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# Compliance with requirements versus situation-based adaptations to work operations in the construction industry

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## **Preface**

This master thesis was written as a final task on the master programme in Health, safety and environment at the Department of Industrial Economics and Technology Management at NTNU. It accounts for 30 credits and the work has been executed in the spring semester of 2013.

I would like to thank my thesis supervisors, associate professor Eirik Albrechtsen and PhD-candidate Eunike Sandberg, for much appreciated and helpful support in the process of preparing interviews and writing my thesis. Thanks to the case company for spending resources on an interesting and important topic. I would like to thank the people involved in the interviews in the construction projects in Trondheim and Oslo for the opportunity to collect valuable input data.

Finally I would like to thank the section of HSE at the Department of Industrial Economy and Technology Management for making HSE an interesting field of study during the two years at NTNU.

Trondheim, June 24<sup>th</sup>

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## **Abstract**

This thesis studied two different safety approaches in the sharp end at a large Norwegian construction company; compliance with requirements versus situation-based adaption (resilience) to work operations. The research method in this thesis is based on qualitative interviews and this data collection took place at two construction projects in Norway; one in Trondheim and one in the Oslo area. The empirical findings are discussed in light of the theoretical findings on the field of compliance and resilience engineering.

It was found that the case company had different rule sets to mitigate risk in different work activities in their two construction projects. The case company uses a set of simple, “golden” rules concerning Behavioral Based Safety, such as use of protective equipment, whereas the most important means to handle risk in complex, hazardous operations was found to be the use of Job Safety Analyses (JSA). Based on the empirical findings, a set of recommendations regarding rule-making and rule-use is given. The conclusions and recommendations recognize operator involvement to be central in rule-making and leadership involvement to be central in rule-use at the sharp end. Rules and procedures should be subject to a continuous, dynamic process of modification to adjust to change and to fit local circumstances. Further, the inherent individual adaptive capabilities of operators play an important role when it comes to overcoming the gap between rules and reality.

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# 1 Introduction

## 1.1 Background

The company used as case company in this study is one of the largest construction companies and property developers in Scandinavia with approximately 6500 employees. The contracts include construction projects such as new homes, commercial property, schools and public buildings, roads, railway and industry. As an entrepreneur, the company has to manage an increasing complexity and variation in construction tasks. Risk handling and accident prevention often has to be considered in the face of a hierarchical order of employees and contractors whose participation may vary in duration and scale. Further, workers from foreign countries represent a challenge with regard to safety in operations and safety culture at the company.

According to the Norwegian Labour Inspectorate, 11 out of 52 fatalities in 2011 happened in the construction industry (Arbeidstilsynet, 2012). There have been several measures towards improving HSE performance in the organization the last decades. Despite this, there has been an increase in the number of injuries and severity within some areas in the course of the recent few years. The company has experienced fatalities in four of the last five years (2008-2012). The accident reporting system in use shows that injuries take place every day, and a Lost Time Injury (LTI) happens every fourth day. Severe accidents occur between two and three times every day at one of the construction sites of the company.

The company has a set of ambitious goals with regard to HSE performance. The main target is to achieve zero injuries, i.e. an injury-free organization. A secondary target is to prevent four out of five injuries from happening within the year 2015. In practice this means a decrease in the number to less than 50 injuries, and the case company states that the goal is to achieve zero severe injuries within this year.

A set of clear goals for HSE performance is, in other words, set. However, these goals have to be achieved with a high degree of autonomy and flexibility in the execution of different projects and work operations. They also have several routines and procedures in use at the sharp end. *Compliance* with rules means that workers follow existing rules and adhere to them, in this case in work operations that take place at the sharp end. *Resilience*, on the other hand, allows the workers to be flexible in the use of those rules in action, in order to be adaptive to the complexity of reality and fit operations into local circumstances at the construction site. A balance between compliance with rules on the one hand, and safe adaption to situations (resilience) on the other has to take place in all actions and activities, and represents a prerequisite for this master thesis.

## 1.2 Purpose

The aim and purpose of this thesis is trying to unveil underlying criteria and factors that govern safe work operations at the sharp end at the construction sites of the case company. The aim is to find out how compliance with safety rules is balanced with resilience at the

sharp end. Based on this research and theory on the subject, the aim is to give recommendations on how the company might balance and combine these two approaches. It has also been an aim to give more generic recommendations on what creates safety at construction sites; not just construction sites operated by the chosen case company.

### **1.3 Research questions**

The work on this master thesis was carried out with use of research questions. These questions were stated before the actual work on the thesis began. The five research questions are:

- *Why do we need both rule-based approach and resilience-based approach in operations?*
- *What are the strengths and weaknesses of rule-based approach?*
- *What are the strengths and weaknesses of situation-based adaption in operations?*
- *How is compliance balanced with resilience at the sharp end at the case company?*
- *How can these two approaches be combined and balanced in order to create and maintain satisfactory safety at the sharp end at the case company?*

### **1.4 Delimitations and clarifications**

The main focus is on compliance-based and resilience-based approach to operations at the sharp end of the organization. This thesis does not (to a large degree) cover the regulatory regime in the construction industry, the management levels or safety management system in use at the company. The focus is on rule-compliance and resilience which affect, or may affect, the operational safety at construction sites. Risk handling in the context of this thesis covers several aspects and hazards in sharp end operations, i.e. the risk of damage to people, health, environment and materials. These activities and operations include for example use of light and heavy machinery, cutting equipment, hand tools, transport, lifting and use of crane on the construction site. The thesis is sought to cover the execution phase of building projects, a phase lasting from ground works on site to completion of a project.

The theoretical framework presented covers use of both compliance and resilience as management approaches to the operator level in organizations. In addition to theory directly linked to the construction industry, there also has been application of relevant literature on compliance and resilience originally written with other industries in mind. However, all the chosen literature deals with safety at the sharp end in organizations.



## 2 Theory

This chapter presents the results from the literature review on rule-compliance and resilience. First, it features a presentation of factors that govern human actions, followed by an explanation to what compliance and resilience implies as concepts or, as used in this chapter, models or paradigms. Further, the chapter seeks to explain why both rule-compliance and resilience is necessary in risk management, and important strengths and weaknesses in both concepts are presented. Finally, this chapter addresses the influence of leadership involvement on rule-compliance.

### 2.1 Introduction to the sharp end

The term “sharp end” is used when dealing with the interactions between practitioners and the hazardous processes of the organization, as stated by Reason (1990). Hale (2003) distinguishes between three different levels at which problem solving can take place in a safety management system; *Structure and policy*, *Plans and procedures*, and *Execution level*. Hale describes workers at the execution level to be those with the primary control of hazards within a timescale often measured in minutes or hours, or sometimes days, weeks or longer. As opposed to the sharp end, managers and executives form the “blunt end” (at the levels *Structure and policy* and *Plans and procedures*) at organizations; where the constraints and resources influence the performance of those operators working at the sharp end. Reason (1990) states the importance of understanding the system as a whole in order to understand how these constraints and resources shape the behavior of sharp end practitioners<sup>1</sup>.

### 2.2 Performance factors at the sharp end

Törner and Pousette (2009) identified four main categories of safety preconditions and components affecting organizational performance in a large Swedish construction project. The categories include (1) *Project characteristics and nature of the work*, (2) *Organization and structures*, (3) *Collective values, norms and behaviors* and (4) *Individual competence and attitudes*. The two subcategories following category 4 are *knowledge, ability and experience*, and *individual attitudes*. The results of this study indicated that management attitudes<sup>2</sup>, formal conditions, collective values and individual attitudes interact and reinforce each other in their influence on safety performance.

Cook and Woods (1994) suggest a framework for issues influencing safety performance at the individual level, which consists of three interrelated classes of cognitive factors: *Knowledge factors*, *Attentional factors* and *Strategic factors*. Knowledge factors are related to the knowledge available when solving problems in context at the sharp end. Effective problem solving involves knowledge *content*, knowledge *organization* and knowledge *activation*. Heuristics may represent effective and necessary adaptations to real workplaces (Rasmussen, 1986). Cook and Woods address the importance of practitioners being aware of the limitations and possible deficits in the shortcuts and simplifications made to adapt to situations. Further,

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<sup>1</sup> Also supported by e.g. Cook and Woods (1994) or Hale (2003)

<sup>2</sup> See also chapter 2.6

the practitioners should have the ability to recognize situations when these simplifications no longer are necessary, and possess the ability to use more advanced concepts, models or methods when the situation requires it.

Attentional dynamics are factors governing the control of attention, situation awareness and the management of mental workload as situations evolve and change over time (Cook & Woods, 1994). The authors take on situations where so-called psychological *fixations* occur. With fixations means a failure of the practitioners to revise situations and change their assessment, when new data in fact is present, in order to adapt with change in situations.

Finally, Cook and Woods address strategic factors as contributors to human performance at the sharp end. Strategic factors are related to the management of workloads in the face of various signals, goals and tasks competing for a limited attentional focus<sup>3</sup>. The authors deal with terms linked to strategic factors such as *goal conflicts*, *responsibility-authority double binds* and *the n-Tuple bind*<sup>4</sup>.

A study of construction sites in Hong Kong (China) conducted by Choudry and Fang (2008), indicates that workers were involved in unsafe behavior because of poor safety awareness, exhibition of being “tough guys”, work pressure, attitude of co-workers, and other organizational, economic and psychological factors.

### **2.3 Paradigm 1 - What is compliance?**

According to Neal et al. (2000), “safety compliance involves adhering to safety procedures and carrying out work in a safe manner”. Rules and procedures have traditionally been seen as an essential and integral part of a safety management system. In the OHSAS 18002:2008 guidance to the 18001 standard, “procedure” is defined as a “specific way to carry out an activity or process”. In this guidance, the term “procedure” is often used towards management of safety in primary processes of the organization. Hale and Borys (2012) mentions rules and procedures as one of the key factors in safety management covered in many publications. Rules are said to be translation of the safety policy into specific detail to carry out the safety management. According to Feldman and Pentland (2003), written procedures must be performed repeatedly in order to become part of the organizational routines.

Organizational routines are also discussed more widely in some literature. Routines are often conceptualized as sources of stability. Prevailing theories suggest that routines lead to inertia, mindlessness, deskilling, demotivation and competency traps (Feldman & Pentland, 2003). “By analogy to individual habit, routines are seen as the antithesis of flexibility and change, locking organizations into inflexible, unchanging patterns of action” (Feldman & Pentland, 2003). Grote (2006) challenges this view and claims that rules can be the source for flexibility and change, and presents some steps towards resilient rules management (see Chapter 2.4).

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<sup>3</sup> See also The ETTO Principle by Erik Hollnagel (2009)

<sup>4</sup> see Cook and Woods (1994) for more details on these terms, and cognitive issues and examples of conflicts present within each three categories of cognitive factors presented in chapter 2.1

Hale & Borys (2012) describes two different paradigms in which rules and procedures are seen and managed; a top-down approach and a bottom-up approach. The two approaches were first formulated explicitly as *model 1* and *model 2* by Dekker (2005). The first model represents a view on rules and procedures as an essential element in the safety management system of an organization. This paradigm represents a rational and optimistic view on procedures as something static, suppressing freedom of action and forced on the workers at the sharp end to overcome human fallibility and tendency to make errors or deviate from the rules, either intentionally or unintentionally. Model 1 has its roots in the classical behaviour-based safety (BBS) which associates learning and change with reward and feedback or punishment of wrong behaviour (Hale & Borys, 2012).

Rules can be divided into different categories according to Hale and Swuste (1998). The three types of rules are *Performance goals*, *Process rules* and *Action rules*. Performance goals are rules defining goals to be achieved. Process rules define the way decisions about a course of action must be arrived at. Both performance goals and process rules need to be translated into detailed *Action rules*; which specify how people shall behave, perform operations, use equipment or the required state of a system.

A number of studies identify rules and procedures and the workers attitude towards them as key elements in safety climate/culture and perceptions (Hale & Borys, 2012). Non-compliance to rules is often identified as a key factor in accident investigations in general (Hopkins, 2011). Hale and Borys (2012) point at studies of offshore accidents showing that “failure to follow rules” is the third most important perceived cause of accidents. The same authors also address the multifaceted “truth” about compliance. Studies from a wide range of scientists show a more complex reality with several possible weaknesses to a (purely) compliance-based management style (Hale & Borys, 2012). Different qualities and characteristics lies behind the degree of compliance to rules. An important factor is the workers actual willingness and attitude to follow rules. Further, the rule-compliance relies on the rules being both realistic, not too complicated nor too many, and supportive to modern demands for efficiency and productivity.

## **2.4 Paradigm 2 - What is resilience?**

Traditional safety management focuses to a large degree on analyzing the sociological, technological and organizational elements separately (Costella, Saurin, & Guimarães, 2009). Clegg (2000) takes on the *socio-technical* approach. This presents a more integrated perspective on these elements, providing a more realistic basis for analysis of interactions and adaptations between people, technology and work. This view where human behavior takes place in an organizational context, served as a foundation for cognitive systems engineering (CSE), and later as basis for the term *resilience engineering*, which is adopted by a number of studies to refer to CSE applications on safety management (Costella, Saurin, & Guimarães, 2009).

*Resilience*, the second paradigm (*model 2*) is derived from sociological and ethnographic studies and sees procedure application as substantive cognitive activity and rules as patterns of behavior, socially constructed, emerging from experience with actions and activities

(Dekker, 2003, Hale & Borys, 2012). Hollnagel and Woods (2006) describe resilience as the ability to adapt to situations, create safety, success and learning in an environment with faults, hazards, trade-offs and multiple goals to be accomplished. Further, resilient organizations have the intrinsic ability “to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions” (Hollnagel, 2012). Hollnagel (2012) claims that resilient organizations must possess an ability to (1) *learn* from past events and understand correctly what happened and why, (2) *respond* to regular and irregular conditions in an effective manner, (3) *monitor* short-term developments and threats and revise risk models, and (4) *anticipate* long-term threats and opportunities. Based on various studies, Costella, Saurin and Guimarães (2009) identified four principles of resilience engineering; (1) *top management commitment*, (2) *increase flexibility*, (3) *learn from both incidents and normal work*, and (4) *be aware of system status*.

Work often requires subtle, local judgments with regard to timing of subtasks, relevance, importance and prioritization (Dekker, 2003). Workers have to interpret procedures with a collection of actions and circumstances in mind; factors that the procedures themselves never can take fully account for. Picking up the thread from chapter 2.2 (and the view that forms the basis for the categories of Cook and Woods (1994), governing human performance at the sharp end), there seems to be a prevailing view on human performance as a means for resolving the uncertainties, conflicts and competing demands of large, complex systems<sup>5</sup>.

This approach uses rules as substrate for adaption (Hollnagel, 2012), as “support and as tools to coordinate and structure creativity and innovation, not as controls to limit freedom” (Hale & Borys, 2012). Grote (2006) makes a distinction between flexible use of a routine and a flexible routine, which seems to fit into the concept of resilience. Flexible use of a routine may include an adaption made by the user of the rule to have taken place. Normally, this is seen as a violation with sanctions attached (Grote, 2006). A flexible routine on the other hand means that the routine gives decision latitude for the user of the rule. Grote proposes these flexible rules to be achieved by goal rules and process rules, as defined by Hale and Swuste (1998). Hale and Swuste (1998) brings up that behind every piece of behavior carried out by an operator a translation process has taken place from *Performance goals*, through *Process rules* to the specific *Action rules*. The interesting question, according to Hale and Swuste, is not whether a rule has been specified, but whether or not the organization, management or regulatory level allows this translation process to be carried out by the individual operator. The conclusion made is that a decentralized rule making requires this translation process also to be executed at lower levels in the hierarchy. The action rules describing a specific action or process in detail, may include an element of discretion, for example including terms such as “when necessary” or “when sufficient evidence for condition X has been identified” (Grote, 2006).

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<sup>5</sup> See e.g. Hollnagel (1993) or Cook and Woods (1994)

## 2.5 Why do we need both compliance and resilience?

Procedures are often viewed as important because activities are too intricate for people to remember the steps, or too difficult to get done in time. The use of procedures is a way of standardizing tasks in order to account for several actors and to provide organizational ability to check, monitor and memorize how processes work (Hale & Borys, 2012).

As mentioned, all rules and procedures must undergo a translation process for them to eventually culminate in specific actions. Further, rules can be seen as resources for actions, but they do not fully determine action (Feldman & Pentland, 2003). This requires improvisation and taking into account actions of relevant others (Grote, 2006). Grote claims that rule management enables interdependency between routines in principle and routines in practice. The routine in principle helps through guiding, accounting and referring. At the same time, routines in practice serve as foundation for the establishment and maintenance of the routine in principle because routines develop through repeated actions. The routine in practice can also modify the routines in principle when new ways of acting are found to be appropriate under specific circumstances (Grote, 2006).

Feldman and Pentland (2003) present organizational routines as dualities; consisting of both an ostensive and performative aspect. Feldman and Pentland claim that both of these aspects are necessary for an organizational routine to exist. The ostensive aspect of a routine is the ideal, schematic form and idea of the routine, or the generalized idea of the routine in practice. The performative aspect of a routine includes specific actions, by specific people, in specific times and places. In accordance to *Model 2*, as presented by Dekker (2003), procedures are resources for action, and safety is created by people who know how to adapt procedures to local circumstances. Safety is then created by people with knowledge and insight into the features of situations and the extension of this into the use of a variety of resources in order to accomplish goals.

According to Grote (2006), flexible use of rules is needed when dealing with a high degree of uncertainty, most preferable together with inherently flexible rules. Further, Grote states that tightly coupled systems require the rules to be less flexible because adaptations to these rules could cause unwanted effects elsewhere in the system. However, prevailing theories state that the construction industry in general is characterized by loose couplings, e.g. in research conducted by Dubois & Gadde (2001). Another assumption made by Grote is that flexible rules must be carried out by highly qualified users.

Some rules and procedures at the sharp end are purely intended for safety reasons, e.g. rules managing the use of personal protective equipment (Hale & Borys, 2012). Other rules may deal with a wide range of other aspects such as quality, production, health, environment and sustainability in addition to safety. Hale and Borys (2012) state the importance of achieving organizational goals by managing safety aspects and rules as an integral part of management systems in the same way as rules regarding other activities and processes. A combined rule set for achieving goals of an organization is smaller and more efficient. This approach has proven to be more favorable than operating with a set of safety rules isolated from all other aspects and activities (Hale & Borys, 2012).

Despite the large differences between model 1 and model 2, Hale and Borys argue for a combination of the two models with important lessons to be learned from both approaches. While model 1 sees the solution in modifying reality to match the rules, model 2 includes changing of the rules to match reality. There seems to be a prevailing academic view that rules should be the concentrated competence and experience carried out by professionals with the ability to adapt to diverse situations. A central challenge in rule management is to deal with the gap between (written and often generic) rules and the diversity and complexity of reality. In simple words, rules and procedures can never be completely adequate and cover all possible eventualities in work operations. In table 1, the strengths and weaknesses of both models are summed up.

**Table 1.** This table presents a summary of strengths and weaknesses of compliance and resilience. List adapted from Hale and Borys (2012).

<b>Model 1 (compliance)</b>	<b>Model 2 (resilience)</b>
<i>Strengths</i>	
<ul style="list-style-type: none"> <li>- Makes rule-making explicit and easy to audit</li> <li>- Makes consequences of rule violation explicit</li> <li>- Emphasises competence in rule-making and role of subject experts</li> <li>- Logical, rational, engineering approach</li> <li>- Works well for novices</li> <li>- Proven effectiveness for simple, “golden rules” (Behavioural Based Safety)</li> <li>- Emphasises the role of organizational complicity in rule violation</li> </ul>	<ul style="list-style-type: none"> <li>- Recognizes operators as experts central to rule making</li> <li>- Recognizes social processes as key to rule use</li> <li>- Sees rule-making as a continuous, dynamic process</li> <li>- Links rules to the crystallized competence of organizational memory</li> <li>- Recognizes the importance of managing exceptions and their link to violations</li> <li>- Recognizes the centrality of experience</li> </ul>
<i>Weaknesses</i>	
<ul style="list-style-type: none"> <li>- Sees operators as robots, lacking competence and social motivation and needing imposed rules</li> <li>- Encourages a blame culture &amp; negative view of rules and violations</li> <li>- Sees rule-making as a one-off, static process, until accidents trigger rule modification</li> <li>- Fails to deal adequately with exceptions except as triggers for rule book growth</li> <li>- Tendency to bureaucracy and gap between rules and reality</li> </ul>	<ul style="list-style-type: none"> <li>- Rule-making and modification process lacks transparency for auditing and for novices learning the skills</li> <li>- Undervalues the need for the organization to explicitly manage rule development and use</li> <li>- Hides differences of interpretation and competence</li> </ul>

Hale and Borys (2012) mention several studies with results indicating that the propensity of operators to follow rules often is characterized by more use of own experience and methods getting the job done. The authors also identify a potential effect of a compliance-based

approach in safety management where the expansion of rule books and procedures causes a shift of focus from leadership interaction, supervision, adaptation and learning, to more paperwork.

## **2.6 The role of leadership involvement**

Numerous scientific studies address the role of leadership elements such as monitoring, correction, reward for safe behavior, and more general how dimensions such as trust, cooperation and involvement, are related to safety compliance. According to the findings in a study of Chinese construction sites (Choudry & Fang, 2008), management involvement and “toolbox talks” are the most effective factors for encouraging and facilitating safety at construction sites. The results showed that workers feel more comfortable working with supervisors who care for their safety.

A study of offshore platforms performed by Dahl and Olsen (2012) shows that daily leadership involvement in work operations has a positive influence on compliance with rules. The focus of the study is on the involvement of leadership in work operations, which according to Dahl and Olsen “is understood as worker’s perceptions of the degree of which leaders participate in planning and preparation of work, follow up the execution of the work, and contribute to good cooperation among team members, and the significance of such involvement for safety compliance”.

The results from the study conducted by Dahl and Olsen demonstrated that leadership involvement in work operations, as described in the section above, has a significantly positive influence on the level of safety compliance. In addition to a direct effect on safety compliance, leadership involvement was found to be of significance to three work climate dimensions selected in the study. The most powerful correlation was that of leadership participation and follow-up on contractors and the influence on safety compliance. The two other dimensions of work climate were role clarity, and worker’s competence and involvement. A maritime study performed by Prasad (2008), draws the conclusion that a safety culture characterized by worker awareness and involvement in development of safe operating procedures, is the most appropriate solution. This also includes an environment free for victimisation or fear related to reporting of deficiencies, near-misses and hazardous situations.



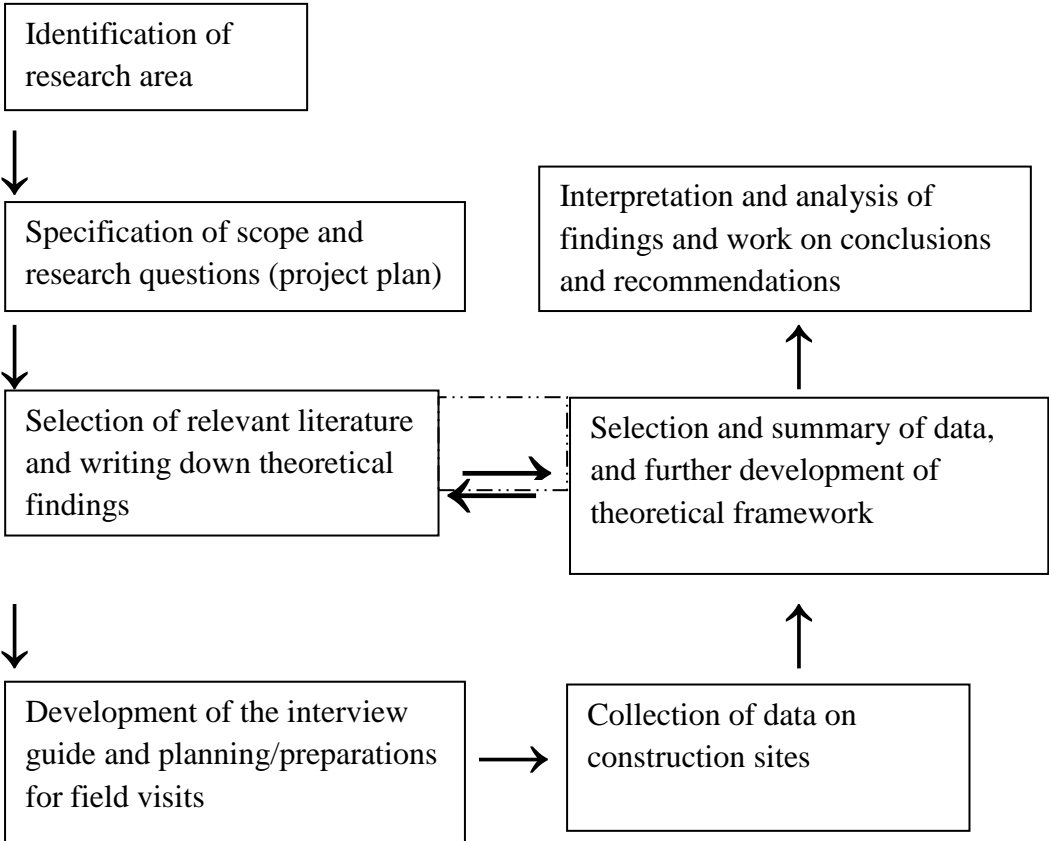


### 3 Scientific methodology

This chapter takes on the scientific methodology used to answer the main issue and research questions in the thesis. The chapter first presents an overview of the research process, followed by descriptions and reasons behind the chosen categories used as a framework for the interviews. Finally, this chapter deals with aspects such as validity, reliability, trustworthiness, authenticity and limitations to the chosen research methodology.

#### 3.1 Overview of the research process

This research process started with a request from the department of HSE at NTNU and the case company to take on the chosen topic of safety at the construction industry. Based on my own personal preferences and interests and dialogue with thesis supervisors, the scope of the thesis and the research questions were further defined and developed in a project plan early in the fall semester of 2013 (see Figure 1).



**Figure 1.** This figure presents an overview of the research process in this thesis.

After finishing work on the project plan, the search for relevant literature began. The literature on rule-compliance has few limitations to the number of academic publications, and the main focus was to do a selection of the most relevant parts and from the most acclaimed authors in order to cover the main and most relevant aspects of rule-compliance. As an academic concept, resilience (engineering) is “newer” than compliance. Despite this, theory on resilience was found to be both adequate and appropriate for my literature review and it

provided a solid foundation for my data analysis and comparisons to the findings from the interviews.

### **3.2 Description of the research process**

In order to gather knowledge about safety in sharp end operations as described in the research questions, it was decided to perform qualitative interviews with workers involved at the sharp end at a regular basis. The case company was regarded as interesting for the thesis topic, and willing to accommodate the interview process. A total of two projects operated by the company were used as case studies; a construction project in the Trondheim area and one construction project in the Oslo area. The project in Oslo includes development of residential buildings on a larger scale than the project in Trondheim. Both projects involve construction of townhouses as well as apartment blocks. When the Oslo project is finalized, it will provide 300 housing units, whereas the equivalent number of the Trondheim project is approximately 170-180. Despite the difference in size and location, and different employees, the projects were assumed to include the same types of operations and challenges in terms of risk handling. This assumption was confirmed to be correct after performing data collection.

There were several reasons for choosing a qualitative approach with interviews as a method to collect data. The most important reason has to do with the nature of the research questions and the open minded approach that seemed necessary to unveil both social elements, as well as the technical aspect in risk handling in sharp end work operations. The selection of projects, interview respondents and the number of respondents is based on the time and resources available in the case company at the period of the data collection, as well as requests from thesis supervisors and thesis author. Studying two different projects gave an opportunity to compare results from both projects. As also stated in the discussion part of the thesis, one should bear in mind that the number of ten respondents was only half of the number that was initially planned. This aspect is further explained and discussed in-depth in the data analysis part of the thesis.

Qualitative interviewing aims at using descriptive feedback in order to provide basis for appropriate solutions to challenges (Andersen & Bendal, 2012). This conversation-based sampling method (Kvale, 1996) represents an inductive approach to the relations between theory and research. With this means that theories and concepts often are extracted from the data material. The approach used in the data collection in this thesis can be characterized as semi-structured interviewing (Andersen & Bendal, 2012). A qualitative approach was regarded to be appropriate in this thesis for the reasons that the main goal was to seek understanding, rather than to generalize, get rich and detailed answers and provide an opportunity to conduct data sampling in a flexible and open-minded manner (Andersen & Bendal, 2012).

The content of the interview guide, and selection of interviewees, is based on categories assumed to be of most relevance to safety at the sharp end. It was important to identify the most important risk factors and safety routines in use at the case company. This assessment took place prior to the data collection and included dialogues with the two thesis supervisors. The PhD-student was one of the two supervisors, and provided valuable input and

contributions to (the selection of) research categories based on knowledge from working at the actual case company. The categories (see appendix B: “Interview guide”) chosen were the following: (1) *Individual risk handling in operations*, (2) *The use of rules and procedures in operations*, (3) *The use of JSA<sup>6</sup> in operations*, (4) *The role of morning meetings* and (5) *Suggestions for improved safety*. All five categories gave room for answers concerning organizational elements as well as individual factors influencing safety in operations. These main categories were meant to be adequate to the demand for being open-minded during the questioning, and at the same time provide a relevant and “to-the-point” basis for answers to the research questions in this thesis. The five research categories also served as a foundation for the discussion, whereas the main goal was answering the research questions more directly when stating the final conclusions.

The length of each interview was approximately 45 minutes. It was preferred by all respondents to conduct the interviews in Norwegian. The chosen language was also preferred by the interviewer. The refinement and translation of the findings into English went well and it is assumed that this was performed without the risk of results being “lost in translation”. The consent form that was presented for the respondents before, and signed by each respondent, were also written (and presented) in Norwegian (see Appendix A: “Information and consent form”). It was decided, after the data collection had taken place, not to use the name of the case company in this thesis. The name is therefore removed from the consent form as well as the interview guide after finishing the interview process, and replaced with synonyms (in Norwegian). The contact information of Eunike Sandberg involved the company name and is therefore removed from the consent form.

### 3.3 Criteria of qualitative research

#### Guidelines for interviewing

According to Kvale (1996), these guidelines are, among others, important when performing qualitative interviews:

- **Knowledgeable:** It is important to be familiar with the focus of the interview, which was sought to be accomplished by developing an interview guide together with thesis supervisors and being updated within the industry and theory on the field of study.
- **Gentle:** It is important to make sure that the respondent gets the time to finish what he has started to talk about. Short periods of silence are not always a bad thing. By interpretations of body language and other signals, this was attempted when performing interviews.
- **Sensitive:** Listen carefully to what is being said and how it is said. The use of a digital recorder provided assurance to this aspect. Written notes were taken in order to keep track of progress and structuring during the interviews. All respondents allowed the conversation to be recorded.

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<sup>6</sup> Job Safety Analysis

- **Open:** It was important to make the anonymity clear to the respondents to provide for openness and honesty without the fear of sanctions or punishment. From the interviewers side, an Overt role, where the participants are aware of the intentions of the researcher (Andersen & Bendal, 2012), was taken by briefly explaining the nature of the thesis before proceeding with the actual interviews.
- **Steering:** During the work on the interview guide, a selection of generic (follow-up) questions was made. Also, more specific questions were asked based on what was found to be of most relevance, most appropriate or most interesting to investigate further or more in-depth at the time of the actual interviews.
- **Remembering:** This was attempted in order to avoid asking the same question more than once, and at the same time in order to seek a deeper understanding to the topic of discussion when desired.

### **Reliability and validity**

Reliability refers to the degree of the correctness of a measurement. A research has high validity when it measures what it is meant to measure (Andersen & Bendal, 2012). According to LeCompte and Goetz (1982), both reliability and validity can be separated into an internal and external meaning.

*Internal reliability* refers to the consistency between the data collections throughout the process, and the consensus of all observers (if several), on what is being observed. The interview guide in use in this work has undergone several discussion processes and reviews from both thesis author and thesis supervisors to make sure of internal reliability. Regarding the execution of the actual interviews, only the thesis author had the function of observing, which served as a prerequisite for inter-observer consistency.

*External reliability* refers to the extent to which a measure varies from one use to another. This means that if a measurement has external reliability, it allows a second measurement to produce similar results as the first measurement. This could probably be tested by the use of the interview guide and performance of interviews at the same company, at the same sites and with the same respondents, although the exact questions may be difficult to replicate. However, a transparent interview process is meant to ensure external reliability.

*Internal validity* has to do with the degree the theoretical sampling matches the theoretical ideas. The main impression throughout the interview process was that relevant and honest answers were delivered.

### **Trustworthiness and authenticity**

In this thesis, only one method for data collection was used. This set a limitation to the degree to which both collection and interpretation can be checked out against each other, and this may weaken the trustworthiness of the conclusions and recommendations. However, with the use of triangulation and proceeding until saturation point throughout the interviews, a certain degree of trustworthiness has been achieved. The interview guide was never presented (in a written version) for the interviewees, which makes it more difficult for the respondents to “agree” on what to say between themselves prior to the interviewing or fabricate answers.

Authenticity in qualitative method relies on five separate parts (Guba & Lincoln, 1994):

- *Fairness*: Ensure that different points of view are represented among different social settings (Andersen & Bendal, 2012).
- *Ontological authenticity*: Better understanding of the social situation (Andersen & Bendal, 2012).
- *Educative authenticity*: Better appreciation of the perspective of others.
- *Catalytic authenticity*: Engaging members to actions towards change of circumstances.
- *Tactical authenticity*: Enable the members to engage in action.

### **3.4 Limitations to the chosen research methodology**

All the answers (results) are from respondents who participate in sharp end actions on a daily or semi-daily basis at the case company. The collection of data includes answers from workers of different age as well as degree of experience. However, there has been no effort made in the processing part of the thesis in comparing these details with the responses in order to find patterns, connections and correlations for example between age, nationality, experience and safe working behavior. The goal has been to find general key factors to what influences safety in operations and investigate how these factors create safety. However, because of the nature of qualitative sampling, it is reasonable to believe that the data not necessarily does provide the basis for direct extrapolation (Andersen & Bendal, 2012) to the general construction industry.

According to Warren (2002), a sampling size of twenty to thirty interviews is recommended when performing qualitative interviews. Due to limited time and resources available in the case company, the number that was initially planned (twenty), was reduced to ten respondents. Since the goal was to seek answers within a relatively narrow field of study, it is reason to believe that this aspect did not represent not as big problem as it would have done if the study had required a broader scope (Andersen & Bendal, 2012). However, a higher number of interviewees would have made comparisons between sites within the organization easier and the theoretical saturation point would have been reached with a higher degree of certainty (Andersen & Bendal, 2012). Although the descriptions (as described in chapter 3.1) is important in qualitative interviewing, it is also important to realize that if it becomes too descriptive this may lead to irrelevant information overshadowing the essence of the research (Lofland & Lofland, 1995).

The interviews took place in the barracks of both construction projects. However, walking and observing around the construction sites was conducted prior to the interviews. These observations created ability for me as an interviewer to better understand practical explanations and examples from the respondents. The observations also include participation in one morning meeting (during the visit to the Trondheim project). These finding are not presented in itself in the thesis.



## 4 Results

This chapter presents the results from the data collection taken place at the projects “Project A” in Trondheim and “Project B” in Oslo/Fornebu. The results follow the same structure as presented in the interview guide and are divided into the five research categories (see chapter 3.2 for more specific criteria for these categories).

### 4.1 Individual risk handling in operations

These tables present a summary of findings concerning risk handling in the most common and dangerous operations at the respective project, how this risk is dealt with and the importance of rules and procedures versus experience.

**Table 2:** Results from Project A in Trondheim

Role	Answer
Foreman carpentry	I have various tasks depending on weekday. 6-week plans, follow-up on individual activities. A goal is to work in a proactive manner, identify safety specific operations and facilitate workers with equipment and materials. Rising of construction elements is the most risky activity at this project. Both experience level and rule-compliance of importance to safety in operations. Experienced workers may take shortcuts. Less experienced workers may be more submissive to rules. Experience is all in all superior to rule-compliance with regard to creating safety in operations.
Safety representative/carpenter	My role is to lead morning meetings with safety as an essential issue. Contribute in various activities. Rising and mounting of construction elements are the most risky activity at this project. My role is requesting and follow-up on JSA when needed. Experience is significant for safety in operations; the ability to keep overview of the construction process and knowing what works, both with regard to own safety and others.
Foreman	My role is to plan and facilitate activities. The risk of people falling and falling objects represents the biggest dangers in the current phase of this project. JSA and morning meetings are essential in dealing with this risk. Experience is important for the ability to work in a safe manner. The transition phase with embracing new procedures is perhaps longer for the more experienced workers. When people face unexpected conditions; experience, rules and attitude towards safety are key factors for success.
Site manager	I am a production manager. Heavy lifting and the risk of falling objects are common in projects such as this. Most basic is worker attitude towards safety and risk reducing measures such as personal protective equipment. A background factor for behavioral attitude is the ability to expect possible situations ahead of time. The management level has a role in raising and sharpening this awareness.
Site manager	The raising and mounting of construction elements represents the biggest risk in this project. This is complex operations with manual assembly

	<p>executed by workers at the sharp end. The risk related to these operations is dealt with in a risk assessment process prior to project start. This assessment culminates in Job Safety Analysis for each activity. The main object is to involve participating workers and create understanding of the risk involved. The safety system itself cannot ensure safe operations. The responsibility lies on the workers and their attitude. The human aspect can lead to unexpected situations. The inherent ability of the system to cope with the situation is therefore important in such cases. The human element is at the same time the only way of coping with changing preconditions for JSA and inadequacy in JSA.</p>
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**Table 3:** Results from Project B outside Oslo

<b>Role</b>	<b>Answer</b>
Carpenter	My field is timber framing and work on outer walls. Manual lifting and lifting with use of crane and forklift. A risk for tripping in objects, falling and falling objects. Experience always beneficial. However, older workers may adopt bad (safety) habits over time. The main factor is the individual attitudes and willingness to comply with the “system”.
Concrete worker	The wall systems are large and heavy pieces which often involves use of crane often with windy conditions. Many precautions are made and we feel safe. We operate with procedures appropriate for the operations and we know what can go wrong and how to avoid it happening. I believe experience generally is superior to rules. A combination of rule-compliance and safe adaptations is important, with the ability to adapt rules to reality. Older workers may take chances more often.
Concrete worker	Work on wall systems and mounting balconies. The biggest risk is falling objects. Important to prevent people from walking underneath the building elements. Closing bands sometimes in use to do so. Both experience and rules are necessary. More experienced workers tend to follow own “rules” more often.
Concrete worker	The weight of the concrete elements is 6 tons and we have to look after ourselves and others involved. These operations require adherence to restricted areas. Adaptions are necessary in unforeseen situations on construction site.
Concrete worker/foreman	My role is to facilitate for efficiency and safety. The most risky operations are the mounting of pre-fabricated wall elements. The measurements are done manually. There will always be an element of individual adaption to the work you do. This project involves both rule-based operations (where training is a prerequisite for safety) and individual-based operations. We need skilled workers; a work force of



	“zombies” (in terms of rule-compliance) is not realistic.
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#### 4.2 The use of rules and procedures in operations

This chapter presents the results from the respondent’s relation to the rules and procedures in use at the sharp end. The results include what proportion of operations are controlled (only) by rules and whether or not these rules are sufficient and appropriate in various situations.

**Table 4:** Results from Project A in Trondheim

Role	Answer
Foreman carpentry	It varies how well rules and procedures are successfully integrated in projects. All leaders are different and affect the conditions for safe work differently. Operations are mostly driven by the use of some rules. Operations with pre-fabricated wall elements and crane are perhaps the most rule-based on this project. Once there was an element that skidded off the bracket. This scenario was not captured in the Job Safety Analysis for the operation. Inexperienced workers contributed to this outcome; however, new people sometimes have to perform JSA-based operations that someone else has prepared. This is not ideal. Sometimes it is necessary to correct the JSA in use.
Safety representative/carpenter	Logistics matters (planning and preparing) are important for safety. Good planning eliminates many problems and makes it easier to foresee and deal with the problems arising. Almost everything on site is rule-based. Accidents would not have occurred if there were complete adherence to rules. At the same time you need to adapt and use common sense. Sometimes the need to work in an efficient manner produces shortcuts to be made which may have a bad influence on safety.
Foreman	Rules sometimes set practical limitations for us. A certain transition phase is necessary when presented for new rules and procedures. Most workers have followed rules throughout their working lives, and safe work therefor emerges from experience from rule use repeatedly over time. Individual attitude governs rule-compliance and risk-taking.
Site manager	Basically, all operations are rule-based. The employees in this company are skilled and few violations to rules occur. Difficult to say whether less experienced workers are more accident-prone or careless than experienced workers. New workers learn to deal with risk together with a site supervisor.

Site manager	Rules and procedures are the basis for our activities and for further work on safety. The safety system in use is as detailed as the operations require. Correct use of rules ensures correct processes.
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**Table 5:** Results from Project B outside Oslo

Role	Answer
Carpenter	Most of what is done is governed by rules, although easier and better solutions, call it shortcuts or adaptations, sometimes take place. Various conditions from place to place and situation to situation sometimes make the rules difficult to follow 100 %.
Concrete worker	Experience is favorable when necessary to remember procedural steps. Fresh workers may have problems with much to learn in a short time span. Rules and procedures may be inadequate. We have the possibility of adjusting rules when desired.
Concrete worker	Rules and procedures are important to plan, coordinate and identify risk factors in activities. Both rule-compliance and safe adaptations are necessary. Procedural steps offers for the most part adequacy to getting the job done.
Concrete worker	Procedural steps offers for the most part adequacy to getting the job done.
Concrete worker/foreman	Procedures work well in general. The use of procedural steps and checklists is vital for safety. Complete and utter rule-compliance, without critical thinking, has the potential to increase risk.

### 4.3 The use of JSA in operations

This chapter presents findings regarding the planning and execution of operations with the use of Job Safety Analysis (JSA).

**Table 6:** Results from Project A in Trondheim

Role	Answer
Foreman carpentry	Job Safety Analysis (JSA) is meant to cover the safety aspect of this operation. The ability to account for the actual conditions and foresee potential scenarios is central when developing a JSA. Non-compliance with JSA represents an increase in risk level.
Safety	The goal of a JSA is to identify and act on potential scenarios that

representative/carpenter	can occur in activities. Shortcuts may take place when developing JSA for the sake of efficiency and saving time. You see faults and weaknesses with JSA without correcting it. The routine can become so repetitive that after a while you fail to identify important details of relevance to safety. A criterion for satisfactory safety is to strive for “living” and dynamic JSAs that all workers involve in and commit to.
Foreman	The main challenge is to involve all the central actors and to remember the steps in a JSA and carry them out in practice. JSA content often gets a place on a board on site. Actors have the possibility of calling off operations and develop JSA further. I have experienced this before, but not on this project. JSA can also be prepared on the actual construction site. All workers involved have to sign on the JSA and confirm their awareness to the JSA and their role as actors.
Site manager	JSA´s are strongly connected with planning of execution. JSA includes assessment of risk factors and mitigation of the risks identified. Challenges are time pressure (the risk of JSA not being performed) and non-compliance to JSA.
Site manager	Non-compliance to JSA has occurred in this project when operating with scaffolding. The reason was time pressure. Difficult to take account for safety breaches and violations. However, the contributing factors, such as time pressure, could have played a smaller role if the management level had stressed the importance of thoroughness. Line leaders play an important role in preparing and implementing the steps of a JSA.

**Table 7:** Results from Project B outside Oslo

<b>Role</b>	<b>Answer</b>
Carpenter	Regular work operations are not regulated by JSAs. Main focus is on how to avoid specific types of dangerous situations. Experience may be beneficial. Experience also may result in an excessive belief in own skills which may produce shortcuts and ignorance of procedural steps in a JSA.
Concrete worker	Experience is favorable when necessary to remember procedural steps in JSA. The routine of JSA offers a possibility for workers to contribute to the contents in JSA. Degree of detail depends on what is needed.

Concrete worker	Procedural steps in JSA offers for the most part adequacy to getting the job done. Rules and procedures are important to plan, coordinate and identify risk factors in activities. The routine of JSA works well and contributes to safety.
Concrete worker	JSA contributes to well planned and executed operations. JSA important especially in operations involving heavy lifting.
Concrete worker/foreman	People may get bored if the number of JSAs gets too high. JSA sometimes force workers to visualize scenarios they normally would not have expected. Implementation of JSA depends on the sense of ownership among workers to the JSA presented.

#### 4.4 The role of morning meetings

These results concern the role that morning meetings play with regard to safety and deals with strengths and weaknesses to this routine.

**Table 8:** Results from Project A in Trondheim

Role	Answer
Foreman carpentry	Essential for safety focus on a daily basis. Discussions about possible previous or future challenges concerning for example incidents or supply of equipment and materials.
Safety representative/carpenter	Arena for repeating routines in JSA and addressing/requesting the need for JSA. Morning meetings make it easier for me as a safety representative (“verneombud”) to keep track of the construction progress. Essential for team spirit. In general, team spirit results in workers that look after each other, and gives them impetus for getting to work in the morning and work in a safe and productive manner.
Foreman	Discussions about challenges from the previous day or possible challenges today. Possible to give out reminders to what is safety critical. Usually, the crane operator does not participate.
Site manager	Morning meetings sharpen safety focus and enhance safe behavior. The focus on safety relies to a certain degree on the individual attributes and leadership style of the persons who are foremen and safety representatives.
Site manager	The man responsible for arranging morning meetings here is very skilled in requesting the demand for safety related aspects in JSAs and challenges individual workers with regard to risk assessment in activities. Morning meetings facilitate for continuous risk

	awareness and repetition of safety related issues.
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**Table 9:** Results from Project B outside Oslo

<b>Role</b>	<b>Answer</b>
Carpenter	Not always necessary to hold morning meetings every day. Whenever an inordinate time is spent on morning meetings, it may cause bored workers with loss of interest. Morning meetings may strengthen the fellowship of workers.
Concrete worker	Keeps a sharp focus on safety and important as an arena for discussions on safety matters. The participation of the crane operator is valuable because he is involved in many operations on site.
Concrete worker	Essential role in planning and this is beneficial for safety as well.
Concrete worker	Essential role in planning and this is beneficial for safety as well. Discussion of results from safety inspections.
Concrete worker/foreman	As a foreman I request the need for (protective) equipment (“Toolbox talks”). Participation from crane operator is valuable.

#### 4.5 Suggestions for improved safety

This chapter presents worker statements and suggestions to improve safety.

**Table 10:** Results from Project A in Trondheim

<b>Role</b>	<b>Answer</b>
Foreman carpentry	Attitudes and safety culture are important factors, and needs to be developed over time. Individuals taking responsibility and part in issues are vital. I do not believe that there has been an increase in accidents in the industry. The reason is a higher degree of reporting nowadays.
Safety representative/carpenter	The system of piecework produces hazardous behavior and shortcuts to be made.
Foreman	Enhanced orderliness on construction site. The need to work in an efficient manner and at the same time be thorough in all activities is challenging. We should have focus on performing JSA and comply with them.

Site manager	Further work on individual attitudes; including subcontractors and hired personnel.
Site manager	Large companies may have an inordinate faith in own safety systems instead of seeing the importance of individual attitude and creating risk awareness among own employees. A system-based mindset may have unwanted effects.

**Table 11:** Results from Project B outside Oslo

<b>Role</b>	<b>Answer</b>
Carpenter	There seems to be an inordinate focus on tidiness when conducting safety inspections. The management level should focus on conditions with the highest risk involved such as risk of falling from heights or the risk of heavy objects falling.
Concrete worker	None.
Concrete worker	None.
Concrete worker	None.
Concrete worker/foreman	The construction industry needs to operate with carefully thought through solutions. Better solutions leads to improved safety. Finding the right persons who are suitable for positions as safety representatives and foremen, is important for safety. It is impossible for a system to create complete and absolute safety.

## 5 Discussion

This chapter discusses the empirical findings from chapter 4. The first subchapter presents general reflections with regard to the findings. The remaining subchapters are (loosely) based on the five research categories from the results; however, the categories are presented in an order different from the order in the results (and the interview guide).

### 5.1 General reflections on the findings

The organization used as a case company in this study is perceived to have high safety standards and ambitious safety goals. The organization regards safety issues as top priority, spending a large amount of time and resources on safety related measures such as safety campaigns, courses, Job Safety Analyses and protective equipment. The main impression from conversations with employees holding various positions in the case company, suggest that risk handling at the sharp end is an aspect characterized by awareness, respect and seriousness by the operators at the sharp end. The main impression was also that the employees are well aware of the most significant risk factors related to the most hazardous activities and work operations. The most complex and hazardous activities (from both projects) were believed to be related to the rising and mounting of big, heavy pre-fabricated building elements, with the risk of people getting struck by falling construction elements or trapped underneath them. Further, the results indicate that the means to handle these challenges were strongly related to both compliance with rules and (safe) adaptations to situations (resilience), with implications to organizational factors as well as individual skills and knowledge.

The discussion (and conclusion) part of this thesis are based on a relatively few number of respondents. If the empirical base had included twice as many respondents, it is possible that this would have provided a different and more correct view on how compliance and resilience affect safety at the sharp end in the case company. This weakness and limitation is also discussed in chapter 3.4. However, there seems to be a large degree of consistency between literature findings and the empirical findings provided in this research. The strongest relations between theoretical findings and empirical findings are found to be related to the most well-known issues and challenges that these two approaches present.

Workers in the sharp end at the case company carries out several types of activities with different types of hazards involved, such as use of manually operated machinery, cutting equipment, hand tools, transport, lifting and use of crane. These activities include different set of (safety) rules; from simple rules concerning use of personal protective equipment (e.g. use of safety goggles or use of hard hat) and restriction of access in specific areas, to rules and procedures in use to handle risk in more complex and hazardous operations, such as those governed by use of JSAs (discussed in chapter 5.4). According to Hale and Borys (2012), a set of “golden rules” (in terms of Behavioral Based Safety (BBS)) has proven effectiveness on general safety. The findings indicate that this also is the case for the general safety at the two construction projects. However, it is important to bear in mind that more experienced workers were said to be more likely to carry out activities in their own way for example without finding the personal protective equipment necessary to use. This suggests that experienced

workers serve as (poor) role models for less experienced workers, and suggests that risk taking and Behavioral Based Safety are important to consider taking place in a social context (see e.g. the study of Baarts (2004)).

## **5.2 Individual risk handling and rule-use in operations**

According to the results, rules and procedures play an important role and govern most activities in some way or another. At the same time, experience is by several respondents acknowledged as superior to rule-use with regard to creating safety. As stated by one of the respondents: “We need skilled workers. A work force of “zombies” is not realistic”. The question to what factor creates safety at the sharp end; rule-compliance or resilience, has not a simple and straightforward answer. Despite the fact that rules and procedures are said to play a very significant role, especially on aspects related to safety, the results indicate that all rules undergo a translation phase (see e.g. Hale and Borys (2012) or Hale and Swuste (1998)) in which the individual operator carry the procedure out into specific actions. The ability to improvise and adapt rules and procedures to the specific circumstances play an important role in this translation phase.

It may be easy to get the impression that rules and rule-use are something completely different and separated from experience. As some of the interviewees also pointed out, rules are merely a concretization of previous, well-known and proven practices; or as stated by Hale and Borys (2012), “rules are the crystallized competence of organizational memory”. In this vein, rules can be seen as an extension of the experience accumulated over time, or pushed to extreme, exactly the same thing as experience; only in a written form. However, regardless of how strongly these two outer-points are believed to be connected or what you believe experience to imply, the prevailing view created by the findings is that experience plays an important role for rule-use in operations at the sharp end.

An ability to be proactive is preferred to being reactive and detecting things that may occur when for example developing a JSA gives an opportunity to know how to respond to the unexpected scenarios. *Monitoring* (Hollnagel, 2012) in order to expose risks that may occur in the near future is closely related to the ability of anticipation. The results show an actual ability to know which hazards to look for in sharp end activities. This is essential to be able to respond to changes that occur in the near future. However, the findings seem to indicate a lack of faith in the importance of corrective actions if accidents occur. This is mostly said to be due to the nature of the operations and the fact that, if things go wrong when operating large construction elements, hazardous situations may happen very fast and develop without the sufficient time for stabilizing measures to be made. It is, however, from the author’s point of view realistic and favorably going through continuous considerations throughout these types of operations, identifying possible escape routes or other maneuvers in an attempt to reduce the consequences of a potential hazardous situation. It is not known what amount of resources is spent by the organization on the skills to cope with unexpected situations (or crisis handling). More in-depth investigation on this aspect of risk reduction would have been preferred in order to conclude from a more solid empirical base.



As far as the results allow a comparison to be drawn between the two chosen projects, the answers from the Trondheim project reflects a more positivistic view on what is important for safety at the sharp end. The interviews in Trondheim were mainly conducted with line leaders and foremen as respondents. These respondents provided answers in favor of rule-compliance being the key factor to create safety, whereas the respondents from the Oslo project had a larger faith in own experience to be the key factor for safety. Unlike the interviews that took place in Trondheim, the respondents from the Oslo project were mostly operators without managerial positions. This rather optimistic view from the line leaders and foremen can be assumed to reflect the degree of compliance with procedural steps that these rule-makers feel is required for the rules to culminate in actions in a safe manner. The users of these rules seemed to emphasize rule-use as more of a matter of own experience; putting social (constructivistic) processes central in closing the gap between rules and reality.

The findings suggest that a rule-based system in use at the case company provides stability and predictability making worker mobility from one project to another possible without the risk of workers being totally unfamiliar with the rules in use in “new” projects. This aspect is assumed to reduce time and effort when workers have to adapt to new locations. However, it is up to the local work teams to adapt the (standardized) rules to reality in a way assumed to be appropriate for the given conditions at that specific construction site. Alternatively, the rule-use has to rely on the intrinsic adaptive abilities of the work force to set out less specified rules into actions. For that reason, new workers on a project have to, in addition to refresh rule competence (if necessary), quickly adapt to the existing safety culture and its local facets. This ability to adapt to new projects, and to the “way we do things around here”, includes therefore more than strictly obtaining knowledge of the rules in use at that specific construction project. Despite the fact that the rules in use at this project (most likely) is the same rule set as used in the previous project he or she participated in, the transition phase includes in other words social processes as a key factor in adapting to new environments.

### **5.3 The role of morning meetings**

In this transition phase to new projects and work teams, the role of morning meetings is assumed to play a role in the social integration of new work members. The routine of morning meetings is, based on the findings, believed to be beneficial for the development of team spirit and social bonding between workers. The influence that these social factors have on sharp end safety is not emphasized to a large degree in this thesis. However, studies such as that of Baarts (2004) suggest that explicit safety rules are subject to individual and collective interpretations, recognizing complex social settings as arenas where safety is created. It is the author’s impression that such implicit rules are guiding factors for behavior and the mindsets of crafters also in the projects chosen as case studies; however, the main focus was not on this aspect of safety and the empiricism do not represent a foundation for bastant conclusions to be drawn within this topic.

Morning meetings are held on a daily basis in the case company. This routine includes a gathering of workers from each professional discipline taking place at separate locations. The practice of morning meetings were said to involve all work members of the individual teams. The findings showed that the crane operator, without exceptions, attended the morning

meetings held in the Oslo project, whereas the crane operator in the Trondheim project used this time to find his way up in the air preparing his role in today's lifting operations. The answers from the respondents in Oslo suggest that the participation of crane operators were highly valued for its strengths in planning, coordination and safety aspects (in crane operations) of today's work activities. Since each professional discipline has its own morning meeting, it is believed to be important for the crane operator to find the work team (e.g. carpentry or concrete) that is assumed to be most heavily involved in crane operations on that particular day. The reasons why the crane operator should participate in these meetings are believed to be strongly connected to the fact that the most hazardous of sharp end operations performed with the participation from the crane operator (i.e. lifting operations).

The findings indicate the repetitive nature of morning meetings and the recurrent (safety) topics to be somewhat uninspiring to participate in. The workers seemed to be aware of the potential deficits these characteristics may have on individual attitudes towards safety issues. The most extreme consequence was found to be lack of attention and focus on the topic under discussion during these meetings.

At the same time, morning meetings play an important role in sharpening and maintaining safety focus from day to day. The respondents (from both projects) expressed the value of the opportunity to share experiences from the previous day in a convenient setting (mostly indoors in the barracks) and discussing situations and aspects related to production or safety. In that way the morning meetings also play a role in the transfer of experience and knowledge between co-workers; however, more in a short-term perspective. Based on the influence that experience has for safety in operations, short-term organizational and individual memory as well as long-term memory should be valued. This view puts social settings, such as morning meetings, central in the facilitation of transfer of (local) experience and knowledge from one worker to another. Experienced workers should play a central role when it comes to education of "juniors" and transfer of individual competence from one generation to the next. As one of the few settings where safety issues are discussed in an open forum, morning meetings have the potential of being an arena where such transfer processes may take place on a daily basis. Further, the individual attributes of the employees chosen as foremen and safety representatives are determinative for how these meetings are carried out; e.g. to what extent safety issues are addressed.

#### **5.4 The use of JSA in operations**

The most important means to mitigate risk in the most dangerous operations was found to be the use of Job Safety Analyses. This routine is characterized by planning of execution, identification of possible hazardous situations and risk factors in order to manage the risk involved in operations. The results indicate that safety is an integrated aspect considered in line with for example productivity when JSAs are performed. A significant strength linked to the use of JSA is the positive effects that planning has on safety. The respondents describe the advantage it gives in daily operations thinking things through before setting about doing them, identify and visualize possible risk factors and coordinate individual responsibilities before performing the actual operations on site. This relates to the ability to expect the unexpected. However, performing this routine is not an absolute guarantee for expecting the unexpected,

or the same as an inherent ability actually to do so. This routine merely provides an arena where such abilities may develop over time and a setting where imaginary capabilities should play a central role in identification of potential risks. This view on procedures and JSAs is not to be seen as critique to the existing routine, rather an attempt to stress that the *opportunity* that JSA provides to anticipate scenarios, is not the same as an actual *ability* to anticipate. This ability is assumed to be connected to the degree of experience and competence of the workers involved in these risk identification processes. This thesis does not cover important factors that affect the development of such abilities, nor does it (to a large degree) cover the inherent ability to anticipate. However, it is reasonable to believe that the case company may accommodate for these abilities to evolve with the involvement of leadership in JSA development and by spending a sufficient amount of time on performing JSAs. The line leaders also play an important role when it comes to emphasizing the importance of being thorough when operators carry out the procedural steps from a JSA, especially in an industry characterized by tight schedules and demands for efficiency.

Another topic of discussion was the degree of details preferable in JSAs. There seems to be a prevailing view that this question has no definite answer. However, literature on resilience suggests that rule-users should play an important role in rule-making. In practice this means that operators have firsthand knowledge for deciding the appropriate degree of details in the procedural steps of JSAs. Worker involvement is also confirmed to be related to the sense of ownership to the rules in use, making the implementation of JSAs more likely to succeed.

The use of JSA was in other words perceived as beneficial for planning, productivity and safety. Non-compliance with JSA was associated with a potential increase in risk. Several factors influencing the propensity of workers to follow the JSA in practice were identified. A higher number of respondents on this topic would have been preferable, however, the results indicate that experienced workers rely more on their own skill sets and knowledge, whereas less experienced workers may be more submissive to rules in general. At the same time, experienced workers may possess a better overview of the construction process and in that way a better ability to foresee things ahead of time and operate in a proactive manner, for the benefit of own and others safety.

The routine of JSA presents a potential challenging demand for the operator from mere compliance with the procedural steps in a JSA, over to a shift in which changing preconditions and an inadequate JSA require a set of well-developed individual skills (experience) in order to maintain operational safety. The human element is therefore the only way of coping with such eventualities. This fact recognizes human variability as the source of fallibility at the same time as a source of adaptability in challenging situations. This view is rooted in literature concerning resilience engineering, such as that of Hollnagel (2012).

Routines are traditionally seen as “the antithesis of flexibility and change, locking organizations into inflexible, unchanging patterns of action” (Feldman & Pentland, 2003). One of the main strengths is the opportunity to change or modify the procedural steps in a JSA if operations reveal that this is necessary. Some of the respondents refer to this as striving for “living” JSAs and emphasizes the importance of involvement and continuous check-up

from all actors involved in the activities. This aspect makes JSAs part of a continuous, dynamic process of rule-making and makes the operators central to rule-making in the organization (Hale & Borys, 2012).

JSA-use includes challenges such as involving all the central actors in a satisfactory way. It is also perceived as a challenge to remember all the procedural steps in a JSA by heart. The results indicate that experience may compensate for the lack of memory to procedural steps and serve as an advantage for getting the job done in a safe manner. At the same time, as mentioned, more experienced workers tend to have more faith in own skills which may produce shortcuts and ignorance to the procedural steps developed in the JSA when these are set out to practice. A risk of shortcuts is also believed to be present in situations when efficiency has a high priority. There is also a potential risk of JSA not being performed at all, or a risk of shortcuts when developing procedural steps in the JSA. As for rules and rule-use in general, the key challenge (for site management) is to choose the appropriate balance between detailed procedural steps, and the level of built-in user flexibility in a JSA. It is therefore necessary to possess a clear understanding of the difference between *flexible use* of a routine, and *flexible routines* (Grote, 2006). Flexible use of a routine involves an adaption by the user of the rule to have taken place. This is normally seen as a violation of the rule. As opposed to flexible use of a routine, a flexible routine gives decision latitude for the user of the rule when it comes to rule-use. Since it is believed to be impossible to make rules without allowing (to any extent) flexible use of a routine, such flexibility should be built into rule-use at the sharp end in a conscious way. It requires a clear intention from the management level behind the degree of details (or similarly the degree of flexibility) when rules are meant to be carried out into specific actions by rule-users.

## 6 Conclusions and recommendations

Rules and procedures can be seen as the culmination of past experience and “best practice” into a written, concrete form. Compliance with requirements and safe adaptations to situations (resilience) can therefore, in a way, be seen as two approaches closely related to one another. This thesis found that both approaches have strong relations to one another and both approaches have to co-exist in order to create and maintain safety. Compliance and resilience are difficult to separate although more distinct features of both approaches can be recognized in the practice and routines of sharp end operations at the chosen case company.

The results from this thesis suggest that rules and procedures are to be seen as a framework for safety and serves as the starting point for risk handling in complex and hazardous operations at the sharp end. The framework itself is not an absolute guarantee for safety. Operators are the ones translating the rules and procedures into specific actions at the sharp end. For that reason, operators should know how to adapt rules and procedures to reality in the most appropriate and safe manner. The management level should be aware and set clear goals, in cooperation with operators, on how the translation phase of rules should take place, and to what extent adaptive abilities should play a part in this process overcoming the gap between rules and reality. The findings in this research indicate that operators should play a central role in rule-making. Line leaders should participate in rule-use. The reason behind this statement is that leadership involvement is believed to have a positive influence on rule-compliance, in addition to the advantage of visualization in real life when it comes to rule-making. Since time and efficiency are contributory factors at the sharp end, foremen and leaders should continually express clearly the importance of being thorough throughout the execution of operations and activities.

Findings in this research suggest that rule-use and rule-making are strongly connected to a set of organizational factors as well as individual abilities and experience. A key factor regarding the organization is facilitation of active involvement from line-leaders as well as operators in these activities. The findings also indicate that the adaptive capabilities of workers to carry rules out into specific actions are strongly connected to experience and individual skill sets. This stresses the importance of facilitation for transfer of (local) knowledge and experience to take place at the sharp end. The more experienced workers play an important role in education of “juniors” in this process.

Based on the empirical findings, a set of five recommendations for the case company is stated below. The first three deals with organizational facilitation of rule-making and rule-use, whereas the last two regards individual skill sets as central in processes of rule-making and rule-use at the sharp end.

- **Involvement in rule-making and rule-use.** Operators at the sharp end should participate in the development phase of rules and Job Safety Analyses (JSA). The management responsible for rule-making, especially line leaders, should participate in rule-use and the execution phase of JSAs in sharp end operations.

- **Rule-making as a dynamic process.** The case company should facilitate and strive for a continuous, dynamic process of rule-making (i.e. “living” JSAs). Emphasize and utilize adaptive capabilities of sharp end operators in the development phase of rules.
- **Overcoming the gap between rules and reality.** Site management has to set clear guidelines, with participation from operators, to the translation phase of rules into specific actions. The role of the required adaptive abilities must be recognized and specified for each specific operation.
- **Organizational memory, exchange and transfer of experience.** The case company should value and facilitate for individual skills, competence and organizational memory to develop over time. The knowledge and experience should be transferred to new generations in order to develop individual skills and adaptive abilities in rule-making and rule-use.
- **Influencing factors for rule-compliance.** The degree of compliance with rules is related to leadership involvement in the sharp end, sense of (worker) ownership to rules, and individual factors such as risk awareness, attitude and motivation. The case company should (continue) recognizing social processes as key to rule-use and risk handling as a phenomenon taking place in a social context and facilitate for a communicative, fair, and integrative safety culture.

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# Appendix



# Appendix A: Information and consent form

NTNU

Institutt for industriell økonomi og teknologiledelse

Trondheim, mars 2013

## **Forespørsel om deltakelse i intervju (og samtykkeerklæring)**

*Masteroppgave i Helse, miljø og sikkerhet:*

*Etterlevelse av regler versus situasjonsbasert adferd i arbeidsoperasjoner*

Fire av de fem siste årene har noen mistet livet under arbeid i denne organisasjonen. Hver dag blir en person skadet på én av dette firmaets byggeplasser. Hver fjerde dag blir en person så sterkt skadet at vedkommende ikke kommer på jobb dagen etter (Aslesen, Sikkerhetsdagene 2012). Organisasjonen jobber mot et hovedmål om å være en skadefri organisasjon, samt et delmål om under 50 skader i 2015. I forbindelse med min masteroppgave på HMS-studiet ved NTNU skal jeg foreta en kvalitativ undersøkelse (intervju) for å forsøke å finne ut av hva som skaper sikkerhet i arbeidsoperasjoner på det operative nivået ("den skarpe enden") på byggeplassen.

Jeg har fokus på bruk av regler og prosedyrer, og søker å finne ut av hvordan dette (bør) balanseres med arbeideres tilpasning til situasjoner og adferd utover hva som defineres i regler og prosedyrer. I tillegg til intervju, kan observasjon og samtaler på byggeplassen være interessant.

Jeg vil se på to ulike byggeprosjekter i Trondheim, og søker personer i ulike stillinger; formenn, baser og håndverkere. Intervjurunden er basert på frivillig deltakelse, og håper denne forespørselen møtes med velvilje til å stille opp. Før intervjuet starter, vil en samtykkeerklæring for deltakelse i prosjektet og håndtering av intervju-materialet underskrives av begge parter (nederst på dette skrivet).

Intervjuet vil ta omtrent 45-60 minutter. Det er ønskelig fra min side å ta intervjuet opp på bånd. Dette for å hindre at viktig informasjon går tapt, og gi en mest mulig korrekt gjengivelse av det som blir sagt. Dersom du motsetter deg dette, vil jeg notere for hånd. Om så skjer, vil jeg gjøre oppmerksom på at intervjuet kan ta noe lenger tid. Intervjuet vil bli oppsummert i en skriftlig utgave. Båndet vil bli slettet etter at oppgaven er ferdig. Navn eller andre kjennetegn vil ikke bli brukt hverken i notat, på bånd, i oppsummeringen eller i oppgaven. Alt materiale vil foreligge i anonymiserte versjoner, så opplysninger kan ikke føres tilbake til den enkelte deltaker. Utskriftene vil kun være tilgjengelig for undertegnede og veiledere, som alle har taushetsplikt. All informasjon behandles konfidensielt. Alle deltakere får tilbud om å lese gjennom utskriften av sitt eget intervju hvis ønskelig. Resultatet som presenteres i oppgaven berører kun det innholdsmessige i samtalen, og vil ikke bli koblet opp til person.

Undersøkelsen gjennomføres av masterstudent Jens Kortner, Institutt for industriell økonomi og teknologiledelse (IØT) ved NTNU. Intervjuguide er utviklet i samråd med veilederne Eunike

Sandberg som gjennomfører en nærings-PhD for den utvalgte bedriften, og førsteamanuensis Eirik Albrechtsen ved IØT, NTNU.

Dersom du har spørsmål i tilknytning til oppgaven, vennligst ta kontakt med undertegnede eller én av mine veiledere: Eunike Sandberg eller Eirik Albrechtsen ([albrecht@iot.ntnu.no](mailto:albrecht@iot.ntnu.no)).

*Takk for at du tar deg tid til å stille opp! ☺*

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**Samtykkeerklæring intervjuperson:**

Jeg har lest informasjonen over og gir mitt samtykke til å delta på intervjuet.

Sted og dato: \_\_\_\_\_ Signatur: \_\_\_\_\_

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**Samtykkeerklæring intervjuer:**

Jeg har lest informasjonen over og gir mitt samtykke til å utføre intervju og videre arbeid som beskrevet ovenfor.

Sted og dato: \_\_\_\_\_ Signatur: \_\_\_\_\_

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Med vennlig hilsen

*Jens N. Kortner*

Telefon: 905 43 027

Mailadresse: [jkortner@gmail.com](mailto:jkortner@gmail.com)

# Appendix B: Interview guide

## Intervjuguide

Prosjekt:  Bygg  Anlegg

- Kort presentasjon av meg selv, masteroppgaven og besøket hos bedriften (husk informasjonsbrev)
- Opplysninger intervjuobjekt:

Ansatt i:  Bedriften  Underentreprenør  Innleid

Alder: \_\_\_\_ Nasjonalitet: \_\_\_\_\_

Stilling:

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- Hva slags bakgrunn har du og hvor lenge har du jobbet i stillingen/bransjen?
- Hvor lenge har du vært på dette prosjektet?
- Personalansvar?
  - For hvor mange?
  - Hvor mange års erfaring har du som leder?

### **I Vurdering og håndtering av risiko i eget arbeid**

- Hva slags arbeidsoppgaver er mest vanlig for deg å utføre på byggeplassen/anlegget
- Hva er den største risikoen ved dine arbeidsoppgaver?
- I hvilken grad vurderer du risikoen før du starter en arbeidsoperasjon?
  - Hvordan håndterer du denne risikoen?
  - Hva mener du skaper god sikkerhet i disse arbeidsoperasjonene?
- Bruker du blokken for løpende risikovurdering?
- Hvor mye vil du si at erfaring og kunnskap betyr for sikkerhet på arbeidsplassen, sammenliknet med regler og prosedyrer?
  - Hvorfor?
- Hva mener du skaper god sikkerhet i uventede situasjoner på byggeplassen/anlegget, dvs. når forholdene endrer seg eller f. eks forutsetningene for SJA endres?
- (Hva ligger bak denne evnen til å takle uventede situasjoner og hendelser som oppstår og likevel opprettholde sikkerheten i arbeidsoppgaver?)
- Kan du gi ett/flere eksempler på utfordrende arbeidsoperasjoner der flere parter (Ansatte, UE og/eller innleide) har samlet ansvar for sikkerheten?
  - Hva mener du er viktig for å oppnå høy sikkerhet i slike situasjoner? (Kommunikasjon i samarbeid mellom ulike aktører?)

### **II Gjeldende regler / rutiner for ditt arbeid**

- *Til ansatte i bedriften:* Hvordan opplever du at det gjeldende styringssystemet (prosedyrer /instrukser) i bedriften fungerer?
- Kjenner du til de kravene som gjelder for de arbeidsoppgavene du utfører? (prosedyrer, instrukser og SJA)?
- Vet du hvor du finner gjeldende rutiner og prosedyrer for dine arbeidsoppgaver?
- Hvor mye av det du gjør på byggeplassen/anlegget vil du si er helt styrt av regler/prosedyrer?
  - Har du eksempler der regler/prosedyrer er helt avgjørende for trygg og sikker utførelse av operasjoner?

- Opplever du noen gang at regler/prosedyrer ikke er tilstrekkelig for å utføre sikre arbeidsoppgaver?
  - o I hvilke situasjoner er det?
  - o Hvor ofte skjer det?
  - o Hva gjør du i så fall i disse tilfellene?
- Har du et eksempel på en slik situasjon?
  - o Hva gjorde du for å lykkes med arbeidsoppgaven?
  - o Har du noen forklaring på hvorfor du/dere lyktes med operasjonen, evt ikke?
- Opplever du ofte at du må bryte regler og krav for å ivareta sikkerheten?
  - o Eksempel?
- Hvordan opplever du at underentreprenørene og innleide sitt forhold til bedriftens regler/prosedyrer er?

### **III Bruk av sikker jobb-analyser (SJA)**

- Kjenner du til rutinen om SJA?
- Fungerer rutinene med SJA bra i praksis?
- Har du selv vært med på å utføre en SJA?
  - o Antall totalt og hvor ofte?
- Hvordan kommuniseres gjennomførte SJA ut til ansatte?
- Har du noen tanker om hvordan en SJA bør være for at den i større grad følges i praksis?
  - o Hvorfor tror du i så fall at den vil bidra til høyere sikkerhet på arbeidsplassen?

*Baser:*

- I hvilken grad vurderer du behovet for SJA?
- Hvem er med på å gjennomføre analysen?
- Hvor/hvordan blir SJA presentert til de ansatte, og for hvilke ansatte?

### **IV Morgenmøter**

- Hvordan er din opplevelse av morgenmøter?
- Hva er i hovedsak tema på møtene?

*Baser:* Hvilke tema tar du opp på morgenmøtene?

- Opplever du at morgenmøtet bidrar til høyere sikkerhet på arbeidsplassen?
  - o Hvorfor/hvorfor ikke?
  - o Sterke/svake sider ved morgenmøtet? (Ta opp Sikker Jobb Analyse og hvordan baser bringer den planlagte SJA ut i praksis)

### **V Forbedringsforslag**

- Har du forslag til tiltak som kan gi økt sikkerhet på arbeidsplassen?
- Er det noe mer du vil tilføye om det vi har snakket om?

***Takk for at du tok deg tid til å stille opp!***