high risk work environments there is a need to balance workers' awareness of H&S risks with their compliance with H&S rules. Consistent with this, Clarke (2013) undertook a comprehensive meta-analysis of H&S and leadership studies and reports that active transactional leadership contributed to a positive H&S climate and safe work behaviours, over and above the impacts accounted for by transformational leadership.

In particular, active transactional leadership was particularly important in ensuring H&S compliance behaviour. The strong relationship between active transactional leadership and workers' perceptions of the importance of H&S in their workplace (the safety climate) suggests that leaders demonstrate their commitment to H&S and provide daily reinforcement that high standards of H&S are expected when they:

- are visible in a workplace,
- engage in active monitoring of H&S, and
- intervene when problems occur.

Clarke (2013) also suggests that active transactional management can increase leaders' credibility in that they are seen to be 'walking the talk' and checking that the way that work is being done is consistent with the espoused H&S priorities of the organisation.

These results suggest effective H&S leadership includes aspects of both transformational and active transactional leadership. This is consistent with an augmentation theory of leadership in which transformational leadership is seen is something that develops from a foundation of effective transactional leadership (see Bass et al., 2003).

Willis et al. (2017) investigated the role of the employment context in moderating the effect of transformational and transactional leadership on H&S participation and performance. In particular they examined the extent to which a workplace is safety-critical (in terms of the level of exposure to hazards and perceived likelihood of experiencing a safety incident). They report that in safety-critical work contexts, management-by-exception active (i.e. monitoring problems as they are identified and correcting them proactively before things go wrong) was positively related to H&S participation and performance. In contrast, transformational leadership was not strongly linked to these H&S performance outcomes in situations of high perceived safety criticality. Willis et al. (2017) draw on complexity theories of leadership to explain these findings. They suggest that reducing ambiguity and helping workers to make sense of the situations they encounter in their work (e.g. through direction setting) is essential to leadership under extreme conditions. In safety-critical situations instructive leadership tactics (which pre-empt error-making and explicitly prioritise H&S) can positively influence performance outcomes (Willis et al., 2017).

Probst (2015) also reports that a transactional form of supervisory leadership (i.e. extrinsic safety motivation) played an important role in reducing under-reporting of workplace incidents and injuries. Thus, in organisations with a poor H&S climate, workers tend to under-report H&S incidents and injuries. However, when supervisors play an active role in enforcing H&S rules and praise workers who comply with rules/procedures, levels of under-reporting are significantly reduced.

Authenticity of leadership has also been linked to H&S. For example, in a study undertaken in the oil and gas industry, Birkeland Nielsen et al. (2013) investigated the impact of authentic leadership on H&S risk perception and H&S climate. They found that authentic leadership was positively correlated with the H&S climate, whereas a negative correlation was found between authentic leadership and risk perception. They explain this finding by suggesting that workers whose supervisors demonstrate authentic leadership have a more positive perception of the workplace H&S climate and this leads them to have lower perceptions of risk. Thus when supervisors promote transparent, fair and ethical workplace environments, safer and healthier work climates will develop and workers will understand the importance of acting safely (Birkeland Nielsen et al., 2013).

Research also highlights the need to evaluate the links between leadership and H&S at different levels within an organisation. Transformational leadership is likely to be important at all managerial levels. However, Flin and Yule (2004) suggest that managers at different levels may need to engage in different types of H&S leadership behaviour to be effective. Some suggestions are provided in Table 2.3.

Table 2.3: Different levels of managerial influence on H&S

Senior managers	Senior managers effectively set the 'tone' of H&S activity within an organisation. They should continuously (and visibly) demonstrate their commitment to H&S. Flin and Yule (2004) suggest this is best demonstrated by devoting time to H&S matters within the organisation.
Middle managers	Middle managers should focus on ensuring effective H&S communication and compliance with organisational H&S systems. They should provide supervisors with a degree of autonomy in managing local H&S issues.
Supervisors	At a supervisory level, transactional leadership styles are likely to be effective when they focus on monitoring compliance and reinforcing H&S practices.

In contrast to the positive effect of transformational and transactional leadership, Kelloway et al. (2006) report negative impacts on H&S climate and performance when H&S leadership style is passive or 'laissez-faire'. This occurs when leaders fail to intervene until problems become serious enough to require attention and/or delay decision making.

Kelloway et al. (2006) examined the roles of H&S-specific transformational leadership and passive leadership in predicting H&S-related outcomes. For the purpose of this study, passive leadership combined laissez-faire with management-by-exception (passive) leadership styles

(Bass, 1990). Safety-specific passive leadership described the behaviour of leaders who approach safety issues in a passive way, either ignoring safety concerns or intervening only when a safety event becomes critical (Kelloway et al., 2006). H&S-specific passive leadership explained workers' H&S consciousness, H&S climate, H&S-related events, and injuries over and above the variance explained by safety-specific transformational leadership. Further, H&S-specific passive leadership exerted a negative effect on H&S consciousness and H&S climate.

Consistency is an important characteristic of leadership behaviour in relation to H&S. Mullen et al. (2011) report that managers do not always demonstrate the same style of leadership in relation to H&S. However, when managers alternate between transformational and passive H&S leadership behaviours, the positive effects of the transformational leadership behaviour are significantly reduced. Mullen et al. (2011) conclude that:

- it is insufficient to promote H&S occasionally – a sustained effort is needed, and
- to produce a positive H&S climate and influence H&S performance, transformational leadership in H&S needs to be consistent.

2.3.2 LMX and H&S

The relationship between LMX and H&S performance has been explored in previous research. Hofmann and Morgeson (1999) investigated the relationship between LMX and workers' H&S communication, H&S commitment and the occurrence of incidents. Hoffman and Morgeson (1999) reported that the quality of the relationships between group members and their supervisors (LMX) predicted H&S communication, H&S commitment and incidents. That is, where relationships were good, workers were more likely to raise legitimate H&S concerns and internalise the organisation's H&S values and less likely to be involved in a work-related safety incident.

It is believed that social exchange processes will encourage workers who have a good relationship with their supervisors to:

- comply with H&S requirements,
- engage in H&S-citizenship behaviours, for example, openly raising H&S concerns with their supervisors,
- monitor coworkers' H&S behaviour,
- correct potential H&S problems, and
- report H&S incidents, hazards or errors (Mearns & Reader, 2008).

Zohar (2002) suggests that the quality of leader-member interactions influences supervisors' level of concern for workers' H&S which, in turn, affects workers' perception of the H&S climate in a workgroup. Under conditions of high quality leader-member exchange relationships supervisors and workers work to support the attainment of group goals, including the protection of individual members' health, safety and welfare (Zohar, 2002).

2.4 Sources of leadership and influence

2.4.1 The pivotal role of supervisors

> *The important role of supervisors as the tender of organisational culture in creating congruence by mixing organisation, group and individual interests into a meaningful whole cannot be overstated.*
>
> (Guldenmund, 2007)

Supervisors are a critical conduit through which senior managers' commitment to H&S is communicated to workers. Subordinates are also reported to model their supervisors' H&S behaviour (such as wearing protective equipment) and develop similar H&S values to those of their supervisors (Maierhofer et al., 2000). H&S issues are raised and discussed on a daily basis by workers with their supervisor and coworkers who are close to the work (and its related H&S hazards). These immediate influences are more likely to be the strongest drivers of H&S performance (Christian et al. 2009). Because most workers have little contact with senior managers, they are more likely to be influenced on a day-to-day basis by interactions with members of their immediate workgroup, including their supervisors. Fugas et al. (2011) describe how social norms in workgroups develop from informal processes of interaction between workers and their supervisors. They argue that the social norms arising from group processes are a more powerful, proximal and relevant to workers and therefore more likely to produce behaviour change (Fugas et al., 2011).

The strength of group-level influences on H&S was highlighted by a study of macro- (organisational-level) and micro- (group-level) factors on workers' H&S performance conducted by Simard and Marchand (1994). In this research, supervisory practices were reported to be the strongest predictor of workgroups' propensity to adopt H&S initiatives (Simard & Marchand, 1995) and to comply with H&S rules (Simard & Marchand, 1997). The effect of workgroup and supervisory practices were considerably higher than macro- (organisational-level) factors, such as top management commitment to H&S as espoused by organisational H&S policies. Further, Simard and Marchand (1995) found that these macro- (organisation-level) factors influenced workers' H&S behaviour indirectly via group-level H&S factors. Thus, interactions at a workgroup level, filter the effect of top management H&S initiatives.

Previous research by Zohar (2002) has found that perceptions of supervisory H&S practices measured at one point in time predicted the incidence of minor (first aid only) incidents experienced by the workgroup for up to six months thereafter: i.e. the stronger the supervisors' H&S response, the lower the incidence of injuries (Zohar, 2002). Research has highlighted the importance of developing H&S supportive supervision within construction organisations. Zohar and Luria (2003, 2004) demonstrated the effectiveness of cross-level safety interventions whereby H&S performance was improved by modifying the way that supervisors interact with workers on a day-to-day basis.

2.4.2 Coworkers as a source of influence

Much H&S leadership research has focused on the behaviours of persons in possession of formal power within an organisation and those who have a defined responsibility for others. However, those without formal power can also substantially influence organisational group norms and H&S performance.

Chiaburu and Harrison (2008) suggest that it is through exchanges with coworkers that individuals develop clear beliefs about what is expected of them, i.e. what they should and should not do in their work role. Drawing on the work of Latané (1981), Tucker et al. (2008) suggest that social impact is a function of the strength, proximity and number of sources of influence. Although supervisors and managers have formal power (i.e. strength of influence), coworkers arguably have a greater ability to influence, as they are perceived to be work task 'experts'. Also, coworkers are closer in proximity to other workers and relatively larger in number than managers and supervisors. All of these factors combine to make coworkers an important source of influence. Coworkers also provide feedback and advice about appropriate behaviour when there is tension between different job-role requirements, such as productivity and H&S. In a comprehensive meta-analysis, Chiaburu and Harrison (2008) report that coworkers exert a unique influence on H&S outcomes, over and above the influence of the group supervisor.

Burt et al. (2008) suggest that, when coworkers care about each other, they will engage in proactive H&S-related behaviours, such as identifying, removing or warning others about workplace hazards. Hofmann and Stetzer (1996) report that coworkers' willingness to approach a group member engaged in unsafe behaviour was a critical linking mechanism through which group processes predicted H&S behaviour. More recently, Breslin et al. (2007) report that young workers in male dominated industries do not express their concerns about H&S risks in order to appear mature to their older coworkers. Similarly, Tucker et al. (2008) found that bus drivers' willingness to voice H&S concerns was dependent on the extent to which the organisation was perceived to be supportive of safety, but that perceptions of coworkers' support for H&S fully mediated this relationship. Westaby and Lowe (2005) report coworkers' tolerance for risk-taking to be a significant predictor of risk-taking orientation among workers across a wide cross section of jobs. Further, coworker risk-taking is reported to be a stronger predictor of workers' personal risk-taking orientation than supervisory influence (Westaby & Lowe, 2005).

Yagil and Luria (2010) investigated the role of social relationships between coworkers on workers' H&S-related behaviours. They report that, even when organisational or workgroup climates are perceived to be unsupportive of H&S, strong social support among coworkers creates an alternative protection net for workers. Fugas et al. (2011) differentiate between descriptive and injunctive norms that develop as a result of social interactions. The former refer to perceptions of others' H&S-related behaviour based on observations of coworkers' and supervisors' participation in and compliance with H&S. The latter, rather than describing what actually happens, establish norms for what 'ought to' happen. The researchers report that coworkers' descriptive H&S norms at one point in time predict coworkers' proactive H&S-related behaviour one year later. That is, proactive H&S behaviour increases when workers perceive that their peers also perform proactive H&S practices. Fugas et al. (2011) note that proactive H&S behaviour reflects more discretionary individual behaviour that is not explicitly recognised in formal job role descriptions by organisational reward mechanisms. They interpret their results to

mean that coworkers are effective models of proactive H&S behaviour for their peers and should therefore be considered as an important reference group when trying to create proactive H&S cultures.

2.5 H&S climate and performance

Climate perceptions "represent the individual's cognitive interpretations of the organisational context, bridging the effects of this wider context on individual attitudes and behaviour" (Clarke, 2013, p. 27). Leaders are believed to shape the prevailing climate within an organisation by their actions (see, for example, Cox & Cheyne, 2000; O'Toole, 2002; Cheyne et al., 2002). Workplace climates are important because they provide a set of normative guidelines for how workers should act in relation to a particular aspect of organisational activity.

Zohar (1980) introduced the concept of facet-specific climate for H&S which reflected workers' perceptions of the relative priority placed on H&S relative to other project goals. The H&S climate has also been defined as "individual perceptions of policies, procedures, and practices relating to safety in the workplace" (Neal & Griffin, 2006, p. 947). Management actions and attitudes towards H&S are the component of the H&S climate that most consistently predicts objective measures of H&S performance (Flin et al., 2000). Research has shown links between transformational leadership behaviour and the development of strong and positive H&S climates (Christian et al., 2009). It has also been argued that leaders play a key role in shaping H&S climates that, in turn, influence H&S behaviour and performance (Hoffmeister et al., 2014). Thus, H&S climate can be seen as a linking mechanism through which leadership impacts H&S performance.

The majority of safety climate studies have focused on the organisation as the unit of analysis. However, Zohar (2000) proposed two levels of H&S climate:

- that arising from the formal organisation-wide policies and procedures established by top management, and
- that arising from the H&S practices associated with the implementation of company policies and procedures within workgroups.

Zohar tested this proposition in a manufacturing context and confirmed that workgroup members develop a shared set of perceptions of supervisory H&S practices, and discriminate between perceptions of the organisation's H&S climate and the workgroup's H&S climate. Frontline leaders are particularly influential because they 'filter' and interpret organisational H&S messages. Put simply, frontline leaders interact directly with the workers and communicate what 'management really wants'. Zohar (2000) reports that workgroups develop distinct H&S climates that are driven by supervisors' actions and attitudes. Thus, Zohar (2000) demonstrated that workers develop shared perceptions about the relative priority of H&S based on regular interactions with their supervisors. These shared perceptions (or group H&S climates) varied considerably between workgroups and were positively linked to the occurrence of injuries within workgroups (Zohar, 2002). Zohar (2000) suggests that the development of group-level climates can explain why some workgroups perform consistently better in H&S compared to other

workgroups, even when they work with the same set of organisational H&S policies and procedures and have similar H&S risk profiles.

Zohar (2000) suggests that the prevailing group H&S climate relates to patterns of supervisory H&S practices, or ways in which organisation-level policies are implemented within each workgroup or sub-unit. Zohar (2000) reports that workgroups develop distinct H&S climates that are driven by supervisors' actions and attitudes. An analysis by Johnson (2007) validated a measure of group-level safety climate developed by Zohar and Luria (2005), reporting that perceptions of supervisors' actions predicted H&S behaviour and the occurrence of incidents in the manufacturing sector.

H&S climate researchers have often incorporated co-worker safety behaviour and supervisory safety leadership in their survey design. For example, Lu and Shang (2005) incorporate both perceptions of co-worker H&S and perceptions of supervisors' H&S leadership in a safety climate survey of container terminal operators in Taiwan, and Fang et al. (2006) identified supervisors' and workmates' role as the third most important component of H&S climate in the Hong Kong construction context. However, these researchers all aggregated these scores to the level of the entire organisation. With regard to supervisory and co-worker facets of H&S climate, the workgroup is a more appropriate unit of analysis. Attempts to aggregate scores for these dimensions at the organisation level are likely to mask important between-group differences, such as those identified by Findley et al. (2007) in their analysis of workers in the nuclear decommissioning and demolition industry.

Arguably, the group-level H&S climate should be a stronger predictor of H&S performance than organisation-level H&S climate, especially in large organisations or decentralised and distributed work environments.

Consistent with this argument, Zohar and Tenne-Gazit (2008) identified supervisors' general transformational leadership and group interactions as predictors of H&S climate strength. Zohar and Tenne-Gazit (2008) discovered that supervisors' transformational leadership positively contributes to group H&S climate strength. They also revealed the relationship between transformational leadership and H&S climate strength to be partially mediated by the density of the communication network (reflecting the proportion of workgroup members who participate in work-related exchange and information sharing).

These results suggest that supervisors with transformational leadership are able to promote shared values, collective goals and teamwork, which positively affects workgroup coherence and also the social interactions that occur within a group, between its members. Through a social learning process, increased interactions produce a strongly shared set of expectations and a common understanding of the importance of H&S within a workgroup (Zohar & Tenne-Gazit, 2008).

Zohar and Luria (2010) tested the moderating effect of transformational supervisory leadership on the relationship between organisational-level H&S climate and group-level H&S climate. The implementation of formal H&S policies and procedures within an organisation provides the cues for the development of organisational-level H&S climate perceptions. However, supervisors' discrepant interpretations and local implementation of formal procedures contribute to group-

level H&S climate perceptions. Zohar and Luria (2010) found that supervisors who demonstrate transformational leadership serve as 'gatekeepers' for group-level safety climate. Specifically, when perceptions of the organisational H&S climate are weak or low, supervisors who demonstrate transformational leadership can still maintain a positive and strong group-level H&S climate that can drive H&S performance.

2.6 Communication, trust and engagement

Communication and good interpersonal skills have been identified as an important competence for construction supervisors (Hardison et al., 2014). Open and frequent communication about H&S is identified as an important component of a positive H&S culture. H&S communication serves to:

- inform workers about H&S hazards, risks and ways of working safely,
- elicit important information about workers' experiences and concerns, and
- elicit suggestions for ways to improve H&S.

One feature of positive H&S culture is the presence of multidirectional communication (HSE, 2005a; HSE, 2005b). The UK Health and Safety Executive (2005a) suggests that effective H&S communication within an organisation occurs in three directions:

- top-down – management to frontline,
- bottom-up – frontline to management, and
- horizontal – between peers or functional groups.

Top-down communication ensures that safety goals and objectives are understood by workers and safety related information is transmitted to employees in a timely way. It is mainly concerned with:

- passing on health and safety policies and statements,
- disseminating information related to risks and safety such as hazard analysis and preventive measures, and
- providing feedback to respond to workers' reporting and raising of H&S concerns.

Bottom-up communication is mainly concerned with H&S reporting, by which workers report H&S issues and concerns to management for action and improvement. Olive et al. (2006) suggest that organisations should develop an atmosphere (and supporting structures) that allows workers to feel comfortable about raising H&S issues and encourages them to ask questions.

The importance of workers raising H&S concerns in high risk work environments is significant because it can facilitate incident prevention and organisational learning (Conchie et al., 2012). Conchie et al. (2012) considered the role of transformational leadership and trust in promoting workers' safety voice, or willingness to raise H&S concerns. They collected data from the oil industry in the UK and report that safety-specific transformational leadership increased workers' voice-citizenship behaviour, but that this relationship was mediated by affect-based trust beliefs. This means that leadership impacted workers' voice-citizenship behaviour through its impact on

affect-based trust. Affect-based trust refers to the belief that the trusted leader will act unselfishly and show care and concern for workers' welfare. This is in contrast to cognition-based trust that arises from knowledge of a leader's role in an organisation or personal abilities. Conchie et al. (2012) conclude that leaders who want to encourage workers to share H&S concerns should focus on improving relationships with workers. This would help to create a sense of psychological safety in which workers feel that their 'voice' behaviour will be supported and that issues they raise will be listened to and acted upon. In the absence of a sense of psychological safety, workers will be less inclined to engage in H&S-related voice citizenship behaviour (Detert & Burris, 2007).

Horizontal communication is related to the transfer of H&S information between peers, departments and functional units. Olive et al. (2006) claim that extensive communication between functional areas is important to maintain a good H&S culture as there is close interdependence between technical safety and organisational processes. Without effective communication, the two elements cannot be coordinated to appropriately manage H&S issues when they arise.

Richness of safety communication is highly reliant on the coexistence of formal and informal communication channels. Formal channels may include safety information systems and formal reporting systems. These systems ensure that information is collected, analysed and disseminated in a structured way.

Informal communication channels enable managers to verbally communicate the importance of safety and to listen to workers' concerns. Examples include conducting management tours and "walking the job, talking to people, listening to people" (HSC, 2001, p. 67). This direct communication conveys managers' commitment to and concern for workers' H&S (Cheyne et al., 2002). Similarly, Olive et al. (2006) suggest that 'management by walking around' (MBWA) is a key indicator of a company with good communication between different levels. MBWA emphasises the importance of managers' physical presence in a workplace, observing work procedures and processes. Managers can develop a deeper understanding of H&S issues by actively discussing H&S challenges and issues with workers. Meaningful face-to-face communication can help to cultivate trust, which enhances workers' willingness to voice H&S concerns and problems.

The extent to which H&S communication works well depends on the quality of relationships between workers and managers. It is most effective when a focus on problem solving and learning prevails. Hofmann and Morgeson (1999) report that the quality of the relationships between group members and their managers (Leader-Member Exchange) predicted safety communication, safety commitment and accidents. Kath et al. (2010) found that good supervisor-employee relationships are conducive to workers' bottom-up H&S communication – that is, raising safety concerns with supervisors. Where relationships are good, workers are:

- more likely to raise legitimate H&S concerns and internalise the organisation's H&S values, and
- less likely to be involved in a work related accident (Kath et al., 2010).

Similarly, Mullen (2005) reports that workers' willingness to voluntarily raise H&S concerns is greater when managers are perceived as supportive and willing to listen.

The UK's Health and Safety Commission (HSC, 1993) suggests that organisations should develop a positive safety culture characterised by 'communication founded on mutual trust'. Previous studies show that developing mutual trust relies on open communication (Conchie & Burns, 2008; Conchie et al., 2006). Open communication is characterised by "… a relationship in which both parties perceive the other to be a willing and receptive listener, and one who refrains from responses that might be seen as negative or nonaccepting" (Redding, 1972, cited in Conchie & Burns, 2008).

Eisenberg and Witten (1987) suggested that organisational activities with potential H&S implications require clear, complete communication, and that "concealing information would lead to the worsening of some problems over time, making them less manageable if confronted in the future' (p. 423).

Recently, Conchie and Burns (2008) investigated the effects of open communication on workers' belief and trust in an organisation's risk management processes. They report that open communication about H&S risks significantly contributes to workers' trust in risk management processes and decisions.

Cigularov et al. (2010) examined the influence of H&S communication in the US construction industry. They reported that when workers feel they can talk openly and freely to their supervisors about H&S, there are safer work practices and fewer instances of work induced bodily pain.

It is important that safety communication is conducted in a clear and meaningful way so that managers and workers can develop a clear and unbiased understanding of each other's interests and priorities. Research confirms that:

- high quality communication positively influences workers' organisational commitment (Parker et al., 2001), and
- misalignment between managers' H&S priorities and workers' perceptions of what managers want will lead to adverse outcomes including distrust, reluctance to engage in communication and a loss of confidence in management.

Clarke (1999) examined the perceptions of the importance of a number of H&S issues at three hierarchical levels of a rail transport organisation – drivers, supervisors, and managers. Participants were asked to indicate their own views about the relationship between H&S and operational efficiency, and to indicate what they thought the views of other levels within the organisation were. For example, workers were asked to comment on their own H&S priorities and those of their managers and supervisors. The results revealed considerable misalignment and misperception. All three groups commented that H&S was important at their own level. However, workers substantially underestimated managers' and supervisors' H&S priorities. Managers believed they were effectively communicating their commitment to H&S to supervisors and workers, yet workers' perceptions of 'what managers really want' were vastly different.

Communication needs to occur within and between all levels of an organisation. Clark (1999) argues that the intermediate role of supervisors in management-worker communication requires careful attention. Supervisors are often the conduit through which managers' H&S priorities are communicated. Zohar and Luria (2003) demonstrated that H&S climate perceptions and H&S behaviours can improve dramatically by increasing the frequency and quality of supervisors' H&S-related interactions with workers. Zohar and Luria (2004) suggested that at a workgroup level, supervisors play a critical role in shaping H&S climates by communicating the importance of H&S in their interactions with workers. They note three aspects of supervisors' communication that help to ensure H&S remains a workgroup priority (see Table 2.4).

Table 2.4: Aspects of supervisor communication

Pattern orientation	This is the extent to which the pattern of supervisory actions suggest the priority of one goal over another – for example, safety over production.
Pattern variability	This is the extent to which similar events or situations elicit similar supervisory actions in terms of relative priorities.
Pattern simplicity	This is the clarity and ease with which supervisors' behavioural patterns can be interpreted and understood.

In the Danish construction industry, Kines et al. (2010) examined the frequency with which supervisors discuss H&S with workgroup members. They reported that supervisors interact very frequently with group members but that 85-97% of these exchanges involved discussing production issues. H&S topics were only raised in 6-16% of exchanges between supervisors and workers. They introduced a feedback based coaching program to encourage supervisors to increase the H&S content of their daily verbal exchanges with workers. This program significantly increased the frequency with which H&S was included in discussions between supervisors and workers (from 6% to 62% at one site).

Kines et al. (2010) also reported that workgroup H&S performance and physical H&S levels at the worksite were significantly improved as a result of the coaching program. The extent to which production was discussed in supervisor-worker exchanges did not reduce during this research, leading Kines et al. (2010) to conclude that increasing H&S communication does not reduce communication about other aspects of workgroup performance.

Employee engagement should also target workers at all levels. Törner and Pousette (2009) investigated the preconditions for, and components of, high H&S standards in the construction industry. They interviewed workers and frontline supervisors and found that a crucial aspect of H&S is to engage employees in high quality interaction and cooperation across organisational functions and hierarchical levels. Interaction and cooperation are supported by mutual trust, empowerment and listening well. Supervisors play an important role in engaging frontline workers by fostering a feeling among workers that supervisors rely on them, expect feedback from them, and trust their judgements. This feeling stimulates workers' intention to take initiative, and to come up with ideas for H&S improvement. To further facilitate worker engagement, upper level management needs to:

- motivate supervisors to facilitate effective worker-management communication in both directions, and to keep H&S communication ‘alive’, and
- demonstrate high levels of interest by listening and responding promptly to workers’ suggestions and contributions.

2.7 H&S leadership, climate and performance in construction

In construction there is likely to be a particularly strong connection between group-level H&S climate and safety performance owing to the multi-tiered subcontracting system and prevalence of semi-autonomous workgroups. In this context, the influence of immediate supervisors and coworkers is likely to be strong, relative to that of senior management. Rowlinson et al. (2003) suggest that, in construction, supervisors are often the point at which breakdown occurs in H&S management systems. Subcontracting is a key feature of the construction industry, which is known to present significant challenges in the management of H&S (Arditi & Chotibhongs, 2005). Loosemore and Andonakis (2007) identify time pressures, confusion over responsibility for H&S, a dominant culture of risk transfer and implementation costs as impediments to H&S associated with subcontracting in the Australian construction industry. Similarly, Mayhew et al. (1997) argue that the ‘payment-by-results’ system pushes subcontractors to work excessive hours and ‘cut corners’ with respect to H&S. Intense competition drives down the price of subcontractors’ services, further reducing the priority placed upon H&S (Mayhew et al., 1997). Subcontractor involvement is a core aspect of construction organisations’ safety culture (Mohamed, 2002; Molenaar et al., 2009) and a feature of effective H&S management in construction (McDonald et al., 2009). Construction subcontractors are often engaged in complex relationships both horizontally (i.e. when multiple subcontractors are engaged by a principal contractor) and vertically (i.e. in the case of a pyramid of multi-layered subcontracting). In this context, workers involved in subcontracted companies are only loosely connected with the principal contractor and relatively isolated from their own company, which could affect the development and impact of the H&S climate (Melia et al., 2008). Facets of the group H&S climate have been linked to subcontractors’ H&S behaviour. For example, Choudhry and Fang (2008) report that when coworkers and supervisors are perceived to be unsupportive of safe behaviour, subcontracted construction workers are more likely to adopt unsafe work practices. The implication of subcontracting for the development and impact of H&S climates within the construction industry is not well understood.

There is emerging evidence that distinct group-level H&S climates develop within construction organisations. For example, Glendon and Litherland (2001) reported significant between-group differences in H&S climate within an Australian road construction and maintenance organisation. Lingard et al. (2009) demonstrated the existence and importance of group-level H&S climates in the Australian building construction context. Consistent with the view that group-level safety climate is likely to be a stronger, more proximal, predictor of safety performance than organisational-level safety climate, group-level safety climate has also been found to mediate the relationship between organisational-level safety climate and the injury frequency rate of subcontracted workgroups in the Australian construction industry (Lingard et al., 2010). Thus groups with strong and positive group-level climates had lower injury frequency rates than those with climates that were weak and/or low.

Relationships between leaders' behaviour, H&S climate and performance have also been found in international construction research. Finneran et al. (2012) undertook a study of the London 2012 Olympics construction which revealed that supervisors' competence enhanced the effectiveness of site H&S practices. Shen et al. (2017) report that transformational leadership had a significant impact on the H&S climate in construction workgroups in Hong Kong. Further, this relationship was mediated by high quality leader-member exchange. In addition, the results suggested that the prevailing H&S climate, in turn, influenced H&S behaviour by increasing workers' knowledge about H&S policies and procedures. Shen et al. (2017) suggest that construction supervisors can contribute to the effectiveness of future H&S climate interventions through exhibiting transformational leadership, encouraging construction personnel to voice safety concerns without fear of retaliation, and repeatedly reminding them about H&S on the job.

Coworkers' behaviours have also been identified as an important predictor of H&S climates in the construction industry. For example, in a study by Melia et al. (2008), construction workers' perceptions of their coworkers' H&S actions and attitudes significantly predicted their own self-reported H&S behaviours.

Hoffmeister et al. (2014) argue that it is possible that different aspects of leadership may affect H&S in different ways and for different reasons. They explored the links between transactional and transformational leadership and H&S in the US construction industry. They report that different leadership styles predicted H&S climate, compliance and participation among journeymen (experienced construction workers) and apprentices. In particular, idealised attributes, idealised behaviours, intellectual stimulation and contingent reward predicted H&S climate among apprentices, while idealised attributes and contingent rewards were the only predictors of H&S climate among journeymen. For apprentices, the only significant leadership predictor of H&S compliance was idealised behaviour, while safety compliance among journey men was predicted by idealised attributes, idealised behaviour and contingent reward. In relation to H&S participation idealised behaviour, idealised attributes and contingent reward were predictors for apprentices but no leadership behaviours predicted H&S participation among journeymen. Hoffmeister et al. (2014) also note that the links between idealised behaviours and attributes and H&S climate and performance suggest that leaders' values and consistency in behaviour in relation to H&S are important determinants of influence and performance in the construction context.

Conchie et al. (2013) suggest that supervisors' engagement in H&S leadership in the construction industry is not independent of the organisational or work environment. In a study of the UK construction industry, Conchie et al. (2013) explored factors that can help or hinder supervisors' engagement in H&S leadership behaviour. Drawing on the job demands and resources theory of engagement, Conchie et al. (2013) identified role overload production pressures and low levels of skill among a predominantly subcontracted workforce as being barriers to the adoption of good leadership behaviours. Good supervisory leadership behaviours in the construction context were identified by industry participants in the research as being transformational, charismatic and participative. In particular, the requirement to undertake significant amounts of administrative work was seen as a particular hindrance to effective supervisory leadership, as paperwork was perceived to remove supervisors from the workplace where they can engage in effective supervisory practices. Production pressures that create a focus on 'getting the job done' were also identified as factors impeding effective supervisory H&S

leadership in construction projects. Supervisors also reported that social support from their peers and autonomy over their work practices were resources that could help them to be more effective H&S leaders.

2.8 Conclusions

In this section, we presented an overview of leadership theories and discussed the links between the nature and quality of leadership and H&S in an organisation or workplace. We also identified H&S climate as a linking mechanism between leadership and H&S performance and presented the evidence relating to the links between leadership and H&S in the construction industry. Lastly, we discussed the relationships between leadership, communication, trust and engagement in relation to H&S performance.

In the remaining sections of this report, we will describe our data collection and analysis methods, present the results and then draw on these results to answer the research questions and make specific recommendations for supervisor H&S leadership in the Australian construction context.

Part 3: Research methods

Quantitative and qualitative data was gathered from workers in the construction rail industry, with construction workgroups at the 'frontline' being the focus of the study. For the purposes of this study, a 'workgroup' was defined as a group of workers that worked together at the same site and had a common supervisor.

The three stages of data collection in this study comprised:

- collection of social network data reflecting the nature of communication occurring between members of a workgroup,
- surveys of the supervisor and workers in each workgroup, and
- observation of workgroup members using an ethnographic approach.

The following sections describe the aforementioned research approaches, and the methods of data collection and analysis used.

3.1 Social networks

Previous research has suggested that H&S is enhanced when there is open communication across all levels of an organisation. However, little research has investigated the efficacy of H&S-related communication at the frontline workgroup level in the construction industry. Social network data can provide information about communication patterns and the flow of information in workgroups. It has been used to understand H&S-related communication in a variety of industry contexts, such as the military (Zohar & Tenne-Gazit, 2008). Social network analysis was used in this study to provide an indication of how H&S-related information is shared and communicated within workgroups.

3.1.1 Social network data collection

Members of a workgroup (i.e. the workers and their supervisor) were asked to indicate the frequency with which they communicated with each of the other workgroup members. This data was captured using a pro-forma, as shown in Figure 3.1.

Your Name:												
Your role:												
			Communication									
Name of individuals in your work crew			*TO whom on your crew do you **PROVIDE** safety and hazard information and how often?*					*Whom on your crew do you **RECEIVE** safety and hazard information from and how often?*				
First Name	Last Name	Position / Role	once a month	bi-weekly	weekly	once a day	more than once a day	once a month	bi-weekly	weekly	once a day	more than once a day

Figure 3.1: Social network data capture tool

This included how often they provided safety information to each member of the workgroup, and how often they received information from each member of the workgroup.

3.1.2 Social network data analysis

The following network measures, i.e. centralisation, density, and actor centrality, were calculated for each workgroup.

Centralisation

Centralisation is the overall cohesion or integration of the network (Pryke, 2012). The measure of centralisation quantifies the range or variability of the individual actor indices (Wasserman & Faust, 1994). This measure is calculated using 'UCInet' software. The measure is high when few actors have a high level of influence in the network compared to others, and low when all actors have almost equal influence.

Network density

Network density refers to the ratio of actual links or relationships available between the network actors to the maximum possible number of links that the network can have (Borgatti & Everett, 2006). The more the actors connect with one another by information exchange, the higher the network density is likely to be. This is calculated using the following formula:

$$\Delta = \frac{L}{\mathrm{g}(\mathrm{g}-1)}$$

where Δ is the network density, L is the number of existing connections, and g is the total number of actors.

Supervisor centrality

An actor's level of centrality is a measure that quantifies the total number of direct relationships that the actor has with other actors in the network (Freeman, 1977). Hence, the level of the supervisor's centrality was calculated using the formula:

$$C_D\ (\text{actor x}) = \frac{C_D\ (actor\ x)}{(\text{g} - 1)}$$

where C_D (actor x) is the total number of relationships that the supervisor has (in or out), and (g – 1) is the maximum possible number of relationships that the supervisor can have, where g is the total number of network actors.

These measures were used as variables in the overall quantitative analysis.

3.2 Surveys

3.2.1 Survey instruments

Two sets of survey questions were developed for this study, i.e. one for workers, and one for supervisors.

Workers' survey

The survey of workers was designed to develop an understanding of workers' perceptions of:

- the H&S commitment of the construction client and the principal contractor,
- their supervisor's leadership styles,
- their workgroup's H&S climate, and
- their own safety behaviours.

H&S commitment of the construction client and principal contractor

The measures of clients' safety response and principal contractors' safety response developed by Zhang et al. (2015) were adapted in this study to assess the H&S commitment of the construction client and principal contractor. Three items were selected from the original measures to assess the H&S commitment of the construction client, while four items were selected to measure the H&S commitment of the principal contractor. All items selected reflect perceptions of the overall priority that the construction client and principal contractor place on H&S.

Supervisors' leadership styles

The leadership measure developed by Podsakoff et al. (1990) was used to assess supervisors' leadership styles. This leadership measure has been widely adopted in the leadership literature. Podsakoff et al.'s (1990) leadership measure assesses six components in relation to transformational leadership behaviours, including:

- Articulating a vision – leadership behaviours in relation to developing, articulating, and inspiring employees with his or her vision for the unit/division (5 measurement items),
- Providing an appropriate model – leadership behaviours that set an example for employees to follow and the example reflects the values that the leader espouses (3 measurement items),
- Fostering the acceptance of group goals – leadership behaviours that aim to promote cooperation among employees and get employees to work together toward a common goal (4 measurement items),
- High performance expectations – leadership behaviours that demonstrate the expectation for employees to achieve excellence, quality and high performance (3 measurement items),
- Providing individualised support – leadership behaviours that indicate the leader respects employees and is concerned about their personal feelings and needs (4 measurement items), and
- Intellectual stimulation – leadership behaviours that challenge employees to re-examine the assumptions about their work and rethink how the work can be performed differently (4 measurement items).

The leadership measure also assesses one component reflecting transactional leadership behaviour, i.e. contingent reward, which describes leadership behaviours that offer rewards to employees in exchange for satisfactory performance in performing tasks. Five items were developed to measure contingent reward.

Podsakoff et al.'s (1990) leadership measure was validated through a study of 988 employees in a large and diverse petrochemical company. Three components in relation to transformational leadership behaviours (i.e. articulating a vision, providing an appropriate model and fostering the acceptance of group goals) were found to be highly correlated, and were thus combined to form the "core" transformational leadership factor (Podsakoff et al., 1990).

However, Podsakoff et al.'s (1990) leadership measure did not assess leaders' communication behaviour, which is a critical aspect in effective supervisory leadership in the construction context. Therefore, Podsakoff et al.'s (1990) leadership measure was supplemented with the measure of communication practice developed by Cigularov et al. (2010). This measure of communication practice contains five items, reflecting a two-way communication style between supervisors and employees.

Workgroup H&S climate

Workgroup H&S climate was assessed using a six-item scale adapted from the Australian Contractors' Association (ACA) Health and Safety (H&S) Climate Assessment tool, which was developed by Lingard et al. (2014). The six-item scale reflects group members' H&S values and responsibility for self and others.

Self-reported H&S-related behaviour

Self-reported H&S-related behaviour was measured using the safety behaviour scale developed by Neal and Griffin (2006). The scale comprises six items, with three of the items relating to workers' compliance with safety rules and procedures, and the other three items reflecting workers' participation, e.g. voluntary behaviours in improving and promoting safety.

Supervisors' survey

The survey of supervisors was designed to assess supervisors' perceptions of:

- the overall level of H&S commitment demonstrated by the principal contractor, and
- the leadership style and communication practices of the principal contractor's site-level manager.

Supervisors' perceptions of the principal contractor's commitment to H&S were measured using the questions in the workers' survey designed to assess the H&S commitment of the principal contractor. In addition, questions designed to assess supervisors' leadership styles in the workers' survey were reworded and used in the supervisors' survey to understand supervisors' perceptions of site-level managers' leadership behaviours.

3.2.2 Evaluation of workers' survey

The items discussed in the previous section in respect to the workers' survey were compiled to form the survey instrument. A Likert scale ranging from "1 = strongly disagree" to "5 = strongly agree" was used to measure the items. A few questions were added to understand workers' employment arrangements with their principal contractor, and their work experience on the project. This resulted in a total of 53 questions being used in the workers' survey.

Modifications were made to the workers' survey in the early stages of data collection (i.e. after a few survey sessions) based on feedback received from workers who completed the survey. Their feedback indicated that the wording of some questions made them hard to understand. For instance, workers questioned the meaning of 'fosters collaboration' and 'second best' in the following questions:

- 'My supervisor fosters collaboration among work groups', and
- 'My supervisor will not settle for second best'.

Their feedback also indicated that some questions were not highly applicable to construction workgroups. For example, workers were confused about some questions that related to articulating a vision and intellectual stimulation, including:

- My supervisor is able to get others committed to his/her dream,
- My supervisor paints an interesting picture of the future for our group, and
- My supervisor has ideas that have challenged me to re-examine some of basic assumptions about my work.

While often very skilled in their respected trades, some construction workers have poor literacy skills and limited schooling (Worksafe ACT, 2012). Hence, it is perhaps not surprising that such

phrasing in the survey questions was not always well understood by workers. Questions that were not fully comprehended, or highlighted as inapplicable by respondents, were removed in subsequent surveys sessions. The number of questions contained in the survey was reduced to 42, and there were no further issues highlighted by respondents in the survey sessions to follow.

3.2.3 Survey administration

The workers' survey was conducted at either an on-site location suggested by the project management team, or inside the site shed. The survey was administered using the 'TurningPoint' automated response system with 'KeePad' hand held devices. As most of the workgroups were relatively small in size (ranging from two to six workers), workers were gathered around a laptop screen. Questions were shown on the screen and read out by a researcher, one by one. Workers were required to press a number on the hand held devices to indicate their response to each survey question. This method of survey administration helped to overcome potential language or literacy issues and helped to ensure anonymity of responses.

The supervisors' survey was administered in web-based mode. The web-based survey, designed using 'QuickSurveyTap' software, could be accessed by respondents through electronic devices such as smart phones and tablets. While workers were completing the workers' survey, their supervisors were asked to complete the supervisors' survey using a tablet, in a different shed or site location. Supervisors were physically separated from workers at the time of survey completion to prevent them from influencing workers' survey responses.

The questions for both the workers' survey and supervisors' survey are presented in the Appendix in Part 8 of this report.

3.2.4 Survey data analysis

Reliability of measurement

Reliability analysis allows an assessment of the measurement scales and items that make them up. For example, reliability analysis provides an answer to the question 'does my survey measure leadership in a useful way?' Using reliability analysis, the extent to which items in the survey scales are related to each other is considered and an overall index of the internal consistency of each scale is produced. Problem items that should be excluded from the scale can also be identified. Cronbach's alpha coefficients were calculated for each of the scales. Cronbach's alpha is a measure of internal consistency based on the average inter-item correlation. Generally speaking, a Cronbach's alpha value of 0.7 or above is considered to indicate acceptable internal consistency reliability.

Scale reliability and descriptive statistics are presented in the results. The reliability and descriptive statistics enable an assessment of the general H&S commitment demonstrated by the construction client and principal contractor, the overall levels of leadership experienced by respondents, as well as their perceptions of the workgroup H&S climate and their self-reported H&S-related participation and compliance behaviour.

However, these descriptive statistics do not allow the experiences of different demographic groups, such as workers who have worked for a long or short time with their current supervisor,

to be compared. Nor do these statistics provide an insight into the way in which the variables are linked. For example, it would be useful to know whether, and in what way, leadership aspects are associated with the workgroup H&S climate and/or self-reported measures of H&S-related behaviour. In order to explore some of these differences and linkages between variables, further statistical analysis was undertaken using the statistical comparison of means, correlation analysis, multiple regression analysis and modelling techniques described below.

Statistical comparisons of means

In order to compare the experiences of different groups of workers, statistical tests were conducted to compare the mean scores for important variables between groups of employees. Analysis of variance (often abbreviated to ANOVAs) and independent t-tests were used to test for significant differences.

Correlation analysis

In order to determine the nature and strength of linkages between the variables measured, bivariate correlation analyses were conducted. These correlations enable an assessment of the degree to which one variable is linearly related to another. Correlation coefficients were calculated for each pair of variables measured in the study. These statistics are presented under the sub-heading, 'Bivariate correlations', in Part 4 of this report.

The correlation coefficients, presented in matrix format, indicate the strength and direction of the linear association between two variables. A positive coefficient indicates that as one variable increases, so too does the other variable. A negative coefficient indicates an inverse relationship, i.e. as one variable increases, the other decreases. Two-tailed significance levels associated with the correlation coefficients were also calculated. Thus, if r=.088 and this is significant at the 0.01 level, the probability of obtaining a correlation coefficient of at least 0.88 in absolute value, when there is no linear association between the two variables, is less than 1%.

Multiple regression analysis

Having gained an understanding of the associations between the variables, it is useful to determine to what extent one variable can be predicted, given knowledge of another variable. Modelling procedures together with multiple regression analysis were undertaken to determine the cascading H&S influence of construction client and principal contractor on supervisory leadership, and the extent to which aspects of supervisory leadership predicted workgroup H&S climate and H&S outcome variables. Several models were developed based on existing theories of leadership and H&S. Once models were specified, data were analysed to determine whether the model was consistent with them. Failure of a model to fit the data results in model falsification, whereas a good fit supports the theoretical arguments. Although no model can be definitively confirmed, repeated failure to disprove a model adds strength to researchers' belief in the theory (Cohen et al., 2003).

The theory-driven models we developed relating to leadership and H&S were tested to determine the extent to which, in our sample, specified outcome variables were 'explained' by the other variables measured in our study. These models and the statistical results are presented in the later part of the workers' survey results in Part 4 of this report.

Multiple regression analysis also enables the relative importance of independent variables to be determined. For example, multiple regression can be used to answer the question: 'how important are different leadership styles when they are used to predict self-reported H&S behaviour along with other independent variables in the regression equation?'

Beta coefficients (denoted β) for the independent variables in a regression model can be compared. Beta coefficients are standardised to accommodate differences between units of measurement among the independent variables. Another way of assessing the relative importance of independent variables is to consider the increase in R^2 when a variable is entered into an equation that already contains the other independent variables. R^2 indicates the percentage of variation in the dependent variable that can be 'explained' by the regression model. Thus, an R^2 of 0.77 indicates that 77% of variation in the dependent variable is explained by the model.

Moderators and mediators

There are a number of different roles variables can play in theory. A cause (X) of some variable (Y) is believed to precede Y in time. However, some theories provide for the inclusion of mechanisms through which variable X is related to variable Y. For example, previous studies have shown that leadership styles are related to H&S performance through the development of workgroup H&S climates. These intervening variables are called mediators of the effect of X on Y. Figure 3.2 provides an example of a mediator (Z) that totally accounts for the relationship between X and Y. Figure 3.3 shows a mediator (W) that partially accounts for the relationship between X and Y.

Figure 3.2: Z as a full mediator of the relationship between X and Y (Source: Cohen et al., 2003, p. 458).

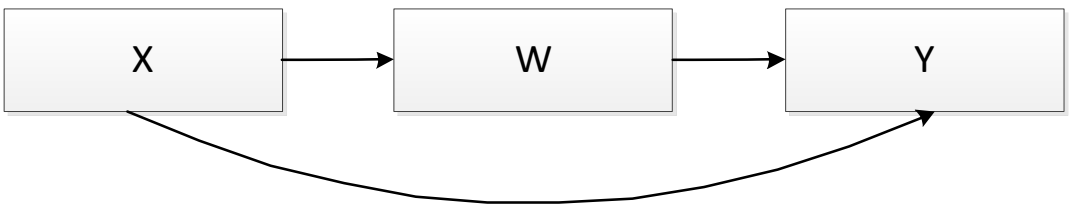


Figure 3.3: W as a partial mediator of the relationship between X and Y (Source: Cohen et al., 2003, p. 458).

In order to test for mediation effects we used procedures described by Baron and Kenny (1986). Baron and Kenny suggest that, to test for mediation, three regression equations must be estimated, as follows:

1. The mediator is regressed on the independent variable.

2. The dependent variable is regressed on the independent variable.

3. The dependent variable is regressed on both the independent variable and the mediator.

To establish mediation, the independent variable must affect the mediator in the first equation; the independent variable must affect the dependent variable in the second equation; and the mediator must affect the dependent variable in the third equation. If these conditions hold, then the effect of the independent variable on the dependent variable in the third equation must be less in the third equation than in the second.

Other important variables in some causal theories are moderators. These are the variables that modify the relationships among other variables (see Figure 3.4). The arrow from Z to the arrow from X to Y indicates that the estimate of the causal effect of X on Y is conditional on the value of Z.

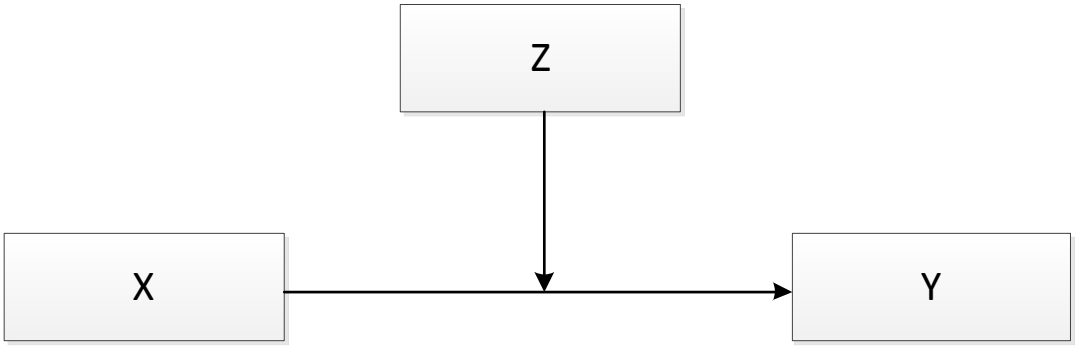


Figure 3.4: Contingent effects, Z as a moderator (Source: Cohen et al., 2003, p. 458)

In order to test for moderation effects, we used procedures described by Baron and Kenny (1986). Prior to conducting any tests for moderation effects, all continuously measured predictor variables were centred (Aiken et al., 1991). Centering is a linear transformation method which eliminates problems associated with multi-collinearity. It is achieved by subtracting the mean value for a variable from each score for that variable. The power of moderated regressions to detect interactions is reported to be low, resulting in a high Type II error rate (Aiken et al., 1991). One remedy for this is to accept a higher Type I error rate. As a result of this, we accepted an alpha level of .10 in testing the significance of moderation effects.

3.3 Ethnography

Ethnographic research is a qualitative 'bottom up' approach, where rather than hypothesising and testing theory, there is a focus on new theories emerging from the data. Considering there is lack of understanding in what leadership traits are associated with positive H&S performance within a construction context, this approach provided an opportunity to capture data and themes that were not being 'tested' through the quantitative research methods discussed above.

Ethnography is an approach of studying a specific group in their natural setting (Phelps & Horman, 2010). Participant observation is usually an ethnographer's main research tool. In participant observation the researcher is exposed to an environment, such as a construction site, and learns through the instruction of other members within the setting (Rooke et al., 2004). Researchers using participant observation can be more of a 'participant' or more of an 'observer', with the research setting typically lending itself to emphasise one or the other (Murchison, 2010). Considering leadership H&S behaviours are often challenging to purely observe, more of a 'participant' stance was undertaken. Hence, this approach aimed to capture the 'difficult to see' behaviours as well as the 'easier to see', as the focus of the study was on leadership (see Figure 3.5). By undertaking more of a 'participant' role, the researcher went beyond observation and often engaged in informal conversations with participants.

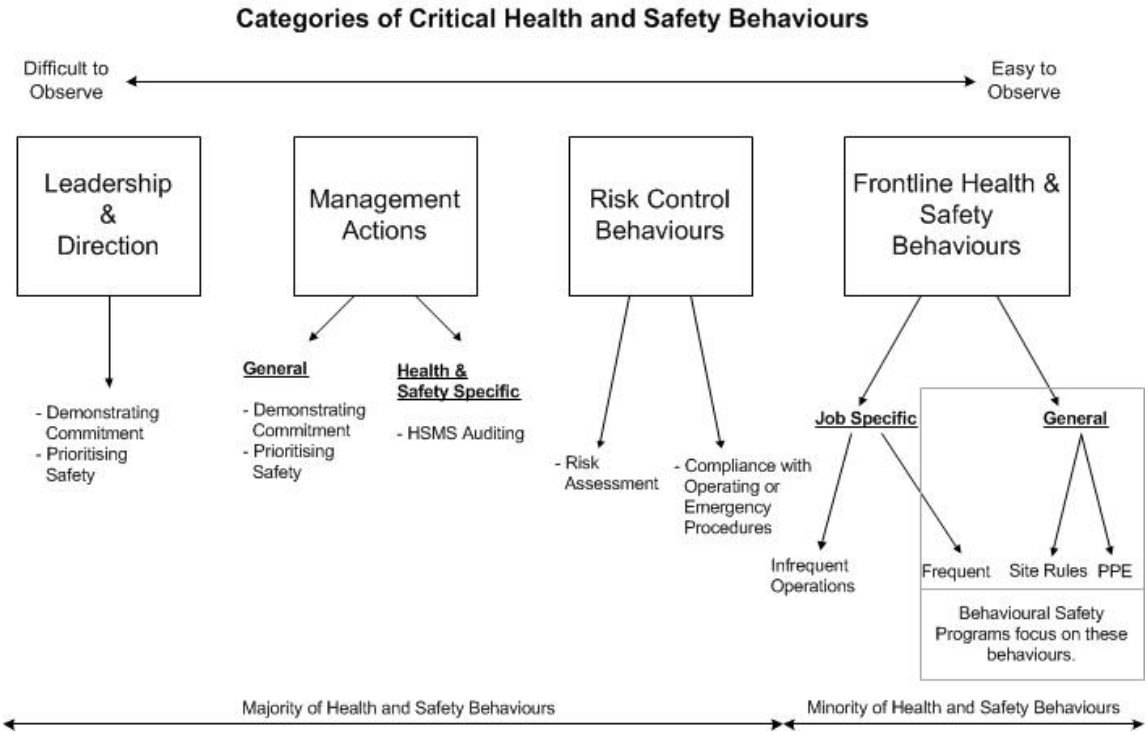


Figure 3.5: Leadership is a difficult H&S behaviour to purely observe (Fleming and Lardner, 2002, p. 17)

The time restrictions of the research project limited opportunities for building deeper relationships and experiences, which characterise a traditional ethnography that can last for several years. Nevertheless, the comparative dimension of the short-term multi-sited

ethnographic approach can capture valuable insights and understanding, and has previously been successfully utilised within the construction industry (see, for example, Tutt et al., 2013). Ethnographic data was gathered during approximately 100 hours of participant observation, across 22 workgroups, at 11 different construction sites.

3.3.1 Ethnographic data collection

The ethnographic data collection typically involved the researcher having short informal discussions with participants on the construction sites. During these discussions, the researcher would often ask open-ended questions relevant to the research such as: 'what do you think makes a good supervisor?' or 'what do you think is an important leadership trait for H&S?' Following this engagement with participants, initial field notes that were relevant to answering the research questions would be jotted down, during the course of the action. As memory is frail and selective, there is a need for note-taking in the field where possible (Denscombe, 1998). These notes were typically typed onto the researcher's mobile phone at appropriate moments. This was less obtrusive to the natural setting than taking notes with pen and paper, which could generate distraction or distrust amongst the participants (Hammersley & Atkinson, 2007), or act as a constant reminder they were being researched, which is typically not what participants want (O'Reilly, 2012). This is an important point considering proponents of ethnography argue that as the research is conducted in natural settings, rather than contrived settings, these types of settings can reflect reality more accurately (LeCompte & Goetz, 1982). The initial jottings made would be written up into more extensive field notes as soon as possible after leaving the research setting.

3.3.2 Ethnographic data analysis

This data was then input into the software package, NVivo, and analysed using a thematic analysis. This approach helps provide a 'bird's-eye view' of emerging patterns that can be drawn out (Aronson, 1994), and identifies patterns across data sets that are relevant in addressing the research aims (Braun & Clarke, 2006).

The thematic approach consisted of six stages:

- familiarisation with data,
- generating initial codes,
- searching for common themes,
- reviewing them,
- defining and naming themes, and
- producing a final report (Braun & Clarke, 2006).

Part 4: Survey and social network analysis results

4.1 Workers' survey results

4.1.1 Descriptive statistics

Sample characteristics

Survey data was collected from 20 workgroups across 11 different worksites between August 2016 and May 2017. The number of participants in each group ranged from two to six. In total, 73 workers participated in the surveys.

Table 4.1 presents background information about survey participants.

The majority of the participants (n=55, 75.3%) indicated that they had been working for more than one month at the project at which data was collected. Another 10 participants (13.7%) indicated that they had worked at the project for more than one week but less than one month. Only five participants (6.8%) indicated that they had spent less than one week at the project.

The majority of participants (n=60, 82.2%) indicated that they were not direct employees of the principal contractor at the worksite at which data was collected.

When asked for how long they had worked with the principal contractor at the participating worksite, only five participants (6.8%) indicated they had less than one week of working experience with the principal contractor and the majority (n=44, 60.3%) indicated they had more than six months of experience working with the principal contractor at the worksite.

The majority of the participants indicated that they had worked with their current supervisor for six months or longer (n=38, 52%). Eight participants (11%) indicated that they had worked with their current supervisor for between one week and one month and another eighteen (24.7%) indicated they had worked for their current supervisor for between one and six months. Only nine participants (12.3%) indicated working with their current supervisor for less than one week.

Table 4.1: Background information about survey participants

	Number	Per cent		Number	Per cent
Time spent working on the project			**Direct employee of the principal contractor?**		
<1 week	5	6.8	Yes	12	16.4
Between 1 week and 1 month	10	13.7	No	60	82.2
> 1 month	55	75.3	No response	1	1.4
No response	3	4.1			
Time spent working with current supervisor			**Time spent working for the principal contractor**		
< 1 week	9	12.3	< 1 week	5	6.8
Between 1 week and 1 month	8	11.0	Between 1 week and 1 month	7	9.6
Between 1 month and 6 months	18	24.7	Between 1 month and 6 months	16	21.9
Between 6 months and 1 year	19	26.0	Between 6 months and 1 year	23	31.5
over 1 year	19	26.0	> 1 year	21	28.8
			No response	1	1.4

Clients' commitment to H&S

Two items were used to measure workers' perceptions of the clients' commitment to H&S at the worksite. Participants were asked to score the items using a five-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly disagree".

The mean scores for each item are shown in Table 4.2. The overall mean score for workers' perceptions of the clients' commitment to H&S was 4.38. The Cronbach's alpha value was 0.77, indicating an acceptable internal consistency for the scale.

Table 4.2: Workers' perceptions of clients' commitment to H&S

	Mean Value	**Std. Deviation**
Workers' safety is given a high priority by the client	4.39	0.72
The client has clearly communicated high expectations for workers' safety in this project	4.36	0.86
Overall mean score	4.38	0.71

Principal contractors' commitment to H&S

Three items were used to measure workers' perceptions of the principal contractors' commitment to H&S at each worksite. Participants were asked to score the items using a five-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly disagree".

The mean scores for each item are shown in Table 4.3. The overall mean score for workers' perceptions of the principal contractors' commitment to H&S was 4.35. The Cronbach's alpha value was 0.85, indicating an acceptable internal consistency for the scale.

Table 4.3: Workers' perceptions of principal contractors' commitment to H&S

	Mean Value	Std. Deviation
[Principal contractor's name] places a strong emphasis on workers' safety	4.40	0.74
I feel that [principal contractor's name] openly accepts ideas for improving safety	4.36	0.67
I feel that [principal contractor's name] encourages open communication about safety	4.29	0.79
Overall mean score	4.35	0.65

Supervisory leadership

Supervisory leadership was measured with 20 items reflecting six leadership components. Participants were asked to score the items based on their experience of working with their supervisor at their current worksite. Items were scored using a five-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly disagree".

The mean scores for each item and leadership component are shown in Table 4.4.

Table 4.4: Workers' perceptions of supervisory leadership

	Mean Value	Std. Deviation
Communication practice		
I feel comfortable discussing safety issues with my supervisor	4.49	0.77
I feel that my supervisor openly accepts ideas for improving safety	4.47	0.67
I am reluctant to discuss safety related problems with my supervisor	3.97	1.21
I feel that my supervisor encourages open communication about safety	4.31	0.68
I try to avoid talking about safety issues with my supervisor	4.20	0.88

Overall mean score	4.29	0.60
Setting high performance expectations		
My supervisor insists on only the best performance	4.37	0.66
My supervisor expects the highest quality work	4.27	0.73
My supervisor shows us that they expect a lot from us	3.99	0.94
Overall mean score	4.21	0.58
Fostering the acceptance of group goals		
My supervisor encourages workers to be “team players”	4.38	0.78
My supervisor creates a cooperative work environment within the group	4.20	0.78
My supervisor gets the group to work together for the same goal	4.36	0.77
Overall mean score	4.31	0.71
Providing an appropriate model		
My supervisor provides a good model for me to follow	4.26	0.78
My supervisor leads by “doing,” rather than simply by “telling”	3.68	1.12
My supervisor leads by example	4.11	0.91
Overall mean score	4.02	0.78
Intellectual stimulation		
My supervisor asks questions that prompt me to think	4.07	0.87
My supervisor challenges me to think about old problems in new ways	3.93	0.92
My supervisor encourages me to rethink the way I work	3.66	0.97
Overall mean score	3.89	0.82
Contingent reward		
My supervisor commends me when I do a better than average job	4.03	1.08
My supervisor gives me special recognition when my work is very good	3.73	1.00
My supervisor always gives me positive feedback when I perform well	3.92	1.05
Overall mean score	3.89	0.95

Figure 4.1 presents the overall mean scores for each of the leadership components. Overall mean scores for all of the leadership components were above 3.80. The highest rated component was ‘fostering the acceptance of group goals’. The three other leadership components with mean scores above 4.00 were ‘communication practice’, ‘setting high performance expectations’ and ‘providing an appropriate model’.

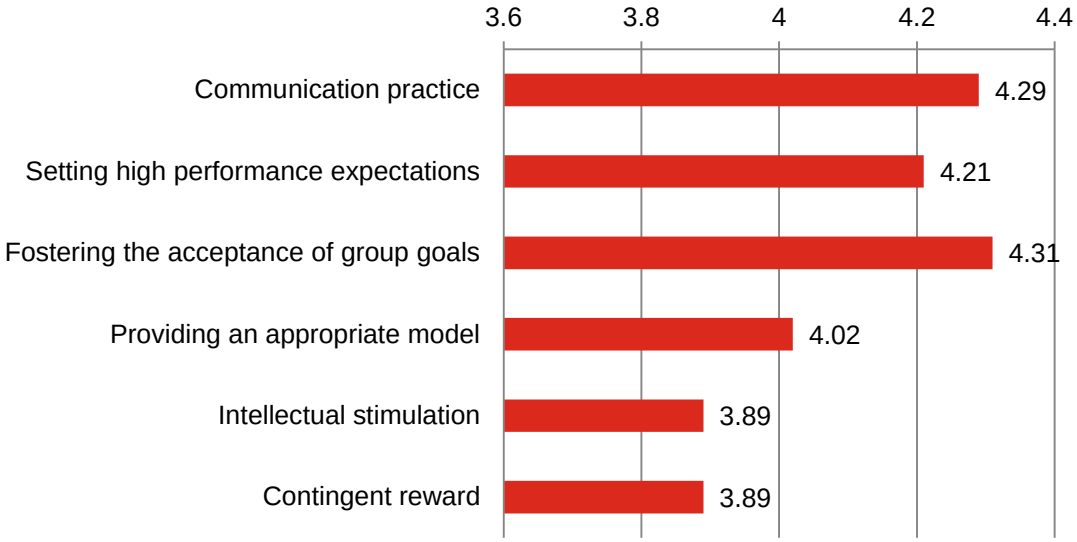


Figure 4.1: Mean scores for each supervisory leadership component

Table 4.5 presents Cronbach’s alpha values for the leadership components. All the leadership components achieved an acceptable internal consistency except for the component of ‘setting high performance expectations’. Based on the low internal consistency reliability of this component sub-scale (alpha=0.60), ‘high performance expectations’ was removed from further analysis.

Table 4.5: Scale for internal consistency by leadership component

Leadership components	No. of items	Internal consistency (Cronbach’s alpha)
Communication practice	5	0.73
Setting high performance expectations	3	0.60
Fostering the acceptance of group goals	3	0.90
Providing an appropriate model	3	0.77
Intellectual stimulation	3	0.87
Contingent reward	3	0.89

Workgroup H&S climate

Workgroup H&S climate was measured using six items. Participants were asked to score the items based on their experience of working with their current workgroup. Items were scored using a five-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly disagree".

Table 4.6 shows the mean scores for each item. All the items were rated higher than 4.00. The overall mean score for workgroup H&S climate was 4.44. The Cronbach's alpha value for the scale of workgroup H&S climate was 0.87, indicating satisfactory internal consistency.

Table 4.6: Workers' perceptions of workgroup H&S climate

	Mean Value	**Std. Deviation**
People in this workgroup want to achieve high levels of safety	4.34	0.67
In this workgroup, workers discuss ways to prevent errors from happening again	4.34	0.80
Safe working is a condition of employment in this workgroup	4.39	0.72
I fully understand the health and safety risks associated with my work	4.56	0.58
In this workgroup, coworkers remind each other to take precautions	4.40	0.66
In this workgroup, I stop working if I think it would be dangerous for me to continue	4.60	0.52
Overall mean score	4.44	0.51

Self-reported H&S-related behaviour

Self-reported H&S-related behaviour was measured with six items reflecting two components of behaviour, i.e. H&S compliance and H&S participation. Participants were asked to rate the extent to which they engage in these behaviours using a five-point Likert scale (from "1 = strongly disagree" to "5 = strongly agree"). Table 4.7 shows that the mean score for each item was higher than 4.00, and the overall mean score for each behaviour component was also higher than 4.00.

The Cronbach's alpha values for components of H&S compliance and H&S participation were 0.85, indicating satisfactory internal consistency.

Table 4.7: Workers' self-reported H&S-related behaviour

	Mean Value	Std. Deviation
Safety compliance		
I use all the necessary safety equipment to do my job	4.43	0.68
I use the correct safety procedures for carrying out my job	4.46	0.60
I ensure the highest levels of safety when I carry out my job	4.50	0.71
Overall mean score	4.46	0.58
Safety participation		
I promote the safety program in the workplace	4.39	0.68
I put in extra effort to improve the safety of the workplace	4.43	0.66
I voluntarily carry out tasks or activities that help to improve workplace safety	4.38	0.58
Overall mean score	4.40	0.56

4.1.2 Comparison between workgroups

One-way analyses of variance (ANOVAs) were performed to determine whether there was a significant difference between workgroups in terms of:

- clients' commitment to H&S,
- principal contractors' commitment to H&S,
- each of the supervisory leadership components,
- workgroup H&S climate, and
- self-reported H&S-related behaviour.

One-way ANOVAs produce an *F ratio* and an associated probability level (*p* value), which are used to determine whether a difference is statistically significant or not. A *p* value which is equal to or less than 0.05 was deemed to be significant for the purposes of this analysis.

Clients' commitment to H&S

Figure 4.2 shows the mean scores for workers' perceptions of the clients' commitment to H&S by workgroup. The highest mean score was 5.00, and the lowest mean score was 2.75. Sixteen workgroups had a mean score higher of 4.00 or greater.

The one-way ANOVA indicated a significant difference in workers' perceptions of the clients' commitment to H&S between workgroups (F= 2.65, *p* = 0.003).

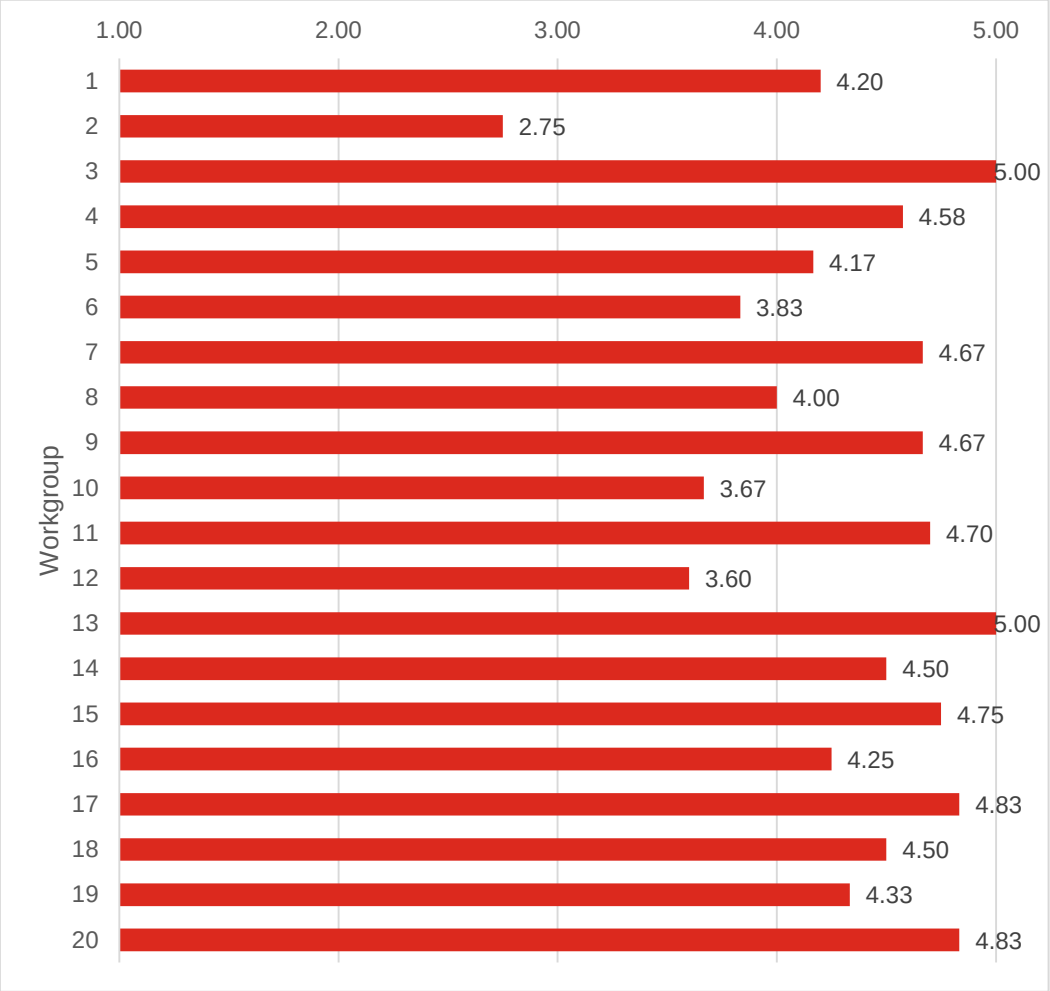


Figure 4.2: Clients' commitment to H&S by workgroup

Principal contractors' commitment to H&S

Figure 4.3 shows the mean scores for workers' perceptions of the principal contractors' commitment to H&S by workgroup. The highest mean score was 5.00, and the lowest mean score was 3.33. Sixteen workgroups had a mean score higher of 4.00 or greater.

The one-way ANOVA indicated a significant difference in workers' perceptions of the principal contractors' commitment to H&S between workgroups (F= 1.92, *p* = 0.034).

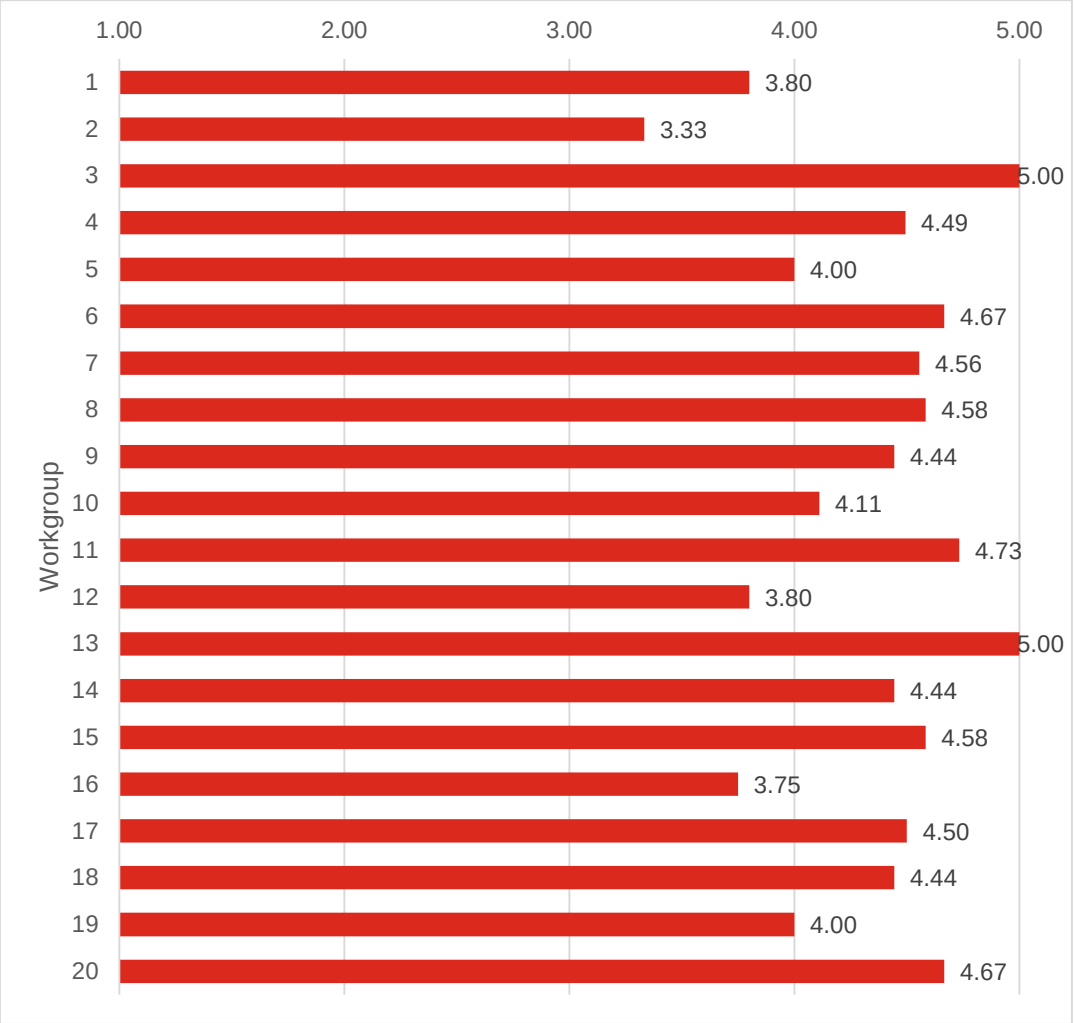


Figure 4.3: Principal contractors' commitment to H&S by workgroup

Supervisory leadership

Communication practice

Figure 4.4 shows the mean scores for the supervisory leadership component of communication practice by workgroup. Mean scores for communication practice ranged from 3.33 to 5.00. Sixteen groups had mean scores higher than 4.00.

The one-way ANOVA indicated a significant difference in workers' perceptions of their supervisors' communication practice between workgroups (F= 2.83, p = 0.001).

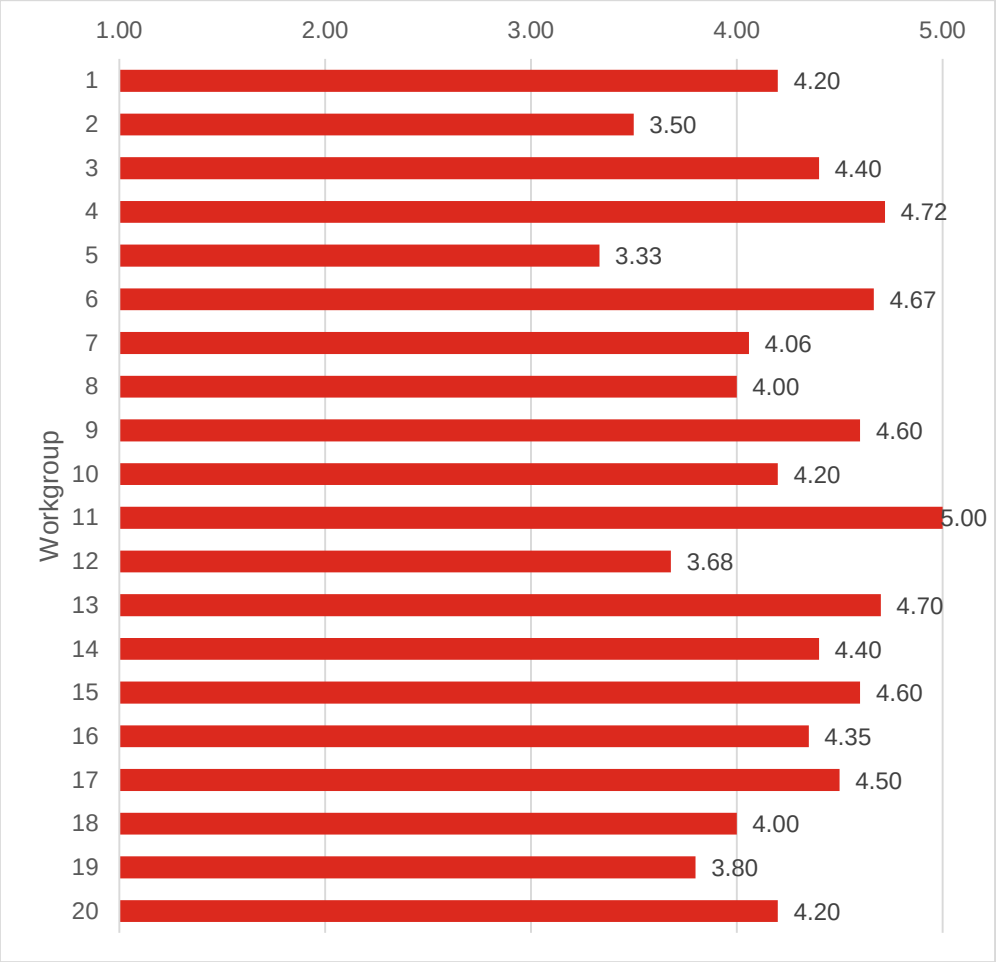


Figure 4.4: Supervisors' communication practice by workgroup

Fostering acceptance of group goals

Figure 4.5 shows the mean scores for the supervisory leadership component of fostering acceptance of group goals by workgroup. Workgroups three and eleven reported the highest mean score of 5.00, while workgroup five reported the lowest mean score of 3.44.

The one-way ANOVA indicated a significant difference in workers' perceptions of their supervisors' fostering of group goals between workgroups ($F = 1.89$, $p = 0.035$).

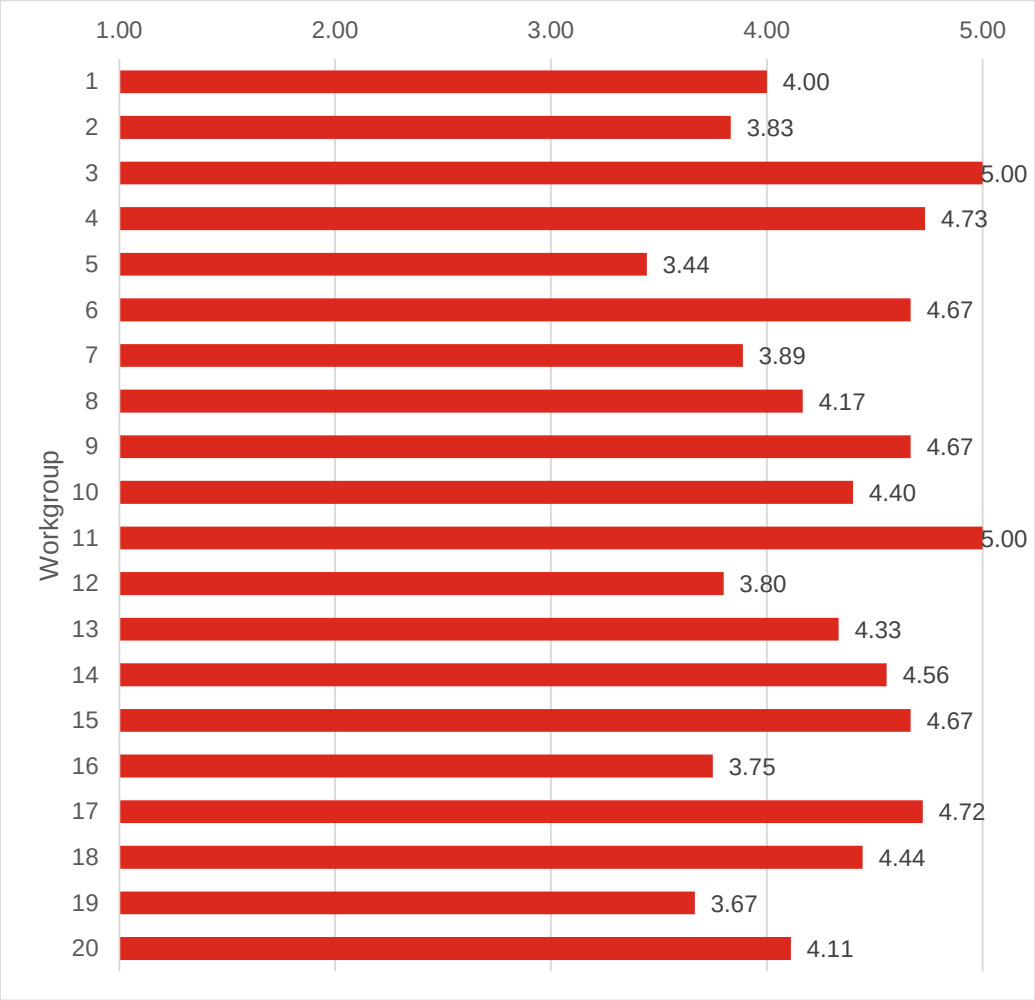


Figure 4.5: Supervisors' fostering acceptance of group goals by workgroup

Providing an appropriate model

Figure 4.6 shows the mean scores for the supervisory leadership component of providing an appropriate model by workgroup. Workgroup eleven reported the highest mean score of 5.00, while workgroups two and nineteen reported the lowest mean scores of 3.00.

The one-way ANOVA indicated a significant difference in workers' perceptions of their supervisors' provision of an appropriate model between workgroups ($F = 2.31$, $p = 0.009$).

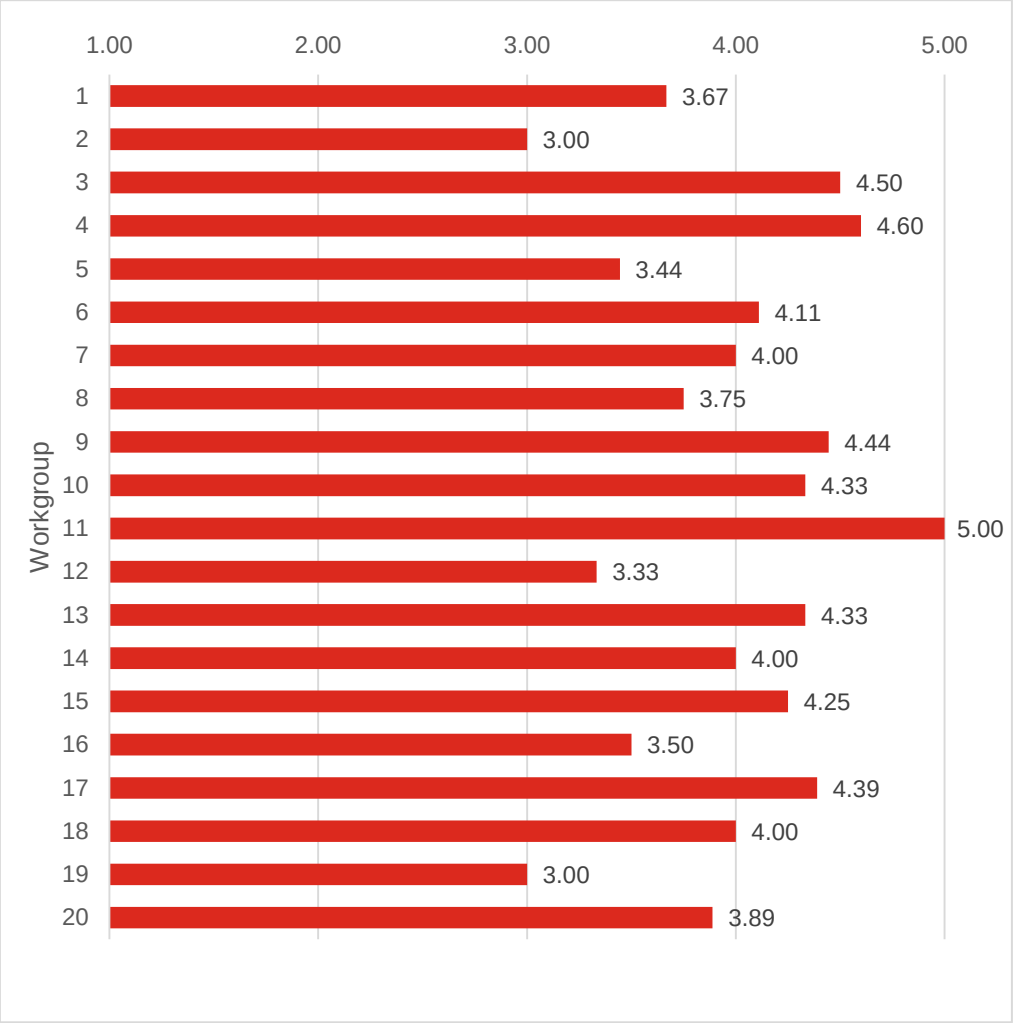


Figure 4.6: Supervisors' provision of an appropriate model

Intellectual stimulation

Figure 4.7 shows the mean scores for the supervisory leadership component of providing intellectual stimulation by workgroup. Workgroup eleven reported the highest mean score of 5.00, while workgroup fourteen reported the lowest mean score of 3.44.

The one-way ANOVA indicated a significant difference in workers' perceptions of their supervisors' provision of intellectual stimulation between workgroups ($F = 1.93$, $p = 0.031$).

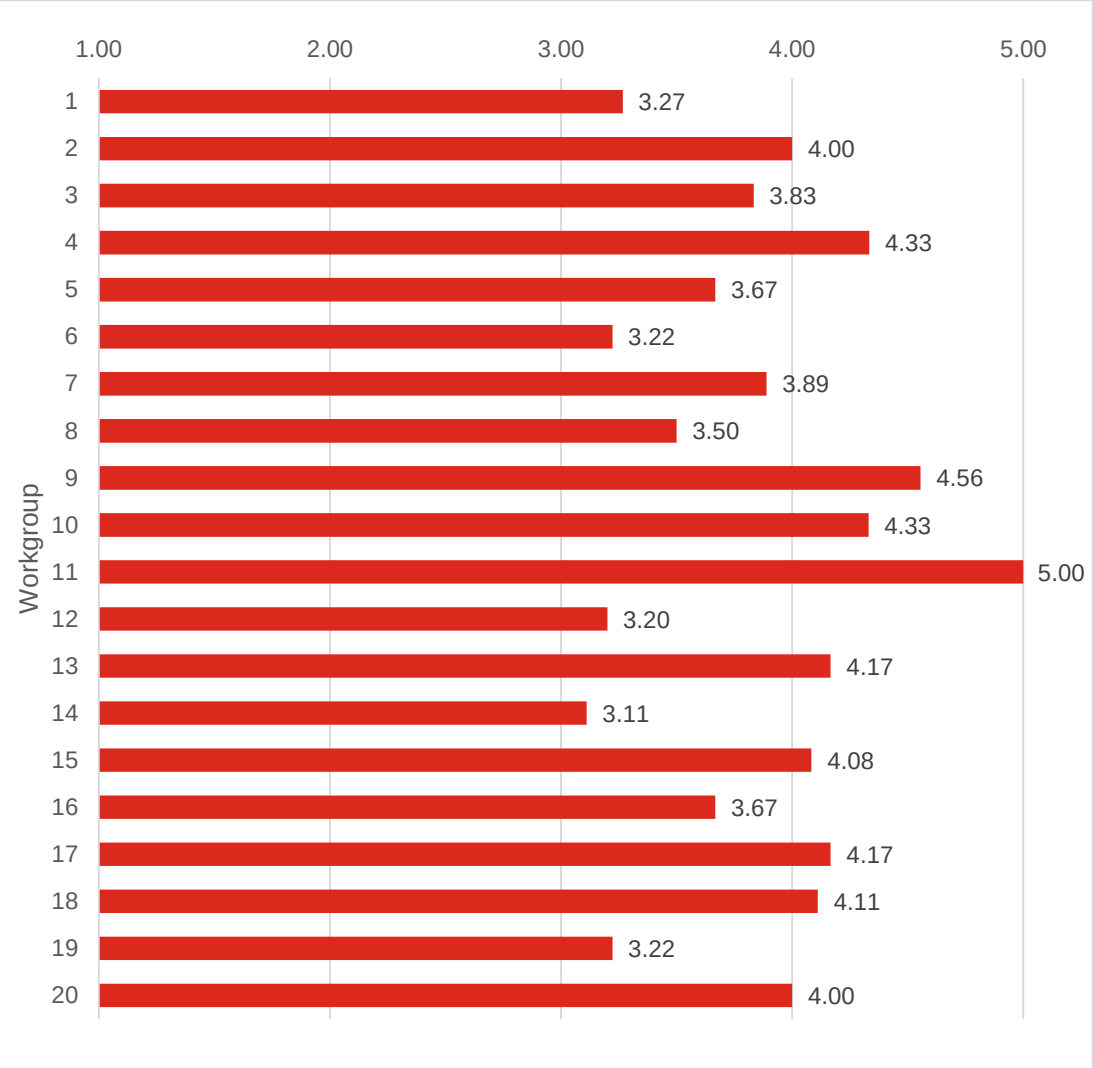


Figure 4.7: Supervisors' provision of intellectual stimulation by workgroup

Contingent reward

Figure 4.8 shows the mean scores for the supervisory leadership component of providing contingent reward by workgroup. Workgroup eleven reported the highest mean score of 4.87, while workgroup seven reported the lowest mean score of 1.67.

The one-way ANOVA indicated a significant difference in workers' perceptions of their supervisors' provision of contingent rewards between workgroups ($F = 3.20$, $p = 0.000$).

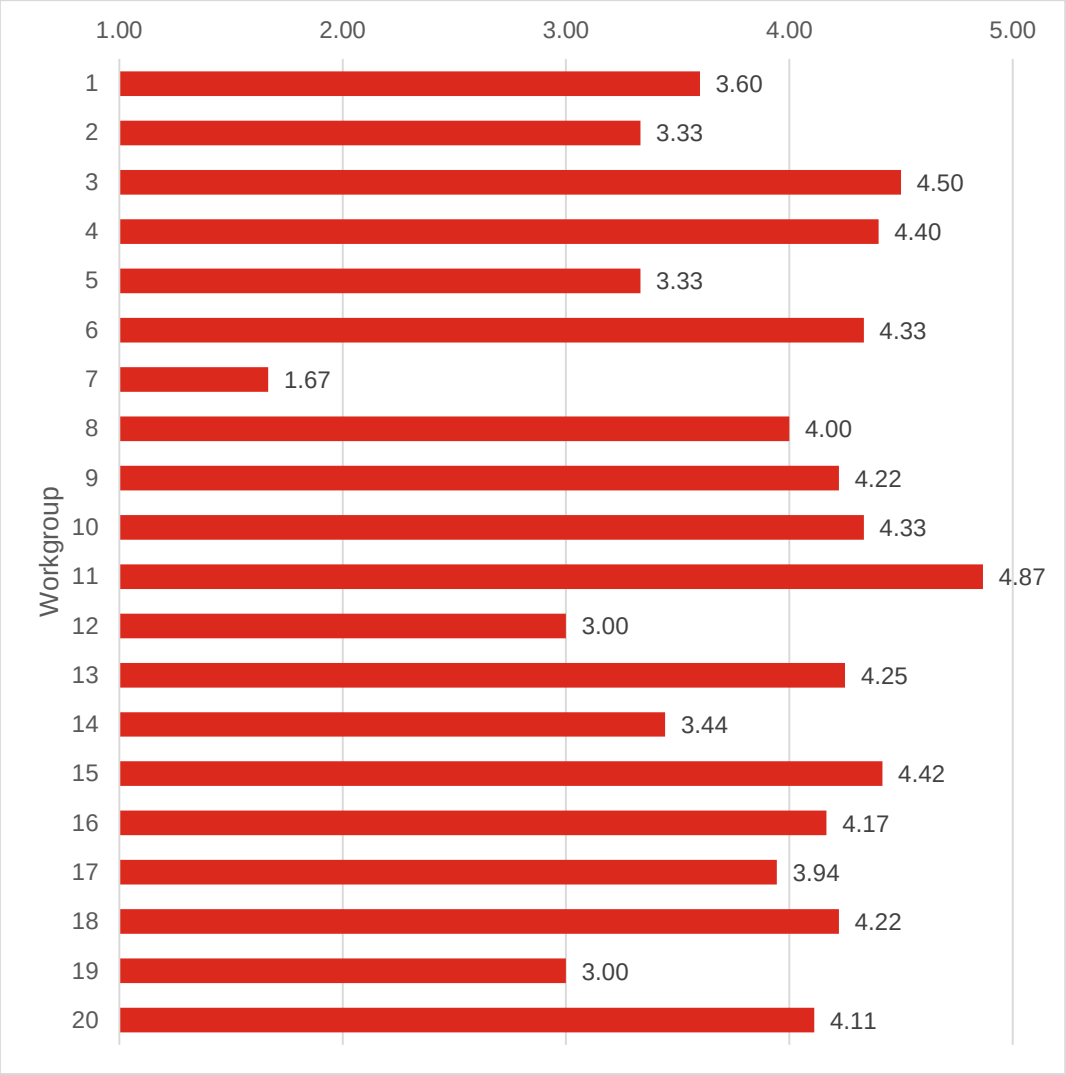


Figure 4.8: Supervisors' provision of contingent reward by workgroup

Workgroup H&S climate

Figure 4.9 presents mean scores for workgroup H&S climate by workgroup. The mean scores ranged from 3.56 to 5.00. With the exception of two groups (five and twelve), all groups scored 4.00 or above.

The one-way ANOVA indicated a significant difference in workers' perceptions of the H&S climate between workgroups ($F = 3.48$, $p = 0.000$).

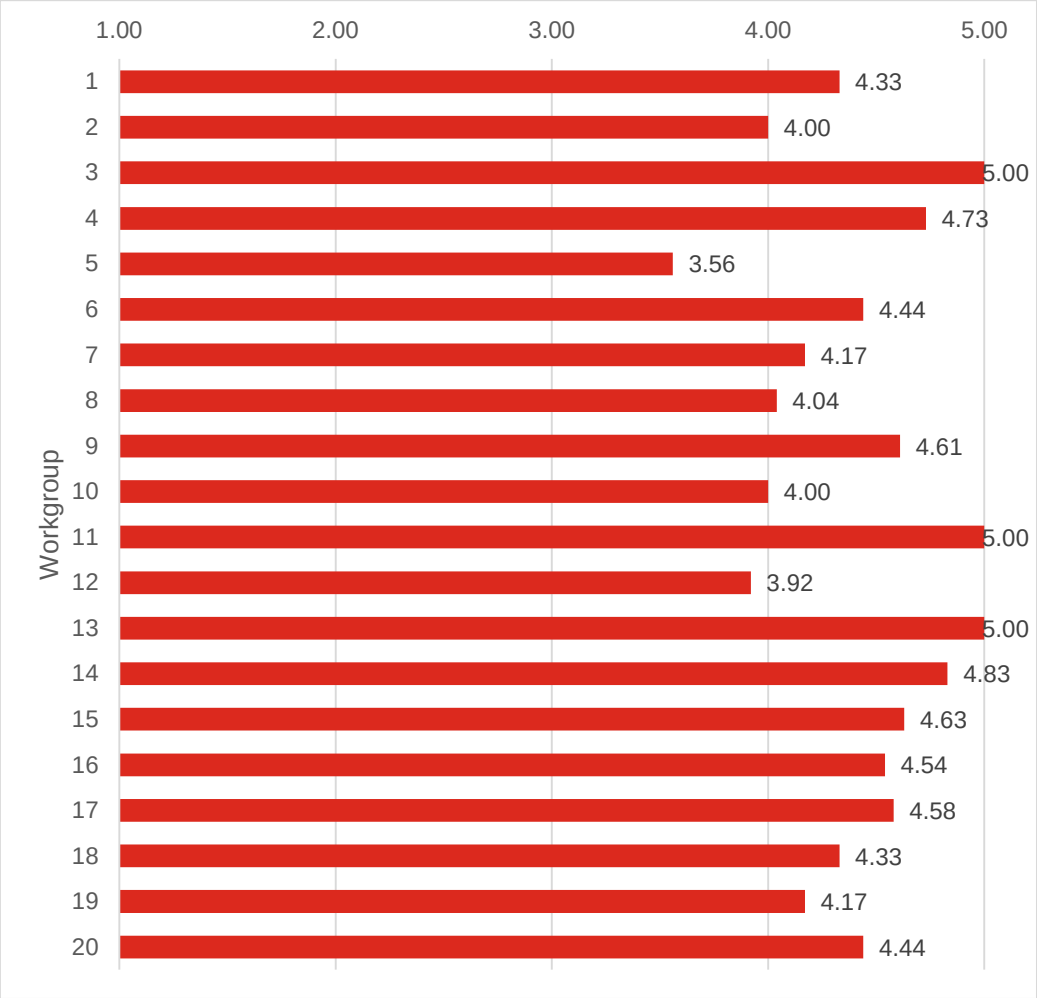


Figure 4.9: H&S climate by workgroup

Self-reported H&S-related behaviour

Figure 4.10 presents the mean scores for the two components of self-reported H&S-related behaviour, i.e. H&S compliance and H&S participation, by workgroup. The mean scores for H&S compliance ranged from 3.78 to 5.00, while the mean scores for H&S participation ranged from 3.56 to 5.00. Fourteen workgroups scored H&S compliance higher than or equal to H&S participation.

The one-way ANOVAs indicated no significant difference in self-reported H&S compliance between workgroups ($F = 3.475$, $p = 0.134$). However, a significant difference was found between workgroups for self-reported H&S participation ($F = 2.79$, $p = 0.002$).

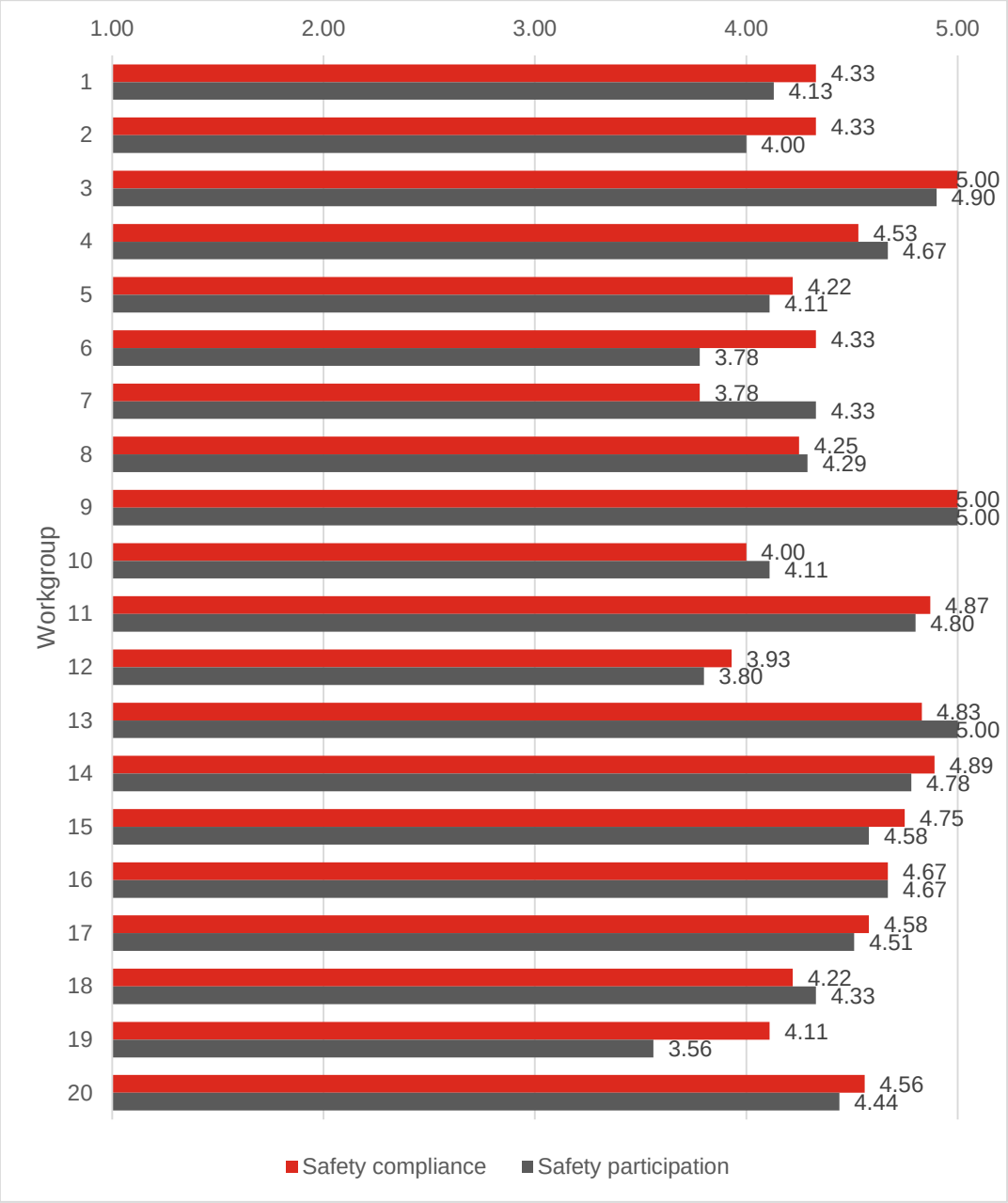


Figure 4.10: Self-reported H&S-related behaviour by workgroup

4.1.3 Bivariate correlations

Table 4.8 presents bivariate correlations between variables measured in the research.

Work experience related variables

The time that workers spent on the project was significantly and positively correlated to:

- the time spent working for the principal contractor, and
- the time spent with the current supervisor.

Meanwhile, the time spent working for the principal contractor was significantly and positively correlated to the time spent working with the current supervisor.

Clients' commitment to H&S

The clients' commitment to H&S was significantly and positively correlated to:

- principal contractors' safety commitment,
- each dimension of supervisory leadership,
- the workgroup H&S climate, and
- self-reported H&S compliance and H&S participation.

Principal contractors' commitment to H&S

The principal contractors' commitment to H&S was significantly and positively correlated to:

- each dimension of supervisory leadership,
- the workgroup H&S climate, and
- self-reported H&S compliance and H&S participation.

Components of supervisory leadership

All the components of supervisory leadership were significantly and positively correlated to each other. In addition, each component of supervisory leadership was significantly and positively correlated to:

- the workgroup H&S climate, and
- self-reported H&S compliance and H&S participation.

The workgroup H&S climate

The workgroup H&S climate was significantly and positively correlated to each component of self-reported H&S-related behaviour, i.e. H&S compliance and H&S participation.

Self-reported H&S-related behaviour

Self-reported H&S compliance was significantly and positively correlated to self-reported H&S participation.

Table 4.8: Bivariate correlation between variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Time spent working on the project	1													
2. Direct employee of the principal contractor?	-.059	1												
3. Time spent working for the principal contractor	.626**	-.094	1											
4. Time spent working with the current supervisor	.490**	-.028	.557**	1										
5. Client's safety commitment	.150	.157	.148	.063	1									
6. Principal contractor's safety commitment	.023	.128	-.040	-.060	.706**	1								
7. Communication practice	.119	-.011	.131	-.032	.533**	.498**	1							
8. Fostering the acceptance of group goals	.013	.055	-.004	-.017	.409**	.607**	.680**	1						
9. Providing an appropriate model	.068	.104	.015	.109	.471**	.580**	.586**	.771**	1					
10. Intellectual stimulation	-.085	.116	-.013	.099	.412**	.436**	.446**	.638**	.758**	1				
11. Contingent reward	.133	-.042	.196	.112	.346**	.460**	.602**	.630**	.613**	.516**	1			
12. Workgroup H&S climate	.009	-.019	.198	-.100	.537**	.492**	.650**	.502**	.521**	.369**	.432**	1		
13. Safety compliance	-.024	.007	.170	.008	.438**	.325**	.479**	.408**	.313**	.273*	.485**	.651**	1	
14. Safety participation	-.108	.117	.027	-.120	.502**	.478**	.455**	.392**	.551**	.490**	.448**	.712**	.678**	1

N = 73

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.1.4 Levels of H&S influence

Statistical analysis was undertaken to examine the way in which the leadership context influences supervisors' leadership behaviour. Specifically, the analysis examined whether workers' perceptions of the principal contractors' commitment to H&S mediated the relationship between their perceptions of the clients' commitment to H&S and supervisory leadership behaviours (see Figure 4.11).

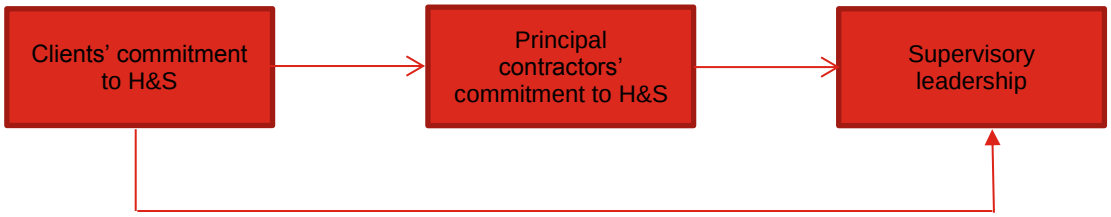


Figure 4.11: Principal contractors' commitment to H&S as a mediator between clients' commitment to H&S and supervisors' leadership

Table 4.9 shows the results of this mediation analysis. The results show that:

- perceptions of the clients' commitment to H&S predict perceptions of the principal contractors' commitment to H&S (Model 1),
- perceptions of the clients' commitment to H&S predict supervisory leadership (Model 2),
- perceptions of the principal contractors' commitment to H&S predict supervisory leadership (Model 3), and
- the effect of perceptions of the clients' commitment to H&S on supervisory leadership is no longer significant when the principal contractors' commitment to H&S is taken into consideration (indicated by a *p* value higher than 0.05) in Model 3.

Therefore, workers' perceptions of the principal contractors' commitment to H&S fully mediates the relationship between their perceptions of the client's commitment to H&S and their supervisors' leadership behaviour.

Table 4.9: Principal contractors' commitment to H&S as a mediator between clients' commitment to H&S and supervisors' leadership

Model	Variable	B	SE	β	*p*
Model 1: Principal contractors' commitment to H&S regressed on clients' commitment to H&S	Constant	1.54	.34		.000
	Clients' commitment to H&S	.64	.08	.71	.000
Model 2: Supervisory leadership regressed on clients' commitment to H&S	Constant	2.09	.39		.000
	Clients' commitment to H&S	.46	.090	.52	.000
Model 3: Supervisory leadership regressed on clients' commitment to H&S and principal contractors' commitment to H&S	Constant	1.36	.41		.002
	Clients' commitment to H&S	.16	.12	.18	.175
	Principal contractors' commitment to H&S	.47	.13	.49	.000

4.1.5 H&S climate as a linking mechanism between leadership and behaviour

Next, we examined whether perceptions of the workgroup H&S climate mediate the relationship between supervisory leadership behaviour and workers' self-reported H&S-related behaviours. This relationship is shown in Figure 4.12.

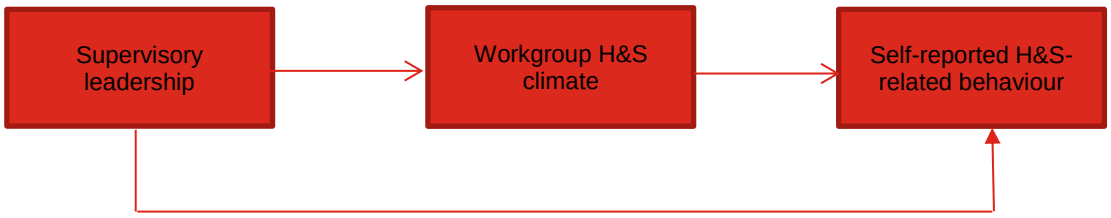


Figure 4.12: Workgroup H&S climate as a mediator between supervisory leadership and self-reported H&S-related behaviour

Table 4.10 shows the results of this mediation analysis. The results show that:

- perceptions of supervisory leadership predict perceptions of the workgroup H&S climate (Model 1),
- perceptions of supervisory leadership predict self-reported H&S-related behaviour (Model 2),
- perceptions of the workgroup H&S climate predict self-reported H&S-related behaviour (Model 3), and
- the effect of supervisory leadership on self-reported H&S-related behaviour is no longer significant when the workgroup H&S climate is taken into consideration (indicated by a *p* value higher than 0.05) in Model 3.

Therefore, workgroup H&S climate fully mediates the relationship between supervisory leadership and self-reported H&S-related behaviour. Thus, the analysis suggests that workgroup H&S climate is a linking mechanism between supervisors' leadership behaviour and workers' self-reported H&S-related behaviour.

Table 4.10: Workgroup H&S climate as a mediator in the relationship between supervisory leadership and self-reported H&S-related behaviour

Model	Variable	B	SE	β	*p*
Model 1: Workgroup H&S climate regressed on supervisory leadership	Constant	2.41	.32		.000
	Supervisory leadership	.49	.08	.60	.000
Model 2: Self-reported H&S-related behaviour regressed on supervisory leadership	Constant	2.48	.34		.000
	Supervisory leadership	.48	.08	.57	.000
Model 3: Self-reported H&S-related behaviour regressed on supervisory leadership and workgroup H&S climate	Constant	.92	.36		.013
	Supervisory leadership	.16	.08	.19	.056
	Workgroup H&S climate	.64	.10	.63	.000

4.1.6 Leadership components that predict workgroup H&S climate

Next we undertook an analysis to identify which specific components of supervisor' leadership predict perceptions of the workgroup H&S climate.

A stepwise hierarchical multiple regression analysis was performed to identify which supervisor leadership components predict workers' perceptions of their workgroup H&S climate. Stepwise regression selects, from a group of predictors, the single variable at each regression step that accounts for the largest variance in the dependent (or outcome) variable (in this case, workgroup H&S climate).

Table 4.11 indicates that supervisors' communication practice contributed significantly to the regression model (F = 52.05, $p < 0.001$) and accounted for 42.3% of the variance in workgroup H&S climate. Thus, supervisors' communication practice is a significant predictor of a workgroup's H&S climate (β = 0.65, $p < 0.001$).

Table 4.11: Leadership predictors of workgroup H&S climate

Model	Predictors	R square change	F change	Sig. F change	B	SE	β	Sig.
Model 1	Constant	.423	52.05	.000	2.04	.34		.000
	Communication practice				.56	.08	.65	.000

4.1.7 Leadership components that predict H&S compliance

A stepwise hierarchical multiple regression analysis was also performed to identify which supervisor leadership components predict workers' self-reported H&S compliance behaviour.

Table 4.12 indicates that the supervisors' provision of contingent reward contributed significantly to the regression model (F = 21.89, $p < 0.001$) and accounted for 23.6% of the variance in self-reported H&S compliance behaviour. Thus, the provision of contingent reward is a significant predictor of self-reported H&S-related compliance (β = 0.49, $p < 0.001$).

The inclusion of communication practice explained an additional 5.5% of the variance in self-reported H&S compliance, and this change was also significant (F = 14.32, $p < 0.001$). Thus, the supervisory leadership practices of contingent reward (β = 0.31, $p < 0.05$) and communication practice (β = 0.29, $p < 0.05$) significantly predict workers' self-reported H&S compliance behaviour.

Table 4.12: Leadership predictors of self-reported H&S compliance

Model	Predictors	R square change	F change	Sig. F change	B	SE	β	Sig.
Model 1	Constant	.24	21.89	.000	3.30	.26		.000
	Contingent reward				.30	.06	.49	.000
Model 2	Constant	.06	5.40	.000	2.49	.43		.000
	Contingent reward				.19	.08	.31	.017
	Communication practice				.29	.12	.29	.023

4.1.8 Leadership components that predict H&S participation

A stepwise hierarchical multiple regression analysis was also performed to identify which supervisor leadership components predict workers' self-reported H&S participation behaviour.

Table 4.13 indicates that the supervisors' provision of an appropriate model contributed significantly to the regression model ($F = 30.92$, $p < 0.001$) and accounted for 30.3% of the variance in self-reported H&S participation behaviour. Thus, the supervisory leadership behaviour of providing an appropriate model is a significant predictor of workers' self-reported H&S-related participation ($\beta = 0.55$, $p < 0.001$).

Table 4.13: Leadership predictors of self-reported H&S participation

Model	Predictors	R square change	F change	Sig. F change	B	SE	β	Sig.
Model 1	Constant	.303	30.917	.000	2.802	.293		.000
	Providing an appropriate model				.398	.072	.551	.000

4.1.9 Workgroup communication characteristics

The characteristics of H&S-related communication within each workgroup were assessed using social network analysis (SNA). SNA uses a range of metrics to understand the frequency and nature of information and communication exchanges within groups. A comprehensive list of what each of these metrics mean is provided in Part 8, the Appendix to this report. Table 4.14 provides the scores for each communication network indicator for each workgroup.

Table 4.14: Communication network measures by workgroup

Group	No. of group members	Network density	Network in-centralisation	Network out-centralisation	Supervisors' in-degree centrality	Supervisors' out-degree centrality
1	13	0.24	0.10	0.10	0.72	0.72
2	4	0.67	0.07	0.07	0.93	0.93
3	5	0.58	0.37	0.37	0.60	0.60
4	8	0.52	0.05	0.05	0.54	0.57
5	17	0.13	0.11	0.08	0.25	0.49
6	4	0.82	0.13	0.13	0.80	0.87
7	8	0.44	0.10	0.11	0.63	0.80
8	6	0.66	0.04	0.07	0.80	0.80
9	4	0.88	0.01	0.01	0.93	0.87
10	4	0.43	0.01	0.07	0.58	0.75
11	7	0.65	0.03	0.03	0.80	0.80
12	6	0.67	0.02	0.04	0.72	0.84
13	7	0.84	0.13	0.13	0.93	0.93
14	7	0.61	0.04	0.05	0.77	0.83
15	6	0.75	0.02	0.03	0.72	0.88
16	5	0.70	0.04	0.05	0.70	0.60
17	7	0.65	0.06	0.06	0.96	0.79
18	6	0.85	0.03	0.03	0.80	0.72
19	5	0.85	0.03	0.03	0.95	0.95
20	5	0.76	0.05	0.01	0.80	0.80

A communication network was developed for each workgroup to represent the way in which H&S-related information is communicated within these workgroups.

These networks are represented in diagrams known as sociograms. Workgroup participants are nodes in each network. The thickness of the lines joining nodes represents the frequency of communication between people in the workgroup and the arrows represent the direction of this communication. Some communication flows in two directions, while other communication flows in a single direction.

All 20 workgroup communication networks and associated descriptions are provided in the Appendix in Part 8 of this report. However, some key points of difference between workgroups are described in greater detail below.

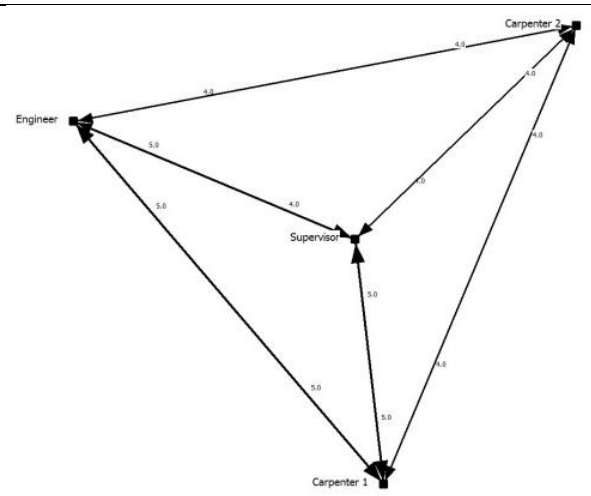
4.1.10 Network density

Network density (sometimes referred to as valued density) is a measure of the overall communication activity in the network. Density reflects the ratio of total tie values (communication frequency) present in a network to the maximum possible number of ties the network could have.

Thus, as proportionally stronger ties (which are more conductive of information exchange) are formed in a communication network, the density of the network increases.

High density indicates a high frequency of H&S-related information exchange between workgroup members.

Workgroup nine: High network density (0.88)



Workgroup nine's network is well-connected with direct and strong communication ties between all pairs of individuals.

The tie values indicate frequent exchange of information (predominantly more than once per

day) between all pairs of participants. Overall, the network indicates a high level of H&S-related communication activity between the participants.

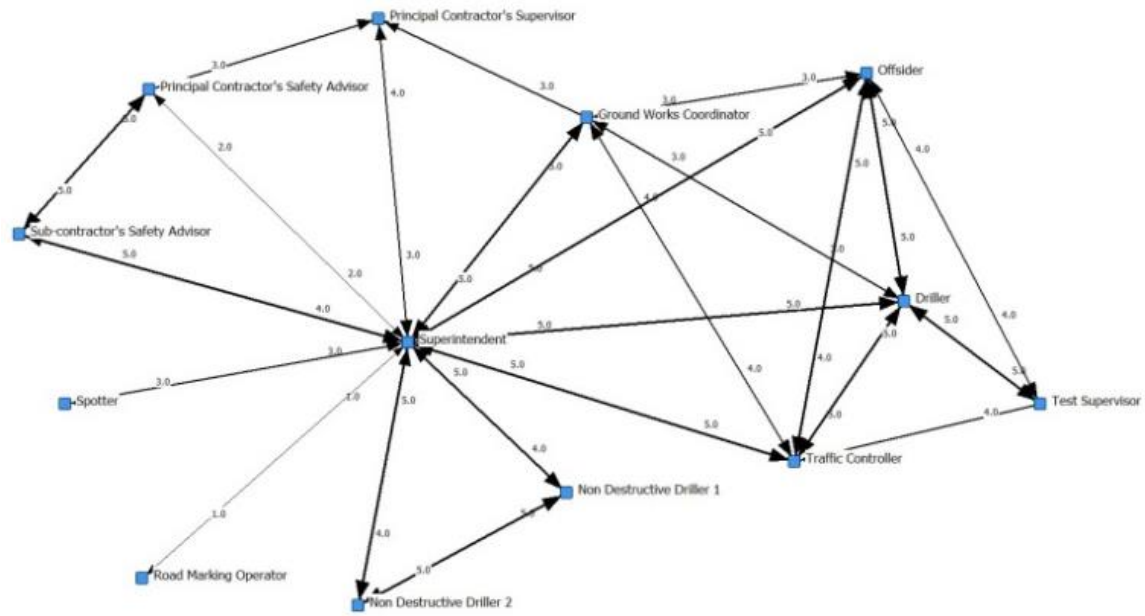
This workgroup is relatively small and stable enabling all the members to directly communicate with each other about H&S-related matters. Survey data also shows that, in workgroup nine:

- coworkers remind each other to take H&S precautions (67% strongly agree, 33% agree), and
- workers discuss ways to prevent errors from happening again (67% strongly agree, 33% agree).

Open communication about H&S was also highly encouraged by site managers at the worksite at which workgroup nine was working. During the pre-start meeting, the site H&S manager stated:

'…*we had WorkSafe in yesterday and they were pretty happy with the controls we have in place. Especially with the rain* [today] *it is important to check all the safety controls in place, and make sure you are happy with them. If you are not, then speak up, it's all right. Just consider the risks*.'

Workgroup one: Low network density (0.24)



Workgroup one's network pattern indicates that H&S information mainly flows through a few central participants (the superintendent, driller and traffic controller). Other participants in the network communicate indirectly in relation to H&S matters.

The network comprises a mix of strong and weak ties, but more than half of the network ties are

weak (between one and three) indicating a low frequency of H&S information exchange.

The survey data shows the site superintendent is perceived to encourage open communication about H&S (i.e. 80% strongly agree or agree).

This workgroup was observed to work in a highly dynamic environment with frequent changes in membership.

The principal contractor used a logbook to keep track of workers on-site:

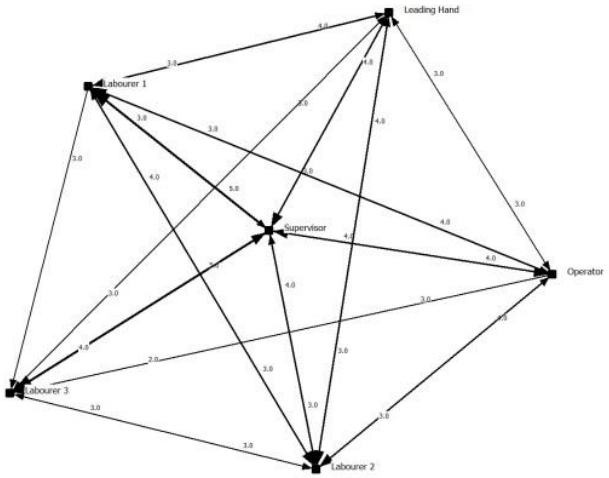
Principal contractor's supervisor: '*so I supervise the work and check everything is going smoothly, that is why I have this logbook. I log everything, so if someone claims they turned up at 6am, I can be like "no you didn't"* [pointing to his logbook]'.

The workgroup members relied on a relatively small number of 'stable' members to communicate H&S-related information.

4.1.11 Supervisors' centrality

The centrality of a person in a communication network reflects the extent to which they are connected to other participants. If a participant's centrality is high, then they are highly involved in communication with other members of the network. Degree centrality can be calculated in two ways. The in-degree centrality measure takes into account the frequency of H&S information received by the supervisor from other workgroup members. Out-degree centrality takes into account the frequency of H&S information given out by the supervisor to other workgroup members.

Workgroup twelve: High supervisor centrality (in degree centrality=0.72, out-degree centrality=0.84)



In workgroup twelve, the supervisor has a central position. He has direct H&S-related communication ties with all other participants. He frequently participates in both sending and receiving H&S-related information, as indicated by the strong ties (tie values equal to or greater than four) connecting him with other participants. Overall, the supervisor is the most central (and therefore influential) group member in terms of H&S-related communication.

The survey data also shows that, in workgroup twelve:

- workers 'feel that their supervisor encourages open communication about safety' (100% agree or strongly agree), and
- workers 'feel comfortable discussing safety issues with the supervisor' (80% strongly agree or agree, 20% neither agree nor disagree).

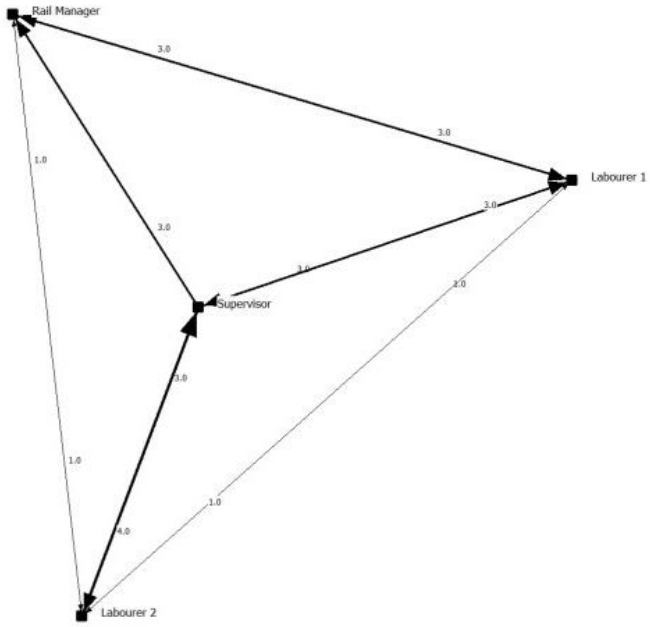
The supervisor described the two-way communication between himself and the workers in group twelve:

'*Safety communication depends of what task we are doing. For example, at the moment we are removing light poles – so I will be talking about things like risk of falls, where the services are and plant movements. The guys give me feedback as well. Remind me about procedures, like if we need an extra spotter for a task.'*

Group members also commented on the frequency of H&S-related communication in their workgroup:

'All day every day you are talking about safety. Every operation, every task, everything, you will say information that is about safety and you might not even realise it.'

Workgroup ten: Low supervisor centrality (in-degree centrality=0.58, out-degree centrality=0.75)



Despite having a relatively central position in the network in comparison to the other participants, in workgroup ten, the supervisor maintains a low frequency of H&S-related communication (tie values of three, indicating communication once per week) with other group members.

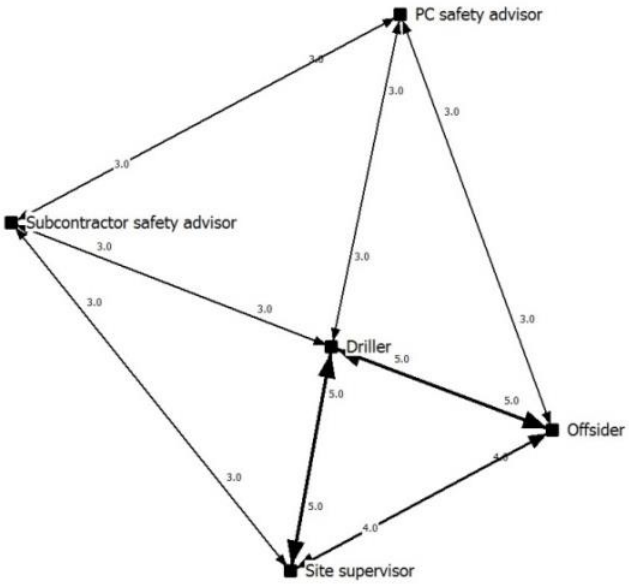
The data was collected just after a safety incident had occurred. The supervisor explained: '*Morale was low after last week's incident, their heads were down like on a cold wet winter morning in Scotland. Everything drops then, productivity, and the whole site performance. And how do you bring it back up? That is so hard to do.'*

4.1.12 Network centralisation

Network centralisation reflects the extent to which 'connectedness' is organised around particular participants in a network. If a network has a highly centralised structure, all communication occurs through a small number of central participants.

Two measures of centralisation can be calculated: network in-centralisation and network out-centralisation. In-centralisation takes into account communication *received* by participants. Thus, a high in-centralisation indicates that there are a few 'popular' members in the workgroup who receive H&S information from many others. Out-centralisation only reflects communication *sent* by participants. Thus, a high out-centralisation indicates that there are a few 'active' members in the workgroup who send H&S information to many others while the majority of the members send little information.

Workgroup three: High network centralisation (in-centralisation=0.37, out-centralisation=0.37)



In workgroup three, the driller is the most central participant in the network with the highest number of direct links to other participants (he is the only participant with four ties).

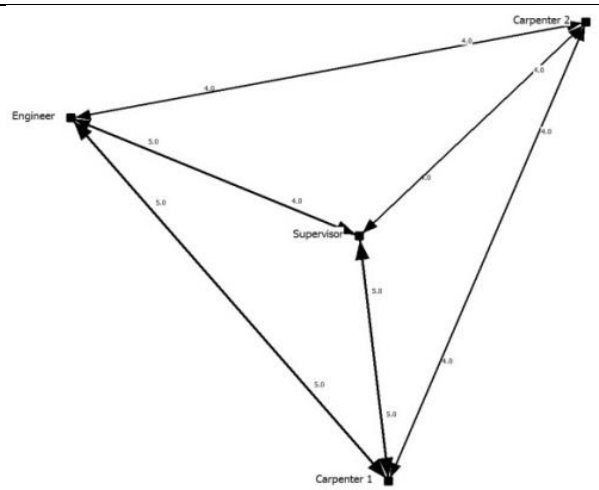
Two distinct groups of participants are identifiable in the network. The first group includes the driller, offsider and site supervisor. These participants engage in a high level of H&S-related communication indicated by strong ties between them. The second group consists of the principal contractor's safety advisor and subcontractor's safety advisor who are linked to the rest of the network with relatively weak ties and participate in H&S-related communication with other members less frequently (on average, once a week).

The network indicates a centralised structure with high reliance on the driller as the central point of H&S-related communication.

The driller was highly experienced and respected and took on a coordination role in relation to H&S.

Referring to the communication between the driller, offsider and site supervisor, the site supervisor explained: '*having open communication means that any safety concerns can be raised. We discuss our families, what we do at the weekend and have a bond, which helps being able to communicate openly about safety*.'

Workgroup nine: Low network centralisation (in-centralisation=0.01, out-centralisation=0.01)

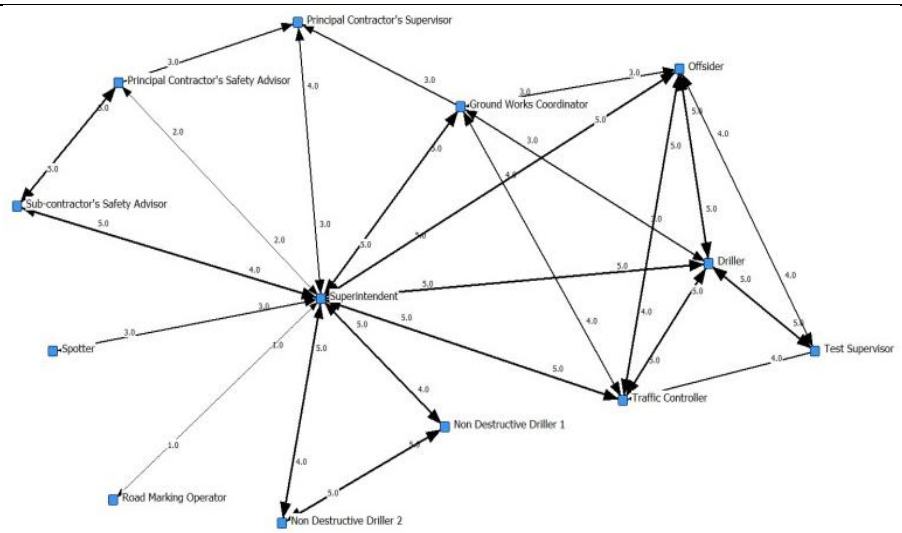


In workgroup nine, there was an evenly spread volume of incoming and outgoing H&S communication among all the participants. This is indicated by the equal number of communication ties (three ties) between participants, and by a similar amount of communication activity (equal tie values) between lines of communication. Overall, the network has a flat and non-centralised structure with a reliance on two-way H&S communication between all participants.

Site managers at the worksite at which workgroup nine was working encouraged open communication during pre-start meetings. The site supervisor explained that all the workgroup members communicated frequently about different aspects of the job, including H&S:

'*We talk safety all the time. We are construction workers, we talk about everything, from construction, to football to* [what we did] *at the weekend.*'

Workgroup one: High network centralisation (in-centralisation=0.10, out-centralisation=0.10)



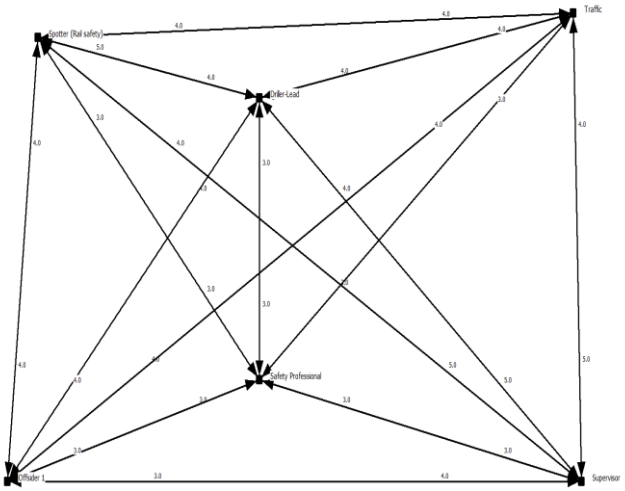
In workgroup one, the superintendent occupies a central position. He maintains the highest number of communication ties compared to other participants. He connects different parts of the network which are otherwise separated from each other (i.e. the superintendent is the only point connection point linking the spotter, road marking operator, and the NDD crew to the rest of the workgroup). Consequently, H&S information mainly flows through him to reach others in the workgroup.

This construction site was very dynamic in terms of changing workgroup configurations and mobile plant and equipment.

The site superintendent was identified as a key point of contact by the H&S advisor during the site induction: '*the site superintendent is responsible for looking after the site, as well as doing all the paperwork and documentation. If you have any questions, or something you aren't sure about, it is best to talk to him*.'

The field-based observation confirmed that the superintendent played a crucial role in coordination and communication with different work crew members who moved in and out of the construction site in short time periods. It was observed that: '*Everything throughout the day appeared to go through* [the superintendent], *from the toolbox talk in the morning, to safely securing the site at night. The site changed shape and form in many ways throughout the day: employees of the client, principal contractor, and various subcontractors would come and go; the site layout area would change shape; the use of different tools, equipment and plant; controlling inquisitive members of the public. And all of this*, [the superintendent] *had to coordinate.'*

Workgroup fifteen: Low network centralisation (in-centralisation=0.02, out-centralisation=0.03)



In workgroup fifteen, there was equal participation in H&S-related communication among all the participants. This is reflected by the equal number of ties and similar tie values between participants.

Workgroup nine worked in a geographically small area which meant there was an opportunity for all the workgroup members to directly communicate about H&S-related matters with one another. The site supervisor explained:

'*Communication is so important. And at all levels. I communicate safety to everyone in* [the] *group, but they also need to communicate between themselves. Like the drillers telling the traffic guy what's going on, so nobody is guessing. We all need to take a lead with communication throughout the day.*'

4.1.13 Communication characteristics, leadership and H&S performance

In order to assess whether the communication characteristics of a workgroup varied according to the supervisory leadership components, workgroup H&S climate, and/or self-reported H&S-related behaviour, the 20 workgroups were divided into two groups based upon each of the communication network characteristics.

The mean value and associated standard deviation (S.D.) for each communication network measure (e.g. density, supervisors' centrality and network centralisation) were calculated across the 20 workgroups. Given the relatively small number of groups, a half standard deviation above the mean and a half standard deviation below the mean were used as the cut-off values to decide whether a group should fall in one group or the other. Thus:

- the above average cut-off value was the mean value + standard deviation (S.D.)*0.5
- the below average cut-off value was the mean value - standard deviation (S.D.)*0.5

Network density

Table 4.15 presents leadership, H&S climate scores and self-reported H&S behaviour for groups classed as having above and below average levels of network density in relation to the communication of H&S information. Five workgroups fell into the below average and seven workgroups fell into the above average categories for network density.

Groups with above average network density reported higher levels of the following supervisory leadership practices, as well as H&S climate and self-reported H&S-related behaviour:

- communication practice,
- fostering the acceptance of group goals,
- contingent reward,
- workgroup H&S climate,
- safety compliance, and
- safety participation.[1]

Thus, those workgroups in which there was more frequent communication of H&S-related information and a higher number of direct communication ties between members, also had stronger supervisory leadership as well as better performance in terms of H&S climate and self-reported H&S behaviour.

Table 4.15: Leadership, H&S climate and behaviour by communication network density

Mean score	Above average density	Below average density
Communication practice	4.10	4.37
Fostering the acceptance of group goals	4.10	4.37
Providing an appropriate model	4.01	4.00
Intellectual stimulation	3.90	3.91
Contingent reward	3.47	4.08
Workgroup H&S climate	4.16	4.52
Self-reported H&S compliance	4.17	4.54
Self-reported H&S participation	4.27	4.39
Mean score of valued density = 0.635; S.D. = 0.203 High cut-off value = 0.534; Low cut-off value = 0.737		

[1] These differences are indicative but not statistically significant. It is likely that statistical significance was impacted by the small number of workgroups in the sample and analysis.

Network in- and out-centralisation

Table 4.16 and Table 4.17 present leadership, H&S climate scores and self-reported H&S behaviour for groups classed as having above and below average levels of network in- and out-degree centralisation in relation to the communication of H&S information.

Six workgroups fell into the below average and three workgroups fell into the above average categories for network in-degree centralisation. Table 4.16 shows that the above average in-degree centralisation groups had higher mean scores than the below average groups for all the variables except for the supervisory leadership component of providing intellectual stimulation.[2]

Table 4.16: Leadership, H&S climate and behaviour by communication network in-centralisation

Mean score	Below average network in-centralisation	Above average network in-centralisation
Communication practice	4.15	4.59
Fostering the acceptance of group goals	4.28	4.67
Providing an appropriate model	3.89	4.31
Intellectual stimulation	3.92	3.74
Contingent reward	3.87	4.36
Workgroup H&S climate	4.28	4.81
Self-reported H&S compliance	4.34	4.72
Self-reported H&S participation	4.23	4.56
Mean score of network in-centralisation = 0.072; S.D. = 0.079 High cut-off value = 0.033; Low cut-off value = 0.112		

Six workgroups fell into the below average and three workgroups fell into the above average categories for network out-degree centralisation. Table 4.17 shows that the above average out-degree centralisation groups had higher mean scores than the below average groups for all the variables except for the supervisory leadership component of providing intellectual stimulation.[3]

[2] These differences are indicative but not statistically significant. It is likely that statistical significance was impacted by the small number of workgroups in the sample and analysis.

[3] These differences are indicative but not statistically significant. It is likely that statistical significance was impacted by the small number of workgroups in the sample and analysis.

High network centralisation (in and out) means a few central group members (including the supervisor) are dominant in communication activities. A centralised communication structure means that H&S-related information is mostly exchanged through those central members. The results also suggest that supervisors who show strong leadership are likely to act as central members in sending H&S messages to group members.

Table 4.17: Leadership, H&S climate and behaviour by communication network out-centralisation

Mean score	Below average network out-centralisation	Above average network out-centralisation
Communication practice	4.37	4.59
Fostering the acceptance of group goals	4.43	4.67
Providing an appropriate model	4.10	4.31
Intellectual stimulation	4.16	3.74
Contingent reward	4.14	4.36
Workgroup H&S climate	4.53	4.81
Self-reported H&S compliance	4.59	4.72
Self-reported H&S participation	4.45	4.56
Mean score of network in-centralisation = 0.076; S.D. = 0.077 Low cut-off value = 0.038; High cut-off value = 0.115		

Supervisors' in and out-degree centrality

Table 4.18 and Table 4.19 present leadership, H&S climate scores and self-reported H&S behaviour for groups classed as having above and below average levels of supervisors' in- and out-degree centrality in relation to the communication of H&S information.

Five workgroups fell into the below average and five workgroups fell into the above average categories for supervisors' in-degree centrality. Table 4.18 shows that the above average supervisors' in-degree centrality groups had higher mean scores than the below average groups for:

- communication practice,
- intellectual stimulation,
- contingent reward,

- workgroup H&S climate, and
- self-reported H&S compliance.[4]

Table 4.18: Leadership, H&S climate and behaviour by supervisors' in-degree centrality

Mean score	Below average supervisors' in-degree centrality	Above average supervisors' in-degree centrality
Communication practice	4.14	4.22
Fostering the acceptance of group goals	4.29	4.25
Providing an appropriate model	4.17	3.83
Intellectual stimulation	4.01	4.02
Contingent reward	3.65	3.75
Workgroup H&S climate	4.29	4.47
Self-reported H&S compliance	4.30	4.57
Self-reported H&S participation	4.43	4.41
Mean score of network in-centralisation = 0.747; S.D. = 0.172 Low cut-off value = 0.661; High cut-off value = 0.833		

Table 4.19 shows that the above average supervisors' out-degree centrality groups had higher mean scores than the below average groups for:

- communication practice,
- fostering the acceptance of goals,
- intellectual stimulation,
- workgroup H&S climate, and
- self-reported H&S compliance.

High supervisors' in-degree centrality means workgroup members communicate frequently with their supervisors on H&S-related matters. Groups with above average supervisor in-degree centrality reported higher levels of intellectual stimulation, perhaps suggesting that in these groups, supervisors encourage workers to think creatively and express their H&S concerns and ideas. Groups with above average supervisor in-degree centrality also indicated higher levels of contingent reward, perhaps indicating that workers' involvement in H&S communication is encouraged and recognised in these groups.

[4] These differences are indicative but not statistically significant. It is likely that statistical significance was impacted by the small number of workgroups in the sample and analysis.

High supervisors' out-degree centrality means the supervisor is influential in the communication network, actively providing H&S-related information to a large number of group members. Groups with above average supervisor out-degree centrality reported higher levels of fostering acceptance of group goals, perhaps suggesting that, in these groups, supervisors use their interactions with workers to communicate H&S expectations and engender a commitment to a shared set of H&S goals for the group.

Supervisors' communication practice, H&S climate and self-reported H&S compliance were also higher in groups where supervisors play a central role in both giving and receving H&S-related information.

Table 4.19: Leadership, H&S climate and behaviour by supervisors' out-degree centrality

Mean score	Below average supervisors' out-degree centrality	Above average supervisors' out-degree centrality
Communication practice	4.20	4.31
Fostering the acceptance of group goals	4.18	4.31
Providing an appropriate model	3.94	3.86
Intellectual stimulation	3.76	3.88
Contingent reward	4.00	3.93
Workgroup H&S climate	4.43	4.48
Self-reported H&S compliance	4.55	4.56
Self-reported H&S participation	4.50	4.32
Mean score of supervisor's norm-out centrality = 0.777; S.D. = 0.128 Low cut-off value = 0.713; High cut-off value = 0.841		

4.1.14 Group communication as moderator of the climate-behaviour relationship

Previous regression analysis (see section 4.1.4) identified that the H&S climate mediates the relationship between supervisory leadership and self-reported H&S-related behaviour.

We also examined whether workgroup H&S-related communication characteristics (network density, centralisation and supervisors' centrality) moderated the relationship between the group climate and self-reported H&S behaviour.

This moderating relationship is depicted in Figure 4.13. A moderator is a variable that specifies conditions under which two other variables are related, e.g. it might change the direction or magnitude of the relationship.

Hierarchical multiple regression is used to test for the operation of a moderator. In order to confirm the effects of a moderator, the interaction effect of the independent variable (e.g. supervisory leadership) and the moderator is taken into account to assess whether such an effect is significant in predicting the dependent variable (e.g. workgroup H&S climate).

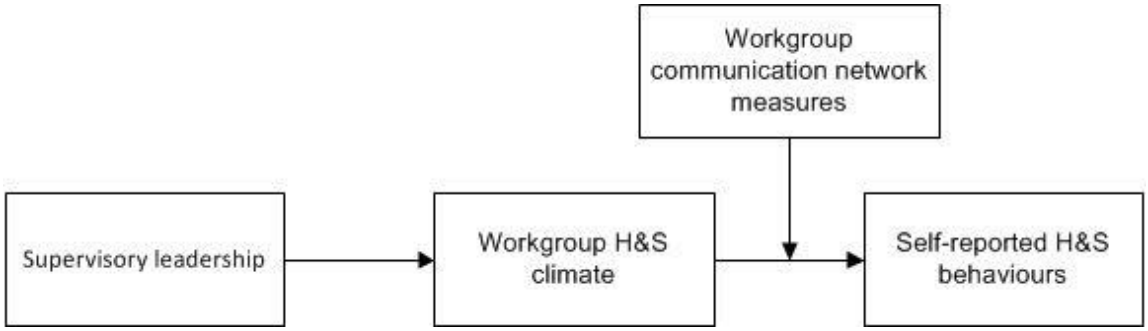


Figure 4.13: Moderating effect of workgroup communication network measures on the relationship between workgroup H&S climate and self-reported H&S behaviour

Table 4.20 shows that the interaction of workgroup H&S climate and network in-degree centralisation had a significant effect in predicting self-reported H&S behaviour, indicating that network in-degree centralisation moderates the relationship between workgroup H&S climate and self-reported H&S-related behaviour.

Table 4.20: In-degree network centralisation as a moderator of the H&S climate-behaviour relationship

Moderator	Predictors	R square change	F change	Sig. F change	β	Sig.
Network in-centralisation						
Step 1	Workgroup H&S climate (WHSC)	.55	43.32	.000	.74	.000
	Network in-centralisation (NIC)				-.003	.971
Step 2	Interaction WHSC*NIC	.03	4.69	.034	-1.95	.034

In order to understand the nature of the significant moderation effect, the relationship was plotted graphically (see Figure 4.14). When network in-centralisation is low, i.e. most of the group members are involved in H&S-related communication and receive H&S-related information from most other group members, the relationship between workgroup H&S climate and self-reported

H&S-related behaviour is stronger (indicated by the steeper slope). When the network in-centralisation is high, i.e. only a few group members are dominantly involved in receiving H&S-related communication, the relationship between the workgroup H&S climate and self-reported H&S-related behaviour is weaker.

This suggests that decentralised networks in which H&S information is frequently shared between the majority of members, may augment or increase the impact of a positive group H&S climate on H&S-related behaviour.

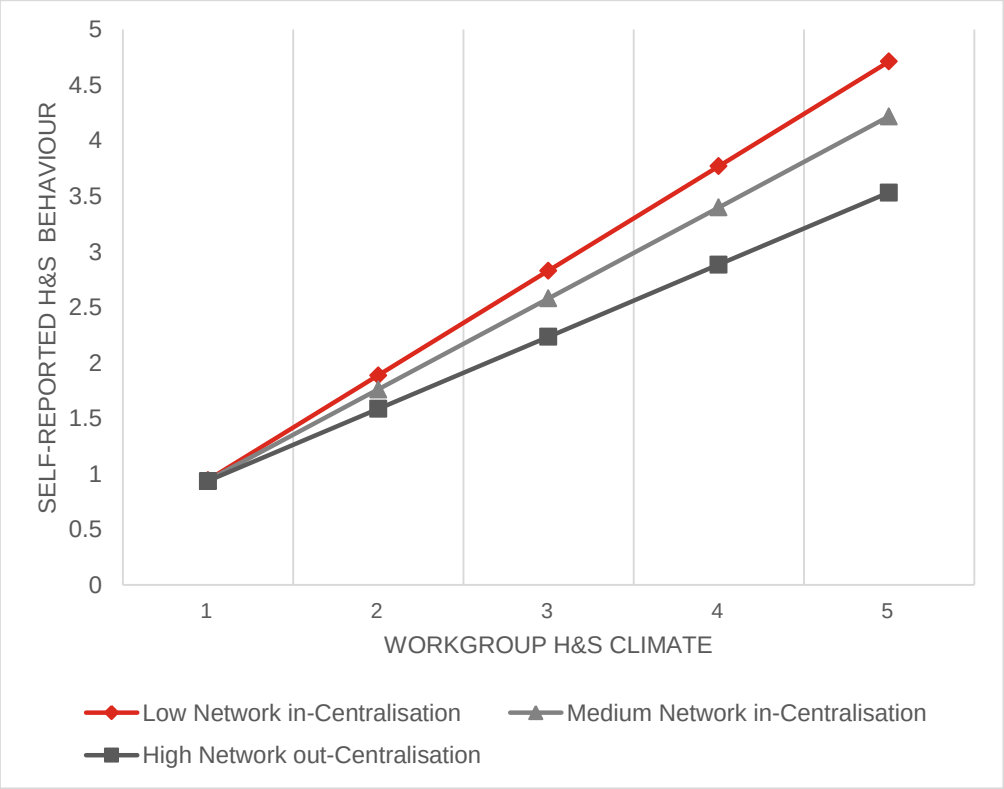


Figure 4.14: The moderation effect of network in-centralisation on the relationship between workgroup H&S climate and self-reported H&S behaviour

4.2 Supervisors' survey

4.2.1 Sample characteristics

A total of 24 supervisors (or other project management personnel) participated in the supervisors' survey. Those supervisors were from 11 worksites and worked for different principal contractors. One participant did not answer most of the questions and the responses given by this participant were removed from further analysis.

Table 4.21 indicates that more than half of the supervisors (n=13, 56.5%) worked with the principal contractor at their worksite for more than one year. Another seven supervisors (30.4%) indicated they had worked with the principal contractor for between six months and one year.

Only one (8.7%) of the supervisors indicated he had worked with the principal contractor at his worksite for less than one month.

Table 4.21: Background information relating to supervisors

Time worked with the principal contractor	Frequency	Per cent
Between 1 week and one month	2	8.7
Between 1 month and 6 months	1	4.3
Between 6 months and one year	7	30.4
More than one year	13	56.5
Total	23	100

4.2.2 Principal contractors' commitment to H&S

Four items were used to measure supervisors' perceptions of the principal contractors' commitment to H&S at each worksite. Participants were asked to score the items using a five-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly disagree".

The mean scores for each item are shown in Table 4.22. All the mean scores were above 4.50. The overall mean score for supervisors' perceptions of the principal contractors' commitment to H&S was 4.65.

Table 4.22: Supervisors' perceptions of principal contractors' commitment to H&S

	Mean Value	Std. Deviation
The Principal Contractor places a strong emphasis on workers' safety	4.65	0.94
Workers' safety is given a high priority by the Principal Contractor	4.78	0.42
I feel that the Principal Contractor openly accepts ideas for improving safety	4.48	0.59
I feel that the Principal Contractor encourages open communication about safety	4.70	0.47
Overall mean score	4.65	0.46

4.2.3 Construction managers' leadership

Thirty items were used to measure supervisors' perceptions of the leadership of the construction management team at participating worksites. The 30 items reflect eight leadership components. Participants were asked to score the items based on their experience of interacting with their immediate supervisor or line manager at their current worksite. Items were scored using a five-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly disagree".

The mean scores for each item and leadership component are shown in Table 4.23.

Table 4.23: Supervisors' perceptions of construction managers' leadership

	Mean Value	Std. Deviation
Communication practice		
I feel comfortable discussing safety issues with my supervisor at this site	4.70	0.47
I feel that my supervisor at this site openly accepts ideas for improving safety	4.60	0.72
I am reluctant to discuss safety-related problems with my supervisor at this site	4.61	0.72
I feel that my supervisor at this site encourages open communication about safety	4.34	0.71
I try to avoid talking about safety issues with my supervisor at this site	4.57	0.79
Overall mean score	4.57	0.59
Setting high performance expectations		
At this site, my supervisor insists on only the best performance	4.09	1.00
At this site, my supervisor will not settle for second best	4.13	0.69
At this site, my supervisor shows us that they expect a lot from us	3.83	0.83
Overall mean score	4.01	0.68
Fostering the acceptance of group goals		
At this site, my supervisor encourages workers to be "team players"	4.48	0.67
At this site, my supervisor fosters collaboration among work groups	4.26	0.81
At this site, my supervisor gets all subcontractors and workers to work together for the same goal	4.13	0.76
At this site, my supervisor develops a team attitude and spirit among workers	4.00	0.67
Overall mean score	4.22	0.61

Articulating a vision		
At this site, my supervisor has a clear understanding of where we are going	4.35	0.57
At this site, my supervisor is able to get others committed to his/her dream	3.78	0.60
At this site, my supervisor inspires others with their plans for the future	3.65	0.49
At this site, my supervisor paints an interesting picture of the future for the project	3.70	0.70
Overall mean score	3.87	0.43
Providing an appropriate model		
At this site, my supervisor provides a good model for me to follow	4.00	0.85
At this site, my supervisor leads by “doing,” rather than simply by “telling”	3.87	1.01
At this site, my supervisor leads by example	4.00	0.80
Overall mean score	3.96	0.76
Individualised support		
At this site, my supervisor behaves in a manner thoughtful of my personal needs	4.04	0.64
At this site, my supervisor shows respect for my personal feelings	4.17	0.65
At this site, my supervisor acts without considering workers’ feelings	3.96	1.02
Overall mean score	4.06	0.59
Intellectual stimulation		
At this site, my supervisor has ideas that have challenged me to re-examine some basic assumptions about my work	3.91	0.73
At this site, my supervisor asks questions that prompt me to think	4.13	0.69
At this site, my supervisor challenges me to think about old problems in new ways	3.74	0.54
At this site, my supervisor has stimulated me to rethink the way I do things	3.65	0.49
Overall mean score	3.86	0.48
Contingent reward		
At this site, my supervisor commends me when I do a better than average job	4.13	0.92
At this site, my supervisor gives me special recognition when my work is very good	3.65	1.03

At this site, my supervisor always gives me positive feedback when I perform well	4.00	0.74
At this site, my supervisor personally compliments me when I do outstanding work	3.91	0.73
Overall mean score	3.92	0.74

Figure 4.15 presents the overall mean scores for each of the leadership components. Overall mean scores for all of the leadership components were above 3.50. The highest rated component was 'communication practice', followed by 'fostering acceptance of group goals'.

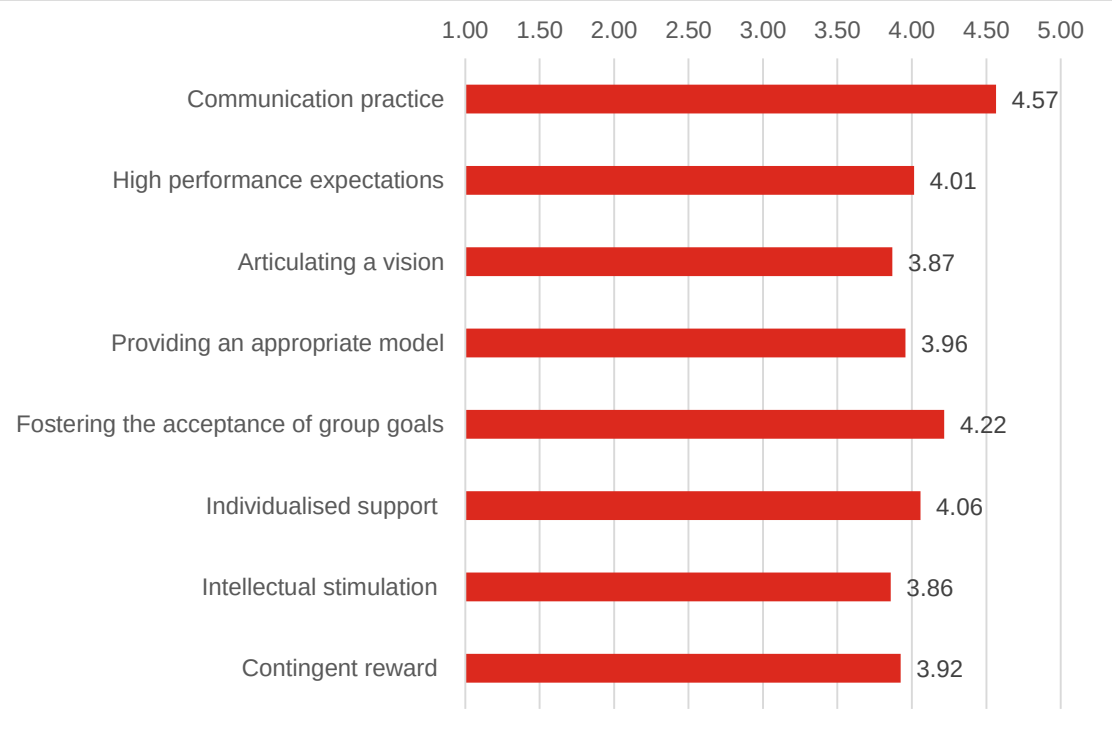


Figure 4.15: Supervisors' perceptions of construction managers' leadership by component

Part 5: Qualitative findings

This section presents the qualitative results on supervisor leadership behaviours and H&S communication.

5.1 Leadership behaviours identified as having a H&S impact

The field-based observation of workers, supervisors and others revealed a number of supervisory behaviours that were identified as having a positive and/or negative impact on workgroup H&S performance.

5.1.1 Supervisors' behaviours with a positive H&S impact

Supervisory leadership behaviours that were identified as having a positive H&S impact were:

- being organised and planning work in advance to anticipate and manage H&S hazards,
- setting a good example by maintaining high standards for H&S,
- establishing a consistent approach and fostering a sense of shared purpose with regard to H&S within the group,
- understanding individual workers' circumstances and responding to individuals' needs,
- eliciting respect through being experienced and demonstrating practical technical capability,
- creating a trusting environment in which workers are listened to and are able to voice concerns,
- being loyal and protecting the interests of workgroup members, and
- recognising and reinforcing good H&S practices.

Further details on these behaviours are provided below, together with example quotations and observations.

Being organised and planning work in advance to anticipate and manage H&S hazards

Workers and supervisors acknowledged that construction is a high risk work environment in which unexpected H&S hazards can emerge to disrupt work and have a negative H&S impact. Effective supervisors were seen to be those who are well organised and prepared for work in advance. For example, one supervisor stated: *'…as a supervisor you need to be steps ahead of them* [the workers], *you need to be thinking a week or so in advance.'*

One of the most important aspects of this supervisory behaviour was the ability to identify and decide how to control H&S hazards before work commenced. Understanding and focusing on H&S issues that were particularly relevant to a worksite or context was identified as a component of effective supervision. For example, on one drilling site, maintaining high standards of housekeeping was identified as being particularly important due to the small size and nature of the work area. One spotter (track safety) explained: '[Supervisors'] *communication is important,*

and having a high priority of housekeeping.These sites are small, they are tight with space so it has to be clean, otherwise there are too many hazards.'

The important role played by supervisors in maintaining high H&S standards, even when facing production pressure, was recognised. One H&S advisor explained: *'This supervisor, I have to keep an eye on more closely. They are all different. He has a good relationship with the guys, but is focused on getting the job done. He's about production, and you can see it – it's so busy down there, and look at the mess up there – it shouldn't be there. So I have to try and advise him to take care of these things before they get out of control… Safety is a priority until something unexpected happens that puts you behind schedule. The end date doesn't change. Then production becomes the priority.'*

In particular, effective supervisors were identified as being able to monitor work, identify and understand the gaps between the way work is documented in work procedures and the way it is performed in practice, and manage these gaps to protect workers' H&S.

While it was typical for supervisors to be frustrated by unanticipated circumstances, there was a perception that effective supervisors responded to these disruptions in ways that prioritised the protection of workers' H&S. One supervisor explained: '*The designers have f****d us with this one. The overheads were meant to be gone according to the design, but they aren't. They are going further down the line. So we can't lift in the steel 'cause we will be too close to the overheads… we don't have the required gap. We have to cut the steel in half, lift one half in, then the other half and weld them together. It is putting us back days, and I'm losing guys for it. That is an unexpected change that I have had to manage.*'

Effective supervisors were considered to be those who maintained a high level of vigilance at all times. For example, while the researcher was attending a site visit, he was engaged in conversation with one supervisor who was explaining the importance of teamwork. The supervisor stopped mid-conversation. The researcher was unaware of a problem. The site was noisy and the researcher did not recognise any particular noise as indicating danger. However, the site supervisor turned his head towards the site. The sound of a large, slow-moving vehicle had caught his attention. The vehicle was approaching the site area where four workers were working. One worker was walking across the site apparently unaware of the approaching vehicle. He walked past a drilling rig, which was obstructing his view of the oncoming vehicle. The site supervisor shouted at the worker, raising his arm to grab the worker's attention. The worker stopped and the vehicle passed without incident.

Participants identified supervisors' awareness of group members' needs, particularly in relation to their levels of experience and the specific H&S hazards in the work context, as being an important aspect of their H&S effectiveness. Being mindful and able to prioritise supervisory activity to fit a particular workgroup or context was identified as an important characteristic of supervisors' behaviour. One H&S advisor explained: '*The excavator operator is very experienced, so the supervisors don't spend much time here. They work closely with other workgroups that aren't as experienced and are doing higher risk work. For instance, here there is only one piece of plant, down there, there might be four or five.*'

Setting a good example by maintaining high standards for H&S

Workers considered that the way supervisors behaved sent an important message to workgroup members about supervisors' H&S expectations. When asked what an effective supervisor does, one worker responded: '*Leading by example. It communicates a message by itself.*'

Supervisors were also aware that their behaviour communicated their H&S expectations to workers. One supervisor explained the importance of 'walking the talk' with regard to H&S: '*To practice what you preach. If you are saying something, then you have to do it as well. If I'm not wearing the right gear, doing the right things and working safely, then the guys will see you do it, and they won't do the right things. We need to lead by example. The pre-starts are useful for leading by example and getting these messages across.'*

Workers acknowledged the importance of consistent supervisory behaviour in relation to H&S. One worker explained: '*Supervisors should lead by example and to listen to suggestions. The supervisors I worked with on this project are good, there are no cowboys. Like Joe* [the supervisor] *always wears his PPE and is experienced*.' However, some workers also noted that some supervisors are inconsistent in relation to H&S, particularly under conditions of production pressure. One worker explained: *'…but you know what they say in the pre-starts is all fine and well but as soon as they are under the pump, it's all different.'*

Supervisors were aware that workers observed their behaviour in relation to H&S and this behaviour would be regarded an acceptable standard. For this reason, supervisors always needed to diligently comply with H&S requirements. One supervisor explained: '*You need one-on-one communication, you need to show them how it is done, and lead by example. They* [workers] *watch you know, they see what their supervisor does, they notice if you do something unsafe, your minimal standard is seen as acceptable.*'

A supervisor's response to safety incidents was also regarded as being indicative of their H&S approach. Being willing to stop work in the event of a near miss to re-evaluate work processes and take corrective action was considered to be an influential supervisory leadership behaviour. A supervisor explained: '*if there is a serious near miss, the supervisor should stop all work, and have a safety stand down. Gather all the lads around, discuss it and reassess the work area*.'

Establishing a consistent approach and fostering a sense of shared purpose with regard to H&S within the group

Participants recognised the role that supervisors play in fostering a shared sense of purpose with regard to H&S within workgroups. One superintendent explained how he works closely with individual supervisors to resolve H&S issues and maintain a safe worksite. When asked whether supervisors report directly to him, the superintended replied: '*Well I guess technically, but I don't see it like that, we are much more on the same level, and help each other out. I will go around and see how they are doing and help them if need be. I like to see us as a pretty flat structure. I think that works*.'

The development of a sense of shared responsibility for H&S was identified as being important and linked to the practice of supervisors and group members looking out for each others' H&S.

One worker observed: '*We are all motivated to stay safe, nobody puts anyone to work in a high risk situation.'* Another commented: '*Safety communication is everything. Communicate with each other to keep each other safe. We need to take responsibility for it as well. I take responsibility for your safety and you take responsibility for mine*.'

The importance of maintaining effective communication between supervisors and workers in relation to H&S was also noted. One supervisor described how: '*The guys* [workers] *are my eyes and ears out there. I can't be everywhere. They tell me if something's not right. If it is minor they might just fix it and not mention it, but if it's major they will let me know*.'

Another supervisor described how he relied on workgroup members to ensure that all hazards are identified and appropriately controlled when planning work: '*At the moment we are removing light poles – so I will be talking about things like risk of falls, where the services are and plant movements. The guys give me feedback as well. Remind me about procedures, like if we need an extra spotter for a task*.'

Understanding individual workers' circumstances and responding to individuals' needs

All parties involved in the field-based observation identified a supervisor's ability to be aware and supportive of workers' personal circumstances as being important. One H&S advisor described how events that occur in workers' lives outside of work can have an impact on their ability to work safely. The H&S advisor tapped his head and explained: *'He* [a worker] *has lost concentration, was thinking about something else. He shouldn't have been where he was without a sign from the operator to pass. Something was wrong – he had missed the last two shifts, and wouldn't say why. Eventually he came out and told us there were issues at home. It is seen as a tough and macho industry, some of the guys don't want to talk about these things. But the reality is a lot of these guys are going through break-ups, divorces, separation from their kids, health issues, finance worries, where is the next job coming from? There is a lack of security and they are working long hours. We are finding that many of the incidents we have are human factors, and these things don't help, people make mistakes. We are all trying to solve the problem of why sometimes people follow the process or do the right thing and sometimes they don't. So after that incident we cut back his hours, he worked on another site away from the incident here to get his head straight, and now he's back. We changed our system too, we now have blue cones where plant is operating, so everyone has to stop at the blue cones and wait for the signal from the plant operator before they can pass through. Everything is orange on rail, so we went with blue.'*

While care needs to be exercised to ensure supervisors do not encroach on workers' private lives, workers themselves perceived that effective supervisors were sensitive and 'in tune' with workers' emotional states. For example, a labourer explained: '*And* [supervisor's name] *knows where you are outside of work. Sometimes you are up, sometimes you are down. I think that has been forgotten about*.'

Another worker explained how he respected his supervisor more as a result of the supervisor's sympathetic and supportive response to a family death: '*The supervisors here are good. You know I just lost my sister, and my supervisor said take as much time as you need. Not all supervisors would do that. I've got great respect for him*.'

Knowing when workers were 'not themselves' and dealing with personal issues at home served as a prompt for some supervisors to provide individualised support. One supervisor explained: '*I had a guy in the morning, who I could tell wasn't right. "I don't want to be here", "I want to go home". That wasn't him. He was never like that. I told him to get in the crane, start it up, I would just finish some work and I would be out in a minute to help. He forgot to put his outriggers on. One of those moments. And… accident. Now I'd never let a guy out there, if I didn't think he was right. Never again. I would get him to stay, and have a chat. Find out what was going on.'*

However, the same supervisor also noted that it is increasingly difficult to provide individualised support to workers as a result of the increasing use of labour hire arrangements in the construction industry.

'But now the problem is, with all these labour hire guys. We don't know them, we don't know when they are off, we don't know where they have come from. Have they come off a major occupation all weekend on another job and are turning up on a Monday here after a couple of coffees? We see them, do the pre-start, try to get the way we do things around here across, but then we don't see them again. We are relying on our leading hands to get the culture across, but it is so hard when you have so many guys coming and going with labour hire.'

Labour hire workers are often temporary workers on a particular job, and this can make it challenging for supervisors to build close relationships with them and understand when they 'don't seem right'.

Eliciting respect through being experienced and demonstrating practical technical capability

Supervisors' credibility, experience and knowledge were identified as being important to their effectiveness as H&S leaders. One labourer explained how supervisors need a diverse range of skills and a broad knowledge base: '*Supervisors need to be organised, and have a broad knowledge. They do a lot of different works, so need to have that range*.'

Supervisors' credibility was often based on their practical experience of the work processes they were responsible for supervising. A plant operator commented: '*What we need is a supervisor with experience, they need to know what they are doing – that's very important*.'

A labourer also noted that experienced supervisors are particularly important in high-intensity periods of work, in which it is easy to be distracted: '*We need supervisors with experience – that is so important. Experienced supervisors understand the distractions, especially during an occupation, when, should I be honest?… it is all about getting the job done. Right now there is nothing going on, but when plant is operating, reversing and there is work going on all over the place, that is when there are distractions. We need experienced supervisors that can manage those distractions*.'

It was also noted that effective supervisors need to have both technical, as well as social skills. A H&S advisor noted: '*We have a lot of supervisors that are graduate engineers. They are good technically but haven't had any training on management or safety. The softer skills. So it's something that we try to help them with, focus on it and coach them through it.*'

Supervisors themselves expressed frustration that the quality of their technical work was not emphasised as strongly as H&S during site inspections. One supervisor explained: '*I get more inspections about safety than I do on the technical aspects of the job. I am the supervisor, and am therefore responsible for the group, and safety is important but the technical aspect is important, too. I'm one of the more experienced supervisors, I've been doing this for years. But sometimes I don't have the answers to the technical questions. I need to call someone with more experience. They are both important, but sometimes I think the technical aspect gets forgotten about*.'

Creating a trusting environment in which workers are listened to and able to voice concerns

Supervisors who actively seek input from workers were regarded as being effective in relation to H&S. The researcher observed one supervisor interacting with workgroup members at a pre-start meeting. The supervisor actively sought input from workers: '*I encourage all of you guys to speak up at the pre-start. Many of you have more experience than me. Let's share ideas and let's listen to one another, as we are always looking at ways to improve. So please speak up.*'

In particular, supervisors who recognise, respect and listen to workers' knowledge and experience were perceived to be effective. For example, one traffic controller explained how their supervisor takes their guidance on traffic safety matters when planning work: '*They* [the supervisor] *listens to our suggestions so everybody can see and understand the best way. For example, they will listen to our advice on the best way to bring the trucks in, which direction to come in from, whether to wait for a change in lights, or whether to let some cars through first*.'

One supervisor also explained how he left some decision-making to experienced work crews in recognition of their practical knowledge of the best way of working in a particular situation: '*Ideally the plant would have barriers around it, isolating it. But that is not possible here, as the guy working in it physically wouldn't be able to get out. We need to make such adaptations to manage the risks. We often leave these adaptations to the offsider. He knows what is best.*'

Workers also identified supervisors' interpersonal skills and ability to develop relationships as being an important feature of effective H&S leadership. One labourer explained: '*They need to have the ability to get to know everyone. Everyone has strengths and weaknesses, a good supervisor knows them*.'

In particular, effective supervisors understood when workers needed particular close supervision or instruction. For example, one worker described how: '*Supervisors need to focus on the bigger picture, the high risk situations. If you have an inexperienced newcomer, the supervisors should be responsible for what risks they are exposed to, as they won't understand what risk is out there. Expose them to some risks, but not others, especially when they are alone*.'

Workers highlighted how it was very important that supervisors encourage workers to discuss H&S problems or concerns and be careful not to make people who ask questions feel uncomfortable or embarrassed. One worker described how: '*Supervisors need to be approachable. Especially for the young guys. They don't have the experience so they may need to ask questions. And they may not feel they can. And they are new to it, so the first time they*

ask they may not understand. They might need to ask two or three times. The supervisor should encourage that, so they don't feel stupid. They should mention it in the pre-start, emphasise that no question is a stupid one, and you can always ask the same question again if you don't get it first time.'

The challenges that being in a leadership role can present for supervisors were also noted by one site superintendent who observed: '*Doing the pre-start is the hardest part of some supervisors' day. Standing up and speaking to the guys can be so emotionally draining. They need to be ahead of the game – prepare it, too. They use so much energy on it, and half the guys probably aren't even listening. Some need support and they aren't getting it. That's why guys crack and get out* [of] *the game. But it is our loss 'cause we lose years of experience.*'

Being loyal and protecting the interests of workgroup members

Supervisors and workers both identified loyalty and looking after workgroup members' interests as being a key feature of effective supervision. One supervisor described how: '*Communicating and have relationships with the guys* [workers] *is absolutely key. You also need to have their back*.'

When supervisors demonstrated loyalty to the workers, it was more likely to be reciprocated as the workers would know they could trust their supervisor. A labourer explained: '*Good communication, confidence and trust. They* [supervisors] *are the main point of focus for us, so they need to be confident in what is going on. They need to have your back, then the guys trust them and they have his back*.'

However, workers suggested that not all supervisors are loyal to their workgroup. One worker explained: '*Supervisors need to show loyalty to the guys. They are like dogs, they need to be loyal. When you get a loyal dog, that's great, but you rarely do. We need more loyal supervisors. Most dogs don't just come loyal, they need to be trained – just like our supervisors. Loyal dogs are easy to get along with, just like loyal supervisors*.'

Supervisors also described how good relationships with workgroup members created an environment of psychological safety in which H&S issues could be discussed openly and honestly: '*If you have that* [good relationships] *then you can be open about safety with each other. You can say whatever you want, as long as it is in the right way 'cause the guys know you mean well. They know you care. It's all relationships.*'

Recognising and reinforcing good H&S practices

While on-site, the researcher observed one H&S manager providing positive feedback and recognising a supervisor for the attention to detail in his job safety analysis (JSA). The H&S manager commented: '*I want to highlight the excellent JSA that been done by John. Incredible attention to detail and a model example. If anyone is struggling with their JSAs or looking to improve, then go have a look at John's.'*

Pre-start meetings were identified as presenting a good opportunity to recognise and reinforce good H&S practices. For example, one worker stated: '*Pre-starts should highlight positive acts*

that have happened such as an intervention that stopped an injury. So we can all learn from it, and people are recognised.'

However, positive reinforcement of good practices was often underused at the pre-start meeting and also in subsequent interactions between supervisors and workers during the course of the working day. By their own admission, supervisors indicated they were quick to identify defects and deviations but that they provided positive feedback much less frequently. One supervisor observed: '*I think positive communication* [is an important aspect of leadership]. *We know when things are going right but we should highlight it more. The communication is all too often "put your hard hat on" or "that's wrong" or "this shouldn't be there". We need to be positive as well*.'

Some workers suggested that giving H&S awards or vouchers could be helpful ways to materially recognise and reinforce positive H&S behaviours. For example: *'…positive interventions should be rewarded with safety awards, vouchers or something.'*

5.1.2 Supervisors' behaviours with a negative H&S impact

Supervisors' behaviours that were identified as having a negative impact on H&S performance were:

- failing to act quickly and decisively when something is wrong, and
- emphasising a rigid and unthinking compliance with H&S procedures.

The details of these behaviours are discussed below.

Failing to act quickly and decisively when something is wrong

Participants recognised that it was important to fix H&S issues before problems arose. For instance, a site supervisor explained that there had been a recent incident in which an inspector had raised a H&S issue in a meeting, but not on-site. The supervisor was unaware of the issue and was frustrated it had not been communicated at the time of the inspector's observation. He stated: *'why couldn't it* [the unsafe condition] *just have been communicated there and then at the time, and it would have been fixed?'*

A passive approach can be problematic for H&S, as risks and hazards are not sufficiently addressed before they become problems. The researcher observed a site superintendent emphasising during a pre-start meeting the importance of being proactive in relation to H&S. In this case, it was the issue of housekeeping and unsecured construction materials. The site superintendent stated: *'I want you all to have a quick housekeeping check before the work starts today, and then again at the end of the shift, making sure that housekeeping is all in order, and that everything is secure 'cause if there are bits of ply and other stuff lying around and unsecured, then we just need some bad weather like we had over the weekend, and s**t starts flying everywhere*.'

The H&S advisor then added: '*Slips, trips and falls from uneven surfaces, and untidy work areas are one of the most common reasons why we have accidents in the construction industry. So it is very important to keep the housekeeping in check, and everything is secured, especially with being so close to the public.*'

Supervisors need to give direction and sometimes make quick decisions in a transient and dynamic site context. Supervisors who could respond to unexpected circumstances decisively were regarded as being effective. One labourer explained: '*supervisors need to be able to make decisions on the spot. Things change on constructions sites, they don't always go to plan, so you need to be able to make decisions there and then*.'

Emphasising a rigid and unthinking compliance with H&S procedures

Supervisors who rigidly dictate policies and procedures without seeking meaningful input from workers in terms of the practicality and applicability of formal H&S rules and prescriptions to the worksite environment were also regarded as having a negative impact on H&S.

In particular, an emphasis on top-down enforcement of H&S rules was regarded as ineffective because, as one project manager explained: '*it's important for the workgroup to be part of the* [H&S] *process rather than a recipient of it'.*

One supervisor, while being observed during the field-based data collection, openly admitted to having a top-down approach to the management of H&S. The supervisor commented: *'I don't receive safety information from these guys, I enforce it* [H&S].'

On-site observation of this supervisor revealed his management approach. At one point during the site visit the H&S advisor noticed a labourer who was wearing a zip-up hoody over his high visibility jacket, and caught the attention of the site supervisor. The advisor pointed at the labourer, which prompted the site supervisor to intervene. The supervisor whistled and shouted at the labourer from a distance. The supervisor then tugged his own jacket to demonstrate that the labourer's zip up hoody should be removed.

Participants described how supervisors should adopt positive leadership behaviours rather that an overly hostile or even abusive approach. One supervisor explained: '*you don't need to shout and swear, or pretend you're a big boss and above everyone. If you do that guys might nod, but as soon as the supervisor isn't there, they will be complaining. Then there are breakdowns in relationships and breakdowns in safety.*'

Instead of being a 'big boss' who is 'above everyone' and dictates rules without discussion, participants explained that to be effective, supervisors need to be approachable. One labourer stated to the researcher that: '*The supervisor giving it* [the pre-start meeting] *should be approachable. Should dictate the site culture. Have that "want to go home" safety culture.'*

A safety leadership approach that focuses on rigid and unthinking compliance with H&S procedures also appeared to increase the risk that leaders would be seen as doing the minimum legally required to 'cover themselves' or their organisations. For example, one driller identified a knee jerk reaction to fear of litigation as having a negative H&S impact: '*The biggest problem is safety leadership is arse covering… Everyone here is covering their arse. I mean there are 10 guys here and only two of us digging. Work that one out*.'

In these cases, leaders were perceived to focus excessively on demonstrating H&S compliance through paperwork and audits, rather than on actively managing H&S on-site. For example, one superintendent stated: '*this job is all about signatures. I must sign my signature 50 times a day.*

Everyone seems scared to put their neck on the line, and make the call. People stop accidents, not paper'.

5.2 H&S communication

5.2.1 Supervisors' role in the translation of H&S documentation

It is acknowledged that work procedures cannot cover all eventualities and consequently they must be interpreted by supervisors who give daily directions to workers about how to perform a task in a given situation (Zohar, 2000). Thus, supervisors play an important role in translating the content of written documents, such as safe work method statements (SWMSs), into action-oriented instructions.

The on-site field observation revealed that the construction industry's reliance on H&S-related paperwork (in particular, SWMSs) is sometimes questioned. The researcher observed the following conversation between a project manager and a construction worker:

Project manager*: 'We don't need a SWMS for everything. We don't need one to sweep the floor in the office. You wouldn't write one to wash your car at home. They are just required for high risk activity, where a severe injury or fatality is possible. In construction, 'cause we are working at height, in and around plant, there is a lot of high risk activities so we need SWMSs there, but not for everything.'*

Worker: *'I agree with you, but that's not the way the industry works.'*

Project manager*: 'I know, but we are trying to shift the way of thinking. And it's typical of everyone's thinking that you always need them, but we should only do it for high risk. The SWMSs can be done two to three months before the job by someone who will never do the task. That's blunt, but it's the truth. Small contractors that pay a consultant to have their SWMSs done for them are shooting themselves in the foot 'cause if an accident happens they are assessed against their safe work system. If the small contractor's safety work system is about SWMSs that they don't know or don't follow, then they are in trouble.'*

The communication of H&S requirements in formal written documents was recognised to be a problem in the construction industry. For example, one H&S advisor explained: '*There's a lot of paperwork here, daily we get about 10 different bits of paperwork from each site. But the paperwork, SWMSs, etc, doesn't mean much to the guys* [workers]. *They are long documents with big words, but guys don't associate with that*.'

One construction worker explained: '*We have all signed SWMSs and had no idea what's in them.'*

Construction workers' preference for verbal instruction and/or practical demonstration of how to perform a task was also noted. The researcher observed the following exchange between an excavator operator and a supervisor in which the excavator operator indicated his antipathy towards H&S documentation, while the supervisor described the operator's skill and craftsmanship in performing his work.

Excavator operator: '*I had to do a lot of paperwork on the last project I was on in Perth. To me, paper and pen is like electricity and water.*'

Site supervisor: '*But out there* [on-site] *he's very good, he's like a surgeon.'*

One perceived advantage of providing H&S information verbally, rather than in written form, is that it enables workers to engage with the content. Rather than being one-way communication of information written by technical specialists, verbal instruction enables workers to ask questions and participate in a two-way dialogue about how to work safely and without risk to health. Participants explained that informal verbal feedback given to workers during the course of their working day encouraged immediate engagement and feedback.

One supervisor explained: '*With verbal* [communication] *you can get feedback, have a conversation, get a reaction to what others say and think. With written it is not the same*.'

A supervisor explained that, while it is important to document safe work practices, the burden of completing paperwork can detract from supervisors' ability to engage in hands-on supervision: '*Drilling has become more like construction in the sense that all the paperwork and everything has become stricter…In some cases, it's necessary to be stricter with safety and think more about it – especially when we are working near live traffic or in public. But sometimes the paperwork is just an added burden that has to be done on top of all the day-to-day management and work that needs to go on.*'

Supervisors also noted that construction projects are constantly changing environments and that sometimes the information contained in H&S-related documents is difficult (or even dangerous) to implement. One supervisor explained: *'It is all about managing risks. Things might look all well and good on the paperwork but things change, and you need to manage that. For example, we should be putting flags at the excavation, but to do that I need to lift out the shield, put the flags in and the put the shield back. I would need a guy at the edge to do that – but that is putting a guy at risk. So is it safer to put the flags in? We are meant to, but then we are putting a guy at risk.'*

Adaptations can also create confusion and uncertainty as indicated by a rail track safety spotter: *'Sometimes the rules are confusing. For example, you work 6.4 metres away from the track, but then some sites get dispensations or exemptions. It's like, what rules are we playing by today? I'm fine with it if it's low risk, but it's not clear. You see on another site they are working closer than 6.4m and you presume they have an exemption, but they might not. It's a grey area.'*

Such uncertainty is problematic as it can signal a drift towards failure if grey areas become unclear and work practices gradually change.

Participants also noted inconsistencies in the application of some H&S-related rules. For example, the same rail track safety spotter noted: *'The pre-starts are always the same. We hear how important safety is, how it is a priority. In the pre-starts, in the inductions, in the paperwork. But when it comes down to it, it sometimes isn't. When it's raining hard, do we always stop the work 'cause it's dangerous? No, some sites do, but others keep going. It's a policy* [to stop]. *And heat as well, you can't work efficiently at 40 degrees, but not all sites will stop. They say it* [H&S] *is a priority, but it isn't always.'*

While supervisors interpret H&S rules and procedures and occasionally make adaptations to suit local site conditions, this also creates what Dekker (2003) calls a 'double bind'. Dekker (2003) describes how safety is not always achieved through the rote following of rules. Rather, safety results from people being skilful at judging how to apply rules to particular contexts or situations. In some instances, adaptation may be good for safety. However, although rules may need to be adapted in some situations, some adaptations can also fail with serious consequences (Dekker, 2003).

5.2.2 Effective supervisor-worker communication

The importance of effective communication of H&S information was a frequently raised theme in our on-site observation and informal conversations with workers and supervisors.

The importance of a supervisor having good interpersonal skills and an ability to communicate was emphasised. One construction worker stated: '*you can be the smartest man in the world, but you are screwed if you can't talk.'*

Supervisors' also acknowledged the importance of 'people skills' and establishing good relationships with workers. One supervisor observed: '*You need to have good people skills. Establish relationships with the guys. I go round and try and speak to everyone, leadings hands operators, labourers, whoever. It is important to have good relationships with the guys*.'

The characteristics of effective supervisor-worker communication (arising from the data analysis) are summarised in Figure 5.1.

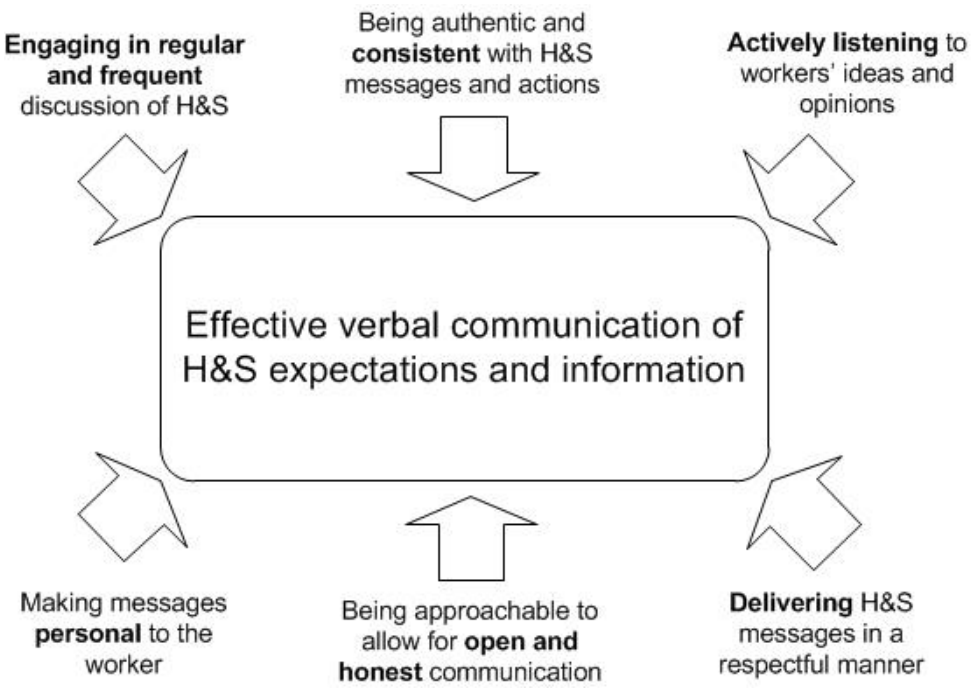


Figure 5.1: Characteristics of effective supervisor-worker communication

Engaging in regular and frequent discussion of H&S

Workers and supervisors both emphasised the importance of pre-start meetings (which will be discussed later in this part of the report) but also indicated that H&S needs to be integrated into frequent and regular interactions between supervisors and workers throughout the working day.

For example, a plant operator explained: '*In the pre-start, it gets communicated what services are around, what plant we are using that day and the safety around them, and those messages get reinforced throughout the day*.' A construction worker expressed a similar view: '*The toolbox talk is important for in the morning, but we need verbal communication throughout the day, again if things change*.' A labourer identified the importance of good supervisor-worker relationships in maintaining this frequent and regular communication: '*Supervisors need to be constantly talking, showing interest in what you are doing, and establish relationships with the guys*.'

When workgroups discuss H&S throughout the working day, these discussions become so routine that workers may not even realise they are discussing H&S-related issues. A labourer observed: '*All day every day you are talking about safety. Every operation, every task, everything, you will say information that is about safety and you might not even realise it*.'

A supervisor similarly observed that he integrates H&S information into his conversations with workers throughout the work shift: '*All day every day I'm talking to the guys about safety and most of the time you think you are talking about the job, but you are also talking about safety. We are doing a lot of excavation work at the moment, and the guys also throw ideas back at me. Like when we are going over permits, or if they thought there was a service cable in the area. And for example, the other day one of the guys raised to me that a guy in another crew wasn't wearing double eye protection. He needed it for his task and I'm not sure he knew that. But anyway, I passed the message on after it was raised.*'

Being authentic and consistent with H&S messages and actions

Participants observed the importance of being consistent in the way that H&S is spoken about and prioritised in a workplace. It was observed that, in some instances, mixed messages arise when H&S is emphasised in site inductions, at pre-start meetings and in H&S documentation, but production pressures are emphasised on-site. For example, one worker commented: '*We hear how important safety is, how it is a priority. In the pre-starts, in the inductions, in the paperwork. But when it comes down to it, it sometimes isn't.*'

The authenticity and honesty of supervisors' communication was also identified as a key feature of effective H&S leadership. A labourer observed: '*They* [supervisors] *need to say it as it is. You know, a spade is a spade. Be honest with the guys and tell it how it really is*.'

The importance of authenticity was also observed in relation to vertical communication of H&S. The role played by supervisors in communicating information to both workers and managers was identified as important. In particular, workers identified supervisors' honest communication to management about 'what is really going on'. A labourer explained: '*you need to have the same communication up and down. That is what makes a good supervisor. What you say to the workforce, you say to management. But sometimes it doesn't happen. Management wouldn't*

want to know what was really going on. To improve though we need more honesty and openness.'

Actively listening to workers' ideas and opinions

The importance of actively listening to workers' ideas and opinions in relation to H&S was identified as a characteristic of effective supervisor-worker communication. When asked what made an effective supervisor in terms of H&S leadership, a supervisor replied: '*Communication… and listening, but that's a two-way thing that is part of communication. If you listen, you can try and understand the different expectations of different people. And that is important because they have to meet somewhere in the middle. Explaining your expectations and getting feedback, too. It is all about good communication*.'

Some supervisors described their approach of asking questions or using prompts to elicit workers' feedback and ideas. Thus, rather than a one-way delivery of information, these supervisors deliberately paused to ask questions and engage workers in a H&S-related conversation. One supervisor described how he elicited workers' input by '*…prompting people. Asking them if you think that is a good idea. Making that intervention with just a prompt*.' Another explained how he deliberately uses questions to '*engage with guys* [workers], *consult with them… I see this. What do you see? And let them take ownership*.'

Making messages personal to the worker

Participants identified a need to make H&S messages more personalised and relatable to workers. They indicated it would be beneficial if H&S messages, rather than just communicating the existence of H&S procedures or rules, explained why these rules were important in 'human terms'. One site superintendent explained: '*People are the key in construction. It is all about people. You need to give the power to the people, give them ownership, so then they can lead, and then they can communicate. Then they can add their own spin on the messages that are more effective, depending on who the message is for. For example, safety glasses. You can ask the guys, what are the glasses for? And you will get to protect your eyes. But they are for seeing your children again… seeing your girlfriend again. That makes it personal and makes them think what protecting your eyes really means. That is a more powerful message than "just wear your glasses, it's a rule". We need to give guys ownership to lead and communicate so they can deliver these messages more effectively*.'

Being approachable to allow for open and honest communication

Supervisors' interpersonal skills were identified as a factor in ensuring effective H&S communication between workers and supervisors. In particular, supervisors who were regarded as being 'approachable' would be more likely to elicit open and honest communication about H&S within their workgroups. A plant operator explained: '*Communication skills are so important, but you also need to be very approachable. The guys have to be comfortable with you, there needs to be honesty, and no fear. When there is no fear, there is never a stupid question. That keeps guys safe*.'

Delivering H&S messages in a respectful manner

Closely related to the issue of approachability is a supervisors' style of interaction with workers. Participants suggested the 'right way' for supervisors to communicate H&S expectations and information was to do it respectfully. Being adversarial, abusive or hostile was deemed to be ineffective and unhelpful. For example, one supervisor stated: *'…you don't shout and yell at them, that doesn't work, they will listen to you at the time, but they probably won't help you out later on. You just need to have a quiet word with them, it is important to communicate it the right way*.'

5.2.3 Approaches for H&S communication, engagement and knowledge retention

The on-site observation of work and conversations with participants revealed a number of different approaches that can facilitate H&S communication, engagement or knowledge retention. These are shown in Table 5.1.

Table 5.1: Communication tools and methods for H&S

Communication approach	Benefits	Limitations
Informal verbal *(e.g. during work task)*	Important for communicating, engaging and retaining and applying H&S knowledge during the working day	H&S knowledge not recorded
Formal verbal *(e.g. pre-start)*	Opportunity to engage with subordinates and transfer H&S knowledge for work tasks	Typically restricted to general and basic H&S knowledge
Visual *(e.g. hand signals)*	Useful in the appropriate contexts (e.g. noisy environments)	Lacks the depth and content of verbal communication
Documentation *(e.g. SWMSs)*	Retains H&S knowledge on particular tasks for the site management team	Not an effective communication method to workers, and can be time-consuming if used for all tasks
Communication systems *(e.g. radios, PA systems)*	Improves communication flow in noisy or geographically fragmented work-sites	Often restricted to short messages, and is not a method available to all workers

Informal verbal communication

Participants explained that during training, inductions or pre-starts help workers to retain H&S knowledge, and that the application of this knowledge – designed to keeps workers safe while performing their tasks – is actively encouraged and reinforced at the worksite and on the job. The following conversation that occurred between the researcher and a non-destructive driller (NDD) explained this to the researcher:

Worker: '*I drive that thing (he points to the NDD van).*'
Researcher: '*I wouldn't know where to start with that thing…'*
Worker: '*Yeah, the first week you are using that, you don't get any work done. You just need to get to know it. Inductions, pre-start meetings, toolbox talks, they won't help you there.*'

Supervisors also acknowledged the importance of on the job experience as a way of ensuring that H&S knowledge is practically applied. One supervisor explained: '*retaining safety knowledge is all about job experience in the field. Doing the same things time and time again*.'

A driller also identified the importance of coworkers' communication and reinforcement of H&S expectations, particularly when new workers join a workgroup: '*When you get new guys in crews, and they don't know what they are doing, that is when it goes wrong. And it is up to us to keep an eye on them, and make sure what they are doing is safe. The tick box in the induction isn't going to do that*.'

Supervisors' daily interactions with workers were also identified as an important 'trigger' to help workers remember to apply the H&S knowledge learned in more formal ways. One supervisor explained: '*sometimes you need a trigger to remind guys. It starts at the pre-start, and then supervisors need to be reminding guys about safety throughout the day. It's all about good communication. Not being negative and yelling, but reminding guys about the safety stuff they already know'.*

The importance of both horizontal and vertical H&S-related communication was also acknowledged. Supervisors need to communicate effectively with workers and higher-level managers, while communication between workers performing different roles or functions in a workgroup is also important. One supervisor explained: '*Communication is so important. And at all levels. I communicate safety to everyone in the group, but they also need to communicate between themselves. Like the drillers telling the traffic guy what's going on, so nobody is guessing. We all need to take a lead with communication throughout the day. And even above me, the management need to effectively communicate. For example, with the planning, if they don't communicate effectively and we dig in the wrong place or whatever, something that wasn't a safety issue, becomes a safety issue.*'

Formal verbal communication

Formal verbal pre-start meetings were regarded as being effective ways to communicate important site or task-specific H&S information to construction workers.

Workers explained that the usefulness of pre-start meetings depends on the content of the presentation/discussion. In particular, standard and obvious H&S messages, such as the alcohol and drug policy on the site, should be avoided in pre-start meetings as this is already known and communicated in project-specific inductions. One worker suggested: '*They should try and keep the pre-start fresh as well. We hear the same things again and again, and sometimes guys switch off. It's important to mix it up.'* Instead, the pre-start should focus on key messages that are relevant to that day's tasks, or of a noteworthy H&S event.

Pre-start meetings were seen as a particularly important mechanism for letting workers know what other contractors or workgroups would be doing in multi-contractor worksites. For example,

one worker recommended that: '*Pre-start meetings should go through what other workgroups are doing in the area, so everyone knows.*' Another construction worker stated that '*having a good pre-start brings togetherness to the job.'*

By keeping the pre-start meetings succinct and covering H&S messages that are relevant to that particular day's work, the key H&S messages will be heard and retained. One supervisor explained how knowledge retention can sometimes be a problem: '*If you don't listen in here* [the pre-start], *and then you go out to the* [rail] *corridor, and you don't know what you can and can't do, that is when it can go wrong. And that happens. For example, in the pre-start we told the guys they couldn't go down an area of the rail corridor. What happens straight after the pre-start? We have guys walking where they shouldn't be, even though we just told them. You know we have some subbies that aren't used to pre-starts like the one we had this morning.'*

It was noted that pre-start meetings are also a good way to elicit workers' thoughts and ideas about H&S. One worker explained that '[The supervisor] *always asks if we have any queries or issues. And this is a great opportunity to raise any concerns.*'

In addition to pre-start meetings, other formal verbal communication mechanisms were also identified as being used and/or effective. For example, engaging workers in formal H&S reviews or workshops was identified as having a positive impact on H&S. One participant explained: '*There are times when I've stopped the job, and reminded them* [workers] *of the process. The process is there, and we should do the process. But it is a living document, and we should get feedback on the process. There should be a review with the whole team. I'm wanting to push having 10 minute workshops that revisit the process 'cause it can always be improved. It can keep complacency at bay, and we can really find out what people think about the process, if it is good or bad, and how it could be improved*.'

The participant explained the benefits that flow from these 10 minute 'workshops': '*The* [H&S] *process should be a learning process for all. And it should be easily communicated and understood by all crews. For instance, if we have a failure where we have hit services. We might need a new crew in to come in six weeks later to do another dig. Communicating the process, why it failed, where to dig, is essential.*'

Other participants raised H&S culture training as an example of formal verbal H&S instruction with the potential to produce improvements. At one such training session observed by the researcher, a project manager explained: '*This training is sending a message that we can all put our hand up and talk about safety.*' During the session (which was observed by the researcher) workers had an opportunity to communicate their opinions and ideas about H&S with supervisors and managers. In some cases, workers challenged H&S rules that they thought were not workable or applicable to all situations. One worker commented: *'if we were to change a rule, it would be that gloves and glasses aren't always mandatory. Sometimes the gloves aren't fit for purpose, we need all kinds of gloves to do the jobs, and sometimes you are better off without them. The gloves in all the posters are good quality, but the ones we get are cheap. The glasses too, and sometimes they steam up if you are sweating on a warm day and then you can't see. It is not safe to wear them then*.'

Communication systems

Depending on the context, equipment can help to improve verbal H&S communication between supervisors and workers. For instance, at one site the railway lines and road level crossing separated the worksite into four discrete zones. Access to all areas of the site was possible, but it took time to walk to the different areas. The leading hand explained the importance of his radio for H&S communication: '*I'm never off it. It's essential for keeping everything flowing across the site. I couldn't do my job without it. I just made a call there to the guys across the road letting them know there was a delivery truck on its way. I'm going to head over there now to help guide it in and visually inspect it's in a safe condition to enter the site, as we have had a few trucks sent away for safety issues. The last one had material on without adequate handrails so we had to send it away*.'

In other contexts, where it was noisy, a public address (PA) system was to be used to improve H&S communication. The researcher observed a site manager during a pre-start meeting state: '*We should definitely have the PA system in here tomorrow. I know with the rain and trains going past it is not easy to hear. And if it is not here tomorrow, then I'll get a f**king karaoke machine.'*

Visual communication

While the H&S-related information was shared verbally, in noisy environments hand signals were also used. One driller explained how he communicated with other team members by way of hand signals: '*I can't hear Jim* [driller] *so the only way to communicate is hand signals. For instance two fingers like this means put the spanner in, and depending on which way I rotate my hand and arm lets him know which way to go in. And on this site, communicating the trip hazards, pointing them out, to keep each other safe*.'

An excavator operator similarly explained that he used hand signals to communicate with a labourer in his workgroup because they were not close enough to effectively use verbal communication. Excavator operator: '*I work closely with the labourer, he's communicating with me all the time, pointing out where services are while I dig.*'

Documentation

Various forms of H&S documentation were also used to record and share H&S-related information. Although, as has already been noted, the effectiveness of written documents for communicating H&S information to workers was questioned by participants. This was due to:

- workers' preference for verbal or visual forms of communication,
- workers not having sufficient time to read documentation, and
- content being developed without significant worker input.

For example, in a safety culture training session, a construction worker described how: '*Take Five's, JSAs, and SWMSs are useful, as long as you have time to read it, understand it, do it properly and make amendments'.*

A driller explained: '*There is so much paperwork that if you did it all properly you would stretch the job out. Do you want to do that? No just get in and get the job done*.'

SWMSs and other forms of written H&S documentation were considered to be a useful mechanism through which the site management team could collate and share H&S knowledge relevant to particular (high risk) work tasks or processes. However, it was recognised that these documents needed to be 'living documents' that are updated as necessary to reflect changes to site conditions or contexts. One project manager explained: '*That is why we have change management guys with speciality in the five work areas, rail, civils, structures, etc. When a change has been made to the original plan, these guys can sign it off, and it is a 10 minute process*.'

Core group of workers

An additional observation about H&S effectiveness relates to contractors' preference to attract and retain a core group of workers at a worksite, who develop a shared understanding of the contractors' H&S values and expected ways of working. Establishing long term supply relationships in the fragmented construction industry context is difficult but regarded as having a positive H&S impact. One H&S advisor stated: '*It is so hard to get the subcontractors you want because there is so much government work going on at the moment. You just can't get them. So then you are left with subbies you don't know, and you don't know what you are getting with them. And how do you get them to work the way we expect here, especially when they are just coming in and out. It's hard*.'

One site superintendent explained: '*We look after them* [the core subcontractor group], *and they look after us. It is all about relationships, and establishing relationships with the guys. If you have that then you can be open about safety with each other. You can say whatever you want, as long as it is in the right way, cause the guys know you mean well. They know you care. It's all relationships. And that is the challenge with the subcontractors, who might only be here for a couple weeks, and have worked on different projects that don't have the same expectations as us*.'

The importance of social interactions outside work and good relationships between workers within subcontracted work crews was also regarded as important for H&S. One supervisor explained: '*They all are mates out of work. They remind each other about safety. Whatever it is. For example, reminding each other that they need a headlight for night work. That's safety knowledge they need. No light, no work*.'

Part 6: Discussion and conclusions

6.1 What management actions at site and supervisor levels have a positive (and/or negative) impact on H&S?

Previous research suggests that leadership style is a strong determinant of H&S perceptions and behaviours. Our results confirm that, in the Australian construction industry context, frontline leaders, and particularly supervisors, play a key role in the creation of a strong and supportive H&S climate within the workgroups that they lead. This, in turn, influences workers to increase their H&S-related behaviours.

All supervisory leadership behaviours measured in the survey were positively correlated with the workgroup H&S climate. Further, the workgroup H&S climate fully mediated the relationship between leadership behaviours and workers' self-reported H&S-related behaviours. This suggests that supervisors' leadership has a positive impact on workers' H&S-related behaviour through the development of workgroup climates that support H&S.

The survey also showed that supervisory leadership and group climate varied significantly between workgroups, indicating that a variety of leadership approaches exist in the Australian rail construction environment and that, as a result, workgroup H&S climates vary in the extent to which they are supportive of H&S.

Thus, supervisors display different leadership behaviours. Over time, workers' observation of these behaviours creates shared understandings of the priority placed on H&S within a workgroup. These shared understandings are not likely to be based on single events but on observed patterns of supervisory behaviour over a period of time. In particular, the simplicity and clarity of H&S messages, consistency of behaviour in different circumstances and between espoused priorities and actions, are likely to contribute to the development of workgroup level climates.

While workgroups varied significantly in terms of leadership, climate and self-reported H&S participation, no significant differences were observed between workgroups in self-reported H&S compliance behaviour.

The on-site observation of supervisors and informal site-based conversations with workers identified a number of leadership behaviours perceived to have a positive H&S impact. These were:

- being organised and planning work in advance to anticipate and manage H&S hazards,
- setting a good example by maintaining high standards for H&S,
- establishing a consistent approach and fostering a sense of shared purpose with regard to H&S within the group,
- understanding individual workers' circumstances and responding to individuals' needs,
- eliciting respect through being experienced and demonstrating practical technical capability,

- creating a trusting environment in which workers are listened to and are able to voice concerns,
- being loyal and protecting the interests of workgroup members, and
- recognising and reinforcing good H&S practices.

Some of these reflect workers' perceptions of supervisors' competence and capability, for example being organised, well-planned and technically competent.

However, others reflect a relationship-oriented leadership approach in which supervisors develop a mutual trust, respect and liking for workers and demonstrate concern for their health, safety and wellbeing. According to theories of social exchange, workers reciprocate by engaging in behaviour valued by supervisors. When supervisors have strong relationships with workers and are perceived to value H&S, workers are more likely, through this reciprocal process of social exchange, to engage in proactive H&S behaviour (Clarke, 2013).

Our field-based observation of construction supervisors' interactions with workers revealed that supervisors who are sensitive to workers' needs and supportive of their individual goals were identified as being more effective H&S leaders. Workers who perceived their supervisors as being supportive of their personal needs expressed respect for their supervisors. Supervisors who are 'in tune' with workers' emotional and physical states also feel able to intervene in the event that a worker may be fatigued, distracted or otherwise unfit for work.

This ability to understand and respond to workers' personal and professional needs and concerns is analogous to individualised concern (a component of transformational leadership).

The workers and supervisors we spoke to suggested that the supervisory behaviour of seeking workers' input into pre-start meetings and other planning opportunities has a positive H&S impact. Workers who are engaged in this way are likely to feel involved and encouraged to take personal responsibility for safety because they have had an input into the development of work processes. The creation of a trusting environment was seen as a key factor in such worker engagement.

Similarly, Clarke and Ward (2006) describe how workers positively respond to 'rational' influence behaviour in which supervisors use persuasive communication, logical argument and factual evidence to encourage H&S behaviour. The intellectual stimulation component of transformational leadership reflects the extent to which a leader seeks workers' perspectives on problems and considers a wide variety of opinions in making decisions. The workers we spoke to in the course of this research described how supervisors who ask for ideas for H&S improvement convey to workers that their opinions are valued which will, in turn, increase workers' H&S-related behaviour. It is likely that, when workers have input into the design of rules and procedures, these procedures will be more practical and applicable, and workers will be more likely to comply with them.

While most of the supervisory behaviours identified in our site-based field observation were analogous with components of transformational leadership, supervisors and workers also identified behaviours more typically associated with transactional leadership as having a positive H&S impact.

In particular, active forms of transactional leadership involving the anticipation of problems, proactive monitoring of workers' behaviour, and correction of errors before they lead to H&S problems, were identified as supervisory behaviours having a positive impact. The workers we spoke to on-site identified supervisors who are organised, plan work, clearly communicate their expectations, and are vigilant in monitoring and maintaining compliance with safe and healthy ways of working as being effective H&S leaders.

These leaders promote compliance with H&S rules and regulations (for example, the use of protective clothing and housekeeping) by workers, which is of critical importance in high risk work environments, such as rail construction.

In contrast to active leadership, the construction workers we spoke to commented on the negative H&S impact of supervisors who react to issues only after a problem has become apparent, or who fail to act quickly and decisively if something is wrong.

Such passive or laissez-faire leadership approaches have been linked to poor H&S performance in previous studies outside the construction industry (Kelloway et al., 2006).

Construction workers we spoke to also described some supervisors as adopting 'forcing' or 'hard' influence tactics in relation to H&S (Clarke & Ward, 2006). Supervisors using such tactics seek to influence behaviour by making threats or exerting pressure to ensure compliance with requests. It was perceived that the use of such tactics would have a negative impact on H&S because they would:

- create hostility between supervisors and workers,
- foster resentment of H&S rules and procedures, and
- encourage workers to break rules, unless being closely observed at all times.

The workers and supervisors we observed and spoke to explained that using abusive or hostile language when issuing H&S instructions or providing corrective feedback was likely to have a negative H&S impact.

6.2 What site management/supervisor behaviour motivates workers to comply with H&S procedures and participate in H&S activities?

The research showed that aspects of both transformational and transactional leadership are important for H&S climate and performance within workgroups in the rail construction context. All aspects of leadership measured were positively correlated with H&S climate and self-rated H&S-related behaviour. These include leaders'/supervisors':

- communication practices,
- fostering an acceptance of group goals,
- providing an appropriate model,
- providing intellectual stimulation, and
- providing contingent reward.

Despite these strong and significant correlations, the regression analyses revealed different predictors of self-reported H&S compliance and participation.

Although closely correlated, H&S compliance and participation are distinct forms of behaviour. H&S compliance relates to in-role behaviour, such as following safety rules and procedures. H&S participation relates to proactive, extra-role or organisational citizenship behaviours (OCBs), for example:

- helping coworkers,
- making suggestions for H&S improvement, and
- engaging in H&S activities and training (Hoffmeister et al., 2014; Clarke, 2013).

Our study shows that the transformational leadership behaviour of providing an appropriate model was a significant predictor of self-reported H&S participation. Supervisors serve as role models for desired H&S-related behaviours to group members. Our results show that when supervisors lead the workgroups by 'doing' rather than just 'telling', group members are more likely to engage in H&S-related participation.

The transactional leadership behaviour of providing contingent reward (combined with having effective communication practices) were positive predictors of H&S-related compliance. Contingent reward involves clearly communicating which behaviours are desired in a given context and what the rewards for such behaviours will be, as well as following through to reinforce these desired behaviours when they are observed. Contingent rewards do not need to be material. For example, Zohar and Luria (2003) report that social incentives, such as recognition, praise and personal attention, are as least as effective as financial incentives. Our results show that, when supervisors are effective communicators and recognise and reward workers' good practices, group members are more likely to report high levels of H&S compliance behaviour.

These findings are consistent with previous studies that link transformational leadership most strongly to H&S participation and transactional leadership most strongly to compliance (Christian et al., 2009).

In our study, construction workers also perceived themselves as performing more compliance H&S behaviours than participation H&S behaviours. This is consistent with studies in other industries (e.g. Neal et al., 2000; Neal & Griffin, 2006; Zacharatos et al., 2005).

The statistically significant relationship between transformational leadership (particularly providing an appropriate model) and H&S participation is important because proactive H&S-related behaviour is recognised to be a key feature of H&S effectiveness in modern organisational environments (Fugas et al., 2011).

The positive impact of supervisors leading by example in relation to H&S was also a key theme in our on-site conversations with supervisors and workers. It was noted that supervisors' behaviour is typically observed and treated as the minimum level of compliance required. Thus, if supervisors 'cut corners' with regard to H&S, this is observed and becomes part of accepted or normative practice within workgroups.

6.3 What are the effective ways for site managers/supervisors to communicate H&S expectations and information to workers?

Our survey results show that supervisors' H&S communication practices were a positive predictor of workgroup H&S climate and workers' self-reported H&S compliance behaviour. To demonstrate good H&S communication practices supervisors should be easy to approach and talk to, willing to listen to workers' H&S concerns, and open to workers' ideas for H&S improvement.

In terms of the qualities of communication that are important for H&S, the on-site field observation identified supervisors' authenticity and consistency as key components of effective H&S-related communication.

One challenge associated with communicating H&S expectations relates to the fact that the benefits of unsafe behaviour (e.g. expected productivity gains) can sometimes seem to outweigh the benefits of working safely, particularly when working under time pressures. This is because H&S behaviour mostly results in non-events, while unsafe behaviour can produce immediate tangible benefits (e.g. earlier completion of a task, perhaps even a bonus payment) (Zohar & Luria, 2003).

In this context, it is therefore extremely important that supervisors:

- provide clear and unambiguous messages about H&S expectations,
- do not change these in response to events or situations (for example, slippages in work program), and
- ensure that their behaviours always reflect their espoused goals and priorities.

Our site-based observation of supervisors revealed that maintaining high standards of H&S and demonstrating consistent behaviour in relation to H&S were believed to have a positive H&S impact. Our results also suggest that supervisors act as important role models. Workers who observe their supervisors behaving safely will be more likely to behave in a safe and healthy manner themselves.

The site-based observation of supervisors and construction workers showed that effective communication between supervisors and workers is characterised by:

- regular and frequent informal interactions,
- authenticity of messages and consistent supervisory behaviours,
- two-way communication and actively listening to workers,
- respectful, open and honest communication, and
- making messages personalised to workers.

The social network analysis results also revealed a range of different communication and information exchange patterns within workgroups. Workgroups varied in terms of the density of communication between members, the centrality of the supervisor in terms of giving and receiving H&S-related information and the extent to which information flows were centralised around a few key group members.

The small number of workgroups in the analysis made statistical analysis of the social network findings difficult. However, groups with high network density (i.e. a high proportion of communication links relative to those possible) generally had supervisors that were rated higher for communication practices and other leadership behaviours, as well as stronger H&S climates and higher levels of self-reported H&S compliance and participation among group members.

Workgroups in which supervisors played a central role in receiving and giving H&S-related information were also high in intellectual stimulation, H&S climate and self-reported H&S compliance. This is likely to be indicative of effective H&S consultative mechanisms in such workgroups as supervisors share H&S information and seek meaningful input from workers in relation to H&S and work processes.

Our analysis revealed that in workgroups in which H&S information is frequently shared between the majority of members (i.e. those with low out-degree centralisation) there is a stronger relationship between the group H&S climate and H&S-related behaviour. This finding suggests that frequent, two-way sharing of H&S information between all members of a group is likely to produce 'crystallised' beliefs about what is important and augment the impact of these beliefs on H&S behaviour.

Thus, supervisors play an important role in creating a workgroup context that places a high value on working safely and healthily by communicating what ought to be done in relation to H&S (Fugas et al., 2011). These injunctive norms (i.e. supervisors' directives about what ought to be done in relation to H&S) are 'crystallised' within the workgroup through communication and information exchanges between members. This process of crystallisation, in turn, creates strong descriptive norms and a shared view of the way work is to be done among group members. This, in turn, is likely to increase workers' H&S-related behaviour and performance in the workgroup.

6.4 What communication methods maximise the retention and application of H&S knowledge?

Supervisors' communication practices were a predictor of workers' self-reported H&S compliance behaviour among rail construction workers who participated in the study.

On-site observation and informal conversations with supervisors and workers indicated that a variety of communication methods are used to communicate H&S information between supervisors and workers, or between coworkers in a workgroup. These include:

- informal verbal interactions (e.g. during a work task),
- formal verbal interaction (e.g. at a pre-start meeting),
- visual communication (e.g. hand signals),
- written documentation (e.g. SWMSs), and
- the use of communication systems (e.g. radios).

Pre-start meetings were identified as a particularly important way to communicate task-specific H&S information at the beginning of the working day and to get an understanding of what other work will be going on in the site environment that could impact workers' H&S. Supervisors are

identified as being critical to the effectiveness of the pre-start meetings. Consequently supervisors' ability to engage workers in pre-start meetings was regarded as important for supervisory effectiveness.

Effective supervisors were observed to be those who used prompts and questions to ensure important information was understood, and allowed workers to ask questions or raise concerns. In particular, ensuring that workers were not made to feel silly if they asked questions was considered to be important.

Workers explained that pre-start meetings should not contain generic H&S information covered in site inductions, but should be task-focused and targeted to the hazards workers are likely to experience in the day ahead.

Although pre-start meetings are considered to be effective (if run well), workers and supervisors observed that frequent interactions throughout the course of the working day were needed to act as a 'trigger' for H&S practices and to reinforce safe and healthy ways of working. Thus, while formal communication mechanisms are regarded as a useful way of providing H&S knowledge to workers, informal interactions between workers and supervisors, and between coworkers, were perceived to be necessary to ensure that knowledge is consistently put into practice. This finding is consistent with the finding of Alsamadani et al. (2013) who found that top H&S performing work crews rely on a mix of formal H&S instruction and informal H&S interactions in the US construction context.

Written forms of communication, particularly SWMSs were regarded as being less effective methods of communicating H&S information to workers than verbal methods of delivery as workers are:

- less likely to read long and sometimes complicated documents, and
- may even sign them without reading them.

6.5 What tools and methods can be used to improve H&S communication and worker engagement in H&S?

Recognising the importance of daily informal H&S-related interactions (as noted above), Kines et al. (2010) developed and evaluated a coaching and feedback program for construction supervisors. Supervisors were provided with eight bi-weekly coaching sessions about how to include safety issues in their daily verbal exchanges with workers. On-site interviews were conducted with workers about the most recent exchanges with their foremen/supervisors, and foremen/supervisors received bi-weekly feedback regarding three of the verbal exchange dimensions (i.e. production, quality and safety). The program resulted in a significant increase in H&S-related interactions (with no reduction in interactions relating to other project objectives, such as production or quality). The research also indicated increased H&S-related behaviours, levels of physical site safety and, in some workgroups, an improved H&S climate (Kines et al., 2010).

However, increasing the number of daily H&S-related interactions by itself may not be sufficient to improve H&S performance in all instances. In certain circumstances increased H&S communication can potentially be seen as management paying 'lip service' to H&S and consequently it is very important that supervisors are considered to be trustworthy and authentic. Simons (2002) argues that behavioural integrity (i.e., congruence between actions and words) is an important component organisational effectiveness.

Our site-based observations of construction supervisors and workers revealed some techniques that are currently being used. For example, one supervisor described holding short 'workshops' to engage workers and elicit their ideas for H&S improvements, and/or to discuss the lessons to be learned from H&S incidents.

H&S culture training was also identified as an important opportunity to develop supervisory capability in leadership and engagement in relation to WHS.

6.6 What can be done to maximise the positive H&S impact of site management/supervisor behaviour?

The results suggest that supervisory leadership is important for H&S. However, workers described to us that not all supervisors are effective leaders. Some were identified as adopting 'hard' influence tactics, while others saw their role as H&S enforcers. Workers described how effective supervisors are loyal and look out for their workgroup members, while others noted that not all supervisors behave in this way.

The variation in supervisors' leadership styles was also evident in the survey in which there was significant variation between workgroups in all aspects of supervisory leadership.

Supervisors play a critical role, acting as the conduit between management and the workforce. They must operationalise formal H&S policies and procedures, respond to changing worksite conditions and take responsibility for the achievement of multiple (sometimes competing) project goals. It was noted by managers that supervisors can find this role stressful and are sometimes poorly equipped to deal with the leadership aspects of their work. They have typically not undergone management/leadership training but possess extensive experience and technical skill.

Given this situation, supervisory leadership development programs are potentially valuable. However, the results also suggest that these programs need to be targeted to the elements of leadership and behaviours that make a difference. Rather than deal with general leadership principles, leadership development for construction supervisors should focus on the development of concrete skills and behaviours relevant to their roles. Further, leadership should not be treated as a unitary concept because different leadership behaviours influence H&S through different mechanisms and in different ways. Transformational and transactional leadership styles have been identified as being important to H&S performance in other safety-critical industries, and our results indicate that this finding also applies in construction.

Previous research conducted by Conchie et al. (2013) indicates that, in order to improve supervisors' engagement in safety leadership, it is important to provide supervisors with a supportive environment characterised by social support and autonomy.

Supervisors commented that having a supportive manager is crucial in their efforts to engage in good safety leadership. This is because the support from managers enhances supervisors' confidence that their leadership behaviours will be 'backed-up' (Conchie et al., 2013).

Another particularly important aspect of social support is the support from peers, i.e. other supervisors. Supervisors share high inter-dependency in terms of their ability to complete tasks and coordinate work. Supervisors also share many similar views of H&S and working procedures. Peer-to-peer supervisor support can enhance supervisors' self-esteem and self-efficacy. A potential way to increase peer support is to provide opportunities for communication and cooperation between supervisors through supervisor forums and other such events (Conchie et al., 2013).

6.7 What can be learned about H&S leadership from other industries and contexts?

Our results are consistent with research conducted in other industries and contexts. That is, a transformational leadership style is more strongly related to H&S participation, while a transactional leadership style is more strongly related to H&S-related compliance behaviour. However, both transactional and transformational leadership are important and positively linked to H&S climate and performance.

However, there is a growing understanding that a uniform leadership style or set of behaviours may not be applicable to all situations. In particular, research shows that effective leadership behaviours vary depending on the level of H&S risk in a work environment.

Thus, safety critical industries, such as oil and gas installations, mining, or military operations are inherently dangerous. In these contexts, there is a low tolerance for deviations from H&S standards because such deviations can produce serious safety consequences.

Such safety-critical industrial environments are also characterised by ambiguity and competing demands, and workers interpret cues in the work environment to determine appropriate behaviours.

In such contexts, directive forms of leadership that reduce ambiguity and make clear the priority placed on H&S may more important than leadership that inspires and motivates, but which does not resolve inherent ambiguities.

Willis et al. (2017) report that the perceived risk of a safety incident moderates the relationship between leadership style and H&S behaviour and performance. They compared manufacturing (a relatively low risk environment) with an oil and gas installation (a complex, high risk environment). They report that when the perceived risk of a safety incident is high, a directive management by exception (active) leadership style is strongly related to H&S behaviour and

performance. This directive leadership style was not linked to H&S behaviour and performance when the risk of a safety incident was perceived to be low. Conversely, transformational leadership was found to be less strongly related to these performance outcomes in contexts where safety was perceived as highly critical.

The lessons for supervisory leadership in rail construction are important because rail construction is a safety-critical work context in which deviation from H&S standards has the potential to result in serious safety consequences. The work environment is complex and subject to ambiguity and competing demands, particularly in periods of high work intensity (such as during full occupations). This was noted by participants in our study. In this context, supervisors' ability to engage in sensemaking and reduce ambiguity through setting clear directions and maintaining high levels of situational awareness are likely to be important and effective (also see Baran & Scott, 2010).

Part 7: References

Aiken, L., West, S., & Reno, R. (1991). *Multiple regression: Testing and interpreting interactions*. Sage.

Alsamadani, R., Hallowell, M., & Javernick-Will, A. (2013). Measuring and modelling safety communication in small work crews in the US using social network analysis. *Construction Management and Economics*, *31*(6), 568-579.

Arditi, D., & Chotibhongs, R. (2005). Issues in subcontracting practice. *Journal of Construction Engineering and Management*, 131, 866-876.

Aronson, J. (1994). A pragmatic view of thematic analysis. *The Qualitative Report*, *2*(1), 1-3.

Ashforth, B. (1994). Petty tyranny in organizations. *Human Relations*, *47*(7), 755-778.

Avolio, B., Gardner, W., Walumbwa, F., Luthans, F., & May, D. (2004). Unlocking the mask: A look at the process by which authentic leaders impact follower attitudes and behaviors. *Leadership Quarterly*, *15*, 801-823.

Baran, B., & Scott, C. (2010). Organizing ambiguity: A grounded theory of leadership and sensemaking within dangerous contexts. *Military Psychology*, *22*(S1), S42-S69.

Barling, J., Loughlin, C., & Kelloway, E. (2002). Development and test of a model linking safety-specific transformational leadership and occupational safety. *Journal of Applied Psychology, 87*(3), 488-496.

Baron, R., & Kenny, D. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology*, *51*, 1173-1182.

Bass, B. (1985). *Leadership and performance beyond expectation*. New York: Harper & Row.

Bass, B. (1990). From transactional to transformational leadership: Learning to share the vision. *Organizational Dynamics*, *18*(3), 19-31.

Bass, B., & Avolio, B. (1990). *Transformational leadership development: Manual for the Multifactor Leadership Questionnaire*. Palo Alto, CA: Consulting Psychologists Press.

Bass, B., & Avolio, B. (1994). *Full range leadership development: Manual for the Multifactor Leadership Questionnaire* (pp. 43-44). Palo Alto, CA: Mind Garden.

Bass, B., Avolio, B., Jung, D., & Berson, Y. (2003). Predicting unit performance by assessing transformational and transactional leadership. *Journal of Applied Psychology*, *88*(2), 207.

Bass, B., & Riggio, R. (2006). *Transformational leadership*. Mahwah, NJ: Lawrence Erlbaum Associates.

Birkeland Nielsen, M., Eid, J., Mearns, K., & Larsson, G. (2013). Authentic leadership and its relationship with risk perception and safety climate. *Leadership & Organisation Development Journal*, *34*(4), 308-325.

Blismas, N., Sher, W., Thorpe, A., & Baldwin, A. (2004a). A typology for clients' multi-project environments. *Construction Management and Economics*, *22*(4), 357-371.

Blismas, N., Sher, W., Thorpe, A., & Baldwin, A. (2004b). Factors influencing project delivery within construction clients' multi-project environments. *Engineering, Construction and Architectural Management*, *11*(2), 113-125.

Borgatti, S., & Everett, M. (2006). A graph theoretic framework for classifying centrality measures. *Social Networks*, *28*(4), 466-484.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101.

Breslin, F., Polzer, J., MacEachen, E., Morrongiello, B., & Shannon, H. (2007). Workplace injury or 'part of the job'? Towards a gendered understanding of injuries and complaints among young workers. *Social Science and Medicine*, *64*, 782-793.

Burt, C., Sepie, B., & McFadden, G. (2008). The development of a considerate and responsible safety attitude in work teams. *Safety Science*, *46*, 79-91.

Cheyne, A., Oliver, A., Tomas, J., & Cox, S. (2002). The architecture of employee attitudes to safety in the manufacturing sector. *Personnel Review*, *31*(5/6), 649-670.

Chiaburu, D., & Harrison, D. (2008). Do peers make the place? Conceptual synthesis and meta-analysis of coworker effects on perceptions, attitudes, OCBs and performance. *Journal of Applied Psychology*, *93*, 1082-1103.

Choudhry, R. & Fang, D. (2008). Why operatives engage in unsafe work behavior: Investigating factors on construction sites. *Safety Science*, *46*, 566-584.

Christian, M., Bradley, J., Wallace, C., & Burke, M. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, *94*, 1103-1127.

Cigularov, K., Chen, P., & Rosecrance, J. (2010). The effects of error management climate and safety communication on safety: A multi-level study. *Accident Analysis & Prevention*, *42*(5), 1498-1506.

Clarke, S. (1999). Perceptions of organisational safety: Implications for the development of a safety culture. *Journal of Organisational Behaviour*, *20*(2), 185-198.

Clarke, S., & Ward, K. (2006). The role of leader influence tactics and safety climate in engaging employees' safety participation. *Risk Analysis*, *26*(5), 1175-1185.

Clarke, S. (2013). Safety leadership: A meta-analytic review of transformational and transactional leadership styles as antecedents of safety behaviours. *Journal of Occupational and Organizational Psychology*, *86*(1), 22-49.

Cohen, J., Cohen, P., West, S., & Aiken, L. (2003). *Applied multiple regression/correlation analysis for the behavioural sciences.* Mahwah, New Jersey: Lawrence Erlbaum Associates.

Conchie, S., & Burns, C. (2008). Trust and risk communication in high-risk organisations: A test of principles from social risk research. *Risk Analysis*, *28*(1), 141-149.

Conchie, S., & Donald, I. (2009). The moderating role of safety-specific trust on the relation between safety-specific leadership and safety citizenship behaviors. *Journal of Occupational Health Psychology*, *14*(2), 137.

Conchie, S., Donald, I., & Taylor, P. (2006). Trust: Missing piece(s) in the safety puzzle. *Risk Analysis*, *26*(5), 1097-1104.

Conchie, S., Moon, S., & Duncan, M. (2013). Supervisors' engagement in safety leadership: Factors that help and hinder. *Safety Science*, *51*(1), 109-117.

Conchie, S., Taylor, P., & Donald, I. (2012). Promoting safety voice with safety-specific transformational leadership: The mediating role of two dimensions of trust. *Journal of Occupational Health Psychology*, *17*(1), 105.

Cox, S., & Cheyne, A. (2000). Assessing safety culture in offshore environments. *Safety Science*, *34*(1-3), 111-129.

Dekker, S. (2003). Failure to adapt or adaptations that fail: Contrasting models on procedures and safety. *Applied Ergonomics*, *34*(3), 233-238.

Denscombe, M. (1998). *The good research guide: For small-scale social research projects*. Buckingham: Open University Press.

Detert, J., & Burris, E. (2007). Leadership behavior and employee voice: Is the door really open? *Academy of Management Journal*, *50*(4), 869-884.

Eisenberg, E., & Witten, M. (1987). Reconsidering openness in organisational communication. *Academy of Management Review*, *12*(3), 418-426.

Fang, D., Yang, C., & Wong, L. (2006). Safety climate in construction industry: A case study in Hong Kong. *ASCE Journal of Construction Engineering and Management*, *132*, 573-584.

Findley, M., Smith, S., Gorski, J., & O'Neil, M. (2007). Safety climate differences among job positions in a nuclear decommissioning and demolition industry: Employees' self-reported safety attitudes and perceptions. *Safety Science*, *45*, 875-889.

Finneran, A., Hartley, R., Gibb, A., Cheyne, A., & Bust, P. (2012). Learning to adapt health and safety initiatives from mega projects: An Olympic case study. *Policy Practice Health Safety*, *10* (2), 81-102.

Fleming, M., & Lardner, R. (2002). *Strategies to promote safe behaviour as part of a health and safety management system*.

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: Identifying the common features. *Safety Science*, *34*(1-3), 177-192.

Flin, R., & Yule S. (2004). Leadership for safety: Industrial experience. *Quality and Safety in Health Care*, *13*, 45-51.

Freeman, L. (1977). A set of measures of centrality based on betweenness. *Sociometry*, *40*, 35-41.

Fugas, C., Meliá, J., & Silva, S. (2011). The “is” and the “ought”: How do perceived social norms influence safety behaviors at work? *Journal of Occupational Health Psychology*, *16*(1), 67.

Glendon, A., & Litherland, D. (2001). Safety climate factors, group differences and safety behaviour in road construction. *Safety Science*, *39*, 157-188.

Gouldner, A. (1960). The norm of reciprocity: A preliminary statement. *American Sociological Review*, 161-178.

Graen, G., & Uhl-Bien, M. (1995). Relationship-based approach to leadership: Development of leader-member exchange (LMX) theory of leadership over 25 years: Applying a multi-level multi-domain perspective. *The Leadership Quarterly, 6*(2), 219-247.

Griffin, M., & Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation. *Journal of Occupational Health Psychology*, *5*(3), 347-358.

Guldenmund, F. (2007). The use of questionnaires in safety culture research – an evaluation. *Safety Science*, *45*(6), 723-743.

Hammersley, M., & Atkinson, P. (2007). *Ethnography: Principles in practice* (3rd ed.). Routledge.

Hardison, D., Behm, M., Hallowell, M., & Fonooni, H. (2014). Identifying construction supervisor competencies for effective site safety. *Safety Science*, *65*, 45-53.

Health and Safety Commission. (1993). *Third report: Organizing for safety, ACSNI study group on human factors*. London: Her Majesty’s Stationary Office.

Health and Safety Commission. (2001). *The Ladbroke Grove Rail inquiry. Part 2 report, the Rt Hon Lord Cullen*. London: HSE Books.

Health and Safety Executive. (2005a). *A review of safety culture and safety climate literature for the development of the safety culture inspection toolkit: Research report 367*. London: HSE Books.

Health and Safety Executive. (2005b). *Development and validation of the HMRI safety culture inspection toolkit: Research report 365*. London: HSE Books.

Hoffmeister, K., Gibbons, A., Johnson, S., Cigularov, K., Chen, P., & Rosecrance, J. (2014). The differential effects of transformational leadership facets on employee safety. *Safety Science*, *62*, 68-78.

Hofmann, D., & Stetzer, A. (1996). A cross-level investigation of factors influencing unsafe behaviours and accidents. *Personnel Psychology*, *49*, 307-339.

Hofmann, D., & Morgeson, F. (1999). Safety-related behavior as a social exchange: The role of perceived organisational support and leader-member exchange. *Journal of Applied Psychology, 84*(2), 286-296.

Inness, M., Turner, N., Barling, J., & Stride, C. (2010). Transformational leadership and employee safety performance: A within-person, between-jobs design. *Journal of Occupational Health Psychology*, *15*(3), 279-290. doi: 10.1037/a0019380

Jablin, F. (1985). Task/work relationships: A life-span perspective. In M.L. Knapp & G.R. Miller (Eds.), *Handbook of Interpersonal Communication* (pp. 615-654). Beverly Hills, CA: Sage.

Johnson, S. (2007). The predictive validity of safety climate. *Journal of Safety Research*, *38*, 511-521.

Kapp, E. (2012). The influence of supervisor leadership practices and perceived group safety climate on employee safety performance. *Safety Science*, *50*(4), 1119-1124.

Kath, L., Magley, V., & Marmet, M. (2010). The role of organizational trust in safety climate's influence on organizational outcomes. *Accident Analysis & Prevention*, *42*(5), 1488-1497.

Kelloway, E., Mullen, J., & Francis, L. (2006). Divergent effects of transformational and passive leadership on employee safety. *Journal of Occupational Health Psychology, 11*(1), 76-86.

Kines, P., Andersen, L., Spangenberg, S., Mikkelsen, K., Dyreborg, J., & Zohar, D. (2010). Improving construction site safety through leader-based verbal safety communication. *Journal of Safety Research*, *41*(5), 399-406.

Latané, B. (1981). The psychology of social impact. *American Psychologist*, *36*(4), 343-356.

LeCompte, M., & Goetz, J. (1982). Problems of reliability and validity in ethnographic research. *Review of Educational Research*, *52*(1), 31-60.

Liden, R., & Graen, G. (1980). Generalizability of the vertical dyad linkage model of leadership. *Academy of Management Journal*, *23*(3), 451-465.

Liden, R., & Maslyn, J. (1998). Multidimensionafity of leader-member exchange: An empirical assessment through scale development. *Journal of Management, 24*(1), 43-72.

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

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

Lingard, H., Zhang, R., Harley, J., Blismas, N., & Wakefield, R. (2014). *Health and safety culture*. Melbourne, Victoria: RMIT Centre for Construction Work Health and Safety Research.

Loosemore, M., & Andonakis, N. (2007). Barriers to implementing H&S reforms: The experiences of small subcontractors in the Australian construction industry. *International Journal of Project Management*, *25*, 579-588.

Lu, C., & Shang, K. (2005). An empirical investigation of safety climate in container terminal operators. *Journal of Safety Research*, *36*, 297-308.

Maierhofer, N., Griffin, M., & Sheehan, M. (2000). Linking manager values and behavior with employee values and behavior: A study of values and safety in the hairdressing industry. *Journal of Occupational Health Psychology*, *5*, 417-427.

Mayhew, C., Quinlan, M., & Ferris, R. (1997). The effects of subcontracting/outsourcing on occupational health and safety: Survey evidence from four Australian industries. *Safety Science*, *25*, 163-175.

Mearns, K., & Reader, T. (2008). Organizational support and safety outcomes: An un-investigated relationship? *Safety Science*, *46*(3), 388-397.

McDonald, M., Lipscomb, H., Bondy, J., & Glazner, J. (2009). Safety is everyone's job: The key to safety on a large university construction site. *Journal of Safety Research*, *40*, 53-61.

Melia, J., Mearns, K., Silva, S., & Lima, M. (2008). Safety climate responses and the perceived risk of accidents in the construction industry. *Safety Science*, *46*, 949-958.

Mohamed, S. (2002). Safety climate in construction site environments. *Journal of Construction Engineering and Management*, *128*, 375-384.

Molenaar, K., Park, J., & Washington, S. (2009). Framework for measuring corporate safety culture and its impact on construction safety performance. *Journal of Construction Engineering and Management*, *135*, 488-496.

Mullen, J. (2005). Testing a model of employee willingness to raise safety issues. *Canadian Journal of Behavioral Sciences*, *37*(4), 259-268.

Mullen, J., & Kelloway, E. (2009). Safety leadership: A longitudinal study of the effects of transformational leadership on safety outcomes. *Journal of Occupational and Organisational Psychology*, *82*(2), 253-272.

Mullen, J., Kelloway, E., & Teed, M. (2011). Inconsistent style of leadership as a predictor of safety behaviour. *Work & Stress*, *25*(1), 41-54.

Mullen, J., Kelloway, E., & Teed, M. (2017). Employer safety obligations, transformational leadership and their interactive effects on employee safety performance. *Safety Science*, *91*, 405-412.

Murchison, J. (2010). *Ethnography essentials: Designing, conducting, and presenting your research*. John Wiley & Sons.

Neal, A., & Griffin, M. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behaviour, and accidents at the individual and group levels. *Journal of Applied Psychology*, *91*(4), 946-953.

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

Northouse, P. (2013). *Leadership* (6th ed.). Sage publications: Thousand Oaks.

O'Dea, A., & Flin, R. (2001). Site managers and safety leadership in the offshore oil and gas industry. *Safety Science*, *37*(1), 39-57.

Olive, C., O'Connor, T., & Mannan, M. (2006). Relationship of safety culture and process safety. *Journal of Hazardous Materials*, *130*(1-2), 133-140.

O'Reilly, K. (2012). *Ethnographic methods*. Routledge.

O'Toole, M. (2002). The relationship between employees' perceptions of safety and organisational culture. *Journal of Safety Research*, *33*, 231-243.

Parker, S., Axtell, C., & Turner, N. (2001). Designing a safer workplace: Importance of job autonomy, communication quality and supportive supervisors. *Journal of Occupational Health Psychology*, *6*, 211-228.

Phelps, A., & Horman, M. (2010). Ethnographic theory-building research in construction. *Journal of Construction Engineering and Management*, *136*, 58-65.

Podsakoff, P., Mackenzie, S., Moorman, R., & Fetter, R. (1990). Transformational leader behaviors and their effects on followers' trust in leader, satisfaction, and organisational citizenship behaviors. *The Leadership Quarterly*, *1*, 107-142.

Probst, T. (2015). Organizational safety climate and supervisor safety enforcement: Multilevel explorations of the causes of accident underreporting. *Journal of Applied Psychology*, *100*(6), 1899-1907.

Pryke, S. (2012). *Social network analysis in construction*. John Wiley & Sons.

Rooke, J., Seymour, D., & Fellows, R. (2004). Planning for claims: An ethnography of industry culture. *Construction Management and Economics*, *22*(6), 655-662.

Redding, W. (1972). *Communication in the organisation: An interpretive review of the research*. New York: Industrial Communication Council.

Rowlinson, S., Mohammed, S., & Lam, S. (2003). Hong Kong construction foremen's safety responsibilities: A case study of management oversight. *Engineering, Construction and Architectural Management*, *10*, 27-35.

Shen, Y., Ju, C., Koh, T., Rowlinson, S., & Bridge, A. (2017). The impact of transformational leadership on safety climate and individual safety behavior on construction sites. *International Journal of Environmental Research and Public Health*, *14*(1), 45.

Simard, M., & Marchand, A. (1994). The behaviour of first-line supervisors in accident prevention and effectiveness on occupational safety. *Safety Science*, *17*, 169-185.

Simard, M., & Marchand, A. (1995). A multi-level analysis of organisational factors related to the taking of safety initiatives by work groups. *Safety Science*, *21*, 113-129.

Simard, M., & Marchand, A. (1997). Workgroups' propensity to comply with safety rules: The influence of micromacro organisational factors. *Ergonomics*, *40*, 172-188.

Simons, T. (2002). Behavioral integrity: The perceived alignment between managers' words and deeds as a research focus. *Organization Science*, *13*, 18-35.

Skogstad, A., Einarsen, S., Torsheim, T., Aasland, M., & Hetland, H. (2007). The destructiveness of laissez-faire leadership behavior. *Journal of Occupational Health Psychology*, *12*(1), 80.

Tepper, B. (2000). Consequences of abusive supervision. *Academy of Management Journal*, *43*(2), 178-190.

Törner, M., & Pousette, A. (2009). Safety in construction – a comprehensive description of the characteristics of high safety standards in construction work, from the combined perspective of supervisors and experienced workers. *Journal of Safety Research*, *40*(6), 399-409.

Tucker, S., Chmiel, N., Turner, N., Hershcovis, M., & Stride, C. (2008). Perceived organisational support for safety and employee safety voice: The mediating role of co-worker support for safety. *Journal of Occupational Health Psychology*, *13*, 319-330.

Tutt, D., Pink, S., Dainty, A., & Gibb, A. (2013). 'In the air' and below the horizon: Migrant workers in UK construction and the practice-based nature of learning and communicating OHS. *Construction Management and Economics*, *31*(6), 515-527.

Walumbwa, F., Avolio, B., Gardner, W., Wernsing, T., & Peterson, S. (2008). Authentic leadership: Development and validation of a theory-based measure. *Journal of Management*, *34*(1), 89-126.

Walumbwa, F., Peterson, S., Avolio, B., & Hartnell, C. (2010). An investigation of the relationships among leader and follower psychological capital, service climate, and job performance. *Personnel Psychology*, *63*(4), 937-963.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications* (Vol. 8). Cambridge University Press.

Wayne, S., Shore, L., & Liden, R. (1997). Perceived organisational support and leader-member exchange: A social exchange perspective. *Academy of Management Journal*, *40*(1), 82-111.

Westaby, J., & Lowe, J. (2005). Risk-taking orientation and injury among youth workers: Examining the social influence of supervisors, coworkers and parents. *Journal of Applied Psychology*, *90*, 1027-1035.

Willis, S., Clarke, S., & O'Connor, E. (2017). Contextualizing leadership: Transformational leadership and Management-By-Exception-Active in safety-critical contexts. *Journal of Occupational and Organisational Psychology*. 1-25.

Worksafe ACT. (2012). *Getting home safely: Inquiry into compliance with work health and safety requirements in the ACT's construction industry*. Canberra: ACT Government.

Yagil, D., & Luria, G. (2010). Friends in need: The protective effect of social relationships under low-safety climate. *Group & Organization Management*, *35*(6), 727-750.

Yammarino, F., Dionne, S., Schriesheim, C., & Dansereau, F. (2008). Authentic leadership and positive organizational behavior: A meso, multi-level perspective. *The Leadership Quarterly, 19*(6), 693-707.

Yukl, G. (1989). Managerial leadership: A review of theory and research. *Journal of Management*, *15*, 251-289.

Zacharatos, A., Barling, J., & Iverson, R. (2005). High-performance work systems and occupational safety. *Journal of Applied Psychology*, *90*(1), 77-93.

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

Zohar, D. (1980). Safety climate in industrial organizations: Theoretical and applied implications. *Journal of Applied Psychology*, *65*(1), 96.

Zohar, D. (2000). A group-level model of safety climate: Testing the effect of group climate on microaccidents in manufacturing jobs. *Journal of Applied Psychology, 85*(4), 587-596.

Zohar, D. (2002). The effect of leadership dimensions, safety climate and assigned priorities on minor injuries in work groups. *Journal of Organisational Behavior*, *23*, 75-92.

Zohar, D., & Luria, G. (2003). The use of supervisory practices as leverage to improve safety behaviour: A cross-level intervention model. *Journal of Safety Research*, *34*, 561-571.

Zohar, D., & Luria, G. (2004). Climate as a social-cognitive construction of supervisory safety practices: Scripts as proxy of behaviour pattern. *Journal of Applied Psychology*, *89*, 322-333.

Zohar, D., & Luria, G. (2005). A multilevel model of safety climate: Cross-level relationships between organisation and group-level climates. *Journal of Applied Psychology*, *90*, 616-628.

Zohar, D., & Luria, G. (2010). Group leaders as gatekeepers: Testing safety climate variations across levels of analysis. *Applied Psychology: An International Review, 59*(4), 647-673.

Zohar, D., & Tenne-Gazit., O. (2008). Transformational leadership and group interaction as climate antecedents: A social network analysis. *Journal of Applied Psychology*, *93*(4), 744-757.

Part 8: Appendix

8.1 Workers' survey

Section 1. About the client

First, we'd like to ask some questions about your involvement in this project and your impression of **the client – Level Crossing Removal Authority (LXRA)**.

How long have you worked on this project? (Please circle the appropriate number)

1. <1 week
2. Between 1 week and one month?
3. More than one month?

A series of statements are provided below. Please indicate your level of agreement with each of these statements. Please base your answers on **your experience of working at this construction project so far**.

Please select the answer that best indicates your agreement or disagreement with the following statements.		1 Strongly disagree	2 Disagree	3 Neither agree nor disagree	4 Agree	5 Strongly agree
1	Workers' safety is given a high priority by the client	○	○	○	○	○
2	The client has clearly communicated high expectations for workers' safety in this project	○	○	○	○	○

Section 2. About the Principal Contractor

Next we'd like to ask you some questions **about the principal contractor** and your interactions with them while working at this project. When answering these questions, please only **consider your experiences at this construction project** and not previous experiences working with the principal contractor.

Are you a direct employee of the principal contractor? (Please circle the appropriate number)

1. Yes
2. No

How long have you worked for or with the principal contractor? (Please circle the appropriate number)

1. 1 week
2. Between 1 week and one month?
3. Between 1 month and 6 months?
4. Between 6 months and one year?
5. More than one year?

A series of statements are provided below. Please indicate your level of agreement with each of these statements. Please base your answers on **your experience of working at this construction project so far**.

Please select the answer that best indicates your agreement or disagreement with the following statements.		1 Strongly disagree	2 Disagree	3 Neither agree nor disagree	4 Agree	5 Strongly agree
1	The principal contractor places a strong emphasis on workers' safety	○	○	○	○	○
2	I feel that the principal contractor openly accepts ideas for improving safety	○	○	○	○	○
3	I feel that the principal contractor encourages open communication about safety	○	○	○	○	○

Section 3. About your supervisor

Next we'd like to ask some questions **about your supervisor**. This is the person who **gives you day to day work instructions**.

How long have you worked with your current supervisor? (Please circle the appropriate number)

1. <1 week
2. Between 1 week and one month?
3. Between 1 month and 6 months?
4. Between 6 months and one year?
5. More than one year?

A series of statements are provided below. Please indicate your level of agreement with each of these statements. Please base your answers on your experience of working with your current supervisor **at this construction site**.

Please select the answer that best indicates your agreement or disagreement with the following statements.		1 Strongly disagree	2 Disagree	3 Neither agree nor disagree	4 Agree	5 Strongly agree
1	My supervisor insists on only the best performance	○	○	○	○	○
2	I feel comfortable discussing safety issues with my supervisor	○	○	○	○	○
3	I feel that my supervisor openly accepts ideas for improving safety	○	○	○	○	○
4	My supervisor encourages workers to be "team players"	○	○	○	○	○
5	My supervisor provides a good model for me to follow	○	○	○	○	○
6	My supervisor gets the group to work together for the same goal	○	○	○	○	○

7	My supervisor commends me when I do a better than average job	○	○	○	○	○
8	I am reluctant to discuss safety-related problems with my supervisor	○	○	○	○	○
9	My supervisor gives me special recognition when my work is very good	○	○	○	○	○
10	I feel that my supervisor encourages open communication about safety	○	○	○	○	○
11	My supervisor asks questions that prompt me to think	○	○	○	○	○
12	My supervisor challenges me to think about old problems in new ways	○	○	○	○	○
13	I try to avoid talking about safety issues with my supervisor	○	○	○	○	○
14	My supervisor leads by “doing,” rather than simply by “telling”	○	○	○	○	○
15	My supervisor always gives me positive feedback when I perform well	○	○	○	○	○
16	My supervisor leads by example	○	○	○	○	○
17	My supervisor shows us that they expect a lot from us	○	○	○	○	○
18	My supervisor expects the highest quality work	○	○	○	○	○
19	My supervisor creates a cooperative work environment within the group	○	○	○	○	○
20	My supervisor encourages me to rethink the way I work	○	○	○	○	○

Section 4. About your workgroup

Now we'd like to ask some questions **about your safety experience in your current workgroup**.

A series of statements are provided below. Please indicate your level of agreement with each of these statements. Please base your answers on **your experience of working in your current workgroup**.

Please select the answer that best indicates your agreement or disagreement with the following statements.		1 Strongly disagree	2 Disagree	3 Neither agree nor disagree	4 Agree	5 Strongly agree
1	People in this workgroup want to achieve high levels of safety	○	○	○	○	○
2	In this workgroup, workers discuss ways to prevent errors from happening again	○	○	○	○	○
3	Safe working is a condition of employment in this workgroup	○	○	○	○	○
4	I fully understand the health and safety risks associated with my work	○	○	○	○	○
5	In this workgroup, coworkers remind each other to take precautions	○	○	○	○	○
6	In this workgroup, I stop working if I think it would be dangerous for me to continue	○	○	○	○	○

Section 5. About yourself

Finally, we'd like to ask you about **your own safety-related behaviour and experiences**.

Please select the answer that best indicates your agreement or disagreement with the following statements :		1 Strongly disagree	2 Disagree	3 Neither agree nor disagree	4 Agree	5 Strongly agree
1	I use all the necessary safety equipment to do my job	○	○	○	○	○
2	I use the correct safety procedures for carrying out my job	○	○	○	○	○
3	I ensure the highest levels of safety when I carry out my job	○	○	○	○	○
4	I promote the safety program in the workplace	○	○	○	○	○
5	I put in extra effort to improve the safety of the workplace	○	○	○	○	○
6	I voluntarily carry out tasks or activities that help to improve workplace safety	○	○	○	○	○

Thank you. We appreciate you taking the time to participate in this survey.

8.2 Supervisors' survey

Section 1. About the principal contractor

First we'd like to ask some questions **about the principal contractor.**

A series of statements are provided below. Please indicate your level of agreement with each of these statements. Please base your answers on **your experience of working at this construction project so far.**

How long have you worked for or with the principal contractor? (Please circle an appropriate number)

1. <1 week
2. Between 1 week and one month?
3. Between 1 month and 6 months?
4. Between 6 months and one year?
5. More than one year?

Please select the answer that best indicates your agreement or disagreement with the following statements.		1 Strongly disagree	2 Disagree	3 Neither agree nor disagree	4 Agree	5 Strongly agree
1	The principal contractor places a strong emphasis on workers' safety	○	○	○	○	○
2	Workers' safety is given a high priority by the principal contractor	○	○	○	○	○
3	I feel that the principal contractor openly accepts ideas for improving safety	○	○	○	○	○
4	I feel that the principal contractor encourages open communication about safety	○	○	○	○	○

Section 2. About your supervisor at this site

Now we'd like to ask some questions **about your supervisor at this site**. This is **the person who you report to at this site**.

A series of statements will be provided. Please indicate your level of agreement with each of these statements. Please base your answers on **your experience of working with the supervisor at this site.**

Please select the answer that best indicates your agreement or disagreement with the following statements.		1 Strongly disagree	2 Disagree	3 Neither agree nor disagree	4 Agree	5 Strongly agree
1	At this site, my supervisor insists on only the best performance	○	○	○	○	○
2	At this site, my supervisor has a clear understanding of where we are going	○	○	○	○	○
3	At this site, I feel comfortable discussing safety issues with my supervisor at this site	○	○	○	○	○
4	I feel that my supervisor at this site openly accepts ideas for improving safety	○	○	○	○	○
5	At this site, my supervisor will not settle for second best	○	○	○	○	○
6	At this site, my supervisor encourages workers to be "team players"	○	○	○	○	○
7	At this site, my supervisor fosters collaboration among work groups	○	○	○	○	○
8	At this site, my supervisor is able to get others committed to his/her dream	○	○	○	○	○
9	At this site, my supervisor provides a good model for me to follow	○	○	○	○	○

10	At this site, my supervisor gets all subcontractors and workers to work together for the same goal	○	○	○	○	○
11	At this site, my supervisor develops a team attitude and spirit among workers	○	○	○	○	○
12	At this site, my supervisor has ideas that have challenged me to re-examine some basic assumptions about my work	○	○	○	○	○
13	At this site, my supervisor commends me when I do a better than average job	○	○	○	○	○
14	I am reluctant to discuss safety-related problems with my supervisor at this site	○	○	○	○	○
15	At this site, my supervisor behaves in a manner thoughtful of my personal needs	○	○	○	○	○
16	At this site, my supervisor gives me special recognition when my work is very good	○	○	○	○	○
17	At this site, my supervisor inspires others with their plans for the future	○	○	○	○	○
18	I feel that my supervisor at this site encourages open communication about safety	○	○	○	○	○
19	At this site, my supervisor asks questions that prompt me to think	○	○	○	○	○
20	At this site, my supervisor challenges me to think about old problems in new ways	○	○	○	○	○
21	I try to avoid talking about safety issues with my supervisor at this site	○	○	○	○	○

22	At this site, my supervisor has stimulated me to rethink the way I do things	○	○	○	○	○
23	At this site, my supervisor leads by “doing,” rather than simply by “telling”	○	○	○	○	○
24	At this site, my supervisor shows respect for my personal feelings	○	○	○	○	○
25	At this site, my supervisor always gives me positive feedback when I perform well	○	○	○	○	○
26	At this site, my supervisor personally compliments me when I do outstanding work	○	○	○	○	○
27	At this site, my supervisor paints an interesting picture of the future for the project	○	○	○	○	○
28	At this site, my supervisor acts without considering workers’ feelings	○	○	○	○	○
29	At this site, my supervisor leads by example	○	○	○	○	○
30	At this site, my supervisor shows us that they expect a lot from us	○	○	○	○	○

Thank you. We appreciate you taking the time to participate in this survey.

8.3 Glossary and explanation of social network analysis terms

Valued density

Network density is a measure of the overall communication activity in the network. Valued density reflects the ratio of total tie values (communication frequency) present in a network to the maximum possible number of ties the network could have. Thus, as proportionally stronger ties (which are more conductive of information exchange) are formed in a communication network, the valued density of the network increases. To calculate the valued density, the frequency of H&S communication (measured on a five-point Likert response format) exchanged between workgroup members was used as the tie value. Thus, a high valued density means, on average, a high frequency of H&S information exchange between workgroup members.

Normalised degree centrality

Degree centrality is a node-level measure. Degree centrality reflects the extent to which one participant is connected to other participants in a network. If a participant possesses high degree centrality, then they are highly involved in communication within the network relative to others. Degree centrality is sensitive to network size (number of participants in a network); hence, in order to compare participants' degree centrality between different networks, the degree centrality measure is normalised. This is done by dividing the value of degree centrality for each participant to the maximum possible degree centrality in the network (which is the number of participants minus one).

Supervisors' normalised in-degree centrality

This measure takes into account the frequency of H&S information received by the supervisor from other workgroup members. If a supervisor receives a lot of information or has high levels of communication directed to them then this may indicate their 'popularity' in the network; thus, these supervisors are more informed about others' views and about what happens in the workgroup.

Supervisors' normalised out-degree centrality

This measure takes into account the frequency of H&S information sent out by the supervisor to other workgroup members. Thus, a supervisor's out-degree centrality was considered to be an indicator of the supervisor's influence or activity in the communication network, i.e. supervisors who display high out-degree centrality exchange information with many others and can make others aware of their views.

Network centralisation

Network centralisation is a network level measure. Network centralisation captures the extent to which the overall connectedness is organised around particular participants in a network. Conceptually, network centralisation can be viewed as an extension of the node-level centrality, i.e. it reflects the distribution of node-level centrality between all the network participants. If a network has a highly centralised structure such that all connections go through only a few central participants, then that network is high on network centralisation. The network with the highest

possible centralisation is one with a star structure, wherein a single node at the centre is connected to all other nodes and these other nodes are not connected to each other. Likewise, the lowest centralisation occurs when all stakeholders have the same number of connections to others.

In directed networks, two measures of centralisation can be calculated: network in-centralisation and network out-centralisation.

Network in-centralisation

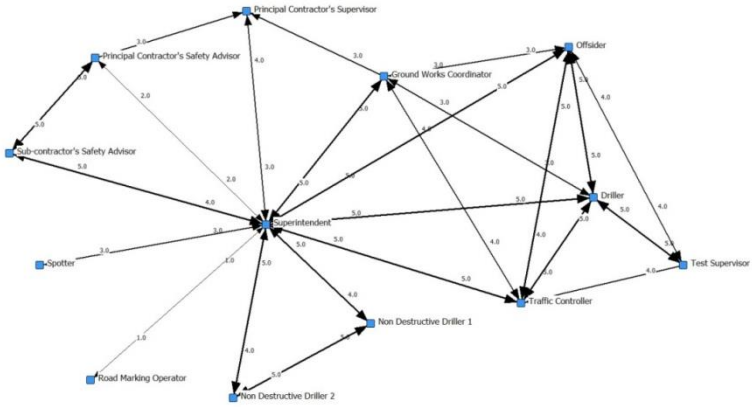
This measure takes into account only the incoming ties for each participant, i.e. only reflects the communication flow received by participants. Thus, a high in-centralisation indicates that there are a few 'popular' members in the workgroup who receive H&S information from many others while the majority of the members receive few information ties. A low in-centralisation, on the other hand, suggests that all the workgroup members are relatively 'equal' in receiving H&S information from other members.

Network out-centralisation

This measure takes into account only the outgoing ties for each participant, i.e. only reflects the communication flow sent by participants. Thus, a high out-centralisation indicates that there are a few 'active' members in the workgroup who send H&S information to many others while the majority of the members send few information ties. A low out-centralisation, on the other hand, suggests that all the workgroup members are relatively 'equal' in sending H&S information (communication activity) to other members.

8.4 Workgroup social networks

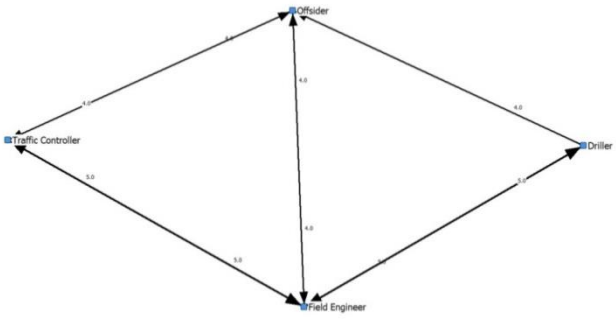
Workgroup 1



Workgroup 1's communication network shows that:

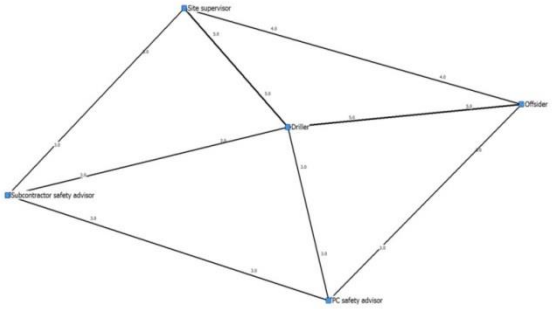
- The superintendent and driller are central to H&S-related communication in the network,
- The superintendent connects separate sub-groups of workers, and acts as a centralised point of contact for H&S information,
- The majority of communication ties between workers and the superintendent show two-way communication of H&S information, and
- The whole network is pretty well connected; however, it still relies heavily on the superintendent as the central point of contact.

Workgroup 2



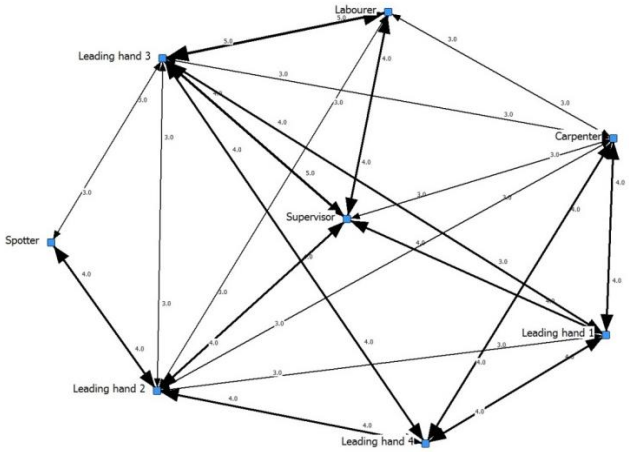
Workgroup 2 is almost fully connected. The field engineer (supervisor) is the most central in the group, as he/she is connected to all members and exhibits the highest levels of H&S communication in terms of frequency.

Workgroup 3



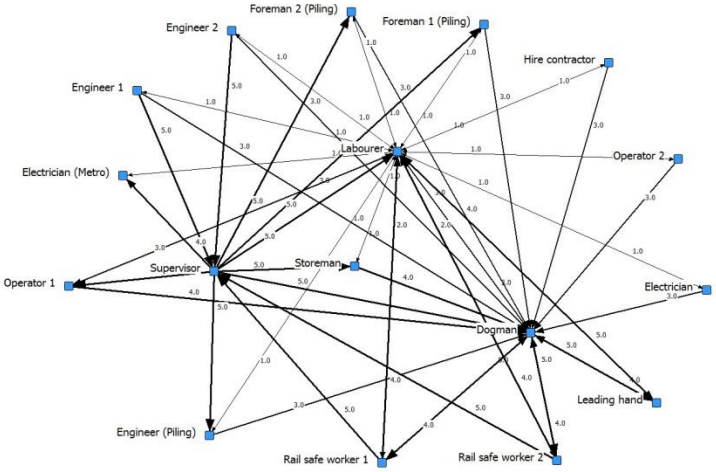
Workgroup 3 is a well-connected network. The driller is the most central, being connected to all other members of the group. He/she provides and receives H&S information more than once a day from the site supervisor and the offsider, and only once a week from the H&S advisors as they were not present on-site on a daily basis.

Workgroup 4



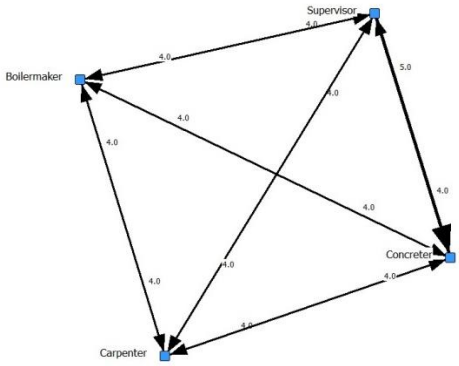
Workgroup 4's communication network indicates a close group with a stable communication pattern. This communication network is pretty well-connected, with the supervisor and leading hands being central to H&S communication. The majority of communication ties between participants show two-way communication of H&S information.

Workgroup 5



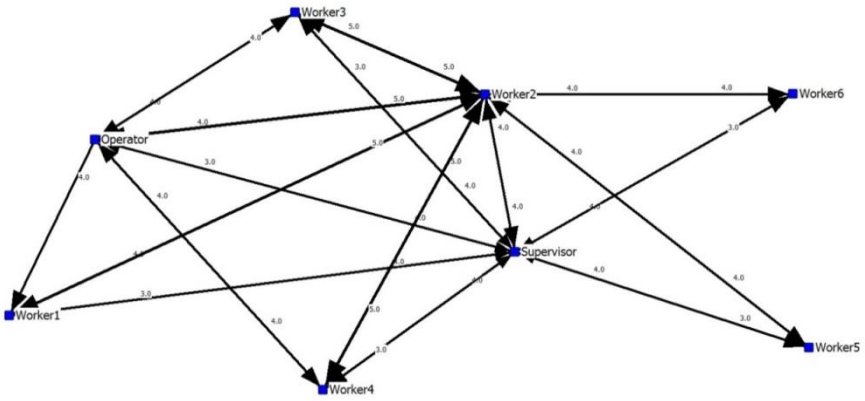
The communication network for *Workgroup 5* represents a large and fluid work site with a less stable communication pattern. The dogman and supervisor are centralised points of contact for H&S information. The communication data depicted here was provided from the perspective of four participants in the network (labourer, supervisor, dogman and electrician metro). Data capturing direct communication between other participants on the edge of the network (e.g. storeman and operator 1) was not collected.

Workgroup 6



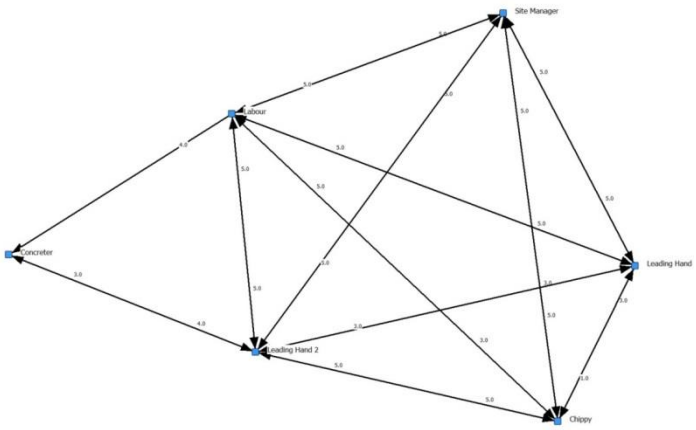
Workgroup 6's network is very well connected with all members communicating two-way H&S information once a day, with the exception of the supervisor who provides H&S information multiple times a day to the concreter, and once a day to the others in the network.

Workgroup 7



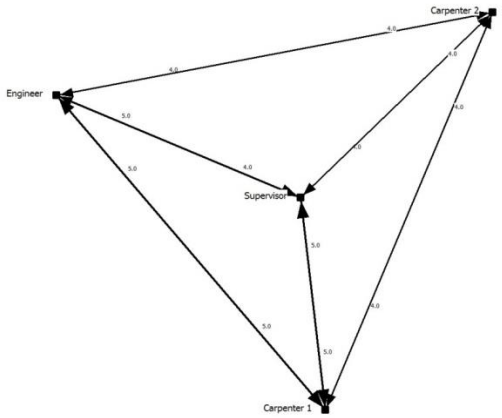
Workgroup 7's communication network is quite well connected, with the operator, worker 2 and the supervisor having the most central roles. Worker 2 is the most influential, being the only member in the group that distributes H&S information multiple times a day (represented by the number 5) to the other workers.

Workgroup 8



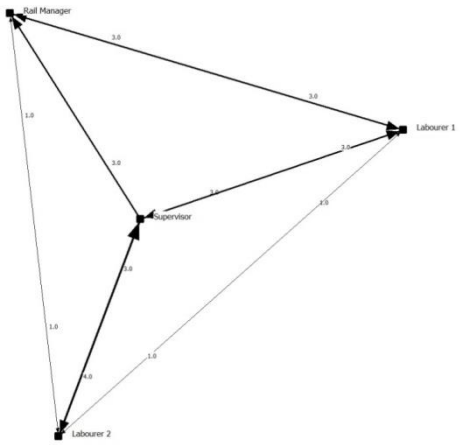
Workgroup 8's network is well-connected. There is a high density of communication activity among participants. All participants, except the concreter, participate equally in daily communication activity. The site manager is directly connected to all of the participants with the exception of the concreter. The majority of communication is two-way.

Workgroup 9



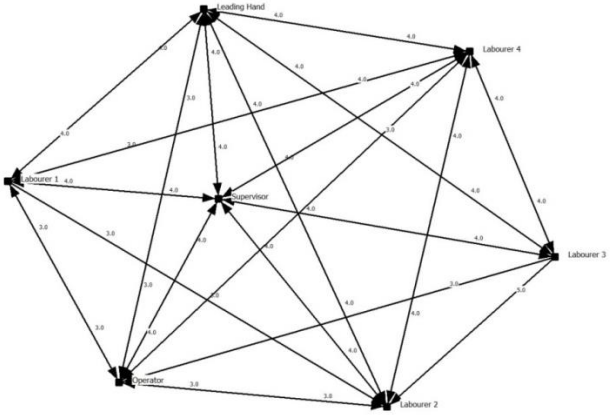
Workgroup 9's network is well-connected and complete. There are direct ties connecting all of the participants to each other. There is a high density of communication activity within the network and all participants exhibit an almost equal level of participation in communication. All ties indicate two-way H&S communication.

Workgroup 10



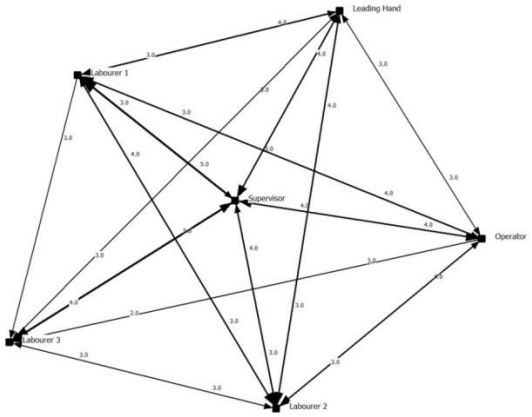
Workgroup 10's communication network is connected. There are direct ties connecting all of the participants. The supervisor is the most influential participant in terms of communication activity. The network density is medium to low, with the highest frequency of communication occurring between the supervisor and labourer 2 (once per day). The supervisor maintains weekly communication with the rest of the participants. Labourer 2 communicates with other participants on a monthly basis.

Workgroup 11



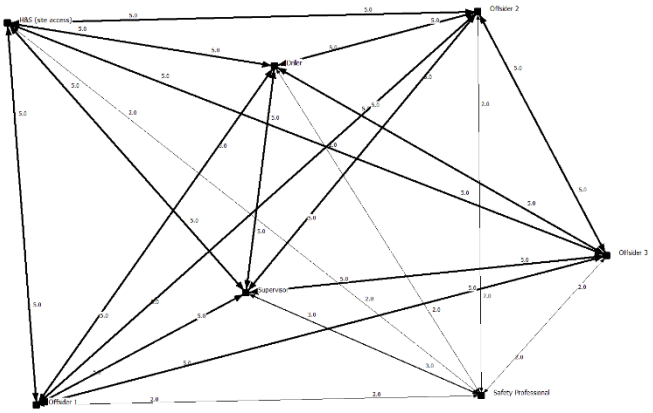
Workgroup 11's network is connected. Participants (except for labourer 1 and labourer 3) directly communicate with each other primarily on a daily basis. Labourer 1 and labourer 3 communicate indirectly through other participants. The supervisor is the most influential participant and maintains two-way daily communication with all the other participants.

Workgroup 12



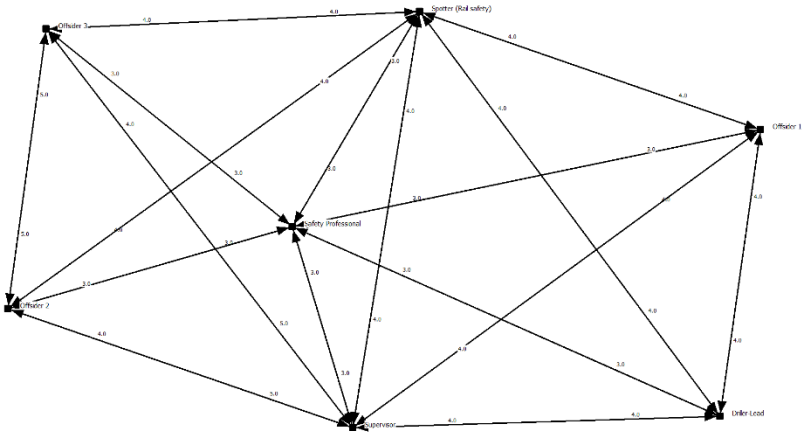
Workgroup 12's network is well-connected and complete; there are direct ties between all of the participants. The density of communication activity is medium. The supervisor is the most influential participant and maintains daily two-way communication with all of the other participants. Other participants mostly communicate with each other on a weekly basis.

Workgroup 13



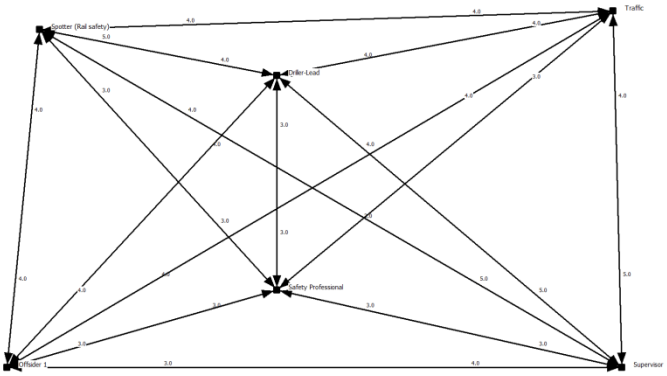
Workgroup 13's communication network is well connected. All of the crew members are almost equally central (influential) in the network. The network indicates two-way and high frequency communication between the supervisor, safety professional, H&S advisor (site access) and driller. The safety professional has a lower frequency of communication with the other crew members, as he works across different workgroups.

Workgroup 14



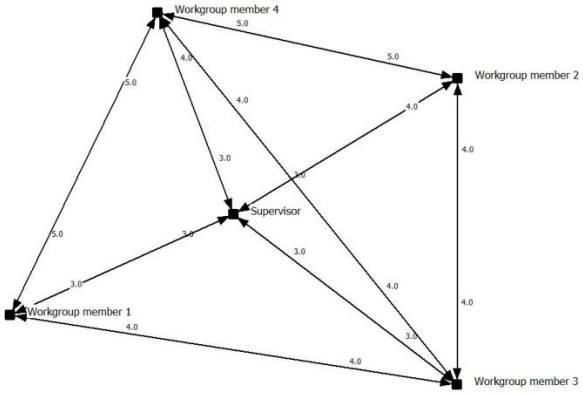
Workgroup 14's communication network is less connected than *Workgroup 13's*. The supervisor is the most central (influential) member in terms of communication activities, followed by the safety professional and the spotter. The network depicts two separate groups of drillers, with the first group comprising offsider 2 and offsider 3, and the second group comprising offsider 1 and the driller-lead. These two subgroups do not communicate directly with each other; rather, they communicate via other actors, i.e. the supervisor, safety professional and spotter.

Workgroup 15



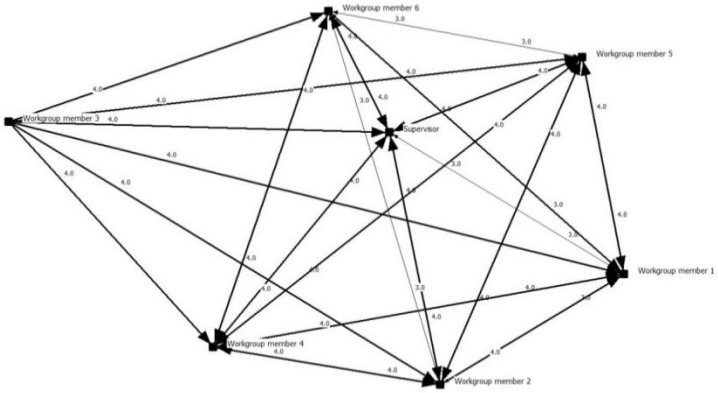
Workgroup 15's communication network is well connected with direct communication links between all members of the work crew. The supervisor is the most central member in communication activities. All of the other crew members are almost equally central (influential) in the network. The supervisor displays the highest level of communication activity with the driller, spotter and traffic controller.

Workgroup 16



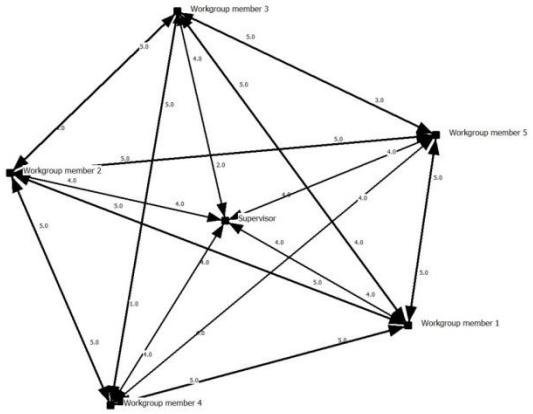
Crew members in this network are connected, but display varying levels of H&S communication frequency. The supervisor is central within the network, connecting all other workgroup members, but only provides H&S information once a week. Workgroup members 1 and 2 are not directly connected to each other, but provide and receive high frequency levels of H&S information to others. The most influential member in terms of H&S communication is workgroup member 4.

Workgroup 17



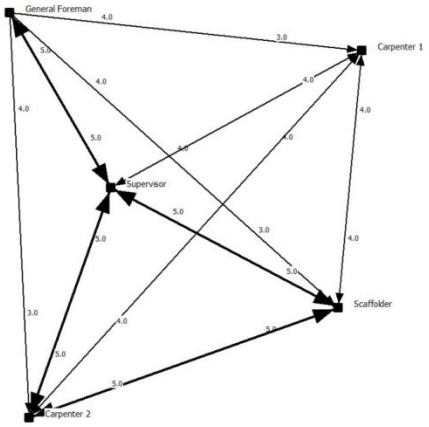
Workgroup 17's network is well connected, with everyone in the workgroup involved in two-way communication of similar frequencies with the exception of workgroup member 3, who only provides (but does not receive) H&S information. Apart from workgroup member 3, all members are almost equally influential in providing and receiving H&S communication.

Workgroup 18



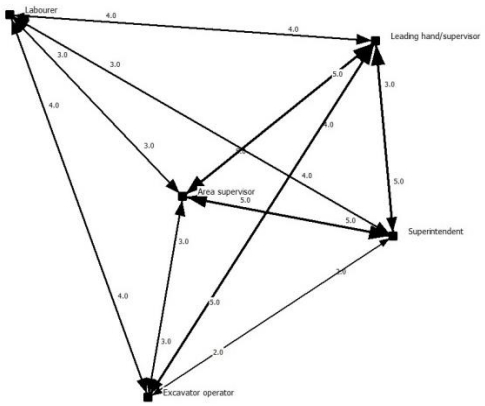
All members in the communication network are very well connected. The supervisor typically provides and receives H&S information once a day. Workgroup member 3 provides H&S information the most frequently (more than once a day) to the other workgroup members.

Workgroup 19



Workgroup 19 is a well-connected network, with group members typically sending and receiving H&S information at least once a day. The supervisor is the most central, providing and receiving information multiple times a day with the scaffolder, carpenter 2 and the general foreman.

Workgroup 20



Workgroup 20 is a connected network. The area supervisor, superintendent and leading hand/supervisor engage in frequent H&S communication with one another. The labourer, excavator operator and leading hand/supervisor also frequently discuss H&S with one another. Therefore, the leading hand/supervisor is the key connection point in the group, as he/she is in frequent two-way communication with individuals at different levels within the workgroup.