

Safety Intelligence: An exploration of senior managers' characteristics

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Abstract

Senior managers can have a strong influence on organisational safety. But little is known about which of their personal attributes support their impact on safety. In this paper, we introduce the concept of 'safety intelligence' as related to senior managers' ability to develop and enact safety policies and explore possible characteristics related to it in two studies. Study 1 (N = 76) involved direct reports to chief executive officers (CEOs) of European air traffic management (ATM) organisations, who completed a short questionnaire asking about characteristics and behaviours that are ideal for a CEO's influence on safety. Study 2 involved senior ATM managers (N=9) in various positions in interviews concerning their day-to-day work on safety. Both studies indicated six attributes of senior managers as relevant for their safety intelligence, particularly, social competence and safety knowledge, followed by motivation, problem-solving, personality and interpersonal leadership skills. These results have recently been applied in guidance for safety management practices in a White Paper published by EUROCONTROL.

Safety Intelligence: An exploration of senior managers' characteristics

1. Introduction

Major accident investigations show that senior managers have a particular influence on organisational safety (e.g. Baker, 2007; National Commission on the BP Deepwater Horizon oil spill, 2011). This paper presents two studies carried out in European air traffic management (ATM), which has a good safety record, but nevertheless suffered a major accident (mid-air collision) with 71 fatalities near Überlingen in Germany in 2002. The investigators found that the way senior management dealt with safety issues was related to the occurrence of the accident: *"[...] managers can change and improve existing corporate culture by establishing safety – recognisable for all staff members – as high priority. Feedback and continual reinforcement from the most senior management down will help develop dedication and accountability that is desirable."* (p. 90; BFU, 2004).

Senior positions in organisations differ from lower levels (Hambrick, 1989). Senior managers can influence up to 45% of organisations' performance (Day & Lord, 1988) and have a distinct influence on organisational safety (Clarke, 1999). Reviews of the safety climate literature (Flin, et al. 2000; Guldenmund, 2007) identified management's attitudes and behaviours as a predominant safety climate factor. Two more recent meta-analyses (Beus et al., 2010; Christian et al., 2009) identified perceptions of management safety commitment as one of the most influential safety climate components in relation to organisational safety performance. While these reviews and meta-analyses suggest that senior managers are central for organisational safety, studies involving senior managers are scarce (Flin, 2003). As a consequence it is unclear which personal attributes support their influence on safety.

In this paper, we examine senior managers' characteristics through the concept of 'safety intelligence'. The strategic leadership literature describes a senior manager's understanding of business issues and their ability to develop policies as 'strategic intelligence' (e.g. Yukl, 2001). Accordingly, we use the term 'safety intelligence' as a concept that captures senior managers' understanding of safety issues and knowledge relevant to their policy-making in relation to safety

(Kirwan, 2008). Zohar (2008) suggests that the ways in which senior managers develop and enact their policies are central to their influence on safety and their policy-making has been found to significantly contribute to employee safety climate perceptions and safety performance (Cohen, 1977; DeJoy et al., 2005).

The aim of the two studies reported in this paper is to identify the personal characteristics that support senior managers' ability to intelligently manage their organisations' safety, i.e. to make and enact policies that will have a positive effect on safety. Leadership is mostly conceptualised through interpersonal leadership behaviours with a focus on the relationships that a manager or supervisor establishes with his or her subordinates (Zaccaro & Horn, 2003) and that is also the dominant approach in studies on leadership and safety (e.g. Clarke, 2013). However, in this study, we focus on traits and skills that can support senior managers in having a positive influence on safety, based on the following rationale. According to Zaccaro (2001), senior managers operate at a system wide level and do not have much opportunity to establish such interpersonal relations with members of their organisation. Therefore, interpersonal leadership theories are unlikely to cover all relevant aspects of senior level influence. Our approach follows the tradition of Hambrick and Mason's (1984) upper echelons theory and considers personal characteristics to be relevant for senior managers' influence on safety. Traits (personality & motivation), skills (social competence & problem-solving) and knowledge have been proposed as influencing leader performance (Mumford et al., 2000) and as particularly relevant for strategic management (e.g. Day & Lord, 1988; Hambrick & Mason, 1984). Studies concerned with senior managers' influence on organisational attributes have focussed on their personal characteristics. For example, Huffman and Hegarty (1993) found senior managers' externally oriented expertise and their planning and control abilities to largely influence innovations in organisations. Berson et al. (2008) found CEO values, such as benevolence, security and self-direction, to influence attributes of organisational culture, such as bureaucratic, innovative and supportive culture. Other studies report CEOs' personality (particularly need for achievement) as impacting organisational culture, strategy and structure via the rationality in their strategy making (Miller & Dröge, 1986; Miller et al., 1988; Miller & Toulouse, 1986).

The investigation of senior managers' influence on organisational safety presented in this paper represents an aspect of macroergonomics, i.e. the analysis and design of work systems, which also include organisations. Hendrick (2002) describes this ergonomics discipline as overlapping with organisational psychology and this is also the case for this paper. Consequently, our study sits on the overlapping fringes of ergonomics and organisational psychology in that it addresses a group that crucially shapes macro-level work systems (i.e. organisations) and investigates this issue via psychological characteristics of senior managers.

We investigate this issue in air traffic management (ATM), an industry that majorly contributes to airspace safety (EUROCONTROL, 2005). ATM organizes traffic flow and helps to prevent the collision of aircraft (Federal Aviation Administration, Air Traffic Organization Policy; February, 2010). ATM's services involve balancing safety against other pressures such as traffic throughput, providing short cuts in the airspace, safety benefits and economic costs of a new technological investment (e.g. radar system), or flight level request from pilots in order to reduce the airlines' fuel costs. Findings obtained in this highly reliable industry might be transferable to others and can promote cross-industry learning. The following section introduces the five characteristics (traits, skills and knowledge) we suggest as relevant for senior managers' safety intelligence.

1.1. Traits: Personality and Motivation

We propose the Big Five personality factors (Costa & McCrae, 1992) to support senior managers' ability to develop effective strategic safety policies and to enact them. For example, a senior manager who is highly extraverted may communicate his or her safety policies more forcefully. A more agreeable senior manager may be able to create a greater sense of trust, which can be positively related to safety (Clarke & Robertson, 2005) and can help them to enact the safety policies convincingly. According to Peterson et al. (2003), conscientious senior managers are more likely to be task focused, and thus may develop safety related policies more cautiously. A senior manager who is low on emotional stability may be less effective in actively and safely controlling stressful situations (Clarke & Robertson, 2005) and this might affect his or her capability to develop effective safety policies. Senior managers' openness to experience may support them in being more receptive to learning

(Clarke & Robertson, 2005), helping them to develop a broader range of safety knowledge and consequently devise better safety policies.

In addition, a motivational trait conceptualised as regulatory focus (Crowe & Higgins, 1997) that has previously been applied to safety (Wallace & Chen, 2006), might influence senior managers' safety policy making. Motivational traits have been found to relate to senior managers' impact on other organisational outcomes (e.g. structure; Miller & Dröge, 1986). Regulatory focus describes individuals to be motivated towards a goal via a pronounced promotion and prevention focus. Promotion focus leads individuals to follow an eagerness strategy and a desire to complete tasks quickly. A pronounced prevention focus leads individuals to follow a vigilant strategy and avoid negative outcomes (Wallace et al., 2008), thus avoiding risks when developing and communicating safety policies. Accordingly, a prominent prevention focus may support senior managers' safety intelligence. This can arise through two mechanisms: first, more prevention focussed managers might pay more attention to detail and spend more time on safety issues. Time is usually a limited resource for senior managers and the amount of time they spend on safety issues has been described as conveying their personal value for safety (Flin, 2003). Secondly, a more pronounced prevention focus might support managers to prioritise safety issues in their policies and communication with the workforce.

1.2 Skills: Problem-solving and social competence

Management's approach towards safety related problems can function as a frame of reference for the workforce and can reflect senior managers' commitment to safety (Zohar & Luria, 2005). We suggest that creative problem-solving (Isaksen & Treffinger, 2004; i.e. investigation of problems, idea generation, planning ability) supports senior managers' safety intelligence as it ultimately contributes to the ways in which managers devise safety policies. Because the way senior managers solve problems shapes organisations and work conditions (e.g. equipment, staffing level), this can also have an immediate effect on the perceived status of safety in organisations.

Personable communication of senior managers with the workforce is frequently emphasised as relevant to conveying their safety messages (e.g. Harper et al., 1996, Hopkins, 2011). A recent study

involving senior managers has investigated their language as a leadership tool through which they might influence organisational safety culture (Fruhen et al., 2013^a). Accordingly, social competence (Baron & Markman, 2000; i.e. their ability to interact with others effectively through for example perception of others intentions, persuasion) can contribute to senior managers' ability to communicate about safety with subordinates and support the ways in which they enact safety policies.

1.3 Knowledge

Finally, safety knowledge may also contribute to senior managers' safety intelligence. Knowledge has been described as one of the main tenets of senior managerial power (Finkelstein, 1992) and has been reported to relate to safety performance at other levels of the organisation (e.g. Griffin & Neal, 2000). Safety knowledge can enable senior managers to understand safety related information and to draw meaningful conclusions from it and in doing so, affect their ability to develop effective safety policies.

In this paper, we empirically identify the role of these characteristics for senior managers' safety intelligence in two studies. The first study focuses on CEOs, the most senior managers in organisations. Using a questionnaire, it investigates whether their direct reports view certain characteristics as desirable for CEOs' influence on safety. The second study is an interview study involving a small sample of CEO's and other senior managers and investigates the role of the characteristics in their actual work on safety. The results should enable insights into the relevance of these characteristics that can be important for the selection, education and training of senior managers.

2. Study 1

2.1 Method

2.1.1 Sample

The sample consisted of 76 senior managers (safety directors and managers), who all worked in European air traffic management (ATM) in positions that required them to interact frequently with the CEO of their organisation (the majority reported to meet the CEO on a daily basis). On average, participants had been in their position for 6 years (range 6 months - 20 years) and the majority had

backgrounds in ATM or engineering. We did not ask for more demographic information in order to maintain participants' anonymity, as they were asked to provide information regarding their superiors.

ATM is provided by organisations (public and private) called Air Navigation Service Providers (ANSPs) whose employees guide airplanes at airports and en-route to avoid traffic conflicts and ensure safety and efficiency. Safety Directors and Managers working for an ANSP play a key role in managing air traffic safety, as they are the most senior safety persons in these organisations. They are responsible for the Safety Management System (SMS) of the organisation, must liaise with safety regulatory authorities, are required to work with other Directors/Managers (e.g. Operations, Human Resources, Engineering, or Finance) to keep the Executive Board aware of key safety risks and trends and are responsible for safety training and safety surveys. In the event of an accident, the Safety Manager/Director will be at the front line, working with legal counsel to liaise with the external investigation body. We did not have access to a sample of CEOs but evaluated this sample of safety directors as familiar with the requirements of CEOs' work on safety for two reasons: First, they frequently interact with CEOs in their work, and are familiar with the requirements and frequent activities entailed in a CEO's role. Second, they can be considered to be the most senior safety experts in ANSPs, with sound safety knowledge and extensive responsibility for safety. Because the safety managers were asked to describe CEOs, the risk of self-presentation effects were reduced (Morgeson et al., 2004), such as impression management and social desirability effects.

2.1.2 Procedure

Participants were recruited during three meetings organised by the European Agency for the Safety of Air Traffic Management (EUROCONTROL; response rate 68%). Participants completed a questionnaire, consisting of two open questions on characteristics and behaviours that were devised with the help of a subject matter expert in ATM. Because not much is known about attributes of CEOs in relation to safety, open questions were used. The questionnaire asked participants "*What kind of person do you think an ideal CEO should be regarding his or her effect on safety? Start with the most important characteristic*" and "*What behaviour do you think an ideal CEO should*

demonstrate regarding his or her effect on safety? Start with the most important behaviour". By asking for ideal, rather than actual personal attributes, we were more likely to identify good, rather than common practice. The questionnaires had allocated space for 5 responses to each question and participants on average provided four descriptions for each question. Using this format in the questionnaire allowed us to maintain an exploratory approach while including a larger number of people under standardised conditions, so that the results are likely to be robust and applicable to many organisations.

2.1.3 Analysis

The coding of the responses followed the procedures of content analysis (Mayring, 2000). Responses were allocated into the five attributes derived from the literature whenever possible with non-allocated responses coded to reflect additional concepts. Two independent raters were provided with definitions and coding rules (Dey, 1993, see Appendix). After independently coding 50% of the questionnaires, the two raters discussed possible changes to the coding scheme. The majority of responses could be coded into the predefined attributes. Responses that did not fit into these categories mostly reflected interpersonal leadership so that an additional category of 'leadership' was introduced. This category included transformational and transactional leadership behaviours (Bass, 1985), as well as authentic leadership (Avolio et al., 2004). Both raters coded the remaining questionnaires and reviewed the previously coded questionnaires using the revised coding scheme. Interrater reliability of the coding was tested with Krippendorff's alpha (Hayes & Krippendorff, 2007) and achieved an agreement of $\alpha = .76$ (95% CI_{LL} .73 to CI_{UL}.80).

2.2. Results and Summary of Study 1

Overall, 86% of the responses were identified as the five attributes listed above, which suggests that these concepts captured the data well (see Table 1). Additionally, leadership was identified in 14% of the responses, mostly reflecting transformational ("*visionary*") and transactional leadership, as well as authenticity. Out of the personal characteristics, social competence (16% of the responses) and safety knowledge (15% of the responses) were found to be particularly relevant for a CEO's influence on organisational safety. The majority of the responses identified as social competence

referred to a CEO's ability to listen ("*being a good listener*", "*asks questions*"). The literature describes the ability of senior managers to convey strong safety messages as central (e.g. Harper et al., 1996). The descriptions identified in this study however suggest that having an 'open ear' for safety problems is equally, if not more important for a CEO. Responses identified as safety knowledge frequently related to theoretical and practical understanding of safety ("*understanding of safety issues*"), as well as facts and information ("*knows about safety*") and background and education ("*educated in safety problems*"). These responses suggest the ideal CEO requires to be educated in safety and to understand safety issues and risks. Although problem-solving was less frequently mentioned (11% of the responses), responses identified as reflecting this concept mostly referred to a CEO's ability to understand problems by considering multiple sources of information ("*makes informed decisions*"), suggesting an inquiring mode as a relevant quality in CEOs' approaches to safety problems.

The content of the responses identified as personality (14% of the responses) often reflected aspects of conscientiousness ("*reliable*"), agreeableness ("*approachable*") and openness to experience ("*open to new ideas*"). The personality trait of agreeableness may support a CEO's engagement with others and encourage staff to speak up about safety by generating trust (Clarke & Roberts, 2005). The rigor in a CEO's engagement with safety related issues is likely to be driven by his or her conscientiousness. Furthermore, openness to new ideas can help CEOs not to dismiss new thinking around safety problems. Finally, responses identified as regulatory focus (11% of the responses) mostly reflected prevention focus ("*proactive in the safety domain*") as facilitating CEOs' work on safety issues through an avoidance of negative outcomes (Wallace & Chen, 2006).

2.4 Strengths and limitations Study 1

One of this study's strength is the sample of senior managers, who are direct reports of CEOs. Although we did not have access to CEOs directly, we captured the views of individuals who are familiar with the work of CEOs, are the most senior safety specialists in organisations and are at the receiving end of CEOs' safety messages.

The use of questionnaires enabled data collection under standardised conditions. Nevertheless, the open question format might have biased the results. Participants were not asked to provide actual, safety related behaviours and characteristics of CEOs. By asking for the ideal behaviours and characteristics of CEOs, we gained insights which can ultimately be used for the development of guidance and best practice sharing. However, it is also possible that these questions triggered respondents' implicit beliefs about ideal safety leadership. Furthermore, the response format used in this study might have de-contextualised the findings and the generated responses are not very rich in their content.

3. Study 2

To further explore the role of the characteristics for senior managerial safety intelligence, this second study employed an interview method. Interviews are a more open approach to data collection and are ideal for capturing issues in their complexity and entirety (Flick, 1998). Consequently this approach allowed us to contextualise our findings and to better illustrate the content of the personal attributes. The interview questions related to senior managers' actual work on safety and did not ask them explicitly about ideal characteristics and behaviours for this work, to differentiate the approach from the previous study. The senior managers were from a number of different positions, not only CEOs, allowing an evaluation of the characteristics' relevance for senior managers' work on safety in those different senior positions.

3.1 Method

3.1.1 Sample and Recruitment

Participants were contacted through the Safety R & D Department at EUROCONTROL. The sample consisted of senior managers (N=9, response rate = 81%) working for three national ATM organisations (ANSPs). These subject matter experts held senior positions such as CEO (in charge of management of the entire organisation; n=2), COO (responsible for the daily operation of the organisation; n=3), Director of Safety (n=3) and Director of Air Navigation Services (n=1), with all being part of the executive teams of their organisations. Average time in position was 32.8 months (SD= 19.3 months).

3.1.2 Procedure

Individual semi-structured interviews were carried out on site by two trained interviewers. Average interview duration was 74.9 min (SD = 15.7, range 60-113 min), using an explorative approach (Scheele & Groeben, 1988). The interviews touched upon the most central aspect of senior managers' work in relation to safety (based on descriptions of general senior managerial activities by Tengblad, 2006). Questions related to the experience of participants, their work environment and typical work activities (e.g. can you describe a typical day's work?). Following this, questions focused on meeting activities (e.g. how often do you usually have top management team meetings?), decision making in relation to safety (e.g. can you give an example of a safety related decision you have made recently?), participants' views on safety culture (e.g. how would you describe the safety culture of your organisation?) and how participants show their commitment to safety (e.g. in what ways can you display your commitment to safety?).

3.1.3 Coding Analysis

The interviews were transcribed verbatim and analysed by two independent raters using deductive qualitative content analysis as in Study 1 (Mayring, 2000). The coding scheme included the overall characteristics and their subcomponents (see Appendix 1). Although additional concepts had emerged from Study 1, it was decided to exclude these in the initial coding scheme, to evaluate whether these would also emerge from the interview material. Raters were advised to identify meaning units defined as "words, sentences or paragraphs containing aspects related to each other through their content and context" (Graneheim & Lundman, 2004, p. 106). The final interrater reliability ($\alpha = 0.72$; 95% CI 0.67 to 0.77) fulfilled the criteria for tentative conclusions (Krippendorff, 2004).

3.2 Results and Summary Study 2

Table 2 shows the relevance of the characteristics and their subcomponents and Table 3 provides example quotes for the most frequently identified subcomponent within each concept. As in the previous study, the personal characteristics captured the data well, as 93% of participants' responses were categorised as reflecting the components of the model. 'Leadership' also emerged as an

additional concept explaining 7% of the data, mostly containing descriptions identified as authentic leadership.

Similar, to Study 1 social competence was most frequently identified (33% of all meaning units) and its most relevant content contained engaging with others, persuasion and perceiving others. This finding is in line with the general senior management literature (e.g. Tengblad, 2006) and the safety literature (e.g. Harper et al., 1996) description of senior managerial activities and this group's influence on organisations and safety respectively. Also similar to Study 1, safety knowledge was one of the most frequently identified characteristic in the interview study (29% of all meaning units). In line with the senior leadership literature (Mintzberg et al., 1998), the results emphasise the importance of facts and information as an aspect of safety knowledge for senior managerial work. Theoretical and practical understanding and awareness gained by experience regarding safety were also indicated as relevant for senior managers' work in relation to safety.

As in Study 1, we also found motivation to be moderately relevant (15% of all meaning units). Contrary to the findings of Study 1 of prevention focus to be more desirable in CEOs according to their subordinates, promotion focus was the most frequently identified subcomponent of regulatory focus in this study. Usually, individuals high on promotion focus are described as engaged in behaviours that maximize production, whereas prevention focus leads to more vigilance to ensure safety (Wallace & Chen, 2006). This study, using responses from the senior managers themselves commenting on their own work, indicates that the ideal and actual way that senior managers approach goals in their work might not agree. It seems that senior managers themselves follow an eagerness strategy. Senior managerial work has been described as having increased in workload and intensity since the 1970s (Tengblad, 2006) and it is possible that role incumbents will have a stronger focus on getting things done quickly because of a greater awareness of the workload entailed in their roles.

Also similar to Study 1 was the relative frequency with which problem-solving emerged (10% of all meaning units). Understanding problems and generating ideas were the most frequently identified subcomponents of problem-solving, whereas planning for action was indicated least frequently. This might reflect the nature of senior managerial work, as they not necessarily responsible for the

implementation of solutions. Generally senior managers need to have an understanding of the problems that their organisations face to prioritise issues and aspects of problems to ensure their decisions reflect their commitment to safety (Fruhen et al., 2013^b).

The personality traits of the Big Five were least frequently indicated in this study (7% of all meaning units). Previous research reports senior managerial personality (Big-Five) as relevant for organisational culture (e.g. Giberson et al., 2009). It is possible that the interviewees did not frequently mention aspects of personality, as questions focused on work activities. It is also possible that this was due to self reporting and actor-observer asymmetry, as actors tend to attribute their own behaviour to stimuli inherent in the situation, whereas observers tend to attribute behaviour to stable dispositions of the actor (Jones & Nisbett, 1971). Within personality, conscientiousness was frequently indicated, which can be due to its focus on the way individuals work (Costa & McCrae, 1992), as the interview questions concerned the participants' work.

3.3.1 Strengths and limitations of study 2

Study 2 used interviews to test and complement the findings of Study 1 and to further investigate the content of the characteristics for senior managers' safety intelligence. This study was more subjective and reflected the inside views of senior managers themselves. Asking senior managers about their own work could have however biased their responses through impression management.

As in the previous study, our analysis was conducted deductively. Had the analysis been carried out inductively, a different set of attributes might have emerged. However, our analysis did allow additional themes to emerge. Finally, it is acknowledged that the sample is small. However, it fulfils the baseline size for saturation, especially for homogenous samples (Guest et al., 2006).

4. Overall Discussion

Overall, the results from both studies suggest a set of traits, skills and knowledge relate to senior managers' safety intelligence. Figure 1 shows the most relevant characteristics at the core of safety intelligence, along with leadership, which emerged from both studies as also relevant, particularly transformational (Study 1) and authentic leadership (Study 2). The findings echo descriptions of characteristics found to be central to senior managerial influence on other organisational outcomes

(e.g. Carmeli & Tishler, 2006; Hambrick & Mason, 1984; Miller & Toulouse, 1986, Mumford et al., 2000). Therefore safety as an organisational goal may be achieved in a similar manner as other objectives and requiring similar skills and traits in senior managers. However, the two studies were conducted in ATM, a business that has safety as a central component of its service. These senior managers may approach safety policies as they do other strategic goals. The frequency with which the majority of the characteristics can be ranked did not differ notably in the two studies, notwithstanding the mixed method design. It should be noted that the contents which emerged from Study 2 might be more informative as the subcomponents of each characteristic were identified in this study by the coders and should therefore be given a stronger weight in the evaluation of the characteristics content. We discuss each characteristic below, starting with the most relevant.

Social competence

The safety literature has frequently described senior managers' personable communication and active involvement, including site visits as central to their influence on safety (Hopkins, 2011; Harper et al., 1996). Likewise, our findings support social competence to be particularly relevant for senior managerial influence on safety. Descriptions of social competence in Study 1 and 2 often reflected a tendency to engage with others through for example an open door policy and suggested the ability to listen to others as especially relevant. This finding supports Schein's (2012) suggestion of humble inquiry as an effective tool for senior managers to influence their organisations. Study 2 also showed persuasion to be relevant for senior managers' safety intelligence and this is likely to help them to communicate strong messages concerning safety policies. Persuasion might be particularly relevant as safety is an abstract goal, for which indicators are not easily defined (Hale, 2009). According to the goal setting theory (Locke & Latham, 1990) these attributes make it all the more challenging to maintain safety as an organisational goal, requiring senior managers to be even more convincing.

Safety knowledge

Senior managers' knowledge has been identified as relevant for their influence on organisations (Finkelstein, 1992) and they have been described as information workers (Mintzberg, et al., 1998). However, safety knowledge had not been previously considered by the safety literature as

contributing to their influence on safety. Our findings suggest that senior managers' safety knowledge can support them in influencing safety positively and so safety knowledge might warrant more attention from safety researchers. Particularly their theoretical and practical understanding of safety issues (Study 1) and their knowledge on facts and information (Study 2) were indicated as relevant here.

Motivation

Motivation, conceptualised as regulatory focus (Crowe & Higgins, 1997), was next most frequently identified across the two studies. Achievement motivation has been found to strongly correlate with senior managers' influence on organisational outcomes (e.g. Miller et al., 1988) and our findings suggest that this trait is also relevant for their influence on safety. However the results concerning regulatory focus were contradictory between Study 1 and 2. In Study 1 it was mostly identified via prevention focus, whereas promotion focus was the dominant theme in Study 2 for this trait (see section 3.2). It is possible that work on safety issues might require senior managers to balance caution with working quickly through a number of tasks (Hambrick, 1989). However, as discussed above, it is possible that the ideal (i.e. prevention focus) and the actual (i.e. promotion focus) motivational approaches by senior managers differ. This issue requires more detailed investigation in the future.

Problem-solving

Although problem-solving is described as the most important part of senior managerial work (e.g. Eden & Spender, 1998) and as relevant for their influence on organisational safety (Zohar & Luria, 2005), it was only found to be the fourth most relevant characteristic across the two studies. Problem-solving was mostly indicated through the way senior managers understand problems and consider various sources of information. Possibly, participants did not mention problem-solving more frequently, because it is not a directly observable activity and senior managers understand it as an integral part of their work (Mintzberg, 1975). Furthermore, problem-solving might have been confounded with other activities such as social interaction, as senior managers often discuss problems in groups and meetings (Zaccaro et al., 2000).

Personality

Overall, personality was the least frequently indicated characteristic in relation to senior managers' safety intelligence. Accordingly, it should not be considered as central to their influence on safety through their policy making and enactment.

Interpersonal leadership

Finally, although some researchers have argued that interpersonal leadership is not related to senior level leaders' influence (Zaccaro & Horn, 2003), it emerged from both studies as relevant for their influence on organisational safety. The results of Study 1, involving direct reports of CEOs, suggested that CEOs may affect organisational safety through interpersonal leadership styles exerted on their teams. It is possible that this form of influence then cascades through the hierarchical layers of the organisations. However it is also possible that, for example authenticity is communicated through interactions during site visits, but might not require direct contact with members of the organisation (i.e. be expressed through speeches or written material). Interpersonal leadership might have emerged more often in Study 1 because the direct reports involved in the data collection were more exposed to their CEOs' interpersonal leadership behaviours and therefore value them as more prominent and important. It is however also probable that interpersonal leadership is especially relevant for CEOs' influence on safety as it has previously been found to influence firm performance (Waldman et al, 2004).

In summary, we found safety intelligence in senior managers, i.e. their positive influence on safety through their ability to devise and enact safety policies, to be particularly supported by their social competence and safety knowledge. It can be proposed that social competence will particularly aid senior managers in enacting their policies and that safety knowledge is central to the development of these policies.

4.2 Future research

This study is only a first, exploratory step towards a better understanding of attributes relevant to senior managers' safety intelligence. Future research can build on our findings by considering the

following issues. First, an investigation of the views of employees further down the organisational hierarchy can complement the perspective of direct reports and role incumbents. Inclusion of more junior managers and the workforce can help identify whether senior managers' personal characteristics differ in their influence on safety at different organisational levels. Secondly, the safety intelligence attributes in this study could be studied in relation to safety outcomes such as safety culture, but also to employees' safety related behaviours, accident rates or even safety policies. Finally, future research should be carried out in industry sectors other than ATM, as these other industries might pose different challenges for senior managers.

4.3 Conclusion and practical implications

CEOs and other senior managers carry the responsibility for their organisations (Hambrick, 1989). Investigation reports repeatedly highlight this group's contribution to organisational safety, yet they are under researched (Flin, 2003). Insights of what it takes in terms of characteristics to perform safety related management duties effectively are essential to inform best practices for selection, training, evaluation and reward systems (Landy & Vasey, 1991). The findings of the two studies can have relevance for the determination of selection criteria for CEOs and other senior managers. It can be proposed that social competence and safety knowledge will be the most effective areas to target for trainings and other interventions. These findings have been included in a recent White Paper published by EUROCONTROL (2013) to provide guidance to senior managers in ATM concerning their influence on safety. It needs to be considered to what extent the findings from the ATM domain can be applied in other industry settings. However, because ATM is so highly reliable, it is proposed that they are likely to represent characteristics that will be effective in managing organisations safety in many other industries. Application of the insights from this study may help to ensure senior managers have what it takes to be safety intelligent.

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Table 1.
 Summary of frequencies of the model components in questionnaire data (Study 1)

Characteristics	Examples
Traits	
Personality $f = 78$ (14% of all meaning units)	<ul style="list-style-type: none"> - approachable - fair • persistent • reliable • open to new ideas • open to suggestions <ul style="list-style-type: none"> • tolerant • reasonable • empathetic • respectful • responsible
Regulatory Focus $f = 61$ (11% of all meaning units)	<ul style="list-style-type: none"> • proactive • devoted to safety • ensured safety has equal priority • proactive in safety domain
Skills	
Problem-solving $f = 61$ (11% of all meaning units)	<ul style="list-style-type: none"> • balancing safety appropriately with costs • makes decisions after consultation • sees interconnections and interdependencies • readiness to understand problems • makes decisions explicit on safety and capacity • makes informed decisions
Social competence $f = 92$ (16% of all meaning units)	<ul style="list-style-type: none"> • having a good contact with all levels of the organisation • operating an open door policy • being a good listener • asks questions • good at listening • listens to everyone <ul style="list-style-type: none"> • talks with everyone in the organisation • very good communication skills • good at listening • captures all views • engages people at the floor level
Safety Knowledge $f = 85$ (15% of all meaning units)	<ul style="list-style-type: none"> • understands how safety culture is build • understands the risks • knows about safety • educated in safety problems • understanding of safety issues • trained in safety and aviation <ul style="list-style-type: none"> • understanding safety management • familiar with safety management systems • understands own safety impact • familiar with regulatory issues • demands data on safety • understands safety risks
Others	
Leadership $f = 78$ (14% of all meaning units)	<ul style="list-style-type: none"> • making his or her safety manager visible • visionary • delegating actions, not responsibilities • authentic • democratic <ul style="list-style-type: none"> • taking the full responsibility • Is supportive • Has a good leadership • Example in behaviour • Walks the talk

Note: Overall meaning units coded = 568; f = frequency

Table 2.

Summary of frequencies of the model components and their subcomponents identified in the interviews (Study 2)

	Characteristics (percentages across overall characteristics)	Sub-components within each characteristic	Percentages within each characteristic
Traits	Personality $f = 17$ (7% of all meaning units) $\alpha = 0.89$ (95% CI 0.68 - 1.00)	Conscientiousness	67%
		Agreeableness	11%
		General	11%
		Extraversion	6%
		Openness to experience	6%
		Emotional stability	0%
	Regulatory focus $f = 44$ (15% of all meaning units) $\alpha = 0.60$ (95% CI 0.53 - 0.80)	Promotion focus	69%
		Prevention focus	31%
Skills	Problem-solving $f = 27$ (10% of all meaning units) $\alpha = 0.71$ (95% CI 0.47 - 0.94),	‘Understanding the problem’	57%
		‘Generating ideas’	22%
		Planning for action	13%
		General	9%
	Social competence $f = 93$ (33% of all meaning units) $\alpha = 0.65$ (95% CI 0.51 - 0.78)	Engaging with others	63%
		Persuasion	25%
		‘Perceiving others’	11%
		Expressiveness	1%
		Social adaptability	0%
	Safety knowledge $f = 82$ (29% of all meaning units) $\alpha = 0.68$ (95% CI 0.53 - 0.80)	Facts and information	51%
		Theoretical and practical understanding	21%
		Awareness gained by experience	17%
		Background and education	11%
Other	Emerged concepts $f = 19$ (7% of all meaning units) $\alpha = 0.89$ (95% CI 0.68 - 1.00)	Authenticity	69%
		Trust	15%
		Vision	15%

Note: Overall meaning units coded = 362; f = frequency; percentages on the right refer to the proportion of frequency within each characteristic; α is Krippendorff’s alpha, CI = confidence interval

Table 3.

Example quotes for the most frequently identified components within each concept in the interview responses

Characteristics	Example quotes
Personality Conscientiousness	<i>“Because, me, myself I would never compromise [safety] if I meant it was going in the wrong direction.”</i>
Regulatory focus Promotion focus	<i>“It is like when you try to lose weight. Once you can see the result you tend to be more motivated to keep going. And it is the same with the business. I can see in my business, that rather than the safety performance being a negative thing, which it was when I started two years ago, people now see it as a sense of pride that actually the people that work in the operations have taken all of these risks out of the business.”</i>
Problem-solving Understanding problems	<i>“So I am looking at where the greatest risk lies. And then I make sure that I am happy that the plans to manage that risk are being dealt with. So if we are having [...] a period of safety issues, incidents or near misses or whatever, then I am very involved in what we are doing about it, what it is. Let’s understand it.”</i>
Social competence - Engaging with others	<i>We are trying to establish yearly meetings with all the chief air traffic controllers now, for two days. Where we have safety discussions on standardisation, and also staffing and safety issues from the safety staff.”</i> <i>“We dedicate time where we discuss safety. For example we have every second week we have meetings in my divisions where we discuss all safety related issues.”</i>
Safety knowledge Facts & Information	<i>“The safety department will do an analysis of the safety issues and find mitigations if this is necessary and then we decide if we do it or not.”</i> <i>“How do we generate data and information about what is our current risk, what is our future risk? Because I think we almost drown ourselves in too much information”</i>
Leadership style Authenticity	<i>“People have to know that right from the top safety really is not just something people will say is our number one priority. You know, it is there, it is there all the time.”</i> <i>“You can’t fake being committed to safety. You either are or you are not.”</i>

Figure Caption

Figure 1

Conceptual model of safety intelligence

Note: Characteristics are ordered based on their ranked percentages across the two studies so that the more dominant characteristics are a located at the core of the model.

Appendix

Coding scheme (Summary)

1. Try to get an understanding for the coding categories and their subcomponents. Are you sure you can distinguish them and can repeat their meaning in your own words?
2. Review the questionnaire outline to understand the questions being asked.
3. Start analysing the responses. Every response should be coded.
 - a. Please look through the coding scheme and identify which of the coding categories is most likely to fit the response made by the participant.
 - b. It is possible that not all relevant categories are included in the coding scheme. If you cannot fit a response into any of the predetermined categories, please identify as other. Please make suggestions, what you think each response in this category will most likely reflect.

Social Competence

- Engaging with others
- Social perception: *perceiving others (traits, intentions, and motives)*
- Social adaptability: *ability to adapt to, or feel comfortable in social situations*
- Expressiveness: *ability to express one's emotions and feelings*
- Persuasion: *Ability to change others' attitudes and/or their behaviour in desired directions. Convincing others to do something.*

Safety Knowledge

- Expertise and skills, experience or education The theoretical or practical understanding of safety
- Facts and information: Awareness gained by experience:

Problem-solving

Participants might describe different parts of problem-solving

- Understanding the problem: *define, construct, or focus your problem-solving efforts, looking for information)*
- Generating ideas: *Producing varied ideas. Identifying promising possibilities*
- Planning for action: *select, strengthen and support promising solutions.*

Personality

- Extraversion: *sociable, talkative, assertive*
- Openness to experience: *imaginative, artistically, sensitive, intellectually*
- Emotional instability: *tense, insecure, nervous (neg. pole)*
- Conscientiousness : *responsible, dependable, persistent, achievement oriented*
- Agreeableness: *good-natured, cooperative, trusting*

Motivation

- Promotion focus: *orientation towards achieving positive outcomes: accomplishments and gains*
 - *can be indicated by prioritisation of issues*
- Prevention focus: *avoiding negative outcomes when working towards a goal: focus on safety and responsibility*
 - *can be avoidance of risks*

Other

- Whatever topics you think are lacking in the above and should be considered as well.