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Influence of corporate top management to safety culture
A literature survey

Abstract

Corporate top managers influence the safety through their decision-making on budgets and policies, but also through their daily actions and attitudes. These channels of influence are important in forming the safety culture of the company. This is of particular interest in transport, where human errors are an important source of safety hazards, and safety culture is closely related to handling of risk.

For the purposes of the study, a simple definition of safety culture has been found useful: "Observable degree of effort by which all organizational members direct their attention and actions toward improving safety on a daily basis".

The factors which influence safety culture can be distilled from organizational studies, which often are questionnaire surveys. Typical recurring factors in surveys have been found to be positive attitudes to safety, management commitment, supervisor competence, and priority of safety over production.

For top management and safety, these factors are generally related to importance the management pays to safety, their ability to initiate safety development in their organization, the effectiveness of communication, training and integration to daily operations, as well as establishing simultaneous trust and accountability in their organizations.

Assessment of safety culture is needed for establishing the safety level for benchmarking, for predicting the outcome of proposed safety interventions and for follow-up of improvements. Typical methods that are used in safety culture assessment are attitude surveys and rating scales; in-depth format or informal interviews with individuals; perception surveys and interviews; safety audits; measurements of the safety management system; behavioural sampling; focus group meetings; examination of written records and databases; and document analysis. Self-administered survey is undoubtedly the most common method.

Survey questionnaires in the safety literature have been studied and the factors and questions related to them have been analysed. A set of suitable questions and statements for shipping industry have been extracted.

Finnish summary

Yrityksen ylimmän johdon vaikutus turvallisuuskulttuuriin

Kirjallisuustutkimus

Tiivistelmä

Yrityksen ylin johto vaikuttaa turvallisuuteen budjetti- ja linjapäätösten kautta, mutta myös päivittäisten toimien ja asenteiden avulla. Nämä ovat tärkeitä yrityksen turvallisuuskulttuurin muotoilussa. Ylimmän johdon vaikutus on erityisen kiinnostavaa kuljetuselinkeinoissa, joissa inhimilliset erehdykset ovat merkittäviä turvallisuutta pienentäviä tekijöitä, ja joissa turvallisuuskulttuuri liittyy läheisesti riskienhallintaan.

Tutkimuksessa on käytetty turvallisuuskulttuurille yksinkertaista määritelmää, jonka mukaan se on "mitattavissa oleva pyrkimys, jolla kaikki organisaation jäsenet päivittäin suuntaavat huomionsa ja toimensa turvallisuuden parantamiseen".

Turvallisuuskulttuuriin vaikuttavia seikkoja voidaan löytää organisaatioiden tutkimuksista, jotka perustuvat useimmiten kyselyhin. Näissä on havaittu tyypillisiksi turvallisuuteen vaikuttaviksi tekijöiksi positiiviset turvallisuusasenteet, johdon sitoutuminen, työnjohdon pätevyys ja turvallisuuden asettaminen tuottavuuden edelle priorisoinneissa.

Turvallisuuden kannalta tärkeimmät ylimmän johdon toimet liittyvät johdon turvallisuuteen kiinnittämään huomioon; johdon kykyyn saada aikaan turvallisuuden parannustoimia organisaatiossa; kommunikoinnin tehokkuuteen; koulutukseen ja integrointiin päivittäisissä toimissa sekä yhtaikaisen luottamuksen ja vastuullisuuden aikaansaamiseen organisaatiossaan.

Turvallisuustason arviointiin ja vertailuun, ehdotettujen toimenpiteiden arviointiin ja parannusten seurantaan tarvitaan turvallisuuskulttuurin arviointimenetelmiä. Tyypillisiä menetelmiä ovat asennekyselyt ja pisteytysmittarit; formaalit tai epäformaalit haastattelut; asennekyselyt ja – haastattelut; turvallisuusauditoinnit; turvallisuusjohtamisjärjestelmän mittaukset; käyttäytymisotokset; kohderyhmätapaamiset; kirjallisen aineiston ja tietokantojen analyysit; sekä dokumenttianalyysit. Selvästi yleisin menetelmä on kyselytutkimus.

Tässä tutkimuksessa on kartoitettu turvallisuuskirjallisuudessa esiintyviä kyselyjä, niihin liittyvä tekijöitä ja niiden kysymyksiä. Näistä on valittu sopivia kysymyksiä ja väitteitä merikuljetuselinkeinon tutkimiseen.

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1. Introduction

After the Chernobyl incident the safety culture of organizations has been one of the focus areas in occupational safety development. However, the term "safety culture" has not been defined unanimously but several variations exist. The variations give emphasis on values, perceptions, behaviour, and practical operation of the organization [e.g. Fernández-Muñiz et al. (2007), Lee and Harrison (2000), Mearns et al. (2003)]. Broadly, the main focus is in the social framework of the employees and managers in the organization that affects safety behaviour. In this review, suitable definitions, viewpoints and assessment methods that could be beneficial for further work within shipping industry are sought.

Safety culture can be viewed from many angles. Typically, the environment close to safety managers of the organizations provides most of the research material, and consequently the middle management view dominates. Similarly, employee perspective is strong in internal material of the organizations, typically work instructions and safety management documentation. From the top management viewpoint, lesser amount of practical information is available. Recent research efforts have been directed much on employees' attitudes and perceptions of safety, [e.g. Hayes et al. (1998), Hurst et al. (1996), O'Toole (2002), Richter and Koch (2004), Rundmo 1996, Seo et al. (2004), Silva et al. 2004, Williamson et al. (1997)] and less on measuring the characteristics of top management efforts and systematic safety management.

In shipping, and especially on board ships the organization is hierarchic, due to tradition and the need for clarity in emergency operations. Therefore, safety considerations depend strongly on the actions of the masters and the officers of the ships, and the interactions of the land-based organization. Few published documents on effects of safety culture exist for shipping (Håvold 2005), although it is one of the riskiest industries in the world [Li (2002), Hanson (1996) as cited by Håvold (2005)]. One typical feature of shipping is that ships are manned with crews of multiple nationalities, and the much of it is carried out in international setting, outside national legislations. These issues complicate the communication and interactions within the ships, between them, and with the land-based stakeholders. Håvold (2005) emphasizes the effects of na-

tional culture, which is less prominent in related safety discussions of other fields. Effects of national cultures notwithstanding, research of other aspects of safety culture in other forms of transportation such as aviation and railway transport has been more active than in shipping.

Safety culture has also been studied actively in connection with high-risk industries such as construction, nuclear power generation, chemical plants and hydrocarbon processing industry [e.g. Carder and Ragan (2003), Cox and Cheyne (2000), Farrington-Darby et al. (2005), Molenaar et al. (2002), Rundmo (1996), Rundmo and Hale, (2003), Sorensen (2002)]. In the general safety and human error research it has been concluded that there are generic types of human and organization-induced errors [e.g. Glendon and Stanton (2000), Petersen (1996), Reason (1997)]. Consequently, findings of the other fields that have been reviewed are expected to be applicable for shipping to some extent.

For practicing safety managers, benchmarking to the other organizations and forming of best practices is important. For this, suitable safety performance assessment is needed. Typical assessment methods are accident and incident statistics, site observations, employee surveys, and safety management questionnaires [e.g. Reason (1997), van Steen (1997)]. The complexity and efforts required for assessment varies greatly depending on the level of perceived risks and available funds. For example, the potential catastrophes looming in nuclear power generation are less relevant for shipping industry. Consequently the literature of safety performance assessment has been read with a keen eye on the easily applicable and robust methods.

In the following chapters, definitions of safety culture, its assessment and the possibilities of top management of organizations are discussed.

2. Definitions of safety culture

The concept of "safety culture" is said to first appear in an International Nuclear Safety Advisory Group report of year 1986 about the Chernobyl nuclear accident (Ghosh 2007). Typically, it refers to attitudes of organizations towards safety and the related procedures. The definition of the term "safety culture" has been discussed widely in the literature. Many of these definitions are very broad and implicit (Fernández-Muñiz et al. 2007). The formulation of definition affects the scope of inquiries, and the tools that are used. They are also important for correct ways of focusing to the relevant phenomena, and, finally achieving practical results in assessment and benchmarking. The early discussions about definitions were especially important in clarifying the crucial role of humans and organization in causal chains of accidents, which could not be explained as purely "technological" failures.

Guldenmund (2000), who has reviewed the concept of safety culture broadly, claims that much of the research has neglected to discuss the validities of the concept. In addition, the concepts of "safety culture" and "safety climate" in an organization are used as synonyms or as sub-concepts of each other (Guldenmund 2000). This has caused some confusion [Lee and Harrison (2000), Fernández-Muñiz et al. (2007)]. For practical purposes it seems that using the concept consistently suffices for many cases, and that the concept validity is less important than the validity of its parts, such as "employee perception of safety" or "management attention". Below, some definitions are discussed.

Before the Chernobyl accident, organizational cultures (and climates) had been studied, and safety was one of its aspects, with suitable definitions. E.g. Cooper (2002) cites Turner et al. (1989) who summarize it as "the set of beliefs, norms, attitudes, roles and social and technical practices that are concerned with minimizing the exposure of employees, managers, customers and members of public to conditions considered dangerous or injurious". However, the accident prompted the International Atomic Energy Authority (IAEA, 1991) to define safety culture as "that assembly of characteristics and attitudes in organizations and individuals which establish that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance". It can be seen that the link to safety management systems is ob-

scure and the relevance of human behavior is not prominent. In United Kingdom, the Health and Safety Commission included these in their view that stresses behavioural components (1993) "the product of individual and group values, attitudes, competencies and patterns of behaviour that determine the commitment to and the style and proficiency of an organization's safety and health programs. Organizations with a positive safety culture are characterized by communications founded on mutual trust, shared perceptions of the importance of safety and confidence in the efficacy of preventive measures." In addition to stressing the behaviour of individuals, the healthy communication and trust within groups are noticeable, which is close to modern views.

Guldenmund (2000) cites Cooper (1998) who goes a step further in formalizing safety culture in three parts as "the product of multiple goal-directed interactions between people (psychological), jobs (behavioural) and the organization (situational)". This definition leaves positivistic outcomes of the culture aside and considers only the description of the phenomenon. Similarly, Richter and Koch (2004), among others, describe safety culture as a subset of the general concept of organizational culture, and define it as "The shared and learned meanings, experiences and interpretations of work and safety – expressed partially symbolically– which guide peoples' actions towards risks, accidents and prevention". From the examples above, it can be seen that the view of a scientific community to describe a social grouping phenomenon as it is (interpretative view) (Glendon and Stanton 2000) differs from the view for the positivistic safety management community (functional view). E.g. Blair (2003, p.18) stresses that the concept must be practically defined to be of value. Further, Cooper (2002) adds the need for observation by his definition: "observable degree of effort by which all organizational members direct their attention and actions toward improving safety on a daily basis".

Fernández-Muñiz et al. (2007) have studied the literature widely, and summarize positive safety culture as a combination of safety mindset and accident prevention practices that are omnipresent in the organization: "A set of values, perceptions, attitudes and patterns of behaviour with regard to safety shared by members of the organization; as well as a set of policies, practices and procedures relating to the reduction employees' exposure to occupational risks, implemented at every level of the organization, and reflecting a high level of concern and commitment to the prevention of accidents and illnesses."

For the practical purposes of safety development in the shipping industry, a positivistic interpretation is tempting, and e.g. the above definitions by UK HSC, Cooper or Fernández-Muñiz et al. could be applied. Of these, Cooper's definition seems to include least pre-assumptions, so it is the selection of the author of this review. In the Appendix, some further definitions are collected in a table format adapted from Guldenmund (2000). For further discussion of the merits of the definitions, see e.g. Cooper (2002), Fernández-Muñiz et al. (2007), Glendon and Stanton (2000), and Guldenmund (2000).

3. Influence of top management on safety culture

The factors that affect the safety culture and its outcomes in an organization have been of interest in many fields, such as nuclear industry, chemical industry, hydrocarbon production, manufacturing, construction and transport (E.g. Carder and Ragan 2003, Rundmo and Hale 2003, Lee and Harris 2000, Sorensen 2002, Mearns et al. 2003, Farrington-Darby 2005, O'Toole 2002). Safety can be analysed from organizational psychology point of view (Guldenmund 2000), but also as a control system (Rasmussen 2000). Studies across fields have also been been conducted (E.g. Williamson et al. 1997, Fernández-Muñiz et al. 2007, Oliver et al. 2002). One conclusion of these is that the factors that influence safety culture seem to be rather independent of the field of application. The industries mentioned typically require hierarchical organizing to produce the required results, and thus similarities may be expected. Summaries of the most influential factors can be made, and their validity in the shipping industry can be tested. It is becoming fully accepted that good safety culture (climate) is essential for safe operation (E.g. Blair 2003, Mearns et al. 2003, Williams 2003). Cooper (2002, p.30) discusses safety culture as a subset of corporate culture. Safety culture can be affected by dominant corporate culture – e.g. need to cut budgets and increase profits for shareholders.

The candidates for most influential factors for safety culture can be distilled from the organizational studies, which are typically questionnaire surveys analysed statistically. In addition to these findings by organizational psychology research methods, information is gained by practicing safety professionals who typically use case reviews to make conclusions on influential issues. Below, some examples are presented.

Typical recurring factors in surveys have been found to be positive attitudes to safety, management commitment, supervisor competence, priority of safety over production, and time pressure (Flin et al. 2000, cited in Mearns et al. 2003). Similarly, practicing safety managers Weibert and Plunkett (2006) list nine factors that are essential for acquiring a safety-committed workforce: management leadership and involvement; teamwork; safety leadership and professional development; positive recognition and praise; ownership and commitment; education and administration; effective commu-

nication; creative motivation and sharing the profits; focus on improvement. The results of theoretical and practical approaches resemble each other.

This kind of features should be distinguishable in the safety culture. Blair (2003, p.20) has produced a seven-point checklist for leadership behaviour which advocates vision and its effective communication and encouragement, management example, engineering support, as well as providing the employees with education and power to make changes. In addition, feedback in form of evaluation of the effectiveness is needed. Similarly, Fernández-Muñiz et al. (2007) list six features that belong in an organization that can be said to possess a safety culture: 1) defined safety management system, 2) established incentives for the employee participation, 3) continuous safety training of the workforce, 4) provision of information about hazards and their avoidance, 5) planning for both prevention and emergencies, and 6) feedback system for actions in the organization, which includes internal feedback as well as benchmarking to other companies.

Also Petersen (2003b, p. 30) lists fundamental qualities, which determine safety culture: spending in safety, safety measurement accuracy, rewards of safety, supporting teamwork, history, corporate heroes, safety system targets, supervisors and managrs visibility, empowerment of employees, profitability of the company. Molenaar et al. (2002, p. 27) have studied safety culture through construction industry cases and conclude that strong correlation exists between corporate safety culture and safety performance in companies with good safety records.

It is also useful to discern factors that can reduce safety, and seek the positive result by eliminating the negative factors. Petersen (2005, p. 47) lists eleven common negative attributes that were associated with major incidents such as Chernobyl. They relate to organizational safety culture:
1) Diffused responsibilities, rigid communication, separation of decision makers from the plant
2) Mindset that success is routine
3) Believing that rule compliance is sufficient for safety
4) Too strong team player sprit with no room for risk reporting
5) Information from other facilities not processed
6) Disregard for lessons learned from past or from others
7) Safety performance less important than other performance indicators

8) Lacking emergency planning and training

9) Allowing unsafe design and operational features that are not used elsewhere

10) Project and risk management techniques available but not used

11) Undefined authorities and responsibilities in safety matters

Fleming and Meaking (2004) list positive safety culture elements: Management commitment; Safety prioritized over profits; Good organizational learning; Good communication; Good premises; Confidence in rules and procedures; Trust in workforce; Satisfaction with training; Employee participation; Acceptance of personal responsibility of safety; Willingness to speak up. Similarly, after a cross-survey analysis, Mearns et al. (2003) conclude that influential factors of safety culture can be divided to three general themes: 1) Genuine and consistent management commitment to safety, 2) Communication about safety issues and 3) Involvement of employees. Cooper (2002) refers to a "Reciprocal Model of Safety Culture" which has person-related, behavioural and situational aspects.

Many of the factors discussed above are related to the attitudes of employees, which have been identified as one of the most important factors to affect safety. The practicing professionals Weiber and Plunkett (2006, p. 34) stress the role of employees by summarizing that "Long term safety success comes … through employees who are motivated and encouraged to buy into the system for their own safety and health and that of their co-workers." Similarly, "When employees' attitudes are favourable, employees follow safe procedures, report and fix safety hazards, and actively participate in safety initiatives" (Williams 2003, p.36). The reasons can be attributed to improvement of workers' satisfaction and motivation and their commitment to common goals of the organization (Fernández-Muñiz et al. 2007, Vecchi-Sadus and Griffiths 2004).

Often employees can be considered to be the final means of prevention and they have an important role in determining the safety performance of an organization Therefore, the risk-taking skills and safety behaviour of individuals is of interest. Especially the behaviour of top managers and their relation to risk-taking is an interesting topic. Unfortunately, few studies have been carried out (Rundmo and Hale 2003, also Holmes et al. (1997), cited by the previous).

Risk behaviour of a person in an organization is often enabled or augmented by latent conditions in the workplace (Reason 1997). The latent conditions can be physical or

organizational, and are affected by management actions. In addition to directly contributing to the motivation of the workforce, management has budgetary power over the safety spending, e.g. the implementation and development of safety management systems. Petersen (2003a, p. 48) refers to "error-provocative" situations which are the result of the workplace organization, and discusses safety cultural approach where employees influence the development work, instead of rule-based rigid safety systems.

Personality characteristics affect risk-taking. D. Cooper (2003, p 41) refers to five main personality characteristics: Conscientiousness, extroversion, neuroticism, agreeableness, and openness to experience. Subsets of extroversion, "need to achieve" and the opposite, "need to avoid failure" are particularly important. The need to avoid failure can drive people to take very large or small risks, and the need to achieve intermediate risks. In addition to personal characteristics, the co-workers exert strong influence on safety behaviour. This can be used for controlling the risk by systematic safety culture development (Blair 2003). Håvold (2005) stresses that the cultural differences between nationalities have a large contribution in shipping, as multinational crews are common.

Also aging presents challenges for safety. Hearing, vision, memory, response time and ability to control movements are decreasing with age. This can be seen e.g. in injury statistics where falling incidents are increasing for workers over 45 years old (Haight 2003, p. 21).

The top management is important in risk-taking of employees as it both creates and controls the environment in which accidents occur (Molenaar et al. 2002) but also through the effects on employee safety attitudes, which correlates strongly with safety behaviour (Håvold 2005). Similarly, the interest and commitment of the management increases the involvement of the employees, and thus contributes to improvement of safety conditions. Blair (2003, p. 22) emphasizes that the role of the HSE professionals in an organization is not to establish the safety culture. Instead, it is his/her duty to influence the company management to establish it.

Fernández-Muñiz et al. (2007) have surveyed the effects of management to safety, and conclude that managers' attitudes contribute positively to safety both through their involvement and also indirectly through investments in safety management systems.

The literature on the subject of improving safety stresses the role of management, feedback and formal safety systems (e.g. Fernández-Muñiz et al. 2007, Michael et al. 2005), which result practically from management commitment and interest in safety, employee empowerment, and a functioning safety management system. Oliver et al. have surveyed factors that relate to safety and conclude (2002, p. 486) that organizational factors are as important to accidents as physical work environment, and confirm previous studies ´where top management commitment has been found important.

Petersen (2003b, p.28) goes one step further by stating bluntly that organization's perception of its safety culture "is what makes or breaks safety" and that management creates it through visions, values, measurement, rewarding and daily decisions. Williams (2002, p.44) lists effective leadership behaviours, e.g. consideration, persuasiveness, tolerance of uncertainty and freedom, integration of organization and influence with superiors. Blair (2003, p.18) emphasizes that leadership and safety culture are "inextricably linked" and that leaders must focus on specific behaviours to bring forth change. He separates managers from leaders (managers are needed for status quo, leaders for change), and believes that cultures are created largely by leaders, and advocates visions and less management.

The management attitudes also affect the other important issues found in the study of Fernández-Muñiz et al. (2007), employees' involvement and the safety management system. Thus the key indicators in an organization can be summarized as management attitudes, employees' involvement and the safety management system.

The above authors' views of management attitudes have largely been created through questionnaire surveys that were analysed statistically. For triangulation, other research methods, such as action research, and case analysis could be used. Anyhow, there is no doubt that positive managerial involvement is beneficial for safety.

4. Assessment of the effects of top management to safety culture

Assessment of safety culture is needed for establishing the safety level for benchmarking, for predicting the outcome of proposed safety interventions and for follow-up of improvements. Referring to the discussion in the previous chapters, the assessment concerns a social behaviour of organizational members in maintaining safety, which is not easy to measure. One obvious type of evidence of safety that can be used in measurement is the accidents and incidents, but, unfortunately this is not without problems. Number of accidents is often low for statistical reliability, and smaller incidents and near misses are difficult to collect (Håvold 2000), or may contribute to incentives (Fernández-Muñiz et al. 2007) such as bonuses for good safety records which leads to non-reporting (Håvold 2000), or an accident-free time may suppress the eagerness for reporting. Small incidents may remain unreported if negative outcome may threat the reporter. Accident rates increase if reporting is improved, leading to false conclusions about worsening safety. Rasmussen (2000, p. 48) advocates measuring of safety margin to boundary values that are determined in the design of safe system operation. Large catastrophes that lead to fatalities are typically disseminated closely. Much can be learned from publicly funded institutions whose failures are reported closely. E.g. the safety culture of U.S. space agency NASA has been subject to changes due to reduced funding: "This (government decisions to save money) eroded NASA's in-house engineering depth, making it a slimmed-down agency largely run by contractors." (Petersen 2005 p.48). Accidents appear to be caused by both human and outside organizational influences (Harriss, 2004, p.25).

Typical methods that are used in safety culture assessment are attitude surveys and rating scales; in-depth format or informal interviews with individuals; perception surveys and interviews; safety audits; measurements of the safety management system; behavioural sampling; focus group meetings; examination of written records and databases; and document analysis (Blair 2003, p. 19, Health and Safety Executive 2008).

Cooper (2002) stresses the need for observation of the functioning of the organization instead of observing only the outcome by accident rates or similar metrics. The previously discussed definition of safety culture, "observable degree of effort by which all

organizational members direct their attention and actions toward improving safety on a daily basis" does not explicate the methods, but stresses that constant measuring needs to be carried out. Based on literature surveys, Håvold (2005) finds that safety attitudes have strong links with observed safety behaviour in an organization, also in the shipping industry. For measuring management attitude he uses six questions, of which four relate directly to onboard management. Cooper (2002, p.31) argues that "observable degree of effort" in improving safety can in an organization be used as a measure instead of accident and incident rates. He also argues that setting challenging goals for improvement helps the performance of the organization once the challenge has been accepted by its members. In aviation, it has been noticed that regular access to safety information improves performance (Lee et al. 2005, p.3). Petersen (2003b, p. 32) refers to similarity of errors irrespective of field of application, e.g. medical, aviation, or industrial.

Most of the safety culture assessments which are reported in the literature have been carried out as surveys with self-administered questionnaires (see Table 1): some of these are described briefly in the following pages. Speaking of employee trust, Barfield (2005, p.8) states that it is declining and has a direct correlation to productivity and safety results. He advocates professionally crafted surveys, as "self-developed surveys and in-house analysis can make matters worse".

Safety survey characteristics and topics		
Brown and Holmes (1986)	40 questions, self-administered questionnaire (SAQ)	Employee perception of how concerned management is with their well-being; Employee perception of how active management is in responding to this concern; Employee physical risk perception
Berends (1996)	34 questions, SAQ	Confidence in the arrangements for safety; Compliance with safe working practices; Perceived priority given to safety; Own active effort put in safety matters Communication about safety;
Cabrera et al. (1997)	69 questions, SAQ	Organisational emphasis on safety; Communication channel about safety; Safety level perceived on the job; Feedback performance on safety; Specific strategies of accident prevention
Carder and Ragan (2003)	96 questions, SAQ	Management demonstration; Education and knowledge; Supervisory process; Employee involvement; Fitness for duty; Emergency preparedness; Off-the job safety; Process safety; Environmental protection
Cooper and Philips (1994)	50 questions, SAQ	Management attitudes towards safety; Perceived level of risk; Effects of work pace; Management actions towards safety; Status of safety officer and committee Importance of safety training; Social status of safety and promotion
Cox and Cox (1991)	18 (+4) questions, SAQ	Personal scepticism; Individual responsibility; Safeness of work environment; Effectiveness of arrangements for safety; Personal immunity
Coyle et al. (1995)	30 - 32 questions	Maintenance and management issues; Company policy; Accountability; Training and management issues; Work environment; Policy/procedures; Personal authority; Training and enforcement of policy
Cox and Cheyne (UK HSE) 1999	43 questions, SAQ	Management Commitment; Communication; Safety Rules and Procedures; Supportive Environment; Involvement; Personal Priorities and Need for Safety; Personal Appreciation of Risk; Work Environment
Dedobbeleer and Biland (1991)	9 questions, SAQ	Management's commitment to safety; Worker's involvement in safety;
Farrington-Darby et al. (2005)	Interviews with 40 factors	Management; Individual and behaviorial factors; Rules and procedures; Reporting system; Immediate supervisors and supervisor-subordinate relationships; Communication

Table 1 Safety inquiry characteristics and topics (Early years adapted from Guldenmund (2000)) (continues on the following pages)

Safety survey characteristics and topics		
Fernández-Muñiz et al. (2007)	57 questions, SAQ	Safety policy; Employees' incentives; Training in occupational hazards; Communication in prevention matters; Preventive planning; Emergency planning; Internal control; Benchmarking techniques; Managers' attitudes; Managers' behavior; Employees' involvement; Safety performance
Geller (1994)	-	Person i.e. knowledge, skills, abilities, intelligence, motives, personality; Behaviour i.e. complying, coaching, recognising, communicating, demonstrating actively caring; Environment i.e. equipment, tools, machines, housekeeping, heat/cold, engineering
Grote and Künzler	57 questions SAQ	Operational safety; Safety and design strategies; Personal job needs
Håvold 2005	45 questions, SAQ	Knowledge; Management attitude to safety; Safety behavior; Attitude to safety rules/instruction; Employees satisfation with safety and quality; Concentration of authority; Training experience; Quality experience; Stress experience; Actions after an unsafe act; Environmental systems
Glennon (1982)	68 questions, self-administered questionnaire (SAQ)	Perceived influence of safety and health legislation; Perceived corporate attitude to safety and health; Perceived organizational status of safety advisory officer; Perceived importance of safety and health training; Perceived effectiveness of encouragement (vs. discipline) in promoting safety; Perceived effect of departmental/section safety record on promotion; Perceived risk level of workplaces; Perceived status of safety targets relative to production pressures
Lee (1996)	172 questions, SAQ	Safety procedures: Confidence in the safety procedures; Safety rules: Personal understanding of safety rules; Perceived clarity of safety rules. Permit to work system: Confidence in effectiveness of PTW; General support for PTW; Perceived need for PTW. Risks: Personal caution over risks; Perceived level of risk at work; Perceived control of risks in the plant; Personal interest in job. Job satisfaction: Satisfaction with work relationships; Satisfaction with rewards for good work. Participation/ownership: Self-participation in safety procedures; Perceived source of safety suggestions; Perceived source of safety actions; Perceived personal control over safety. Design: Satisfaction with design of plant. Training: Satisfaction with training. Selection: Satisfaction with staff suitability.
Lee and Harrison (2000)	120 questions, SAQ	Confidence in safety; Contractors; Job satisfaction; Participation; Risk; Safety rules; Stress; Training
Michel et al. (2005)	13 items?, SAQ	Management commitment to safety; Supervisor gender; Employee gender; Supervisor-rated performance; Injured; Perceived dangerousness; Job satisfaction; Withdrawal behavior; Affective commitment
Molenaar et al. (2002)	54 questions, SAQ	Management Component; Field Component; Subcontractor Relationships; Safety plan; Assessment and Change; Training and Education; Incentives; Disincentives; Safety Values; Behavior-Based Safety

Table 1 (Continued from previous page) Safety inquiry characteristics and topics (continues on the following page)

Safety survey characteristics and topics		
Niskanen (1994)	22 questions (workers), 21 (supervisors), SAQ	Workers: Attitude towards safety in the organization; Changes in work demands; Appreciation of the work; Safety as part of productive work Supervisors: Changes in job demands; Attitude towards safety within the organization; Value of the work; Safety as part of productive work;
Ostrom et al. (1993)	88 questions, SAQ	Safety awareness; Teamwork; Pride and commitment; Excellence; Honesty; Communications; Leadership and supervision; Innovation; Training; Customer relations; Procedure compliance; Safety effectiveness; Facilities
Oliver et al. (2002)	Survey with interviews, 18 factors	Supervisor 's response; Co-worker's response; Safety management; Environmental conditions; Noise; Workload; Hazards; Taking shortcuts; Following rules; Using safety equipment; Safety vs. speed; Anxiety checklist; GHQ anxiety; GHQ depression; Near misses; Minor accidents; Up to 3 days off; Severe accidents
Ostrom et al. (1993)	88 questions, SAQ	Safety awareness; Teamwork; Pride and commitment; Excellence; Honesty; Communications; Leadership and supervision; Innovation; Training; Customer relations; Procedure compliance; Safety effectiveness; Facilities
O'Toole (2002)	41 questions, SAQ	Management's commitment to safety demonstration; Education and knowledge; Safety supervisory process; Employee involvement and commitment; Drugs and Alcohol; Emergency Response; Off-the job safety;
Rundmo (1996)	Approximately 250 questions, SAQ	Subjective assessment of risk; Determination of job stress; Physical working conditions; Experience of accidents or near-accidents; Satisfaction/dissatisfaction with safety and contingency measures; Attitudes towards safety; Social support from management, supervisors and colleagues; and employee and management commitment and involvement in safety work
Rundmo and Hale (2003)	195 questions, SAQ, Top management only	Management safety commitment and involvement; Fatalism concerning accident prevention; Management attitude concerning accident prevention; Management attitude towards rule violations; Management safety talk and risk communication with employees; Personal worry and emotion; Powerlessness; Priority of safety; Mastery; Hindrances; Risk awareness; Motivation and information; Procedures and safety regulations; Design and development of equipment; Safety instructions/training
Safety Research Unit (1993)	65 questions, SAQ	Management/supervisor satisfaction; Management/supervisor knowledge; Management/supervisor encouragement and support; Management/supervisor enforcement; Personal management contact; Management support: meetings; Shop floor satisfaction; Shop floor environment: hardware; Work group support/encouragement; Shop floor training; Global self safety; Meetings; Safe working procedures; Safety information; Safety representatives: practice; Safety representatives: authority
Seo et al (2004)	32- item questionnaire scale	Management commitment; Supervisor support; Co-worker support; Employee participation; Competence level
Silva et al (2004)	78 questions, SAQ	Strength of organisational climate; Strength of safety climate; Strength of safety as a vale; Strength of safety practices; Strength of personal involvement
Williamson et al. (1997)	67 questions, SAQ	Personal motivation for safety; Positive safety - practice; Risk justification - fatalism; Optimism
Zohar (1980)	40 questions, questionnaire is administered during interview	Importance of safety training programmes; Management attitudes towards safety; Effects of safe conduct on promotion; Level of risk at work place; Effects of required work pace on safety; Status of safety officer; Effects of safe conduct on social status; Status of safety committee

Table 1 (Continued from previous pages) Safety inquiry characteristics and topics

The tables of the previous pages show that certain topics are recurring across the industries. Cox and Cheyne (2000) refer to a Safety Climate Assessment Toolkit, produced for Health and Safety Executive (2008). The toolkit has three methods of inquiry: employee attitude surveys; face to face interviews and focus discussion groups; and structured observations. Their questionnaire has 43 questions of which 9 relate to management. Lee and Harrison (2000 p. 63) conclude that for full and comprehensive assessment of a safety culture, both safety audits and peer reviews are needed. From previous questionnaires used in nuclear industry with 172 questions they have reduced the number to 80 and 120 depending on the purpose. The most relevant factors have few direct questions about management behaviour, but it is inquired indirectly.

Rundmo (1996) has studied safety in offshore oil industry and concludes that employee risk perceptions may be good indicators of the safety level, and proposes that is objective measures (such as accident rates) might be wrong and should be looked at, if findings of employee risk perception do not correspond with these "objective" (apostrophes by Rundmo) risk estimates. Also, he proposes that safety can not be reduced by increasing risk perception, but other measures are needed. Further, he found that management priority of production goals over safety is the strongest predictor of acceptability in safety rule violations. Rundmo's questionnaire had approximately 250 questions.

Rundmo and Hale (2003) have measured the managers attitudes towards safety and accident prevention. The study has been carried out in offshore industry management seminars and had 195 questions. The issues measured were: Management safety commitment and involvement; Fatalism concerning accident prevention; Management attitude concerning accident prevention; Management attitude towards rule violations; Management safety talk and risk communication with employees; Personal worry and emotion; Powerlessness; Priority of safety; Mastery; Hindrances; Risk awareness; Motivation and information; Procedures and safety regulations; Design and development of equipment; Safety instructions/training. The results indicate that "safety attitudes *may* be an important causal factor for managers' behavioural intentions as well as behaviour." (italics by Rundmo and Hale). In practice this can mean that intentions may be good but time and means for action may be lacking. Rundmo and Hale also

conclude that high management commitment, low fatalism, high safety priority and high risk awareness seem to be especially important attitudes for managers.

Mearns et al. (2003) tested the perceived management commitment to safety with eight or six questions, which were graded on a Likert scale. Similarly, Fernández-Muñiz et al. (2007) measured the effects of safety management systems, managers' commitment, employees' involvement and safety performance in organizations. Grote and Künzler developed a questionnaire for Swiss insurance companies, with 57 questions, three of which relate to management behaviour. Williamsen (2005, p. 42) refers to safety perception surveys, which can be used for determining the safety status of an organization. Safety in construction has been surveyed by O'Toole (2002) with a 41-item survey. Also, Molenaar et al. (2002) studied three construction companies, and their results indicate that the company with best safety record also had the most consistent safety culture. Also its results emphasize the role of management. Carder and Ragan (2003) use a survey that has 96 questions, out of which 21 % relate to management factors. Their view is that the most important factors for safety are management's commitment, knowledge of the workforce, effectiveness of supervisory process and employee involvement and commitment.

Seo et al. (2004) have analysed the previous models of safety climate (culture) thoroughly and, finally, applied a 32-item scale of which seven concerned management commitment. The change of safety behaviour of all employees can be discerned – not just those who perform the most risky tasks (Hansen 2000, p.29). Farrington-Darby et al. (2005) have used structured interviews in transport, and found 40 influential factors, out which five related to manager's behaviour. The factors on management resemble those of other studies, excepting the factor on the need of technical knowledge of managers.

The influential factors that concern top management, and could be used in assessment can be extracted from the research summarized in Table 1. These form the conclusions of this study. A sample from [Cox and Cheyne (2000), Fernández-Muñiz et al. (2007), Grote and Küntzler (2000), Health and Safety Executive (2008), Håvold (2005), Mearns et al. (2003), Lee and Harrison (2000), Rundmo and Hale (2003)] is collected in the list below. The survey topics below can be expressed as statements and scaled e.g. by Likert scale, or as questions that require answering by numbers or narratives. The statement can be either positive or negative, and naturally this can be used for cross-examining the opinions.

Firstly, some positive statements:

- Senior management are genuinely concerned about the health and safety of their employees
- Members of management are often in the plant and discuss safety with plant personnel
- Safety proposals are welcomed during safety meetings, and are swiftly implemented
- Safety is a work requirement and a condition for contracting
- My company will stop work due to safety concerns, even if it means they are going to lose money
- Management is aware of the safety problems in the organization
- Management act decisively when a safety concern is raised
- Managers consider that employees' participation, commitment and involvement is fundamental in reducing accident rate
- Managers and supervisors express concern if safety procedures are not adhered to
- There are sufficient written procedures, checklists etc., to ensure safety of plant operation
- Employees are given enough training to do their work tasks safely

Secondly, some questions that can be used to attain narratives or numerical values for comparisons:

- How frequently did senior managers conduct health and safety tours on the site?
- How frequently did senior managers attend health and safety meetings on the site?
- Are health and safety issues on the agenda at all routine meetings? Where are they in the agenda?
- How managers are held accountable for their health and safety performance?

Thirdly, some negative statements:

- Involvement in accident prevention is time-consuming
- My company's procedures are only there to cover the management's backs
- Management act only after accidents have occurred
- Sometimes it is necessary to depart from safety requirements for production's sake
- I am sometimes made to feel that I am not paid to think
- The rules are too strict and I can work without them
- Some health and safety rules and procedures are not really practical
- If you say too much about safety they might fire you
- Minor accidents cause so much hassle they are quite often ignored

It is noticeable from the lists above that that some numerical metrics are possible, and that surveying the attitudes of managers and their subordinates can be carried out for comparisons and benchmarking.

5. Summary

The view that safety culture is a dominant factor in safe operation of complex techno-logical systems has been accepted after the Chernobyl incident. Many opinions exist of the correct definition, though. However, it can be said that they commonly refer to attitudes of organization members towards safety and the related procedures. It is a social grouping phenomenon that can be described as it is (interpretative view) or val-ued with positivistic (functional) view. For the purposes of the study, a simple defini-tion should suffice, and the definition of Cooper has been found useful: "Observable degree of effort by which all organizational members direct their attention and actions toward improving safety on a daily basis".

The factors which influence safety culture can be distilled from organizational studies, which often are questionnaire surveys. Information is also gained from practicing safety professionals who typically use case reviews. Typical recurring factors in sur-veys have been found to be positive attitudes to safety, management commitment, supervisor competence, and priority of safety over production. Of these, management commitment has been studied more in detail, as organization's perception of its safety culture is crucial, and management creates it through visions, values, measurement, rewarding and daily decisions.

Assessment of safety culture is needed for establishing the safety level for bench-marking, for predicting the outcome of proposed safety interventions and for follow-up of improvements. Typical methods that are used in safety culture assessment are atti-tude surveys and rating scales; in-depth format or informal interviews with individuals; perception surveys and interviews; safety audits; measurements of the safety man-agement system; behavioural sampling; focus group meetings; examination of written records and databases; and document analysis. Self-administered survey is undoubt-edly the most common method.

Survey questionnaires have been studied and the factors and questions related to them have been analysed. A set of suitable questions and statements have been ex-tracted from the literature. Common features of the factors are the emphasis on inter-action between management and the other members of the organization, priorities in safety work and positive reactions to safety issues.

This study is a part of a larger programme where safety in shipping in southern Finland is studied. The next step in the inquiry of effects of top management is using a suitable combination of the statements concluded in the previous chapter in the shipping industry. As the time and scope is limited, the factors need to be condensed further in co-operation with the other research partners. This will be carried out during 2008.

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* The list includes some reference works that are useful but are not mentioned in the text. Some older references that are mentioned only in the tables have been omitted for brevity, and can be found in Guldenmund (2000).

Appendix

Definitions of safety culture (or climate)	
Brown and Holmes (1986)	A set of perceptions or beliefs held by an individual and/or group about a particular entity
Berends (1996)	The collective mental programming towards safety of a group of organisation members
Cabrera et al. (1997)	The shared perceptions of organisational members about their work environment and, more precisely, about their organisational safety policies
Cooper and Philips (1994)	Safety climate is concerned with the shared perceptions and beliefs that workers hold regarding safety in their work place
Cooper (1998)	The observable degree of effort by which all organizational members direct their attention and actions toward improving safety on a daily basis
Cox and Cox (1991)	Safety cultures reflect the attitudes, beliefs, perceptions, and values that employees share in relation to safety
Coyle et al. (1995)	The objective measurement of attitudes and perceptions toward occupational health and safety issues
Dedobbeleer and Biland (1991)	Molar perceptions people have of their work settings
Fernández-Muñiz et al. (2007)	A set of values, perceptions, attitudes and patterns of behaviour with regard to safety shared by members of the organization; as well as a set of policies, practices and procedures relating to the reduction employees' exposure to occupational risks, implemented at every level of the organization, and reflecting a high level of concern and commitment to the prevention of accidents and illnesses
Geller (1994)	In a total safety culture (TSC), everyone feels responsible for safety and pursues it on a daily basis

Some definitions of safety culture (or safety climate), the early years adapted from Guldenmund (2000) (continued on next page)

Definitions of safety culture (or climate)	
Glennon (1982)	Employees' perceptions of the many characteristics of their organisation that have a direct impact upon their behaviour to reduce or eliminate danger (safety climate) and, safety climate is a special kind of organisational climate
International Safety Advisory Group (1991) (IAEA)	Safety culture is that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance
Lee (1996)	The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, and organisation's health and safety management
Niskanen (1994)	Safety climate refers to a set of attributes that can be perceived about particular work organisations and which may be induced by the policies and practices that those organisations impose upon their workers and supervisors
Ostrom et al. (1993)	The concept that the organisation's beliefs and attitudes, manifested in actions, policies, and procedures, affect its safety performance
Pidgeon (1991)	The set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimising the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious
Richter and Koch (2004)	The shared and learned meanings, experiences and interpretations of work and safety - expressed partially symbolically- which guide peoples' actions towards risks, accidents and prevention
Silva et al (2004)	The shared perceptions about safety values, norms, beliefs, practices and procedures that can be observed at general or specific levels
Turner et al. (1989)	The set of beliefs, norms, attitudes, roles and social and technical practices that are concerned with minimizing the exposure of employees, managers, customers and members of public to conditions considered dangerous or injurious
Williamson et al. (1997)	Safety climate is a summary concept describing the safety ethic in an organisation or workplace which is reflected in employers' beliefs about safety
Zohar (1980)	A summary of molar perceptions that employees share about their work environments

Some definitions of safety culture (or safety climate) (continued from previous page)