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# Prerequisites and Possibilities for Manufacturing Companies to Prioritize and Manage Occupational Health and Safety

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### **Abstract**

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Legislation demands that health and safety of humans at work must be secured. Today, far from every company has a functioning systematic management of occupational health and safety (OHS) in place to fulfill its legal obligations. Instead, other day-to-day tasks appear to have greater priority.

The overall aim of this thesis was to investigate prerequisites and possibilities for manufacturing companies to prioritize and manage OHS, with focus on professional roles, company size, safety culture, and financial performance.

Four papers (I–IV) are included in this thesis, based on three data collections. A questionnaire measuring the priority accorded to work environment was completed by 249 representatives of 142 manufacturing companies (I & II). Focus group interviews were conducted with 66 workers at a large steel-manufacturing company, discussing their experiences and perceptions of safety and risks at work (III). A questionnaire measuring OHS management practices, safety culture, and priority given to work environment was completed by 280 representatives of 197 manufacturing companies (IV). Information regarding the companies' financial performance was retrieved from a credit bureau database.

The main findings of the four papers demonstrated that profitability was considered as the most prioritized interest in the companies (I), and that trade-offs between productivity and safety is an obstacle to working safely (III). Managers generally perceived their companies to prioritize work environment factors more than the safety delegates did (I & IV). Perceptions of work environment priority did, however, not differ depending on company size (II & IV). Responsibility for safety was perceived to rest on the individual to the largest extent, and risk-taking was believed to originate from a combination of individual factors and external circumstances in the work environment (III). Larger company size, positive safety culture, and low risk in creditworthiness were found to be associated with better OHS management practices in companies (IV). Correspondingly, smaller company size, negative safety culture, and high risk in creditworthiness were found to be associated with worse OHS management practices.

In summary, *structural*, *social*, and *financial* aspects seem to be important in companies' possibilities for prioritizing and managing OHS. Recommendations for industry and future research are discussed.

*Keywords:* Occupational health and safety (OHS), Small and medium-sized enterprises (SMEs), Professional roles, Company size, Safety culture, Financial performance

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*Für Elja*



# List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

- I Nordlöf, H., Wijk, K., & Lindberg, P. (2012) A comparison of managers' and safety delegates' perceptions of work environment priorities in the manufacturing industry. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 22(3):235–247.
- II Nordlöf, H., Wijk, K., & Westergren, K-E. (2015) Perceptions of work environment priorities: Are there any differences by company size? An ecological study. *WORK: A Journal of Prevention, Assessment, and Rehabilitation*, 52.
- III Nordlöf, H., Wiitavaara, B., Winblad, U., Wijk, K., & Westerling, R. (2015) Safety culture and reasons for risk-taking at a large steel-manufacturing company: Investigating the worker perspective. *Safety Science*, 73:126–135.
- IV Nordlöf, H., Wiitavaara, B., Högberg, H., & Westerling, R. (*Submitted manuscript*) A cross-sectional study of factors influencing occupational health and safety management practices in companies.

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# Abbreviations

BM	Billet mill
CRTM	Cold rolled tubes mill
GEE	Generalized estimating equations
HFE	Human factors and ergonomics
HRTM	Hot rolled tubes mill
HTO	Human–technology–organization
KPI	Key performance indicator
OHS	Occupational health and safety
OHSM	Occupational health and safety management
SM	Steel mill
SME	Small and medium-sized enterprise
STT	Sociotechnical theory
RM	Ring mill
ROA	Return on assets
ROP	Return on prevention
ROS	Return on sales
VAS	Visual analogue scale
WHP	Workplace health promotion



# Introduction

Around the world, nations have legislation intended to secure the health and safety of humans at work. Employers need to ensure that their organizations have a system of management that meets the demands of the legislation. Hazards and risks in the workplace, for example, chemicals, machines, heavy lifting, repetitive work, noise, and air pollution, causing stress, falls, burns, cuts, and the like need to be assessed, and the dangerous conditions adjusted. Other day-to-day tasks of companies often come first, though. Increasing productivity is normally viewed as the most important task, and therefore gets greater priority than activities aimed at occupational health and safety (OHS) (1, 2). Since a company needs to handle many different tasks, it is not uncommon that a “conflict of priorities” is present (1). Adhering to the legislation is important and results in, for example, fewer accidents and injuries (3, 4). It is therefore noteworthy that only about 55% of Swedish companies are reported to have a functioning systematic management of occupational health and safety in place (5–8). Some companies lack such systematic management, some have it and fulfill the legal requirements, and some companies invest even beyond the minimum requirements and consciously try to promote the health of their workforce. There are different underlying factors that may explain why companies are seemingly able, or unable, to successfully prioritize OHS in their day-to-day operations.

The purpose of this thesis was to investigate prerequisites and possibilities for manufacturing companies to prioritize and manage occupational health and safety, with focus on professional roles, company size, safety culture, and financial performance.

## Occupational health and safety

### Legislation

Internationally, one finds that societies have laws and regulations in place with the aim to secure health and safety of humans in their occupations. Occupational health and safety laws across nations share many similarities. They have in common that the health and safety of employees must be secured by assessing, analyzing, adjusting, and minimizing hazards and risks

for injury and disease in the workplace. Modern national OHS legislation has been implemented during recent decades. In the United States, for instance, the Occupational Safety and Health Act was passed in 1970 (9). For the member states of the European Union a “framework directive” for occupational safety and health has been in force since 1989 (10). The Work Environment Act for Sweden was implemented in 1978 (11).

Some important points of the Swedish Work Environment Act are that the ultimate responsibility to secure OHS rests with the employer and that the employees need to assist by actively contributing to OHS, that the employer and employees should collaborate in managing OHS, and that the employer needs to arrange the OHS management in a systematic manner (11). A supplementary provision of the Swedish Work Environment Act also emphasizes that risks at work must be investigated, adjusted, and followed up on *systematically* (12).

It is noteworthy that not more than 55% of the Swedish working population states that there is systematic OHS management going on at their workplace (5). These figures have been quite stable over the years (6–8): 55% (2011), 56% (2009), 53% (2007). Why is it that not more than about 55% of companies have a functioning systematic management of OHS? Company size often seems to matter; management activities for OHS have been shown to generally be more prevalent in larger companies, with, for example, a higher prevalence of workplace assessments, and OHS management systems are less developed in smaller companies (13–17). Company size therefore appears to be a partial factor associated with the difficulties companies have in prioritizing OHS in their day-to-day operations.

## Roles in OHS management

In Sweden, the CEO/employer has the ultimate responsibility for the OHS of a company and for ensuring that the legislated requirements are met (11). The OHS responsibility can be delegated as tasks to deputy managers or other staff in the organization. Such delegation must, however, be done in a clear and structured manner. In larger companies it is also common that some white-collar staff work full-time with supervising different aspects of OHS and coordinating OHS management. The employer and employees are supposed to collaborate to achieve satisfactory OHS (11). This may translate into the employer representatives of a company having a close collaboration with the local trade union organization. By regulation, every workplace with five or more employees should have at least one safety delegate appointed to represent the employees in OHS issues (11). Correspondingly, the larger the company, the larger the safety delegation needs to be. Safety delegates are normally elected by the trade union members, and it is a part-time duty ad-

junct to the normal work tasks in the employment. Safety delegates have regular meetings, and a senior safety delegate has a full-time position as the head of the local trade union organization. Managers and safety delegates cooperate in managing OHS, including by conducting regular safety audits together. They represent two different professional roles that have direct or partial responsibility for OHS at a workplace. If employees wish to call attention to an OHS issue, they can talk directly to their manager or go through the local safety delegate for help and support. In industrial organizations, for example, every employee has the right to stop production if he or she perceives that health and safety is at serious jeopardy.

It has been demonstrated that managers play a pivotal role in how well OHS is performed in an organization (18, 19). Managers may, though, experience a “conflict of priorities” with their tasks, since they naturally have many tasks other than OHS to handle (1). They typically consider monitoring productivity to be the most important task, which therefore gets greater priority than OHS (1, 2, 20, 21). This kind of “conflict of priorities” is more likely found in smaller companies, where the owner/manager may be solely responsible for OHS issues without having delegated some of them to other persons in the company (1, 22). Another aspect of the working atmosphere in smaller companies is that about two-thirds of small company managers are of the opinion that the employees themselves are the main cause of accidents that occur in the workplace (13). Moreover, anecdotal evidence indicates that managers and employees/safety delegates often have different opinions about the state of OHS in their organizations—about how content they are with it. In a Swedish nation-wide survey 80% of employers agreed with the statement that their organization has a strong interest in OHS activities, in contrast to 60% of safety delegates agreeing with the statement (23). The managers and employees/safety delegates cooperate to manage OHS; they do, however, have different roles, status, and identities in the workplace.

## OHS management practices

To achieve a functioning systematic management of OHS, there are different practices and tools available to use. Companies set up their own routines to meet the legislative demands on their types of businesses. There are checklists and systems available for free to handle OHS issues systematically (24). There are also OHS systems available for purchase. OHS management practices include, for example, regularly investigating working conditions, conducting risk assessments, monitoring sick leave, reporting incidents, following up adjustments, or having an OHS policy in place (12). Incidents in the workplace include near misses, accidents, and work-related diseases, and should be reported and documented. If near misses are repeatedly reported

from some part of the workplace, then the company needs to make adjustments to achieve a lasting improvement. If an accident occurs, the company must make necessary adjustments to prevent a reoccurrence (12). Many industrial companies in Sweden use a web-based incident reporting system developed by AFA Insurance, an insurance company owned by the Swedish labor market parties (25). Each new case in the incident system needs some action taken for adjustment, and then later followed up on, before the case can be marked as executed.

An investigation of Swedish workplaces, performed by inspectors from the Swedish Work Environment Authority, showed that six out of ten employers had insufficient OHS management practices, which did not meet legislative demands, with, for example, no routines in place to document near misses in order to learn from them (26). Similarly, the use of risk assessments was also found to be insufficient in a study of German companies (27). Smaller companies tend to use formal practices less frequently, and it is more common for them to use informal or non-systematic OHS systems (3, 28), a reason being that large companies' management concepts normally do not fit small companies very well (29). Even so, despite there not being a formal structure in place, OHS activities have been reported to be more frequent in companies where employees are given responsibilities for them (13).

## Benefits of OHS management

The motivation for OHS management is that by managing hazards and minimizing risks a safe workplace ought to be achieved for everyone working there. It is a moral sentiment that nobody should have to be injured in an accident, suffer from disease, or become chronically ill or depressed from laboring in a workplace (9, 11). The workplace should be organized in such a manner as to achieve a sound physical as well as psychosocial environment.

A study from Spain demonstrated that the kind of OHS management system a company used affected the accident rate (3). The companies in the study that were putting an effort into technical preventive activities showed low accident rates, while the companies that combined preventive activities of technical kinds with people/organizational kinds were the safest. It was also evident that companies with no commitment whatsoever to OHS management were the worst in safety performance (3). Other earlier studies have shown an inverse relationship between frequency of injuries and company size, that is, the injury frequency decreases as the company size increases (30–33).

In another study companies that had been inspected by the U.S. Occupational Safety and Health Administration were compared to companies that had not been inspected, and it was found that injury rates had declined in the inspected companies (4). This study also found that the inspections did not carry negative consequences for the companies, with respect, for example, to their ability to offer employment, or their sales, creditworthiness, or survival. The inspections led to the organizations having to take action to improve their OHS management, and this improvement, in turn, improved the injury rates. Management commitment seems a plausible factor for the effects in the study, since committing to the demands from the inspections was necessary. As mentioned earlier, managers' commitment and prioritization of safety is essential for the OHS performance in an organization (18, 19).

Another positive dimension of being committed to OHS, less often considered, is *employer branding*, that companies are more attractive to potential employees because of a reputation for prioritizing safety, health, well-being, and benefits for their staff (34). Often, for a company to want to prioritize OHS management, there need to be some noticeable effects of the efforts taken (35). The perceived advantages are crucial for companies' decision-making about how to set the priorities (36). But even if companies are motivated to improve OHS management, they often do not associate it with better business performance (37). It is generally difficult to estimate the benefits of investing in OHS, and there are several calculation tools to choose from (38). Reduced sick-leave costs often come to mind as a direct beneficial effect, but frequently, there are productivity and quality improvements to consider as well (37–39). Estimations of return on prevention (ROP) done by the International Social Security Association (40) indicate an average cost–benefit ratio of 1:2.2. Every euro invested in OHS-related improvements, is estimated to render 2.2 euros in benefits.

## Workplace health promotion

In addition to the legally required OHS management, some companies choose to invest further in the workplace by using workplace health promotion (WHP). OHS has most of its focus on protecting people from hazardous risks, while WHP activities focus in addition on promoting health and well-being of people at work (41). WHP activities include offering wellness activities—programs to positively influence lifestyle factors, to involve employees in decisions, to improve skills and competence, and to improve the work organization. Companies with more than 100 employees are about twice as likely as companies with fewer employees to have implemented health promotional programs (42).

# Theoretical framework for OHS in companies

## Human factors and ergonomics

The field of human factors and ergonomics (HFE) is multidisciplinary and both an academic discipline as well as a profession (43, 44). HFE is the study and practice of designing work to fit humans in an optimal manner. The theoretical and practical approach of HFE is to achieve holistic systems solutions that produce both the outcome of well-being for the employees and business performance for the company (44). HFE is about problem-solving, adjusting, and re-designing work systems, for example by improving equipment, physical and cognitive work environments, and organization (43, 44). The underlying principle of HFE is that work should be fitted and optimized to the human condition, and *not* the other way around; that people should have to accept or adjust themselves to non-optimal systems that could pose a threat to health and safety (43–45). Systems used in the day-to-day operations of organizations define the risks that are present at work, as well as which actions/behaviors are possible to perform within the system (45). Health and safety can therefore be improved by designing systems to better fit humans.

An ergonomist in an industrial company, for instance, practices the profession by analyzing and optimizing work tasks and systems to improve comfort, safety, performance, and so forth. An ergonomist is one of the professionals at a workplace to involve in the systematic OHS management.

## Human–technology–organization

Hazards and risks are multifactorial, and it is necessary to regularly and systematically assess all work systems, to assure safe and healthy workplaces (45, 46). There are, however, different schools of thought regarding OHS and the causation of incidents. The person can be viewed as the cause, the system can be viewed as the cause, or a system–person sequence can be viewed as the cause of an incident (46, 47). The latter view, system–person sequence as cause, is in line with the concept of human–technology–organization (HTO). HTO acknowledges that there is mutual interdependence and interaction between humans, technology, and organization in a workplace (48, 49). None of these three components operates in isolation from the others. HTO is a systemic view of the workplace, and can be used to analyze incidents in a wide manner to come up with holistic systems adjustments. In Sweden it has become common to use HTO when analyzing workplaces and complex work tasks in safety-critical industries (49). When considering all three of the components together, successful and holistic work adjustments can be achieved (48). HTO is in turn based on the classic

sociotechnical theory (STT) (50). STT acknowledges that work systems are sociotechnical, which means that there are constant and inevitable interactions between humans and technology (50, 51). It underlines the fact that production systems require both the social, as well as the technological, structures in order to function. None of the structures can be left out. STT proposes that the social and technical structures should be developed and adjusted in such a manner that “joint optimization” is achieved (50). When considering the approach of “joint optimization,” it is obvious that HFE and HTO share a common theoretical base with STT.

## Safety culture

Safety culture is a concept often used to highlight the fact that there are social processes in organizations that help or hinder behaviors or outcomes regarding OHS (52–54). To define safety culture, one needs first to describe *culture* (54). A definition of culture is that it “consists of the **values** the members of a given group hold, the **norms** they follow, and the *material goods* they create” (emphasis original) (55, p. 31). Values comprise what is perceived to be right and wrong, how things should and should not be; they are “abstract ideals” (55, p. 31). Norms are the rules for what behaviors are acceptable or not, the rules that govern social conduct, and they are “definite principles or rules which people are expected to observe” (55, p. 31). Culture is learned through socialization, by humans learning values and norms from others in the groups they associate with, for instance, in a workplace (55–57). Another definition of culture is that it is “a set of solutions produced by a group of people to meet specific problems posed by the situations that they face in common. The solutions become institutionalized, remembered and passed on as the rules, rituals, and values of the group” (58, p. 64).

Thus, the part of workplace culture that concerns health and safety, risks and hazards, is called safety culture (52, 53, 59). Unsafe attitudes and behaviors in an organization has been demonstrated to partly be a result of workplace culture (47, 60–62). Workplace norms have been shown to predict unsafe and risky behavior among employees (62). Behavior is, however, influenced by many different factors, of which safety culture is one (63). How well safety rules and regulations are adhered to in an organization is considered to be influenced by culture (52, 59, 64). A poor safety culture have been associated with organizational accidents, such as the Chernobyl nuclear disaster and the two NASA space shuttle accidents (58, 65, 66).

Expressions of culture can, of course, contribute to either unsafe, or safe, attitudes or behaviors in an organization. In one study it was found that an organization was paralyzed in recognizing warning signs before an accident happened because of two unfortunate cultural expressions (64). The first of

them was a “belief that it was important to rely on personal experience in assessing the evidence” (64, p. 148), which led to a systematic rejection of the reports of others. The other unfortunate cultural expression was “denial, an elaborate set of beliefs which held that ‘it couldn’t happen here’” (64, p. 141). Cultural expressions for a positive safety culture are, among others, to look for errors, not keeping out of sight when difficult situations arise, and to resolve conflicts in a constructive manner (67). Also, managers’ commitment to safety stands out as a crucial factor associated with positive culture, attitudes, and behavior, regarding safety in the workplace (19, 68–70). If employees perceive an atmosphere in the company that suggests safety is supported and important, then they are less ambivalent about whether or not to use personal protective equipment (71). A belief by employees that managers are insincere about stated safety values has been shown to predict unsafe and risky behavior (62).

Safety culture has also been described as “the collection of characteristics and attitudes in an organization – promoted by its leaders and internalized by its members – that makes safety an overriding priority” (66, p. 190). Earlier studies have used the concept of safety culture for organizations in two different ways, assuming either that (1) organizations that are really committed to OHS are the ones that have a safety culture, or (2) all organizations have a safety culture, and that it can vary in being strong/positive or weak/negative (51, 72). The latter way of thinking about safety culture is used in this thesis. In a quasi-experimental case study of a company it was shown that safety culture indicators were improved after changes were made in the OHS organization, as well as by improving the communication and interaction between safety management agents and the shop-floor workers (73). An association between safety culture and OHS management practices is assumed, but more research is needed to investigate whether it is possible to further establish a relationship (59, 69, 70).

## Summary of the introduction

OHS legislation demands that companies secure health and safety of everybody in a workplace (9–11), but companies’ commitments to this obligation vary (1, 5). Some companies lack a systematic OHS management, some fulfill the legislative requirements, and some companies even invest further in OHS by using WHP to promote health and well-being (41). Much advancement in health and safety for humans at work has taken place in nations and companies over the decades since the inception of OHS laws. Still, there is room for improvement, considering, for example, that only about 55% of Swedish companies have a functioning systematic management of OHS in place (5–8). Benefits of managing OHS properly are, for instance,

that fewer accidents and injuries occur (3, 4). Financial benefits of OHS investments can often be estimated; such investments can result in reduced sick leave as well as improvements in productivity and quality (37–40). Another benefit is the possibility of being an attractive employer, as a part of the employer brand (34).

The theoretical and practical approach of HFE is to achieve general system improvements in work tasks, and to ensure that they are fitted to the worker, not the other way around (43, 44). STT and HTO highlight that humans, technology, and organization are mutually interdependent and that a holistic approach to OHS therefore is preferable (48–50). Designing work holistically is thus thought to improve health and well-being of the worker in conjunction with business performance (44). The concept of safety culture highlights that there are social processes at work that influence OHS, due to what people in organizations *value* as important and what social *norms* partly guide their activities regarding OHS (52, 53, 55, 74).

There are underlying factors regarding why companies succeed in prioritizing and managing OHS, as well as why they do not succeed. Some factors deemed to be relevant are the size of the company (e.g., 13, 17), the interplay between different professional roles at the company (e.g., 18, 22), whether formal OHS management procedures are used or not (e.g., 3, 5), lack of commitment (e.g., 3, 68) and motivation (e.g., 35, 36), and a poor safety culture where OHS issues are not valued highly enough (e.g., 52, 59). Further research is needed to better understand which factors play a part (and to what extent) in companies' prioritization and management of OHS. This thesis investigates some of these factors further.

# Aims of the thesis

The overall aim of this thesis was to investigate prerequisites and possibilities for manufacturing companies to prioritize and manage occupational health and safety, with focus on professional roles, company size, safety culture, and financial performance. The specific aims for each paper were:

- I To investigate the extent to which work environment factors are prioritized at manufacturing companies, and whether there are differences between managers' and safety delegates' perceptions of work environment priorities.
- II To investigate whether there is an association between company size and perceptions of work environment prioritization at manufacturing companies.
- III To investigate and describe safety culture and risk-taking at a large steel-manufacturing company by exploring workers' experiences and perceptions of safety and risks.
- IV To investigate different factors (e.g., company size, safety culture, and financial performance) that may influence occupational health and safety management practices in manufacturing companies.

# Methods

## Designs

Papers I, II, and IV had a quantitative and cross-sectional design, while paper III had a qualitative design. Papers I, II, and IV were based on data collections using questionnaires, while paper III was based on a data collection using focus group interviews. Table 1 gives an overview of the study designs, methods, and samples.

Table 1. *Overview of study designs, methods, and samples*

Data collections		Collection 1		Collection 2	Collection 3
		Paper I	Paper II	Paper III	Paper IV
Designs	Cross-sectional	×	×		×
	Ecological		×		×
	Qualitative			×	
Methods	Questionnaire	×	×		×
	Focus group interview			×	
Samples	Subjects	<i>n</i> = 249	<i>n</i> = 212	<i>n</i> = 66	<i>n</i> = 280
	Managers	<i>n</i> = 125	<i>n</i> = 106	–	<i>n</i> = 191
	Safety delegates	<i>n</i> = 124	<i>n</i> = 106	<i>n</i> = 12	<i>n</i> = 89
	Workers	–	–	<i>n</i> = 66	–
	Men	<i>n</i> = 201	<i>n</i> = 171	<i>n</i> = 42	<i>n</i> = 217
	Women	<i>n</i> = 45	<i>n</i> = 40	<i>n</i> = 24	<i>n</i> = 57
	Age (mean)	–	–	(44)	(48)
	<35	<i>n</i> = 36	<i>n</i> = 30	<i>n</i> = 12	<i>n</i> = 25
	36–50	<i>n</i> = 120	<i>n</i> = 107	<i>n</i> = 33	<i>n</i> = 108
	>51	<i>n</i> = 93	<i>n</i> = 75	<i>n</i> = 20	<i>n</i> = 92
	Companies	<i>n</i> = 142	<i>n</i> = 106	<i>n</i> = 1	<i>n</i> = 197
	Small	<i>n</i> = 104	<i>n</i> = 79	–	<i>n</i> = 146
	Medium	<i>n</i> = 36	<i>n</i> = 27	–	<i>n</i> = 42
Large	–	–	<i>n</i> = 1	<i>n</i> = 9	

Missing data: Paper I: Gender for three subjects. Company size for two companies. Paper II: Gender for one subject.

Paper III: Age for one subject. Paper IV: Gender for six subjects. Age for 55 subjects.

Company sizes: Small = <49 employees, Medium = 50–249 employees, and Large = >250 employees.

# Subjects

## Papers I and II

The study population approached in the data collection for papers I and II was all manufacturing companies in a county in central Sweden employing 10 to 249 employees (a total of 210 companies). The response rate was 68% ( $n = 142$ ). At each of the companies one manager and one safety delegate were approached (a total of 420 respondents). The response rate of the subjects was 59% ( $n = 249$ ). This sample was used in the analysis for paper I. For the analysis in paper II the sample was the companies where both managers and safety delegates had filled out the questionnaire. This represented 50% ( $n = 106$ ) of the companies and 50% ( $n = 212$ ) of the subjects. The characteristics of the subjects are described in Table 1.

## Paper III

The study context of paper III was a steel-manufacturing company situated in a typical industrial works community such as is found in many smaller towns in Sweden. These kinds of companies have played an important role in the development of Swedish communities over many centuries. The particular company in paper III operates in the steel industry, smelting steel and manufacturing different products that are sold on to other manufacturing companies for further use. The production is divided into five departments: steel mill, billet mill, ring mill, hot rolled tubes mill, and cold rolled tubes mill. The work is heavy and demanding on the body, and the environment can be hot, sweaty, noisy, and sooty. In some departments there are risks for burns, and in others, risks for crushing injuries. The staff can call attention to occupational health and safety matters by using the incident reporting system, by talking to their manager, or by asking local safety delegates for help and support. The company is required to take measures to prevent accidents from reoccurring (10–12). This company was chosen as study context, since it represents a *typical case* (75) of a heavy industrial workplace with a variety of internal risks for health and safety.

The study population approached in the data collection for paper III was workers in this large steel-manufacturing company in central Sweden with about 1000 employees. Blue-collar workers of all five departments at the company were recruited to ten focus group interviews ( $n = 66$ ) (Table 1), to achieve *maximum variation* (75).

## Paper IV

The study population approached in the data collection for paper IV was all manufacturing companies employing 10 employees or more in a county in central Sweden (a total of 238 companies). The response rate was 82% ( $n = 197$ ). At each of the companies, one manager and one safety delegate were approached (a total of 476 subjects). The response rate of the subjects was 59% ( $n = 280$ ) (Table 1).

## Data collection instruments

### Papers I and II

The instrument used for the data collection in papers I and II was a 43-item questionnaire developed to measure perceived priority of the work environment in companies. Examination of the literature revealed no existing instrument appropriate for use in achieving the study aim. Therefore, items were formulated after reviewing earlier questionnaires, research studies, legislation, and gray literature (e.g., 11, 76, 77), which gave an initial list of 130 items to measure work environment factors. Then, through mind-mapping and discussions in the research team, the items were narrowed down to 43. Table 2 gives an overview of the questionnaire items.

Forty-two of the items were presented as questions to be answered using a visual analogue scale (VAS) by rating the extent of priority of that particular factor within the respondent's own company, with the end-points *no priority whatsoever* and *highest possible priority*. Seven different indexes were calculated using the 42 rating questions: (1) physical working conditions, (2) psychosocial working conditions, (3) organizational improvements, (4) work environment routines, (5) communication and interaction, (6) management, and (7) health and prevention.

The forty-third item was a ranking question where areas of interest for companies were to be ranked in descending order corresponding to the extent to which the respondent perceived that they were prioritized at the company (Table 2). The ranking item was constructed with the notion that prioritization not only is about the *extent* to which a factor is being prioritized (the rating items), but also whether other factors come in first, second, or third, and so forth (the ranking item). Six alternatives to rank, with the option to add a seventh of one's own choice, were thought to be a manageable number of alternatives to respond to.

Table 2. Description of the work environment priority questionnaire of papers I & II

Index constructs	Items	Response alternatives
	<i>To what extent does your company...</i>	
Physical working conditions	Q1: ...engage in physical working environment improvements? Q2: ...provide ergonomically designed equipment? Q3: ...provide an adequate workspace? Q4: ...work to minimize physical workloads? Q5: ...provide ergonomically designed work station? Q6: ...provide the possibility for breaks and recovery?	VAS (Endpoints: <i>no priority whatsoever</i> and <i>highest possible priority</i> )
Psychosocial working conditions	Q7: ...promote a good psychosocial climate? Q8: ...support work-life balance? Q9: ...promote collaboration? Q10: ...promote job satisfaction? Q11: ...promote employee well-being? Q12: ...provide employees with both positive and negative feedback?	
Organizational improvements	Q13: ...engage in organizational improvements? Q14: ...promote development of worker competency? Q15: ...work toward effective workplace routines? Q16: ...permit flexible work times when required? Q17: ...strive for gender equality? Q18: ...strive for company diversity?	
Work environment routines	Q19: ...provide work environment routines? Q20: ...provide orientation and care for new employees? Q21: ...promote employee involvement in work environment management? Q22: ...provide a work environment policy? Q23: ...engage in continuous risk assessments? Q24: ...work toward clean and enjoyable workplaces?	
Communication & interaction	Q25: ...have open communication and dialogue? Q26: ...promote internal communication and information transfer? Q27: ...promote free expression and discussion of workplace opinions? Q28: ...enable employee influence over the workplace? Q29: ...engage in dialogue-style performance review? Q30: ...support effective interaction between employees and management?	
Management	Q31: ...work toward clear leadership? Q32: ...strive for clearly defined work tasks? Q33: ...engage in leadership development? Q34: ...promote clearly defined goals? Q35: ...promote company spirit? Q36: ...appreciate and apply employee innovation?	
Health & prevention	Q37: ...promote total employee health? Q38: ...work toward reducing the amount of sick leave taken? Q39: ...provide access to physical training and health	

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	maintenance facilities?	
	Q40: ...strive to prevent work-related musculoskeletal disorders?	
	Q41: ...work toward risk and accident prevention?	
	Q42: ...provide suitable tasks for workers on reduced capacity employment?	
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<b>Ranking item</b>	Q43: <i>Please rank the following areas according to their order of importance at your company from 1 (highest importance) to 7 (lowest importance):</i> (i) Physical work environment, (ii) Branding, (iii) Psychosocial work environment, (iv) Profitability, (v) Economic goals (other than profitability), (vi) Environmental work, (vii) Other (specify)	1–7

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Q = Question. Items translated from Swedish.

### Validity and reliability

A small pilot study ( $n = 10$ ) was done to check the face validity of the items, which resulted in some adjustments. VAS was chosen as response alternative with the rationale that it should be well suited when it comes to “rating the *prioritization* of something” in an accessible and straightforward manner. High index scores would indicate that the work environment was prioritized at a company, and low scores would indicate that the work environment was lowly prioritized and that actions would probably need to be taken at the company to better fulfill legal requirements of OHS. The items inquire about both OHS and WHP, hence, both legal requirements for health and safety as well as optional activities for achieving a good work environment. To test the internal consistency of the seven index measures, Cronbach’s alpha test statistic was calculated and found as satisfactory with scores within the range of 0.77–0.91.

### Paper III

The instrument used for the paper III data collection was a semi-structured interview guide. It was developed for the study in order to investigate workers’ experiences and perceptions of safety and risks at work. The guide had three main discussion themes and some subtopics. These are presented in Table 3. The focus group interviews were recorded digitally as audio files. A short questionnaire was used to collect some descriptive information about the subjects.

Table 3. *Description of the semi-structured interview guide for paper III*

<b>Theme 1: What is safety like at your workplace?</b>	Importance of safety at the workplace, of working safely How high safety is valued in the organization Risk-taking at the company—allowed, not allowed Correction of colleagues if violating safety procedure
<b>Theme 2: How is safety handled at your workplace?</b>	Safety arrangements at the workplace Thinking, not thinking, about safety at work People involved in safety management Tools, equipment to work in a safe manner Hazardous situations at the workplace Safety problems at the workplace
<b>Theme 3: What could be improved regarding safety at your workplace?</b>	Improving safety at the workplace Reasons for work injuries at the workplace Reasons for risk-taking at the workplace Missing in safety management Creating good safety
<b>Examples of follow-up questions</b>	Interesting, please explain more. What does that mean? Do you have an example? Something else you are thinking of? Would someone else like to say something about that? If I have understood you correctly, you mean that... Please tell more. How come? What do you think about that?

## Paper IV

The instrument used for the paper IV data collection was a 35-item questionnaire, developed to measure OHSM practices in companies, safety culture, work environment priority, perception of whether a company is profitable at the moment or not, and number of employees (company size). Table 4 gives an overview of the questionnaire items.

### OHSM practices index

Thirteen items to measure OHSM practices were developed, since no established instrument to measure it was found in the literature. The items were formulated after reviewing the essential dimensions of OHSM in earlier research and legislation (e.g., 10–12, 78, 79). The items were to be answered with yes / no / don't know. An index was calculated by summing the number of yes answers.

### Safety culture index

Questionnaire items to measure safety culture have been used in earlier research (53, 72), but when going through the literature no questionnaire was found that produces *one* global safety culture measure. Therefore, 13 items to reflect primary factors for safety culture were developed by reviewing earlier research (e.g., 52, 53, 80–82). The items were written as statements and were to be answered with a Likert-type scale with the alternatives yes, absolutely / yes, partly / no, not really / no, not at all.

Table 4. Description of the paper IV questionnaire

Index constructs	Items	Response alternatives
OHSM practices index	Q1: <i>Written routines</i> : Does your company have written routines stating how your OHS management should be carried out?	Yes / No / Don't know
	Q2: <i>Safety delegates</i> : Is any employee appointed as a safety delegate / employee representative here?	
	Q3: <i>Risk assessment</i> : Has your company conducted any written risk assessment during the last 12 months?	
	Q4: <i>Collaboration for risk assessment</i> : Do both the employer and the safety delegates / employees participate when risk assessments are conducted?	
	Q5: <i>Written action plan</i> : Has your company during the last 12 months established a written action plan to address a risk?	
	Q6: <i>Action plan follow-up</i> : Has your company during the last 12 months followed up on an action plan?	
	Q7: <i>Reporting incidents</i> : Does your company have routines to report occupational health and safety incidents that occur (e.g., deviation, near miss, accident)?	
	Q8: <i>Emergency plan</i> : Does your company have a written emergency plan to follow if a severe accident were to occur?	
	Q9: <i>Safety training</i> : Do new employees get an introduction to what risks there are at the workplace and how to protect themselves against them?	
	Q10: <i>OHS policy statement</i> : Is there an OHS policy statement available?	
	Q11: <i>OHSAS 18001 certification</i> : Is your OHS management certified according to the OHSAS 18001 standard?	
	Q12: <i>Occupational health services</i> : Is your company affiliated with an occupational health service (or does it have its own)?	
	Q13: <i>Budget item for OHSM</i> : Does your company have a specific budget item for costs concerning OHS management?	
Q14: <i>Safety rules</i> : In our company it is considered very important to follow safety regulations.		
Q15: <i>Risk acceptance</i> : Here it is OK to sometimes ignore a safety regulation to perform a task.		
Q16: <i>Management commitment</i> : In our company managers set a good example when it comes to following safety regulations.		
Q17: <i>Productivity pressure</i> : Here it is OK that productivity sometimes gets priority over safety.		
Q18: <i>Employee involvement</i> : In our company it is considered very important that employees are involved in safety management.		
Q19: <i>Individual responsibility</i> : Here the individual's own responsibility is considered very important for working safely.		
Q20: <i>Incident reporting</i> : In our company it is considered important to report incidents that occur (e.g., deviation, near miss, accident).		
Safety culture index		

	Q21: <i>No fatalism</i> : Here it is considered possible to completely prevent existing hazards.	
	Q22: <i>Blaming</i> : In our company we primarily try to identify who is at fault if any incident occurs (e.g., deviation, near miss, accident).	
	Q23: <i>Peer feedback</i> : Here colleagues appreciate being reminded to work in a safe manner.	
	Q24: <i>Safety training</i> : In our company it is considered very important that everyone gets proper training in working safely.	
	Q25: <i>Communication</i> : Here there is direct and clear communication regarding work tasks and performance, which contributes to safe work.	
	Q26: <i>Continuous improvements</i> : In our company there is engagement to constantly improve safety.	
Work environment priority index	Q27: <i>Physical working conditions</i> : Here we work toward ensuring good physical working conditions.	Yes, absolutely / Yes, partly / No, not really / No, not at all
	Q28: <i>Psychosocial working conditions</i> : Here we work toward ensuring good psychosocial working conditions.	
	Q29: <i>Organizational functionality</i> : Here we work toward ensuring that the organization functions well.	
	Q30: <i>OHSM routines</i> : Here we work toward ensuring that the occupational health and safety management system functions well.	
	Q31: <i>Communication &amp; interaction</i> : Here we work toward achieving open communication and dialogue.	
	Q32: <i>Leadership</i> : Here we work toward having leadership that is clear and unambiguous.	
	Q33: <i>Health</i> : Here we work toward ensuring that everyone enjoys good health at work.	
<b>Profitability item</b>	Q34: Do you perceive the company you work for to be profitable at the moment?	Same as above
<b>Company size item</b>	Q35: How many employees are there in total at the company worksite where you work? (specify) _____	Open _____

Q = Question. Items translated from Swedish.

### Work environment priority index

The seven indexes of work environment priority, which were used for data collection in papers I and II, were also used in this questionnaire, but here they were reformulated as seven *items* instead of seven *indexes*. This was done to reduce the total number of items in the questionnaire. The items were written as statements, and the same Likert-type scale as used for safety culture was used for these responses.

### Validity and reliability

Several steps were taken to assert validity of the questionnaire items—as mentioned previously, by reviewing the literature (legislation, research, theory, and earlier questionnaires)—but also by obtaining advice and feedback from 22 different persons in order to improve the questionnaire (two OHS

managers in manufacturing companies, two officers from the Swedish Work Environment Authority, two safety delegates and one OHS coordinator at a university, and 15 university researchers). To test the internal consistency of the index measures, Cronbach's alpha test statistic was calculated and found as satisfactory: OHSM practices (0.73), safety culture (0.85), and work environment priority (0.91).

## Data collection procedures

### Papers I, II, and IV

The data collection for papers I and II, as well as the data collection for paper IV, was performed using a postal questionnaire and similar procedures. The addresses to the companies were extracted from a self-service credit bureau database ([www.uc.se](http://www.uc.se)). Each company was sent two questionnaires in separate envelopes. One of the questionnaires was intended to be answered by either the executive or the personnel manager of the company. The other questionnaire was intended to be answered by the senior safety delegate or the safety delegate of the company. An information letter explaining the aim and procedure of the study was included, and subjects were free to choose or decline participation. Completed questionnaires were returned in a response envelope. Non-respondents were reminded with a written letter, followed by a telephone call, followed finally by another written letter. In the paper IV data collection respondents were also given the option to answer a shorter version of the questionnaire by telephone. This shorter version included the questions on OHSM practices, the profitability item, and the company size item, but did not include the questions on safety culture or work environment priority.

The non-response rate of the companies in the data collection for papers I and II was 32% ( $n = 68$ ). A non-response analysis showed that the non-responding companies did not deviate from the participating companies in size or geographical location in the county. The non-response rate of the companies in the paper IV data collection was 18% ( $n = 41$ ). The non-responding companies in this sample did also not deviate from the participating companies in their geographical location in the county. There were also no significant differences across creditworthiness, quick ratio, equity ratio, return on sales, or return on assets. It was, however, a bit more usual for large companies, and companies belonging to a corporate group, to participate.

### **Further data collected for paper IV**

Apart from the questionnaire, data for the analysis in paper IV were also collected from the self-service credit bureau database ([www.uc.se](http://www.uc.se)). The following information on financial key performance indicators (KPIs) of the sampled companies was extracted: two measures of profitability, return on sales (ROS) and return on assets (ROA); two measures of solvency, quick ratio and equity ratio; and one measure of creditworthiness. The variables ROS, ROA, quick ratio, and equity ratio were expressed as percentages. Creditworthiness was expressed as a five-point ordinal scale ranging from 5 (*very low risk*) to 1 (*high risk*). Information on whether or not a company was part of a corporate group was also collected from the database.

### **Paper III**

The data collection for paper III was performed using focus group interviews. Focus groups are a method appropriate for investigating cultural values and group norms by identifying shared knowledge and experiences within groups (83, 84). Two shift teams from each of the five departments were randomly selected and approached. The numbers of workers in the focus groups ranged from five to nine. Each focus group consisted of collegial workers from the same shift team and department, enabling them to feel comfortable in discussing their workplace. The departmental and deputy managers helped to facilitate the recruitment of subjects. They gave the workers an information letter explaining the aim and procedure of the study and informing them that they were free to choose or decline participation. The managers also helped to organize dates and meeting rooms for the interviews.

All interviews were performed by two people, the interviewer and an assistant. Each interview started with the subjects receiving information about the study and the voluntary nature of participation, whereafter they filled out a written consent to participate. The main part of the interviews lasted about 75 minutes. The interviewer used the interview guide to pose open-ended questions and asked the participants to elaborate on the topic when appropriate. The assistant took notes but did not participate in the discussions. The sessions ended with the subjects filling out the short questionnaire for descriptive information.

# Data processing and analyses

## Papers I and II

The VAS lines of the priority rating items were divided into ten equidistant parts. The markings filled out by the respondents were read and then registered as numeric values ranging from 1 to 10. Ten values were considered a reasonable range when analyzing prioritization of work environment factors. These variables were treated as ordinal data. For the VAS items the respondents had been asked to indicate to what extent the factors were prioritized *now* as well as *one year ago*, producing two score values for each item. The index scores were calculated by summarizing and then averaging the six item values to get a mean value for each index. The statistical software used for data processing and analyses was PASW Statistics 18.0 (SPSS Inc., Chicago, IL, USA). *P*-values <0.05 were considered statistically significant.

### Paper I

The respondent (manager or safety delegate) was the independent variable, and the work environment priority indexes were the dependent variables in analysis. To test for differences between managers and safety delegates on the work environment priority indexes, the nonparametric Kruskal–Wallis test was used. Then, the Wilcoxon signed rank test was used to make pairwise comparisons of the managers and safety delegates working at the same companies. To test for differences between the ratings of now and one year ago, the Kruskal–Wallis test was used. Managers and safety delegates were compared on the ranking variable using the Mann–Whitney *U* test.

### Paper II

Responses from 106 companies were used in the analysis, since that was the number of companies for which both respondents (safety delegate and manager) participated. The two ratings of each company were averaged to get an aggregated mean value rating for each company. Company size was the independent variable, and the work environment priority indexes were the dependent variables in analysis. To test for association between company size and the indexes, the Kruskal–Wallis test was used. To test for consensus in the work environment priority ratings between the paired respondents from each company, first, the extent of agreement was tested by Spearman's rank correlation. Then, a ranking test of the obtained correlation coefficients was done using the Mann–Whitney *U* test. The ranking item was not used in the analyses for paper II.

### Paper III

The recorded interviews were transcribed verbatim. Before the analysis the interviewer read all the transcripts at least once while listening to the recordings, to make corrections in the text. The transcripts were transferred to the qualitative analysis software Atlas.ti in order to work with the data and to perform the analysis (ATLAS.ti 6.0 GmbH, Berlin). The data were analyzed using the approach of *qualitative content analysis* (85). The analysis was inductive and had an explorative approach.

To address the study aim, the transcripts were read to identify text segments dealing with normative beliefs and fundamental values (assumptions, expectations, philosophies, norms, and rules), with regard to safety in the workplace (74). Such text segments were treated as meaning units and coded. Codes were written as short sentences to mirror the content of the text and to not lose information. Text segments dealing with reasons for risk-taking were also identified and coded. In the next step of the analysis codes were sorted and narrowed down. They were then printed on paper and cut out on separate paper strips. The codes were sorted and organized on a tabletop, and categories were formed. Codes, subcategories, and categories were derived from the data and not identified in advance.

### Paper IV

The yes answers of the OHSM practices items were summed together to create the index variable (scores 0–13). Then, based on these scores, OHSM practices were recoded into a four-category variable for analysis, with the categories *minimal* (0–7), *good* (8–9), *very good* (10–11), and *excellent* (12–13). The *yes, absolutely* and *yes, partly* answers for safety culture were coded as 1 and summed together to create the index variable (scores 0–13) for analysis. Safety culture was also recoded into a four-category variable for a complementary analysis (categories: 0–9, 10–11, 12, 13). The *yes, absolutely* and *yes, partly* answers for work environment priority were also coded as 1 and summed together to create the index variable (scores 0–7).

The company size variable (number of employees) was used as it was (continuous) in analysis, but was also recoded into a five-category variable for a complementary analysis (categories: 1–9, 10–19, 20–49, 50–99, >100). The creditworthiness variable needed no further preparation (five categories). Perceived profitability was used with its four categories (*yes, absolutely*; *yes, partly*; *no, not really*; *no, not at all*), but was also recoded into a dichotomous variable (*yes* and *no*). Information on the financial KPIs of ROS, ROA, quick ratio, and equity ratio was available for the three latest years, and a mean value score was calculated for each of these variables. The di-

chotomous variable of being part of a corporate group or not needed no further preparation.

In the statistical analysis, OHSM practices was used as outcome variable, and the other variables as predictor variables. Generalized estimating equations (GEE) were used to perform ordinal regression analysis. GEE is considered a robust method where it is possible to adjust for clustered data (86). The data in these analyses were clustered in the sense that there was more than one respondent per company in most cases; “company” was thereby set as the subject variable in the analysis, and “respondents” at the companies as the within-subject variable. First, separate univariate analyses for each of the predictor variables together with the outcome were conducted. Thereafter, the statistically significant predictor variables were used together in a multivariate analysis together with the outcome, to estimate how they contribute to better OHSM practices. A complementary multivariate analysis was also performed with safety culture and company size as category variables. Finally, a multivariate analysis was performed with the predictor variables and outcome variable reversed, to estimate whether the factors also may contribute to worse OHSM practices. PASW Statistics 22.0 (SPSS Inc., Chicago, IL, USA) was used for the statistical analyses, and  $p$ -values  $<0.05$  were considered statistically significant.

#### **Further analyses of the paper IV data**

To verify results from the analyses of paper I and II comparing managers and safety delegates, as well as comparing small and medium-sized companies, the corresponding statistical analyses were also performed with the paper IV data. These complementary analyses and results are presented in this thesis summary but not in the submitted paper IV manuscript. To test possible differences between managers and safety delegates on the variables work environment priority, safety culture, and OHSM practices, the nonparametric Mann–Whitney  $U$  test was used. Also, the Wilcoxon signed rank test was used to make pairwise comparisons of the managers and safety delegates working at the same companies. Furthermore, there were a total of 80 companies where two respondents had answered the questionnaire. The two ratings of each company were averaged to get an aggregated mean value rating for each company, just as in the analysis for paper II. The Mann–Whitney  $U$  and Kruskal–Wallis tests were used to investigate associations between company size and work environment priority, safety culture, and OHSM practices.

# Results

## Prioritization of work environment factors at the manufacturing companies (paper I)

Profitability was perceived as the most highly prioritized company interest, according to the ranking item (Q43 in Table 2). The scores of the ranking item are presented in Table 5 for both managers and safety delegates. Managers and safety delegates ranked the interests alike, with *physical work environment* following *profitability*. They differed from one another in the ranking order on the other company interests.

Table 5. Ranking scores of the different company interests

	Managers ( <i>n</i> = 122) <sup>1</sup>			Safety delegates ( <i>n</i> = 122) <sup>1</sup>		
	Me- dian	Total ranking score	%	Me- dian	Total ranking score	%
Profitability	1	215	54	1	232	66
Physical work environment	3	319	19	3	414	8
Psychosocial work environment	4	438	6	5	544	5
Environmental work	4	491	6	4	487	8
Economic goals, other than profitability	4	492	3	4	462	5
Branding	5	500	8	3	446	6

<sup>1</sup>Missing data for three managers and two safety delegates. The instruction to the ranking item (Q43 in Table 2) asked respondents to *Please rank the following areas according to their order of importance at your company from 1 (highest importance) to 7 (lowest importance)*. Total ranking score = All rankings summarized, where low scores signify higher priority. % = How often each company interest was ranked as the number one priority.

Comparing the seven work environment prioritization indexes on the ratings of *now* and *one year ago* for all subjects revealed statistically significant differences (Kruskal–Wallis test). The indexes for *now* had VAS scores that were significantly higher. This means that respondents generally rated prioritization of the work environment as having improved from the previous year. The indexes are presented in Figure 1. The index with the highest VAS scores for both now and one year ago was *communication and interaction*. The index with the lowest VAS scores for both now and one year ago was *organizational improvements*.

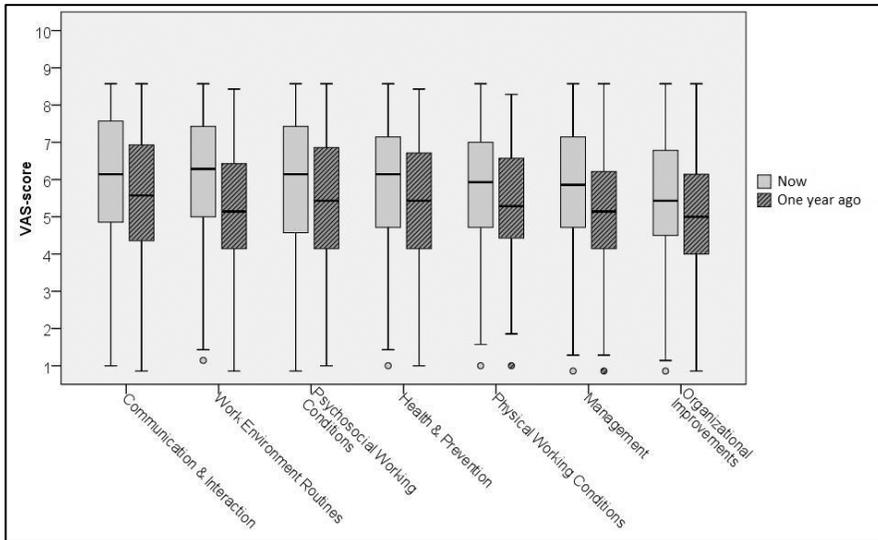


Figure 1. Box-and-whisker plots of the seven work environment indexes comparing the ratings of *now* and *one year ago*. The differences were statistically significant (Kruskal–Wallis test). All subjects ( $n = 249$ ). *Now* included 249 ratings; *one year ago* included 195 ratings because of missing data. The line inside the boxes is the median. The bottom and the top of the boxes are the lower and upper quartiles. The ends of the whiskers represent the minimum and maximum of the data, outliers excluded. The dots are plotted outliers.

## Differences between managers and safety delegates (paper I and data from paper IV)

There were statistically significant differences when comparing the seven work environment prioritization indexes between managers and safety delegates in paper I (Kruskal–Wallis test). All the index scores were higher for managers than for safety delegates. This means that managers generally rated work environment prioritization within companies as higher than safety delegates did. The indexes are presented in Figure 2. The differences were also statistically significant when pairwise comparisons were made of the managers and safety delegates working at the same companies ( $n = 106$  companies, Wilcoxon signed rank test). The index with the highest VAS score for managers was *communication and interaction*. That was also the index where the two roles differed in VAS scores the most. The index with the highest VAS score for safety delegates was *work environment routines*. The index *organizational improvements* got the lowest VAS score by both roles.

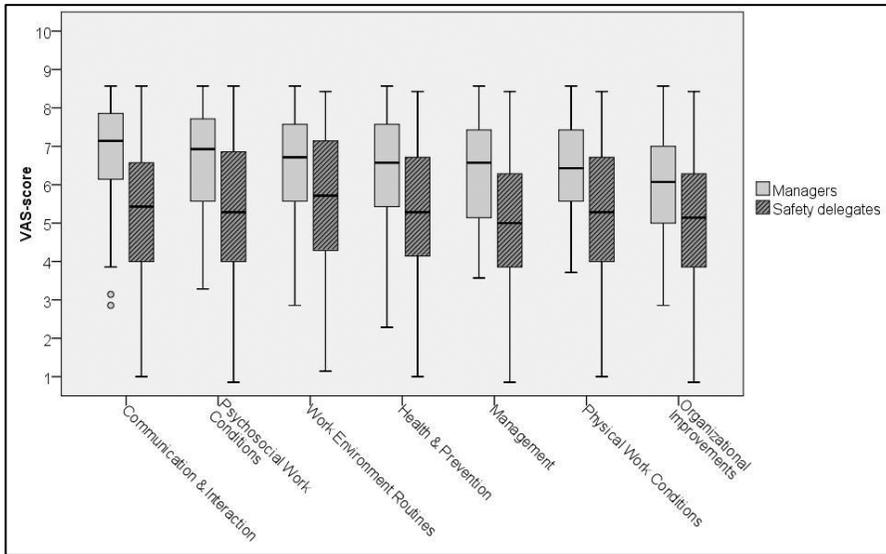


Figure 2. Box-and-whisker plots of the seven work environment indexes comparing the ratings of *managers* and *safety delegates* in paper I. The differences were statistically significant (Kruskal–Wallis test). All subjects ( $n = 249$ ). The line inside the boxes is the median. The bottom and the top of the boxes are the lower and upper quartiles. The ends of the whiskers represent the minimum and maximum of the data, outliers excluded. The dots are plotted outliers.

There were also statistically significant differences between managers and safety delegates on the ranking item in paper I (Table 5). Managers ranked *physical work environment* and *psychosocial work environment* higher than the safety delegates did (Mann–Whitney  $U$  test). This also demonstrates that managers and safety delegates generally perceived prioritizations of the work environment within the companies differently.

Table 6. Comparing the ratings of managers and safety delegates (paper IV data)

Variables	$n$ Managers	$n$ Safety delegates	$p$
Work environment priority, scores	138	89	<b>.000</b>
Safety culture, scores	136	84	<b>.001</b>
Safety culture, 4 categories	136	84	<b>.001</b>
OHSM practices, scores	184	83	.143
OHSM practices, 4 categories	184	83	.154

Statistical test: Mann–Whitney  $U$  test.  $p = p$ -value. Work environment priority, scores = 0–7; Safety culture, scores = 0–13; Safety culture, 4 categories = 0–9, 10–11, 12, 13; OHSM practices, scores = 0–13; OHSM practices, 4 categories = *minimal* (0–7), *good* (8–9), *very good* (10–11), *excellent* (12–13). Statistically significant results were also found as in this table when using Wilcoxon signed rank test to compare managers and safety delegates working at the same company ( $n = 65$ ).

Analyses of paper IV data (not included in the submitted manuscript) verified the results obtained in paper I regarding the differences between managers’ and safety delegates’ perceptions of work environment priority (Table 6). Managers generally rated work environment priority and safety culture

higher than did safety delegates, and this difference was statistically significant. There were no statistically significant differences between them in the information given regarding their companies' OHSM practices.

## Differences due to company size (paper II and data from paper IV)

When comparing the small companies ( $n = 79$ ) with the medium-sized companies ( $n = 27$ ) on the work environment prioritization indexes, there were no statistically significant differences in paper II (Kruskal–Wallis). This means that company size did not generally influence the ratings of work environment priority. The indexes are presented in Figure 3. The small companies were then divided into two new groups for further comparison. The groups were, then, small-1 (10–19 employees), small-2 (20–49 employees), and medium (50–249 employees). This comparison also showed no statistically significant differences due to company size (Kruskal–Wallis). Furthermore, there were no significant differences when company sizes were compared using the ratings from managers and safety delegates separately rather than the aggregated company rating.

To test for consensus in the ratings between the paired respondents of each company, first, the extent of agreement was tested by Spearman's rank correlation. Small companies were shown to have statistically significantly higher correlation coefficients than the medium-sized companies (Mann–Whitney  $U$  test). This means that there generally was greater consensus of the ratings within the small companies than within the medium-sized companies.

Table 7. Comparing the ratings of small and medium companies (paper IV data)

Variables	$n$ Small	$n$ Medium	$p$
Work environment priority, scores	34	26	.841
Safety culture, scores	31	26	.552
Safety culture, 4 categories	31	26	.438
OHSM practices, scores	36	24	<b>.000</b>
OHSM practices, 4 categories	36	24	<b>.000</b>

Statistical test: Mann–Whitney  $U$  test. Small = 10–49 employees, and Medium = 50–249 employees.  $p = p$ -value. Work environment priority, scores = 0–7; Safety culture, scores = 0–13; Safety culture, 4 categories = 0–9, 10–11, 12, 13; OHSM practices, scores = 0–13; OHSM practices, 4 categories = *minimal* (0–7), *good* (8–9), *very good* (10–11), *excellent* (12–13). Statistically significant results were also obtained when using Kruskal–Wallis test to compare other category divisions of company size, as well as when comparing the ratings from managers and safety delegates separately.

Analyses of paper IV data (not included in the submitted manuscript) verified the results obtained in paper II regarding no differences due to company size (Table 7). When comparing the small with the medium companies on

work environment priority and safety culture, there were no statistically significant differences (Mann–Whitney  $U$  test). There were, however, significant differences between company size and the information given regarding the companies' OHSM practices, which will be elaborated on further in the forthcoming section presenting the main results from paper IV.

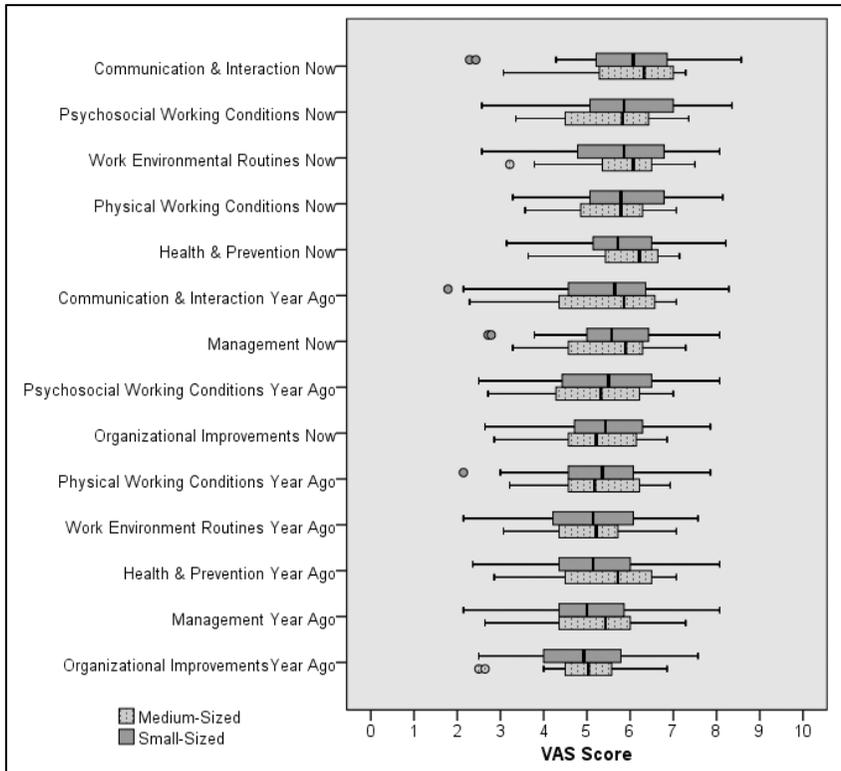


Figure 3. Box-and-whisker plots of the 14 work environment prioritization indexes (now and one year ago) comparing the ratings of *small* and *medium* companies in paper II. No statistically significant differences were found (Kruskal–Wallis test). All companies ( $n = 79$  small,  $n = 27$  medium). The indexes are arranged in descending order of the small companies' ratings. The line inside the boxes is the median. The bottom and the top of the boxes are the lower and upper quartiles. The ends of the whiskers represent the minimum and maximum of the data, outliers excluded. The dots are plotted outliers.

## Safety culture and reasons for risk-taking (paper III)

The findings of the qualitative study were summarized as 5 categories and 16 subcategories describing the safety culture and reasons for risk-taking at the steel-manufacturing company (Table 8). The categories and content are elaborated in the following sections. Acronyms in the text represent the five different departments: ring mill (RM), hot rolled tubes mill (HRTM), billet

mill (BM), cold rolled tubes mill (CRTM), and steel mill (SM). The numerals 1–10 paired with the acronyms represent the ten focus groups.

Table 8. *Safety culture and reasons for risk-taking at a large steel-manufacturing company summarized as categories and subcategories*

Categories	Subcategories
Acceptance of risks	Danger tolerance Fatalistic beliefs
Individual responsibility for safety	Up to the individual Low company commitment
Trade-off between productivity and safety	Management expectations Worker expectations Practical obstacles
Importance of communication	To think about safety Collaboration between colleagues Reporting incidents
State-of-the-day and external conditions	New at work Tiredness Nonchalance Routine Low staffing High pace

### Acceptance of risks

The workers expressed the view that the risks that are present in their work environment have to be accepted, since there is not much else to do than to make the best of the situation. They explained that there are large forces in their workplace, and one cannot completely avoid risks. They considered risks to be present everywhere, including outside of the workplace: “There are risks everywhere, driving the car is a risk in itself, but that is not something one thinks about” (CRTM, 5), and “It is actually a heavy industry, it is not possible to ‘bolster’ everything” (SM, 10). The workers use shortcuts on the job that make the work more risky, which is perceived as acceptable, if one masters them. Despite one’s own safety awareness, one is always dependent on others in the workplace, and how they act: “It does not matter how good you are yourself to think of everything; there will always be fools around you” (RM, 6). They perceived that an accident-free and healthy workplace will never be achievable. They believed that human errors make it impossible to ever reach a zero-accident vision, or that poor air conditions ever could be avoided: “It will never be possible to achieve one hundred percent safety; nothing can become one hundred percent” (SM, 10). They also experienced that “It is a wonder that so few accidents happen, considering the type of heavy industry that it actually is” (RM, 1). All in all, they perceived that one needs to accept these conditions, because it is just how it is.

## Individual responsibility for safety

The workers expressed that the individual worker, through common sense, has responsibility for safe procedures, since one cannot count on the company for that. They stated that one cannot rely on the manager or the company to take responsibility for safety during a work shift; one needs to do that oneself, because safety rests on the judgment and decisions of the individual during a work task: “No one else can take that responsibility, the individual has the largest responsibility” (BM, 4). One’s own common sense was perceived to be crucial: “It is all about knowledge and common sense” (HRTM, 2), and it is a “Personal responsibility—everybody needs to see the risks” (HRTM, 2). The workers experienced that if one points out a concern regarding safety, it gets treated with indifference by the company: “Sometimes there is nonchalance about what we say and what we think is dangerous” (HRTM, 2), and “They spend more time on finding ‘scapegoats’ than on fixing problems” (SM, 9). If something acute happens concerning safety, a severe near miss or an accident, the company acts quickly to implement improvements. The workers perceived that it is good that the company then acts quickly, but that it is too bad that something needs to happen before measures are taken: “When one reports things that they need to fix, they do not take care of it, and then when something happens, yeah, then they take care of it” (CRTM, 5).

## Trade-off between productivity and safety

The workers described productivity and safety to be conflicting entities, wanting to produce as well as wanting to work safely, and sometimes encountering practical obstacles to working safely. They perceived that there is an expectation from the management that, even though there is low staffing one day, it should not result in less productivity. Their experiences were that when staffing goes down, accidents go up. The management does not want the production to slow down, and therefore, as the workers explained, they need to find temporary solutions and work with tools that are not appropriate for the job, or to work with equipment that is broken or does not work properly: “The management says that one should use the different aids there are, but if one really would do that to the fullest, then one slows down production, and they do not like that either” (RM, 1). Temporary solutions were perceived as necessary to get the production running again quickly when a stoppage occurs: “We can make it easy for us, take the absolutely safest way, but then we will not produce so damn much” (RM, 1). The workers also described that they have their own expectations that production should run smoothly: “We are a bit foolish ourselves, really; one wants to keep the production going, which is how it is” (RM, 1). The production is the reason for

being there: “One should take care of liquid steel, which is the first priority” (SM, 9).

### Importance of communication

The workers experienced the possibility opportunity to communicate to be very important for safety at the workplace. They perceived that it is important to feel comfortable with one another in order to work in a safe manner, to know each other’s personalities and standpoints: “We talk a lot to one another between the cockpits, and then we get the safety to work really well” (BM, 4). They considered that pointing out someone’s risky behavior is the right thing to do, but also a sensitive matter, and that one needs common sense in approaching the colleague who has made a mistake or taken a risk. Otherwise, one can be faced with the attitude that “No one should tell me how to do my job” and “Mind your own business, and I’ll mind mine” (RM, 1). The workers stated that they know that it is important to report incidents (risk observations, near misses, and accidents), but still, the incident reporting is often ignored. It was said that, “If we were to report everything that happens, we would have to write the whole time” (SM, 10). Embarrassment is another reason not to report incidents. They described that it is embarrassing enough that the mistake happened, and that one is not keen on writing a report describing it. They perceived that safety training is important and that one cannot get too much of it: “One *has* to know what one is doing” (HRTM, 2). They reported that there is not enough time for introducing new staff to production and safety: “There is a staff shortage, so there is not enough time for them to get the training that really is needed—often it is too short” (HRTM, 2).

### State-of-the-day and external conditions

The workers reported that new employees take more risks, because they are less experienced: “Experience is lacking; they just rush in and do not think about where they are going” (HRTM, 3), and “When someone is new, they do not see the dangers, which one learns about over the years” (HRTM, 3). Another reason for risk-taking was described as being “blind to flaws,” meaning that one follows certain routines during work, becoming blind to risks that one should see: “It is routine. One gets accustomed to being out in production, and one does not think. One does what one should, but does not think about *what* one is doing” (CRTM, 5). It was described as a risky state of mind that is hard to be aware of. They perceived that being blind to flaws is the opposite of being new at work, but that both these states are dangerous.

The workers experienced that nonchalance also is a common reason for risk-taking: “A bit of nonchalance is pretty common” (HRTM, 2). A more experienced worker may be more nonchalant, being unobservant or underestimating risks: “One does not think before...” (CRTM, 8). Nonchalance was also described as being present because of laziness or of wanting to minimize the work effort.

The workers described that being tired results in more risk-taking. It was said to be influenced by amount of sleep, time of the day because of shift work, the hot work environment, and slumberous sounds from machines. “We are shift workers, and one can be terribly sleepy sometimes,” and “Four o’clock in the morning, one does not think so damn well” (HRTM, 2). Another reason offered for risk-taking was being short of staff on a shift team. The workers then have to take more risks because of the extra workload: “Even if there is a temporary cut-down of the staff, it is expected that production should not be affected, and one has the mindset to ‘go at it’ and maintain the production, even though that is a bit wrong, since it involves more risk-taking” (RM, 1). The workers stated that to stress, hurry, and work faster to save time results in more risk-taking, for example, loading transports with more weight than they are intended to carry, in order to finish more quickly; performing maintenance on running machines without stopping the production process, to keep production flowing; forgetting to communicate with colleagues; lifting heavy loads and lifting the wrong way; and using the wrong tools, because the right ones are missing or broken. “Being under stress is when one starts to use shortcuts” (RM, 6). Colleagues expect the shift team before them to not leave any work behind; therefore, there sometimes is a need to finish the planned production under time pressure.

## Factors influencing OHSM practices (paper IV)

In the univariate analyses, the following predictor variables were significantly associated with better OHSM practices: company size, safety culture, work environment priority, quick ratio, return on assets, perceived profitability with two categories, creditworthiness, and being part of a corporate group (Table 9). Then, when these variables were adjusted to one another in the multivariate analysis, company size, safety culture, creditworthiness, and being part of a corporate group remained as statistically significant factors for better OHSM practices in companies (Table 9).

Table 9. Predictor variables associated with better OHSM practices

Predictor variables	Univariate analyses					Multivariate analysis <sup>1</sup>		
	<i>nc</i>	<i>n</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Company size	193	267	1.004	1.001–1.006	<b>.006</b>	1.003	1.001–1.004	<b>.003</b>
Safety culture, scores	146	208	1.495	1.333–1.676	<b>.000</b>	1.299	1.020–1.654	<b>.034</b>
Work environment priority, scores	149	214	1.493	1.280–1.741	<b>.000</b>	1.283	.838–1.962	.251
Quick ratio	192	265	1.001	1.000–1.003	<b>.011</b>	1.001	1.000–1.002	.181
Return on assets	190	261	1.026	1.004–1.048	<b>.020</b>	1.015	.993–1.038	.182
Perceived profitability, 2 categories	193	265	<i>model</i>	-	<b>.049</b>	<i>model</i>	-	.624
<i>Yes</i>	-	-	1.955	1.004–3.810	.049	1.214	.558–2.640	.624
<i>No</i>	-	-	1	-	-	1	-	-
Creditworthiness, 5 categories	191	263	<i>model</i>	-	<b>.019</b>	<i>model</i>	-	<b>.007</b>
<i>Very low risk</i>	-	-	6.395	1.185–34.520	.031	6.126	1.867–20.105	.003
<i>Low risk</i>	-	-	2.883	.512–16.226	.230	3.551	1.011–12.469	.048
<i>Normal risk</i>	-	-	2.898	.527–15.941	.221	5.281	1.674–16.657	.005
<i>Risk out of the ordinary</i>	-	-	2.045	.335–12.468	.438	1.474	.345–6.302	.601
<i>High risk</i>	-	-	1	-	-	1	-	-
Part of corporate group	193	267	<i>model</i>	-	<b>.003</b>	<i>model</i>	-	<b>.009</b>
<i>Yes</i>	-	-	3.518	1.531–8.086	.003	3.245	1.342–7.848	.009
<i>No</i>	-	-	1	-	-	1	-	-

Statistical test: Ordinal regression analysis using GEE. *nc* = number of companies. OR = odds ratios for better OHSM practices. CI = confidence interval. *p* = *p*-value. <sup>1</sup>In the multivariate analysis, number of companies = 142; *n* = 198 respondents.

For every 10 additional employees there was a 3% estimated increase in odds of better OHSM practices in a company (Table 9). For every additional score in safety culture there was a 30% estimated increase in odds of better OHSM practices. For the categories *normal*, *low*, or *very low risk* in creditworthiness there was a three to six times estimated increase in odds of better OHSM practices in a company. There was a three times estimated increase in odds of better OHSM practices for a company being part of a corporate group.

In the further multivariate analysis (Table 10), when company size and safety culture were used as category variables, their association with better OHSM practices remained statistically significant. The trend was that the larger the company, the higher the estimated odds for better OHSM practices; and the higher the score for safety culture, the higher the odds for better OHSM practices. The category of *>100 employees* showed a 26 times estimated increase in the odds, and the category of most positive safety culture

(score 13) showed a seven times estimated increase in the odds of better OHSM practices. Nor being part of a corporate group or creditworthiness remained statistically significant in this model, but there was a tendency toward the creditworthiness categories *normal*, *low*, and *very low risk* (Table 10).

Table 10. *Second multivariate analysis: predictor variables with categories associated with better OHSM practices*

Predictor variables	OR	95% CI	<i>p</i>
Company size, 5 categories	<i>model</i>	-	<b>.000</b>
>100 employees	26.285	5.613–123.076	.000
50–99 employees	18.058	3.967–82.197	.000
20–49 employees	4.454	.995–19.931	.051
10–19 employees	4.846	1.158–20.289	.031
1–9 employees	1	-	-
Safety culture, 4 categories	<i>model</i>	-	<b>.009</b>
13	6.942	2.146–22.451	.001
12	5.610	1.962–16.040	.001
10–11	4.410	1.548–12.564	.005
1–9	1	-	-
Creditworthiness, 5 categories	<i>model</i>	-	.051
<i>Very low risk</i>	9.329	2.030–42.873	.004
<i>Low risk</i>	6.222	1.257–30.810	.025
<i>Normal risk</i>	7.077	1.488–33.658	.014
<i>Risk out of the ordinary</i>	3.674	.461–29.296	.219
<i>High risk</i>	1	-	-
Part of corporate group	<i>model</i>	-	.244
Yes	1.624	.718–3.673	.244
No	1	-	-

Statistical test: Ordinal regression analysis using GEE. OR = odds ratios for better OHSM practices. CI = confidence interval. *p* = *p*-value. Number of companies = 144; n = 204 respondents.

In the final multivariate analysis (Table 11), company size, safety culture, and creditworthiness were found to be significantly associated with *worse* OHSM practices. The reversed trend was demonstrated, that the smaller the company, the higher the estimated odds for worse OHSM practices; and the lower the score for safety culture, the higher the odds for worse OHSM practices. The category *1–9 employees* showed a 21 times estimated increase in the odds, and the category lowest safety culture (*1–9*) showed a seven times estimated increase in the odds of worse OHSM practices. For the *high risk* category in creditworthiness there was a nine times estimated increase in odds of worse OHSM practices.

Table 11. *Third multivariate analysis: predictor variables with categories associated with worse (reversed) OHSM practices*

Predictor variables	OR	95% CI	<i>p</i>
Company size, 5 categories	<i>model</i>	-	<b>.001</b>
1–9 employees	21.194	4.127–108.848	.000
10–19 employees	4.620	1.737–12.288	.002
20–49 employees	4.012	1.507–10.682	.005
50–99 employees	1.587	.594–4.236	.357
>100 employees	1	-	-
Safety culture, 4 categories	<i>model</i>	-	<b>.001</b>
1–9	6.943	2.721–17.713	.000
10–11	2.346	1.068–5.155	.034
12	1.733	.922–3.258	.088
13	1	-	-
Creditworthiness, 5 categories	<i>model</i>	-	<b>.045</b>
High risk	9.430	2.037–43.647	.004
Risk out of the ordinary	2.434	.549–10.786	.242
Normal risk	1.515	.756–3.078	.250
Low risk	1.724	.719–4.132	.222
Very low risk	1	-	-
Part of corporate group	<i>model</i>	-	.092
No	1.944	.898–4.209	.092
Yes	1	-	-

Statistical test: Ordinal regression analysis using GEE. OR = odds ratios for worse OHSM practices. CI = confidence interval. *p* = *p*-value. Number of companies = 144; n = 204 respondents.

# Discussion

## Main findings

Profitability was considered to be the most highly prioritized interest in the companies (paper I), and that trade-offs are made between productivity and safety, which is an obstacle for functioning safety performance (paper III). There were differences between managers' and safety delegates' perceptions of work environment prioritization at the companies (paper I and IV). They also perceived that prioritization of the work environment had improved from the previous year. No association between company size and perceptions of work environment priority was found (papers II and IV), but there was greater consensus among the respondents within small companies regarding the prioritizations. Risk-taking was perceived to arise from a combination of individual factors and circumstances in the work environment (paper III). It was also found that workers perceived that they carry a large responsibility for safety, and that risks are accepted and handled (paper III). Company size, safety culture, and creditworthiness were found to be associated with OHSM practices in companies (paper IV). The findings are discussed in the following sections.

## Prioritization of OHS at the companies

The respondents in paper I perceived that prioritization of the work environment at their companies had improved from the previous year. This finding may mean that they felt positive about how OHS has been developing in the companies. That managers and safety delegates agree on a positive development over time has been seen earlier in the Swedish reports of the work environment (5–8). However, that the respondents of paper I perceive an improvement from the previous year could be a bias of wishful thinking (87). There is also a possibility that the results could be explained with “time-slice errors,” which refers to the recall of a true event but from another time period (88). They do, however, seem to generally believe that the work environment has improved from a short-term perspective, reflected by on which side of the rating of *now* they placed the rating *one year ago*. This may indicate more a positive attitude of most of the respondents, than that actual improvements have taken place; it is, however, not possible to know.

The respondents of paper I also perceived profitability to be the most highly prioritized interest at their companies. This result indicates, as could be expected, that a motivating force within the companies is to be profitable, and that there may be a pressure to produce, and to survive. The finding is in line with earlier studies (89, 90). In a study by Peel and Bridge (90), respondents were asked to indicate how important they perceived different objectives to be at their companies; 150 manufacturing companies participated, and the highest ranked objective was “improving profitability.” Spence and Rutherford (89) found that profit maximization was the top priority for many small company managers that they interviewed. Daily survival has been suggested to be the number one priority for companies (91, 92).

Similarly, in paper III the informants perceived that there is a trade-off between productivity and safety in their organization, meaning that production goals get priority over safety activities. To get the production running again if a stop occurs was an important incentive for the workers to risk their safety, for example, by not using the appropriate tools. A constant and ongoing trade-off between productivity and safety in companies has also been found in earlier studies (47, 52, 93–95). Antonsen (52), for instance, described how the desire to meet production targets was a dominant cultural value in a study conducted at an oil platform. The trade-off between productivity and safety may be a fundamentally built-in feature in production systems as we know them today. It may be a “cultural universal” of production systems. A cultural universal is a feature of some kind found in every society, for example, gift-giving or the institution of marriage (55).

## Different ways of measuring OHS performance

In paper II (and in the paper IV data) there were no differences in perceptions of work environment prioritization found between company sizes. There was, however, a greater consensus in the ratings within the small companies. An explanation for this finding could be that the respondents within smaller companies have closer contact than in larger ones and therefore tend to be more alike in their perceptions and ratings. Earlier findings have shown there to be a better manager–employee relationship in smaller companies (28). Turner et al. (96) have shown that companies, regardless of size, spend about the same percentage of the turnover on internal projects. This means that smaller companies have smaller projects and that advanced project management tools and techniques are less likely used. Applying this circumstance to the companies of papers II and IV, spending a similar percentage of the turnover on OHS could perhaps be reflected in the similar subjective ratings of work environment prioritization. But in reality, the factual circumstance is that the larger the companies are, the more formalized

are their practices and activities in OHS. This is supported by the paper IV data, since there were no differences in work environment priority and safety culture ratings when comparing company size, but there were differences in OHSM practices when comparing company size. Then, when comparing how managers and safety delegates had rated work environment priority and safety culture, there were differences between them, but there were no differences between them in the information they had provided on OHSM practices.

This suggests that when asking the respondents about their company's OHSM practices, it did not matter which of them provided the information. But when asking the respondents to *rate* OHS performance (i.e., safety culture or work environment priority), it mattered who provided the information, probably because this involved more of a personal opinion on the matter. Both work environment priority and safety culture had items that were to be rated, and that explains why the personal perceptions of the individual respondents left an impact on them. OHSM practices constituted information about the companies that did not depend on the personal perceptions of the respondent to the same extent. These findings, in paper II and the paper IV data, show that it is important to distinguish between the *perceptions* representatives have of their companies and *factual* conditions that can be asked about their companies, when comparing organizations. A study by Holte and Kjestveit (97) helps to demonstrate how this kind of difference depends on types of information. In companies, regardless of size, it was *perceived* important that young workers get practical training in OHS (97). At the same companies, however, there were differences between small and large companies in how they *actually* performed in providing practical training. The larger companies had a system and formalized routines for the practical training, which the small companies did not.

## Different roles and OHS

### Managers and safety delegates

In papers I and IV it was found that managers perceived work environment factors to be more highly prioritized than the safety delegates did. An explanation for this finding may lie in the professional roles per se: what it means to be a manager or a safety delegate. There are some earlier findings indicating that managers seem more optimistic about work environment factors than employees/safety delegates (20, 23, 28). The managers and safety delegates of the participating companies work in the same context, but these two roles seem to represent two different perspectives, influenced by different frameworks. How a phenomenon is perceived can be said to be “situated,”

that is, that it is perceived differently depending on person and circumstance (98). Newman (99) showed that perceptions employees had of the work environment were less related to their personal characteristics and more related to their place in the organization. It was explained with that “one’s perception of the work environment is more a function of where one is (in organizational space) than who one is” (99, p. 374). Another aspect to consider is that managers and safety delegates adhere to different political agendas; the mission of the safety delegates is to represent the employees, and they often are appointed by the local trade union organization.

A metaphor of “parent–child and adult–adult relationships” could be used to explain the differences between managers and safety delegates. It was first introduced by Harris (100), and Hale (101) used it to analyze relationships of people in different OHS professional roles. The dynamics of the relationships are explained as follows: “Parent–child relationships are often immature and disturbed, particularly if one person is unhappy with their (usually) child role. They are characterized by power games and dominance rituals. On the other hand adult–adult relationships are mature and concentrated on mutual support and the achievement of common goals” (101, p. 236). Role relationships could possibly influence how OHS tasks are handled. The role relationship between managers and safety delegates could be described as a parent–child relationship, and that they position themselves with different perceptions of the commitment to work environment, since managers are true to their management/employer context and safety delegates to their production/employee context.

## Workers and responsibility

Another role, apart from those of managers and safety delegates, is that of the general worker. In paper III it was found that the workers perceived the responsibility for safety to rest on the individual to the largest extent. They perceived that it really is up to the individual to work safely, and neither colleagues nor the manager can be relied on, when it comes down to it. An explanation for the finding may be that individual responsibility is rather important in shift work, since there are periods during a day (night shift) when the manager is not present, and the workers manage the work tasks themselves. Earlier studies have also demonstrated that safety is perceived to be the responsibility of the individual (95, 102, 103). It is perhaps surprising that safety is perceived to be the responsibility of the individual, and not the responsibility of the management to arrange, which rather is what the OHS legislation specifies (10–12). On the other hand, it makes sense that the responsibility for safety rests on the individuals who actually perform the work tasks. The legal responsibility for safety rests with the employer and managers, but the actual responsibility for safe performance in the company’s day-

to-day operations is perceived to rest with the workers. A main principle of a positive safety culture is when every employee of an organization feels responsible for safety (103). Another main principle for a positive safety culture is that management shows real commitment to safety, which influences the culture, the attitudes, and the behavior at the workplace (68–70). The workers in paper III perceived, however, that the management was a bit absent and not particularly responsive to concerns raised regarding safety.

### Newly employed and experienced workers

Two other roles in the workplace are those of the newly employed and the experienced workers. In paper III it was found that the workers perceived newly employed persons to be able to see the workplace with “fresh eyes”—to be able to see things that the experienced workers no longer are able to see because they have become “blind to flaws.” That new employees can see the workplace with fresh eyes was valued as a good thing, but at the same time there also existed norms that stated that new employees should not come forward with suggestions for improvement. If they did, they were rebuked by the more experienced colleagues, who expressed their disliking, as they had their established ways of working. The workers described it as a bit foolish that fresh eyes are valued but that they at the same time are restricted from being put to use. The metaphor of “parent–child and adult–adult relationships” could be used here as well (100, 101). There are power games and dominance rituals between newly employed and more experienced workers. When the new workers have acquired enough experience, the role relationship becomes an adult–adult relationship. At that point they have unfortunately presumably already lost their innocent, fresh view of how work is done; they have become socialized, and they too have become blind to flaws.

### Workers and managers

Another role aspect of the workplace and OHS is the dynamic between general workers and managers. In paper III the workers reported that they themselves think it is important that they prioritize production. They also perceived that there are unspoken expectations from managers that productivity has priority over safety. The findings of paper III and Haukelid (104, p. 421) are similar in that the workers think that “Safety rules are ok – but it takes too long time if we always should follow them!” These findings may have to do with two things, the *expectations* that workers set for themselves as well as the expectations managers have for the workers, and the *boundaries* that organization and work environment set for how it is possible to act/ behave in situations. The concept of human–technology–organization, which is based on sociotechnical theory, can be applied to these findings (48–50). The workers (*humans*) act within the boundaries of what is possible, considering

the physical environment and machines (*technologies*) and considering the expectations set by managers and the nature of work tasks (*organization*). Also, the reasons that risk-taking occurs were perceived to be a combination of individual (*human*) and external factors (*technology, organization*). Furthermore, the expectations (values, norms) of how it is possible to act (behavior) during work can be said to constitute the workplace's safety culture. It therefore seems appropriate to unite a systemic and sociotechnical view of the workplace with the concept of safety culture, into a combined view of workplace dynamics that affects OHS (105–107).

## Better and worse OHSM practices at the companies

In paper IV it was found that larger company size, positive safety culture, and low risk in creditworthiness were associated with *better* OHSM practices, and that smaller company size, negative safety culture, and high risk in creditworthiness were associated with *worse* OHSM practices. This means that depending on directionality, these three factors were protective as well as risk factors of OHSM practices. These findings are in line with what Arocena and Nunez (3) demonstrated in their study, that it was more common for large companies to use formal practices for OHSM, and that smaller companies used informal or non-systematic OHSM practices. Similar patterns have been found in other research studies as well (13, 15–17, 108, 109). The reason the extent of OHSM practices differs depending on company size may be that underlying factors other than OHSM practices differ between smaller and larger companies. These underlying prerequisites that change depending on company size could be several, but the most obvious ones surely are the *financial* and *human resources* available in the organization. Other factors that have been suggested to differ between organizations depending on size are the organizations' structure, routines, knowledge, commitment, and incentives (1, 3, 13, 97, 110, 111).

It seems reasonable to believe that companies with low risk in creditworthiness have more financial resources available to use for OHS management, and that companies with high risk in creditworthiness have fewer financial resources available to allocate for OHS management. This highlights the fact that financial performance of companies is a factor to consider when thinking about companies' prerequisites to prioritize and manage OHS. Fernández-Muñiz et al. (112) demonstrated an association between safety management and better competitiveness and financial performance in companies. A financial connection with OHSM practices has also been shown in a study by Larsson et al. (110), where companies with advanced OHSM practices performed better than the average in development of stock market share value over time. It is though understandable, that smaller companies in par-

ticular, would be more hesitant towards investing in OHSM practices, due to limited financial resources. OHS investments have, however, been shown to yield ROP in earlier studies, and that such investments are worthwhile (37–40).

### The relationship between safety culture and OHSM practices

An association between safety culture and OHS management has been assumed in earlier research (59, 69, 70). Such an association seems plausible, considering the social nature of safety culture and the notion that it thereby would have a bearing on how management is prioritized and managed. Nielsen (73), however, considered the relationship between safety culture and OHSM the other way around, that improving the OHS organization would influence safety culture, which it seemed to do in the study. Thus, it appears as if safety culture and OHSM practices mutually influence one another. A reasonable way to look at their relationship is that they go hand in hand, and that any causality is cyclical. If an organization were to have a long-term commitment to implementing all necessary routines for advanced systematic OHS management, it surely would affect the workplace culture, in that working safely slowly would be further underlined as a highly valued matter in the organization. Also, the other way around, if an organization were to put effort into clearly espousing positive values and norms regarding working safely, in the long run it would surely mean that the organization also was committed to routines of OHS management. However, that safety culture and OHSM practices arguably go hand in hand does not necessarily mean that this always would be the case in every organization. It therefore makes sense to keep these two dimensions of safety performance separate (63), since one encompasses the actual routines for OHS performed in an organization, and the other concerns the perceptions regarding how much OHS is valued in an organization.

### Methodological considerations

The study designs used in this thesis were cross-sectional as well as qualitative, and can therefore only demonstrate cross-sectional association, and not causality. Papers II and IV were also ecological in design, considering that the companies were treated as *subjects* in the statistical analyses, and that information given by respondents therefore was aggregated to represent their companies. It can be cumbersome to compare organizations with one another by letting a couple of answers represent a whole organization. Managers and safety delegates were, though, chosen as relevant representatives, as they could be expected to have insight and competence regarding the OHS situation in their organizations.

A limitation with the data collection instruments in papers I and II, as well as in paper IV, was that the scales for work environment priority, safety culture, and OHSM practices, were designed for the purpose of these studies and have therefore not been used in earlier research. Thus, several steps were taken to address validity and reliability of these constructs, by reviewing the literature (earlier questionnaires, research studies, legislation, and grey literature) and by seeking advice from other researchers and people working with OHS in organizations. Efforts were put into formulating the items with uncomplicated wording to make them easy to understand and to minimize the risk of measuring something other than what was intended by the stated question. The index constructs were also satisfactorily tested for internal consistency with the Cronbach's alpha test statistic.

The VAS data (from the first data collection) were divided into ten equidistant parts in the analysis (1–10). This was considered appropriate for papers I and II; there would not have been any advantages in using a scale wider than 10 when measuring *perceptions* (for instance, 1–100, which commonly is the case when measuring self-rated *pain*). A limitation with VAS, however, is that each step on the scale is not specifically assigned a meaning (unlike Likert-type scales, for instance, where each option on the answering scale normally is expressed in words). There are different opinions in the literature regarding whether it is appropriate to use parametric or non-parametric statistical analyses for VAS data (113–116). Non-parametric tests are useful in the sense that they do not assume normal distribution of variable values and that they can be used for ordinal as well as interval data. Therefore, the VAS data in papers I and II were analyzed with non-parametric statistical tests.

The analysis for paper III was done inductively, by not applying theory when analyzing the qualitative data. There are advantages with applying theory already during the analysis phase, in that it can guide the analysis, and also the possibility to verify existing theories. To achieve the aim it was however chosen as relevant to first conduct the investigation inductively and to later apply relevant theory after the results had been formed. A definition of safety culture was though used during the analysis in order to have a delimitation of what to look for in the interview transcripts when coding text segments. It was, however, the content of the text that determined how the codes and categories were written.

The response rate of the two questionnaire data collections may be considered low (59% for both occasions). Such a response rate is, however, in line with what can be expected when using postal questionnaires (117, 118). The non-response analyses did not indicate that there would be any crucial systematic differences between the participating companies in the county and the ones that did not participate.

The generalizability of the findings in this thesis could be said to first and foremost apply to the manufacturing industry in Sweden. The reader can judge for him/herself the possible transferability of the results to other contexts. The findings may be especially applicable to countries with similar national legislation governing OHS and where there is a tradition of close collaboration between employers and trade union organizations.

## Future research

Future studies could try to replicate the findings of the research in this thesis in occupational contexts other than the manufacturing industry, as well as in other countries. Future research could also try to study how collaboration between professional roles within companies may matter for successful management of OHS and prioritization of the work environment.

The research in this thesis points to the fact that it matters what kind of data on OHS performance is obtained from companies—whether it is information on factual circumstances regarding the management of OHS within a company, or whether it is respondents' personal views (rated information) on whether the management of OHS within a company is sufficient or not. Future research should pay attention to the difference between these two types of information and be aware of which kind is used when studying OHS performance in companies. Future studies could investigate both types of information regarding self-reported OHS performance of companies, the rating-scale kind (perceptual) and the fixed-choice kind (factual), in order to further evaluate how they are related to one another.

Studies within the OHS field also need to take on more research with quasi-experimental designs in the future, to better evaluate which OHSM practices work well and which work less well for companies. Doing organizational research can be challenging because of the dynamic nature of corporations and the sudden changes in organizational structure that can occur. Nevertheless, it is important to try to evaluate companies' OHS efforts by mimicking the *randomized controlled trial* standards, to advance accurate knowledge regarding causation in these matters. Within this field it can be done with designs that compare companies before and after implementation of new practices, as well as using control companies that did not implement new practices.

Using information on financial performance of companies is also encouraged, to evaluate how financial circumstances may influence OHS performance in organizations as well as the other way around, that is, whether financial effects can be traced back to implementation of OHS practices.

Also, more cost/benefit and ROP analyses of implemented OHS efforts are needed in future research projects.

For the concept of safety culture it is suggested that more qualitative descriptive studies of values and norms regarding safety in the workplace be conducted. Basic research of such kind can support further development of safety culture theory, as well as supporting further refinements of quantitative instruments to use when inquiring about safety culture within organizations. Consensus regarding which primary factors are relevant for safety culture should also continue to form within the field.

## Recommendations for industry

Considering that the research in this thesis showed that managers and safety delegates differed in their perceptions of the priority accorded to work environment and of safety culture, a recommendation for those in professional roles handling OHS issues is to openly discuss priorities and culture within companies in order to continuously reevaluate their versions of the situation and to find shared understanding. An organizational environment where it is possible to openly discuss prioritizations and management regarding OHS is an important part of a positive safety culture.

As was shown in the research of this thesis, workplace culture does seem to influence OHSM practices in companies. Since safety culture and OHSM practices go hand in hand, it is reasonable for companies to put effort into both, to aim for excellence in total OHS performance. It is therefore advisable for organizations to regularly measure and keep track of the own safety culture, and to openly discuss values and priorities regarding OHS within the company.

Workers in the interview study pointed out that newly employed staff offer fresh views of the organization when they begin, but often their perspectives or suggestions for improvement are not valued. Managers could be aware of this and make efforts to ensure that fresh views of the organization come to their attention to be used in constantly striving for improvements in OHS.

The findings in this thesis showed that smaller companies were more likely than larger ones to have few OHSM practices in place. To get OHSM practices to function better, small companies are advised to ask for help and support, for instance, by benchmarking best practices with other companies in the same industry or consulting occupational health services.

About four-fifths of the respondents in paper IV stated that their companies are not certified in accordance with the OHSAS 18001 standard. A possibility for companies, of all sizes, in order to strive for improvement in their OHSM systems, could be to consider certification in accordance with this management standard.

Respondents in paper IV also pointed toward a need in the companies of more training and competence development in OHS management. Also, about four-fifths of the respondents in paper IV stated that their companies do not have a specific budget item for costs concerning OHSM. This may also be advisable for organizations to implement, if not already in use. Having a specific budget item could be a crucial, and enabling, factor for achieving excellent total OHS performance within an organization.

# Conclusions

Several factors are important for companies' possibilities to prioritize and manage occupational health and safety. This thesis primarily investigated professional roles, company size, safety culture, and financial performance concerning companies' commitment to health and safety.

Profitability was perceived as the most highly prioritized interest in the companies. It was also perceived that safety takes a back seat to productivity, that there is a trade-off between them, which often is an obstacle to working safely. Managers and safety delegates differed in how much they perceived their companies to prioritize work environment factors. Managers generally perceived the companies to prioritize it more than the safety delegates did. Perceptions of work environment priority did not, however, differ depending on company size. There was, though, a greater consensus among respondents within small companies regarding the prioritization of the work environment.

Risk-taking was perceived to originate from the interplay between individual factors and external circumstances in the work environment. Also, workers perceived that the responsibility for safety rests to the largest extent on the individual, who needs to accept and handle the risks in the work environment. Clear communication between colleagues was perceived as very important for safety in the workplace.

Larger company size, positive safety culture, and low risk in creditworthiness were found to be associated with better OHSM practices in companies. Correspondingly, smaller company size, negative safety culture, and high risk in creditworthiness were found to be associated with worse OHSM practices in companies.

Thus, *structural*, *social*, and *financial* aspects seem to be important for companies' possibilities to prioritize and manage occupational health and safety. The findings can be summarized with the *thesis* that it is the *active engagement of humans* that is crucial in achieving safety, both on the individual as well as on the organizational level.

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# Sammanfattning på svenska

Arbetsmiljölagen kräver att människors hälsa och säkerhet på arbetet ska tryggas genom att risker kontinuerligt ska bedömas och åtgärdas. Många företag saknar idag ett fungerande systematiskt arbetsmiljöarbete (SAM) som uppfyller lagens krav fullt ut. Istället tycks andra dagliga aktiviteter ha högre prioritet.

Det övergripande syftet med denna avhandling var att undersöka förutsättningar och möjligheter för tillverkande företag att prioritera och arbeta med säkerheten och arbetsmiljön; med särskilt fokus på yrkesroller, företagsstorlek, säkerhetskultur och finansiella nyckeltal.

Fyra delstudier (I–IV) ingår i denna avhandling, vilka är baserade på tre datainsamlingar. En enkät som mätte arbetsmiljöprioritering besvarades av 249 representanter vid 142 tillverkande företag (I & II). Fokusgruppintervjuer genomfördes med 66 arbetare på ett stort ståltillverkningsföretag, där deras erfarenheter och uppfattningar om säkerhet och risker i arbetet diskuterades (III). En enkät som mätte SAM, säkerhetskultur och arbetsmiljöprioritering besvarades av 280 representanter vid 197 tillverkande företag (IV). Information om företagens finansiella nyckeltal hämtades från ett kreditupplysningsföretag.

De viktigaste resultaten från de fyra delstudierna kan bland annat sammanfattas med att lönsamheten uppfattades vara det mest prioriterade intresset vid företagen (I), och att avvägningar mellan produktivitet och säkerhet ansågs vara ett hinder för att kunna arbeta på ett säkert sätt (III). Chefer uppfattade generellt att arbetsmiljön prioriterades mer på företagen än vad skyddsombuden gjorde (I & IV). Uppfattningar om arbetsmiljöprioritering skiljde sig dock inte åt beroende på företagsstorlek (II & IV). Ansvaret för säkerheten på arbetet ansågs främst vila hos den enskilda individen, och risktagande betraktades komma ur en kombination av individuella faktorer och yttre omständigheter i arbetsmiljön (III). Att vara ett större företag, ha positiv säkerhetskultur och hög kreditvärdighet visade sig ha samband med att också ha ett bättre utvecklat SAM (IV). På motsvarande sätt, att vara ett mindre företag, ha negativ säkerhetskultur och låg kreditvärdighet befanns ha samband med att också ha ett sämre utvecklat SAM.

Sammanfattningsvis verkar därmed *strukturella*, *sociala* såväl som *ekonomiska* aspekter vara väsentliga för företags möjligheter att prioritera och arbeta med säkerheten och arbetsmiljön. Detta ger uppslag till rekommendationer för industrin samt vidare forskning.

# Zusammenfassung auf Deutsch

Das Arbeitsschutzgesetz verlangt, dass die Sicherheit und Gesundheit (SG) von Menschen am Arbeitsplatz gewährleistet werden muss, indem Risiken kontinuierlich überprüft und behoben werden. Vielen Unternehmen fehlt heutzutage eine systematische Handhabung von SG, die den gesetzlichen Anforderungen vollständig entspricht. Stattdessen scheinen andere alltägliche Tätigkeiten eine höhere Priorität zu haben.

Das übergeordnete Ziel der vorliegenden Abhandlung war es zu untersuchen, welche Voraussetzungen und Möglichkeiten herstellende Unternehmen besitzen, SG am Arbeitsplatz zu priorisieren und handzuhaben – unter besonderer Berücksichtigung von Berufsrollen, Unternehmensgröße, Sicherheitskultur und Finanzleistungen.

Die vorliegende Abhandlung besteht aus vier Teilstudien (I–IV), die auf drei Datensammlungen basieren. Die Priorisierung von SG wurde mit einem Fragebogen untersucht, der von 249 Vertretern aus 142 herstellenden Unternehmen beantwortet wurde (I & II). Fokusgruppeninterviews wurden mit 66 Arbeitern eines großen Stahlherstellers durchgeführt, in welchen die Arbeiter ihre Erfahrungen und Wahrnehmungen von Sicherheit und Berufsrisiken diskutierten (III). Ein weiterer Fragebogen enthielt Fragen zur systematischen Handhabung von SG, Sicherheitskultur und Priorisierung von SG und wurde von 280 Vertretern aus 197 herstellenden Unternehmen beantwortet (IV). Angaben zu den Finanzleistungen der Unternehmen wurden einem öffentlichen Register entnommen.

Die wichtigsten Ergebnisse der vier Teilstudien können unter anderem damit zusammengefasst werden, dass die Rentabilität des Unternehmens als höchste Priorität wahrgenommen wurde (I) und dass Kompromisse zwischen Produktivität und Sicherheit als Hindernis für eine sichere Arbeitsweise beurteilt wurden (III). Manager waren im Allgemeinen häufiger als die Sicherheitsbeauftragten der Unternehmen der Auffassung, dass SG priorisiert werden (I & IV). Der Unterschied in der Wahrnehmung der Prioritätensetzung hing jedoch nicht von der Unternehmensgröße ab (II & IV). Sicherheit am Arbeitsplatz wurde in erster Linie als die Verantwortung des einzelnen Mitarbeiters angesehen und das Eingehen von Risiken als eine Kombination aus individuellen Faktoren und äußeren Umständen im Arbeitsumfeld beurteilt (III).

Ein großes Unternehmen zu sein, eine positive Sicherheitskultur zu haben und niedriges Risiko in der Kreditwürdigkeit, erwies sich mit einer besser entwickelten systematischen Handhabung von SG in Zusammenhang zu stehen (IV). Dementsprechend erwies es sich, dass kleine Unternehmen, eine negative Sicherheitskultur und hohes Risiko in der Kreditwürdigkeit, mit einer schlechter entwickelten systematischen Handhabung von SG in Zusammenhang stehen.

Zusammenfassend scheinen also *strukturelle*, *soziale* und *finanzielle* Aspekte grundlegend dafür zu sein, ob ein Unternehmen die Möglichkeit hat, SG zu priorisieren und zu handhaben. Dies dient als Vorlage für Empfehlungen für die Industrie und zukünftige Forschung.

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