Safety leadership in the construction industry

Managing safety at Swedish and Danish construction sites

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Cover illustration: Reinforcing bars

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“The importance of feedback is clear. The organism must be stimulated by the consequences of its behavior if conditioning is to take place.” /B. F. Skinner, 1953

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ABSTRACT

The overall aim of this thesis was to identify and describe essential components of safety leadership behavior in the construction industry in Sweden and Denmark. The methods used were semi-structured interviews, cross-sectional and longitudinal questionnaire studies, and behavioral observations. The results of Paper I indicate that participative leadership and rule-oriented leadership may be vital for occupational safety at construction sites. The results of Paper II indicate that participative leadership is learned by future construction managers and employees during their vocational education and training. The results of Paper III indicate that transformational, active transactional, participative, and rule-oriented leadership were positively associated with occupational safety at construction sites; and that laissez-faire leadership was negatively associated with occupational safety at construction sites. The results of Paper IV provides qualitative context-specific descriptions of how transformational, active transactional, and passive/avoidant leadership are enacted by construction site managers. In addition, Paper IV confirm the positive association between transformational leadership and construction site safety climate as well as the negative association between passive/avoidant leadership and construction site safety climate. The results of Papers I and III indicate that a high occurrence of rule-oriented and participative leadership behaviors among construction managers at Swedish construction sites may help explain the relatively low injury rates in the Swedish construction industry.

Keywords: occupational safety, leadership, safety leadership, construction manager, participative leadership, rule-oriented leadership, transformational leadership, transactional leadership, passive leadership, safety climate

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SAMMANFATTNING PÅ SVENSKA

Det övergripande syftet med föreliggande avhandling var att identifiera och beskriva väsentliga komponenter i säkerhetsledarskap inom bygg- och anläggningsbranschen i Sverige och Danmark. De metoder som användes var semi-strukturerade intervjuer, tvärsnitts- och longitudinella enkätstudier, samt beteendeobservationer. Resultaten i artikel I indikerar att participativt ledarskap och regelorienterat ledarskap är betydelsefullt för arbetssäkerheten på arbetsplatser i bygg- och anläggningsbranschen. Resultaten i artikel II indikerar att participativt ledarskap lärs in av blivande chefer och yrkesarbetare redan under sin yrkesutbildning. Resultaten i artikel III indikerar att de ledarbeteenden som är förknippade med hög arbetssäkerhet på arbetsplatser inom bygg- och anläggningsbranschen inbegriper transformativt ledarskap, aktivt transaktionellt ledarskap, participativt ledarskap, och regelorienterat ledarskap; samt att laissez-faire ledarskap är förknippat med låg arbetssäkerhet. Resultaten i artikel IV bekräftar den positiva kopplingen som identifierats i artikel I mellan transformativt ledarskap och säkerhetsklimat samt den negativa kopplingen mellan passivt/undvikande ledarskap och säkerhetsklimat. Dessutom innehåller artikel IV kvalitativa kontextspecifika beskrivningar av hur transformativt, aktivt transaktionellt och passivt/undvikande ledarskap visar sig i konkreta beteenden hos platschefer på arbetsplatser inom bygg- och anläggningsbranschen i Sverige och Danmark. Resultaten i artikel I och III indikerar att en hög förekomst av regelorienterade och participativa ledarbeteenden hos platschefer på arbetsplatser inom bygg- och anläggningsbranschen i Sverige kan vara en bidragande förklaring till de jämförelsevis låga olyckstalen i den svenska bygg- och anläggningsbranschen.

LIST OF PAPERS

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

I. Grill M, Grytnes R, Törner M. Approaching safety in the Swedish and Danish construction industry: professionals' perceptions of safety culture differences. Safety Science Monitor. 2015;19(2):1–17.

II. Grill M, Pousette A, Nielsen K, Grytnes R, Törner M. Supervisors and teachers' influence on expectations on empowering leadership among students in vocational education and training. Empirical Research in Vocational Education and Training. 2017;9(2):1–15.

III. Grill M, Pousette A, Nielsen K, Grytnes R, Törner M. Safety leadership at construction sites: the importance of rule oriented and participative leadership. Scandinavian Journal of Work, Environment & Health. 2017;43(4):375–384.

IV. Grill M, Nielsen K, Grytnes R, Pousette A, Törner M Construction site managers' leadership practices and their influence on safety climate: an observational study of transformational, active transactional and passive/avoidant leadership. Submitted manuscript.

CONTENT

ABBREVIATIONS

BBS	Behavior-based safety
GLOBE	Global leadership and organizational behavior effectiveness
ILTs	Implicit leadership theories
OBM	Organizational behavior management
PPE	Personal protective equipment
VET	Vocational education and training

DEFINITIONS IN SHORT

Antecedent	Stimulus that precede behavior and influences its performance; constitute a controlling condition for the behavior (1)
Behavior	Any observable or measurable response, movement or activity, of an individual, including overt behavior, such as speech and body movements, and covert behavior, such as thoughts (1, 2)
Directive feedback	Information about performance that allows an individual to adjust his or her future performance (3)
Negative reinforcement	Removing stimuli following a behavior and thereby increasing the likelihood of the behavior recurring (1)
Positive reinforcement	Providing stimuli following a behavior and thereby increasing the likelihood of the behavior recurring (1)
Rewarding feedback	Recognition for a particular behavior, making people more likely to perform the same behavior again (4)
Safety leadership	Specific leader behaviors that motivate employees to achieve safety goals (5)
Safe work behavior	Behavior at work that reduce risks and increase safety
Stimulus generalization	A behavior reinforced in the presence of one stimulus will subsequently be performed in the presence of other stimuli that share some common property (1)
Unsafe work behavior	Behavior at work that increases risks and reduce safety

1 INTRODUCTION

Developing high occupational safety in the construction industry is a major concern for construction managers, employees, companies, employer organizations, employee organizations and governmental agencies. Despite this, the construction industry remains one of the economic sectors worst affected by occupational injuries, severe and fatal injuries in particular (Figure 1) (6). The introduction of improved technical solutions for safety has reduced occupational injury rates over the last century. However, technical solutions do not seem to be enough to ensure safety at work. More recently, the importance of managerial leadership for occupational safety performance has been highlighted and safety leadership is today a vibrant research field. Leadership has been found to be critical for occupational safety across economic sectors (5, 7-10). Safety leadership was defined by Griffin and Hu (5) as "specific leader behaviors that motivate employees to achieve safety goals" (p. 200).

Construction site managers have been identified as vital leaders in the construction industry (11). These managers occupy a middle management position operating across organizational boundaries, requiring the coordination of many interacting employees, subcontractors, and external organizations (12, 13). On a day-to-day basis, construction site managers implement leadership at the operational as well as strategic levels (11, 14). Mustapha and Naoum (11) concluded that central performance variables in construction projects were more closely related to site managers' personal leadership abilities than to project characteristics such as building type, complexity/size, and project duration. Furthermore, studies have found that the leadership practices of construction site managers seem to be important for construction site safety performance, in terms of occupational injuries (15), safety-related work behavior among employees (15-19), and construction site safety climate (15, 19, 20).

The goal of this thesis is to distinguish the kind of leadership needed to attain high safety standards in the construction industry. Previous safety leadership research is a natural point of departure for this endeavor. However, a more innovative stance is also taken, namely, cross-cultural comparisons between the leadership practices of construction site managers in Sweden and Denmark. Sweden and Denmark are neighboring and similar countries that nevertheless differ considerably in occupational injury rates, found to be substantially lower in the Swedish than the Danish construction industry (6). Comparing construction site leadership practices in the Swedish and Danish construction

industries may enhance our understanding of what managers can do to augment occupational safety in the construction industry.

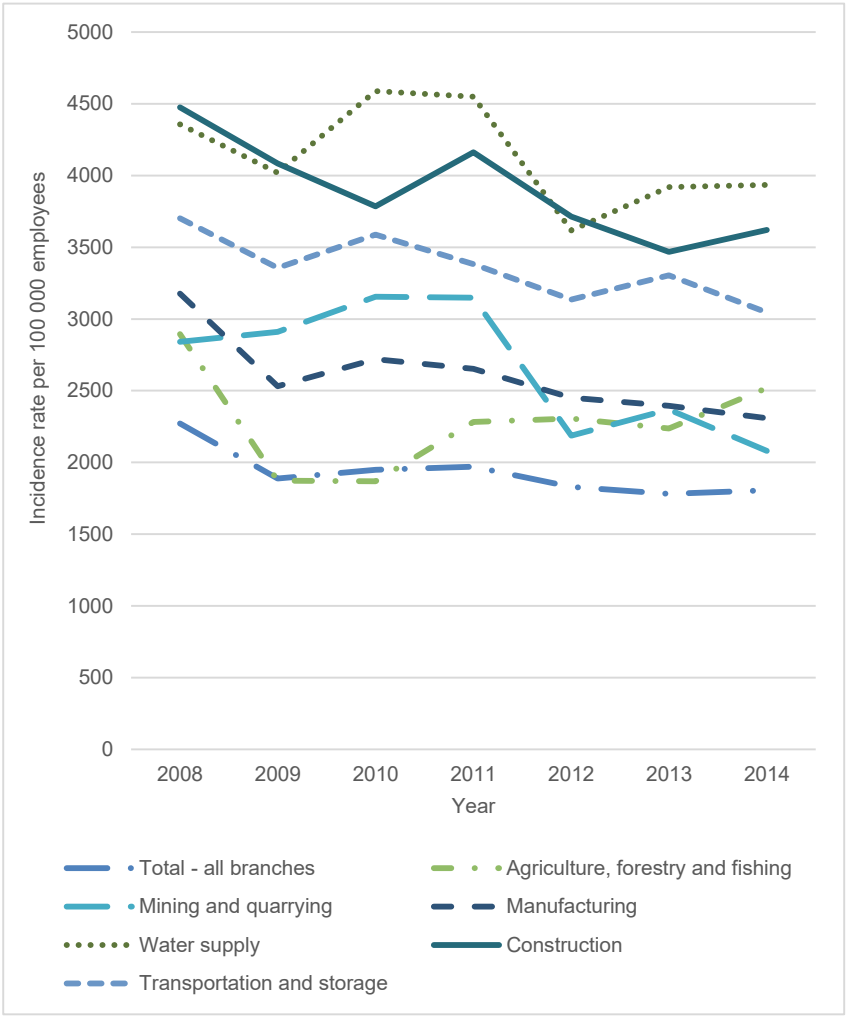

Figure 1. Incidence rates of serious injuries, resulting in more than three days of absence from work in the six worst affected economic sectors in EU-15[1] (6).

[1] EU-15 comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the UK.

1.1 Construction safety leadership in Sweden and Denmark

Most research into safety leadership in the construction industry has been conducted in the USA and Australia. Whether the influence of specific leadership behaviors on organizational outcomes is universal or culturally dependent is the subject of ongoing debate among leadership scholars, and evidence for both standpoints has been presented. Some leadership research indicates that particular leadership behaviors are universally effective (21), while other research suggests that cultural factors may constitute important establishing operations for the effects of leadership behaviors on organizational outcomes (22, 23). Thus, the influence of leadership behaviors on safety outcomes may be moderated by cultural factors, i.e., leadership behaviors that effectively promote safety performance at American or Australian construction sites may not necessarily be effective at Swedish or Danish construction sites (24).

Research into safety leadership in the construction industry in Scandinavia is rare, though a few relevant articles have been published. In an intervention study, Kines at al. (25) concluded that feedback-based coaching for construction site supervisors regarding their verbal exchanges with construction employees resulted in significantly better employee safety performance and physical safety levels at construction sites.

A common element of research into safety leadership in the construction industry in Sweden and Denmark is the centrality of participative leadership, in that involving construction employees in decision-making processes appears to improve safety performance (26, 27). Participative leadership may be essential for efficient safety leadership in the construction industry in Sweden and Denmark.

1.1.1 Learning participative leadership

Assuming that participative leadership is important for efficient safety performance in the Scandinavian construction industry, it is worth considering how participative leadership practice is reproduced in the industry. The learning process involved in developing leadership behaviors may already begin when young people are socialized into work in the construction industry, i.e., during vocational education and training (VET). VET students can be expected to learn how leadership is exercised by modeling and imitation, as they are subjected to the leadership of teachers, supervisors, and managers during VET.

In terms of psychological cognition, human preconception/knowledge of leadership may be organized in mental cognitive schemas (28), i.e., a cognitive category containing information about what a leader is in terms of traits, abilities, and behaviors. Eden and Leviatan (29) called this mental structure "implicit leadership theories" (ILTs). Some ILTs may be universal while others may differ notably between cultures (23). Still, how and when ILTs develop is a research area left largely unexamined. Whether ILTs develop during early childhood and remain stable thereafter, or whether they are responsive and dynamic, continuing to develop as the individual proceeds into adulthood and working life, is still an unanswered research question.

1.2 Transformational and transactional leadership

The full-range leadership theory, encompassing primarily transformational and transactional leadership, has developed into an established subfield in safety leadership research (30). Transformational and transactional leadership behaviors have been found to have a positive influence on safety as well as on productivity and profitability (21). A transformational and transactional leadership approach is now also being applied to research into safety leadership in the construction industry. Hoffmeister et al.'s (15) results indicate that transformational and active transactional leadership may be positively associated with safety outcomes at construction sites in the USA.

Transformational leadership has four facets: (i) *intellectual stimulation*, i.e., managers challenge assumptions and encourage employees to expand their problem-solving skills; (ii) *individualized consideration*, i.e., managers show interest in employees' personal and professional development and listen to their needs and concerns; (iii) *inspirational motivation*, i.e., managers inspire employees to achieve goals by evoking meaning, optimism, and enthusiasm and by articulating appealing and inspiring visions; and (iv) *idealized influence*, i.e., managers instill confidence and behave in positive ways that support the employees' identification with their manager.

Active transactional leadership has two facets: (i) *contingent reward*, i.e., managers clarify expectations and provide rewards in exchange for employees' meeting such expectations; and (ii) *active management by exception*, i.e., managers monitor work progress and employee behavior and take corrective action to prevent deviations from standards.

Full-range leadership theory also includes two facets of passive/avoidant leadership: (i) *passive management by exception*, i.e., managers take corrective actions once problems have occurred; and (ii) *laissez-faire leadership*, i.e., managers display avoidant behaviors and lack of leadership.

Most studies of the influence of transformational, active transactional, and passive/avoidant leadership on occupational safety are quantitative questionnaire studies. There is a lack of qualitative studies of how these kinds of leadership behaviors are enacted and performed in day-to-day interactions between managers and employees in the construction industry. Also, the influence of transformational, active transactional, and passive/avoidant leadership on safety outcomes has not yet been assessed in the Scandinavian construction industry.

1.2.1 Domain specificity

Barling et al. (31) suggested that transformational and transactional leadership may be operationalized in safety-specific terms to ensure the influence of such leadership behaviors on safety outcomes. However, such operationalization may result in difficulties interpreting research results, because it becomes unclear whether it is the transformational or the safety-specific aspects of the leadership behavior that stimulate safety performance, a problem also recognized by Barling et al.. Consequently, most research into safety leadership in the construction industry uses non-safety-specific leadership concepts. In addition, for most construction companies, the overall aim is to stimulate safety as well as other organizational goals, hence a more general approach to leadership may be preferable.

1.3 Safety priorities

The domain specificity issue is not restricted to transformational and transactional leadership research, but is applicable to safety leadership research in general. Safety leadership research recognized early on the importance of managerial commitment to safety, i.e., engaging in and prioritizing safety issues. The importance of managers commitment to safety issues may be evaluated by assessing situations in which safety is competing with other organizational goals, such as productivity, quality, and speed (32). However, safety is today integral to performance evaluation in the construction industry (33), and leadership research provides models for stimulating employee behaviors associated with productivity and quality, as well as with health and safety. For example, Törner et al. (34) recently found that seemingly competing goals were in fact not competing: effective leaders at construction

sites were found to stimulate not only efficiency, but also safety and innovation. By overcoming seeming paradoxes of competing goals, leaders can behave in ways beneficial for several organizational outcomes. Similarly, Kines et al. (25) demonstrated that a quantitative increase in safety topics in verbal exchanges did not affect the quantity or quality of production topics addressed; safety and production topics seemed instead to supplement each other.

Correspondingly, Conchie and Donald (16) found that when leaders address safety issues, employees perform more safety-related behavior. However, this association between managers' safety priorities and employees' safety-related behavior was moderated by the level of employees' trust in their managers. It seems not enough simply to attend to safety issues; rather this attention must be aligned with general leadership behaviors displaying authenticity and trustworthiness.

Essentially, trust can be developed by consistently pairing antecedents with consequences, i.e., doing (consequence) what one says one will do (antecedent) (3). Contexts in which leaders demonstrate that antecedents are paired with consequences include participative decision-making processes. For example, Conchie and Donald (16) suggested that employee trust in management at construction sites can be developed through participative leadership.

1.4 Possible mechanisms of influence in safety leadership

Searching the Scopus database in December 2017 for research into safety leadership in the construction industry identified 72 peer-reviewed journal articles, 92% of which were published in the last ten years (2008-2017). Actually, more than half of all articles in construction safety leadership research have been published since 2013, when the research studies resulting in the four papers of this thesis were originally designed. While most contemporary construction safety leadership research is undertaken in the engineering field (e.g., 65% of all articles registered in Scopus since 2013), a fair amount of construction safety leadership research is today undertaken in the fields of psychology and medicine (i.e., 22% of all Scopus articles since 2013). Applying psychological research findings in construction safety leadership research is now increasingly common. To align the findings of the constituent papers of this thesis with contemporary psychological construction

safety leadership research, the results of the papers will be discussed in light of recent research findings.

1.4.1 Developing safety through consequences

One fundamental psychological finding applied with increasing success in contemporary construction safety leadership research in the last few years is the basic human mechanism of operant learning (18, 32, 35-41). Operant learning research indicates that human behavior is largely influenced by the consequences that follow behavior (42). Particularly, certain and immediate consequences appear to motivate human behavior; generally, consequences that are more probable and closer in time seem to exert greater influence on behavior than do improbable and remote consequences (1). Because occupational injuries are relatively rare and may appear remote, this and similar behavioral learning mechanisms have been integrated into modern construction safety leadership research.

Operant learning research suggests that positive consequences following a behavior may increase the likelihood of the behavior recurring, while negative consequences following a behavior may reduce the likelihood of the behavior recurring. Unfortunately, unsafe work behavior among employees at construction sites typically incurs substantial positive reinforcement, such as greater comfort without personal protective equipment, getting the work done quickly, staying on schedule, and being rewarded for productivity. For safety leadership in the construction industry, operant learning research findings suggest that construction site managers would benefit from analyzing how employees' safety-related behaviors incur consequences reinforcing safe and unsafe work behaviors, and should consider how to promote safe work behaviors among employees that incur more positive and fewer negative consequences.

However, a consequence that is positive for one employee may not necessarily be positive for others. Reinforcement contingencies should therefore be understood and managed at the individual level. Having said that, some consequences are more likely to be positive for most people, for example, eye contact, smiles, attention, approval, appraisal, and encouragement (42). Social responses in general appear to be particularly important, i.e., the positive and negative social consequences of our behavior are a good place to start looking if one wants to find consequences likely to increase or decrease the occurrence of safety-related work behaviors at construction sites.

Even if psychological research findings have been applied more successfully into construction safety leadership research during the last few years, understanding the influence of managerial leadership on employees' safety-related behavior in terms of leaders providing employees with reinforcement contingencies is not new. Pioneering research into safety leadership in the construction industry had already been undertaken in the 1970s in the Netherlands by organizational psychologist Erik Andriessen (43). Andriessen found that managerial leadership at construction sites influences how construction employees conduct their work in a safe or an unsafe manner, measured in terms of both carefulness and safety initiative. Andriessen described how leaders primarily influenced the safety of construction employees by responding to their work behaviors in a positive or negative manner. In particular, by responding positively to safe work behaviors, employees' safe work behaviors increased in prevalence. Andriessen's study outlined how managers can cultivate safe work behaviors at construction sites by providing rewarding and directive feedback, reinforcing employees' safe work behavior.

The effect of rewarding feedback in terms of positive reinforcement to promote safe work behavior among employees has subsequently been systematically researched in the fields of organizational behavior management (OBM) and behavior-based safety (BBS). OBM and BBS provide a broad approach to occupational safety in the construction industry by applying findings from operant learning research and applied behavioral analysis to understand and develop safety at the individual and workgroup levels (18, 37, 44-51).

To emphasize the potentially profound influence of managers on organizational behaviors and outcomes, managerial leadership can be defined as "the management of reinforcement contingencies in work settings" (52, p. 113). Knowingly or unknowingly, managers continuously influence employees by introducing and altering reinforcement contingencies at the work place (53). Reinforcement contingencies can be material as well as psychological (21, 54), influencing employees either directly in manager-employee interactions, or indirectly though systems and structures set in place and managed by leaders (55). Primarily, managers may stimulate safe work behavior among employees by increasing the likelihood that such behavior will have positive consequences, such as positive social stimuli (e.g., attention, approval, appraisal, recognition, and endorsement) (4, 42), and material stimuli (e.g., wages, rewards, and bonuses) (4).

One of the more effective ways for managers to increase safe work behavior at construction sites is to stimulate positive reinforcement by providing

employees with rewarding feedback (18, 36, 37, 39). However, leaders can also increase safe work behavior through negative reinforcement, for example, increasing employees' use of personal protective equipment (PPE) by monitoring and correcting those who use inappropriate PPE (39). In addition, leaders can reduce unsafe work behaviors among construction employees through punishment, for example by expressing dissatisfaction when employees engage in unsafe behaviors, and through penalties, for example, by issuing salary deductions for unsafe work procedures (56). The operant mechanism whereby contingent consequences influence employee behavior is outlined in Figure 2.

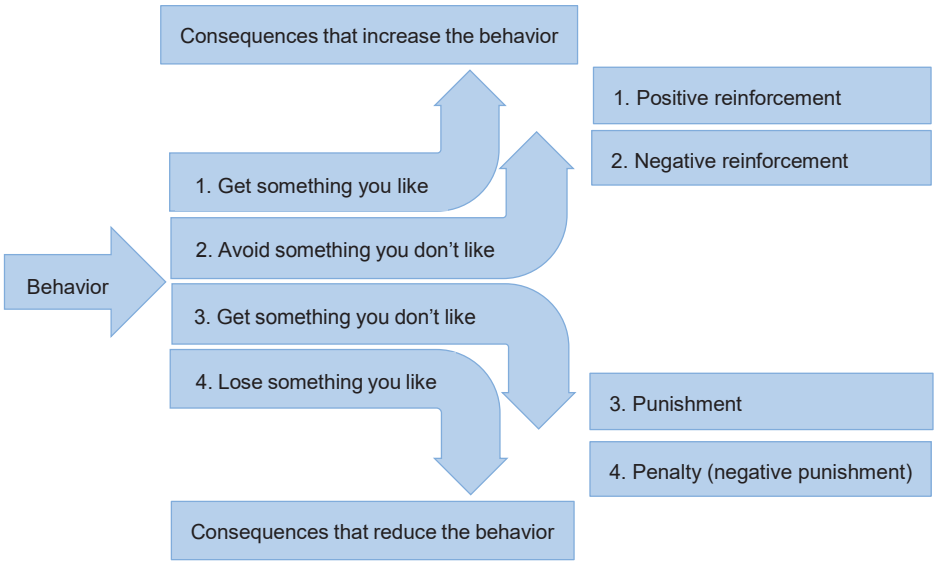

Figure 2. The operant mechanism whereby contingent consequences influence employee behavior; adapted from Daniels (3).

1.4.2 Developing safety through antecedents

Apart from managing reinforcement contingencies, managers' safety leadership behaviors also involve activators (4), i.e., antecedent stimuli for safety-related behavior among employees, such as providing employees with goals/expectations, rules/instructions, safety barriers, and behavior-based directive feedback (i.e., information about desired behavior that stimulates employees to adjust their future behavior) (3, 4). Furthermore, by also "walking the talk", i.e., aligning verbal leadership behaviors (e.g., encouraging

employees to address safety issues) with corresponding overt leadership behavior (e.g., the manager him-/herself addressing safety issues), managers can become role models for safe work behavior (35). Role models function as antecedents of safe work behavior by activating imitation, i.e., employees are likely to imitate managers, particularly those perceived as credible, influential, and attractive, who resemble the employees and who encourage them to follow their lead (1, 2, 57). Moreover, when employees who respond to antecedent safety leadership behaviors by performing more safe work behaviors, are provided with rewarding feedback for their behavior, the effect of the antecedent leadership behavior can be amplified (1, 56).

Safety leadership can also include attending to stimulus generalization processes among employees (53, 58, 59). Stimulus generalization is a fundamental learning mechanism in which when a behavior is reinforced in the presence of one stimulus, it will subsequently be performed in the presence of other stimuli that share some common property (1). This process implies that employees' safety-related behaviors, reinforced by construction site managers in one situation, are likely to recur when the employees encounter similar situations in the future. The stimulus generalization process may advantageously be simulated by prompting (1, 2), i.e., instructing or informing employees about desired safe work behaviors. Effective prompts or instructions may gradually be internalized and induce rule-governed behaviors among the employees, i.e., self-instructions or descriptions of the relationship between behaviors and consequences (2, 4). Likewise, rewarding feedback, such as verbal approval, appraisal, and encouragement, may be internalized and gradually become self-administered, i.e., rewarding covert behavior (thoughts) as a contingent consequence of performing the appropriate behavior (1). The influence of leadership behaviors on employee behaviors through antecedent stimuli and contingent consequences is outlined in Figure 3.

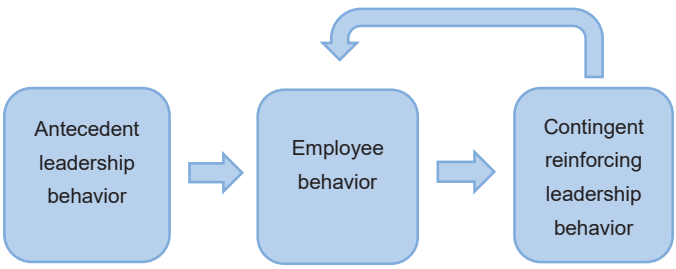

Figure 3. The influence of leadership behavior on employee behavior through antecedent stimuli and contingent consequences.

1.4.3 Instructional, supportive and motivational leadership

In a review of safety leadership, Geller (4) categorized managerial influence on safety-related behavior among employees as *instructional*, *supportive*, and *motivational* leadership. In *instructional* leadership, the manager's leadership behavior is an activator (i.e., antecedent) that may initiate safe work behaviors among employees, or that may move unsafe work behaviors from being habitual, i.e., automatic behaviors, to awareness, i.e., self-directed behaviors. With instructional leadership, employees are stimulated to transition from unrecognized unsafe work behaviors, via recognized unsafe work behaviors, to safe work behaviors. This type of leadership at construction sites can, for example, consist of instructions, goal-setting, and directive feedback (18).

When employees know the safe way of doing a work task, practice may be needed for the behavior to become part of a natural routine. Continued practice may lead to fluency (i.e., fast and accurate behavior) and in the long run to automatic or habitual safe work behavior. However, practice may not come easily, and could benefit from *supportive* leadership behaviors. Employees may need to be reassured that they are doing the right thing and be encouraged to maintain the effort. Supportive leadership focuses on the application of positive consequences. When receiving rewarding feedback on or recognition for particular safe behaviors, construction employees may feel appreciated and be more likely to perform the safe behaviors in the future (18).

When employees know how to perform a safe behavior but refrain from doing so, external encouragement or pressure to change may be required, i.e., *motivational* leadership. Instruction alone is obviously insufficient, because employees are knowingly working unsafely, i.e., taking calculated risks. Employees may take calculated risks when they perceive the positive consequences of the risky behavior to be stronger than the negative. Typically, this is because the positive consequences in terms of comfort, convenience, and efficiency are immediate and certain, whereas the negative consequence of unsafe work behavior, such as an injury, are improbable and seem remote. Motivational leadership may consist of incentives and rewards to motivate safe work behavior by indicating to employees that safe behavior will result in positive consequences. The indication is the incentive, i.e., antecedent, and the consequence is the reward.

Motivational leadership can also include disincentives. Threats of negative consequences for failing to perform safe work behaviors can motivate employees to perform those behaviors by negatively reinforcing them. Typically, however, negative reinforcement only motivates employees to

engage in safe work behavior to a level of performance that is just enough to get by (56). In addition, negative reinforcement may produce negative side effects: Geller (4) listed sabotage, theft, interpersonal aggression, and more calculated risk taking, and Daniels (3) extended the list of negative side effects by adding stress, short tempers, and hostile interactions.

1.4.4 Safety leadership in groups and organizations

As early as 1978, Andriessen (43) recognized that construction employees are influenced by their leaders, not only as individuals but also as members of a workgroup, i.e., safety leadership behaviors influence occupational safety at construction sites at both the individual and group/organizational levels. Hence, when managing workgroups and organizations, safety leadership behaviors also need to target the safety culture or safety climate of the group and the organization.

Safety culture and safety climate are overlapping concepts that are often operationalized in similar ways (44). Furthermore, both culture and climate are complex phenomena, and the concepts are used in a wide range of research areas and fields with diverging epistemological and ontological perspectives (60). However, most definitions of culture and climate contain behavioral components, and pragmatic definitions as applied to safety leadership behavior in the construction industry, and to managers' potential impact on work conditions, work environments, and the safety-related behaviors of individuals and groups, should address shared behavioral learning processes (42, 60-62). In this context, the culture/climate of a workgroup or organization may be defined as "the extent to which a group of individuals engage in overt and verbal behavior reflecting shared behavioral learning histories, serving to differentiate the group from other groups, and predicting how individuals within the group act in specific setting conditions" (61).

In this sense, the culture or climate reflects a collection of common verbal and overt behaviors learned and maintained by a set of similar social and environmental contingences (i.e., learning history) that are or are not occasioned by actions and objects (i.e., stimuli) defining a given setting or context (61). Shared behavioral learning experiences include numerous reinforcement contingencies from various sources, one noteworthy source being other employees at the same construction site or company. Also, being subjected to leadership behaviors may constitute an important aspect of such shared behavioral learning experiences. Having a shared experience of leadership has been described as the prime aspect of the safety climate in workgroups and organizations (44). From this perspective, developing a safety culture at a construction site can essentially be understood in terms of changing

people's safety-related behavior by providing people with similar safety-related learning experiences (18).

Observational learning can be considered vital for developing safe work behavior among individuals (63) as well as in groups and organizations. The shared behavioral learning experiences of individuals within a group may include group members repeatedly observing what kind of behavior is recognized and rewarded by their leaders (64). Schwatka and Rosecrance (65) concluded that an essential proportion of the influence of safety leadership on safety-related behavior among employees at construction sites arises from shared experiences of leadership in the workgroup. The process whereby antecedent observational stimuli influence coworkers' safety-related behavior is outlined in Figure 4.

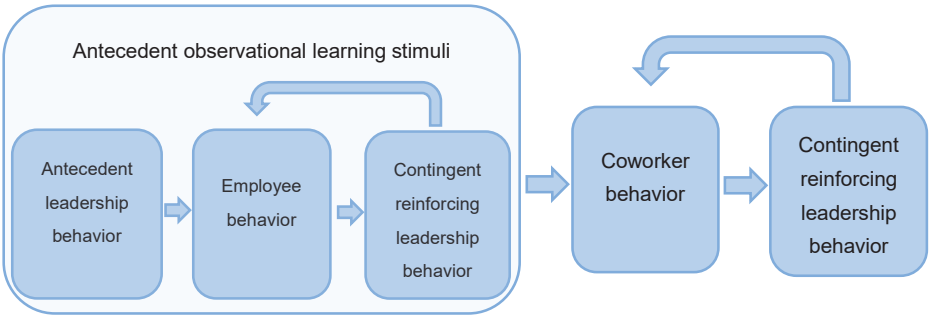

Figure 4. The process whereby antecedent observational stimuli influence safety-related behavior among coworkers in groups and organizations.

Similarly, role modeling and imitation, as antecedents to safe work behavior among employees, may be particularly important for safety leadership in groups and organizations. Safe work behaviors are typically modeled and imitated in groups before multiple employees and may therefore influence several employees at a time, consequently contributing to their shared behavioral learning experience. In addition, modeling and imitation can progress through hierarchical levels, from CEOs to trainees, and through contractor levels, from owner via main contractors to subcontractors (35). Wu et al. (35) concluded that owners' role modeling exerted the widest range of influence on the safety culture in construction projects.

2 AIMS

The overall aim of this thesis was to identify and describe essential components of safety leadership behavior in the construction industry in Sweden and Denmark. The specific aims of each paper related to the overall aim of the thesis were as follows:

I. to generate hypotheses about the constitution of safety leadership by exploring managers' and employees' experiences related to what they perceive as essential for occupational safety at Swedish and Danish construction sites;

II. to determine whether and how future construction managers' and employees' ILTs about participative leadership change as they undergo vocational education and training in Sweden and Denmark;

III. to assess the importance of transformational, active transactional, participative, rule-oriented, and laissez-faire leadership behavior for construction site safety climate, safety-related behavior among employees, and injuries at Swedish and Danish construction sites; and

IV. to develop an objective method for observing, categorizing, describing, and quantifying transformational, active transactional, and passive/avoidant leadership behaviors among construction site managers at Swedish and Danish construction sites, and to assess whether such objectively observed leadership behaviors are associated with employees' ratings of the construction site safety climate.

3 PARTICIPANTS AND METHODS

This research applied a broad methodological approach, utilizing questionnaires, interviews, and behavioral observations. Table 1 is an overview of the research designs and methods of the constituent papers of the thesis.

Table 1. Overview of research designs and methods.

	Paper I	**Paper II**	**Paper III**	**Paper IV**
Aim	To generate hypotheses about the constitution of safety leadership at Swedish and Danish construction sites	To determine whether and how future construction managers' and employees' ILTs about participative leadership change as they undergo VET	To assess the importance of transformational, active transactional, participative, rule-oriented, and laissez-faire leadership behavior for construction site safety outcomes	To develop an objective method for observing, categorizing, describing, and quantifying safety leadership behaviors among construction site managers
Study Design	Semi-structured interviews	Longitudinal questionnaire study	Cross-sectional questionnaire study	Behavioral observations and questionnaires
Participants	Five construction managers and four construction employees	1907 VET students	811 construction employees at 85 construction sites	37 construction managers and 409 construction employees
Data analysis method	Semantic thematic analysis	Multilevel growth curve modeling	Multilevel and binary logistic regression analyses	Thematic content analysis and multilevel regression analyses

3.1 Paper I

The explorative aim of Paper I was addressed by conducting explorative qualitative interviews. Individual managers and employees in the construction industry are central safety-culture-producing units creating and recreating safety culture through their everyday interactions. To capture descriptions of safety in the construction industry from the perspective of these central units, qualitative interviews were conducted with Swedish and Danish construction managers and employees. The informants were five construction managers and four construction employees from Sweden and Denmark. A semantic thematic analysis (66) of the transcripts was conducted using NVivo, version 10.

3.2 Paper II

The hypothesis-testing aim of Paper II was addressed by conducting a quantitative questionnaire study.

3.2.1 Participants

Seven construction VET schools were strategically selected to provide variation in school size and in school location in large and small communities. The inclusion of both Swedish and Danish VET schools allowed for the assessment of the hypothesized dynamic nature of ILTs in two cultural contexts. All students attending the schools in February–June 2014 (T1) and February–June 2015 (T2) were invited to participate in the study; the response rate was 80% at T1 and 83% at T2. The 643 Swedish respondents were 94% male and the average age was 18.3 years. The 1264 Danish respondents were 93% male and the average age was 22.8 years. An accelerated longitudinal design (67) was employed to assess changes in ILTs over the whole VET period using two measurement points, one year apart.

3.2.2 Measures

The following three items were adapted from the participative decision-making scale of the Empowering Leadership Questionnaire (68) and used to measure students' participative ILT: "An effective leader encourages team members to express ideas and suggestions"; "An effective leader uses team members' suggestions to make decisions"; and "An effective leader considers team members' ideas, even when he/she disagrees with them." Each item was rated on a six-point scale, ranging from 1 (completely disagree) to 6 (completely agree). The participative leadership of school teachers and supervisors at the training companies was measured with two single items capturing students' experience of each source of leadership: "My teachers at school are keen to

listen to suggestions and ideas from us students on how work can be improved" and "My supervisors at the training company are keen to listen to suggestions and ideas from us students on how work can be improved." Both items were rated on a frequency scale ranging from 1 (always) to 7 (never).

3.2.3 Data analyses

Data were analyzed in SPSS, version 20. Changes in participative ILTs were evaluated using mixed method growth curve modeling, comparing models with and without fixed and random effects of time. The students' experiences of supervisors' and teachers' participative leadership were measured at T1 and the students' participative ILTs were measured at T1 and T2. Instantaneous/synchronous and delayed/lagged influences/effects of each source of leadership on the students' ILTs were assessed by comparing empty growth curve models with models that included the students' experiences of each source of leadership as a predictor of the students' ILTs. Single main effects of leadership were estimated to assess the synchronous effects, and interaction effects between leadership and time were estimated to assess the lagged effects of leadership on ILTs.

3.3 Paper III

The hypothesis-testing aim of Paper III was addressed by conducting a quantitative questionnaire study among construction employees at construction sites in Sweden and Denmark between 1 January and 1 July 2016.

3.3.1 Participants

The sampling frame consisted of all sites registered by the national work environment authorities in Sweden and Denmark (26) between 1 October and 15 November 2015 and in operation any time between 1 January and 1 July 2016. Of the 160 construction sites randomly selected, contacted, and invited to participate in the study, 117 sites accepted the invitation and 1270 questionnaires were administered. In total, 811 construction employees at 85 sites responded to the questionnaire, giving a site response rate of 73% and an individual response rate of 64%.

3.3.2 Measures

The respondents were asked to identify their current first-line formal leader and to relate all ratings to this person. The respondents rated how often the leader engaged in the behaviors described in each item, using a seven-point scale ranging from 1 (never) to 7 (always). Transformational, active transactional and laissez-faire leadership were measured with 18 items from

the Multi-Factor Leadership Questionnaire (69). Two items were included for each of three facets of transformational leadership: intellectual stimulation (sample item: "Seeks differing perspectives when solving problems"); individualized consideration (sample item: "Helps others to develop their strengths"); and inspirational motivation (sample item: "Talks enthusiastically about what needs to be accomplished"). Four items were included for each of the two facets of active transactional leadership: contingent reward (sample item: "Expresses satisfaction when others meet expectations"); and active management by exception (sample item: "Focuses attention on irregularities, mistakes, exceptions, and deviations from standards"). Four items were included for laissez-faire leadership (sample item: "Avoids getting involved when important issues arise"). Rule-oriented leadership was measured with two items adapted from the procedural/bureaucratic scale of the GLOBE questionnaire (70) (sample item: "Enforces rules and regulations"). Participative leadership was measured with three items from the participative decision-making scale of the Empowering Leadership Questionnaire (68) (sample item: "Uses my workgroup's suggestions to make decisions that affect us").

The safety outcome measures were construction site safety climate, safety-related work behavior, and self-rated injury occurrence. Safety climate was measured with eight items from the Nordic Safety Climate Questionnaire (71) (sample item: "We who work here try to find a solution if someone points out a safety problem"). Participants rated the extent to which they agreed with the statements using a six-point scale, ranging from 1 (strongly disagree) to 6 (strongly agree). Safety-related work behavior was measured with five items formulated by Neal and Griffin (72) (sample item: "I ensure the highest level of safety when I carry out my job"). Participants rated how often they engaged in each type of behavior, using a seven-point scale ranging from 1 (never) to 7 (always). Injury occurrence was measured with a single item: "How many times, during the last three months, have you had an injury at work that forced you to stop working for at least one hour?"

3.3.3 Data analyses

Regression coefficients for the effects of leadership behaviors on safety outcomes were estimated with univariate mixed model regression analyses and binary logistic regression analyses. To assess the extent to which the effect of rule-oriented leadership on safety-related behavior among employees was moderated by participative leadership, a regression model that included the control variables and the main effects of rule-oriented and participative leadership was compared with a regression model including the control

variables, main effects, and an interaction effect between rule-oriented and participative leadership. To assess differences in the effects of leadership behaviors on safety outcomes at Swedish versus Danish construction sites, univariate regression coefficients for the effects of leadership behaviors on safety outcomes were first estimated separately in each subsample. Thereafter, in the complete sample, interaction effects between leadership behaviors and national context were estimated for all safety outcomes. Finally, to assess the differences in the levels of leadership behavior between the Swedish and Danish construction sites, regression coefficients for the effect of national context were estimated for each leadership behavior. All regression coefficients were estimated while controlling of age, gender, profession, and company size.

3.4 Paper IV

In Paper IV, a multiple-method approach was applied, combining observations of construction site managers, questionnaire responses from construction employees at the studied sites, and contextual background information regarding the site managers and their sites.

3.4.1 Participants

For Paper IV, the informants were recruited among the construction sites participating in Paper III. Fifty randomly selected sites were invited to participate in the study and 37 managers accepted, 22 Swedish and 15 Danish. All construction employees at the participating sites were invited to complete a questionnaire and 409 employees participated, for a total response rate of 68%.

3.4.2 Measures

To explore how construction site managers practiced leadership in their daily interactions, naturalistic observations of the site managers' interactions were performed. Each manager was subject to two hours of direct observation, during which the researcher followed the manager around the site, in meetings and during office work. Every interaction between the site manager and any other person at the construction site was observed and described in writing by the researcher.

The description of each interaction was subsequently coded into one or more of the eight leadership categories of the full-range leadership theory: idealized influence, inspirational motivation, individualized consideration, intellectual

stimulation, contingent reward, active management by exception, passive management by exception, and laissez-faire leadership.

The safety climate questionnaire contained four items from the Management safety priorities and commitment scale from NOSACQ-50 (71) (sample item: "Management encourages employees to work in accordance with safety rules - even when the work schedule is tight"). Participants rated the extent to which they agreed with the statements, using a six-point scale ranging from 1 (strongly disagree) to 6 (strongly agree).

3.4.3 Data analyses

The behavioral descriptions in each leadership category were analyzed using thematic content analysis (73) to identify patterns in the descriptions in each category, so that the behavioral themes in them could emerge. These patterns and themes were used to obtain rich data-driven context-specific descriptions of the theoretically defined categories of leadership behaviors.

For the quantitative analyses of the observational data, the eight leadership behavioral sub-categories were ordered into their respective main behavioral categories: transformational, active transactional, and passive/avoidant leadership. The proportion of each leadership behavior was determined by dividing the number of behaviors observed in each category by the total number of observed behaviors in all categories, resulting in a 0-1 scale for the proportions.

To assess whether the proportions of transformational, active transactional and passive/avoidant leadership behavior predicted the level of construction site safety climate, as measured by the employee questionnaire, an empty regression model of the safety climate was compared with three univariate models, each containing the proportion of one of the three leadership categories. Thereafter, multiple regression models including all leadership categories that significantly predicted safety climate were tested to obtain the regression model that best fit the data.

4 RESULTS AND DISCUSSION

The results of the constituent papers of this thesis indicate that the leadership behaviors of construction site managers were associated with fundamental occupational safety outcomes. Several types of leadership behaviors were found to be important for occupational safety at Swedish and Danish construction sites.

The leadership behavior of construction site managers found in the constituent papers of the thesis will be discussed in light of contemporary construction safety leadership research, to identify possible mechanisms that may explain the associations between leadership behaviors and behavioral and organizational safety outcomes.

4.1 Rule-oriented leadership

The importance of rule-oriented leadership for occupational safety was already identified in Paper I. One manager described rule-oriented leadership as an integral and essential component of efficient safety management:

> There are so many rules in Sweden – you must have a license to operate an aerial platform, and then there is this thing with waste management. And so things are perceived differently, and you become stricter about your own safety. I think that if the management commits to it, it reverberates out to the employees. We know Sweden to be a country of rules, so things are in order there. It's always safer to work in Sweden, that's how it is. That's an approach that reverberates. That's safety culture.

Being described by the informants in Paper I as defining safety culture, rule-oriented leadership was incorporated into and further assessed in Paper III. In Paper III, rule-oriented leadership was found to be the leadership behavior most strongly positively associated with construction site safety climate (β = 0.40, Table 3 in Paper III). In addition, it was the only leadership behavior directly linked to lower injury rates (OR = 0.78, Table 3 in Paper III). Furthermore, the effect of rule-oriented leadership on safety was not moderated by national context, suggesting that the importance of rule-oriented leadership for safety performance is not dependent on culturally specific establishing operations.

By understanding this finding of Papers I and III in terms of possible mechanisms whereby managers influence the safety-related behaviors of individuals and groups, rule-oriented leadership behavior can be seen to consist mainly of providing construction employees with antecedent stimuli, such as the formulation and enforcement of rules. Rule-oriented leadership may primarily influence safety-related behavior by providing employees with antecedent stimuli that prompt and activate rule-oriented behaviors. However, managers subsequently also seem to provide employees with rewarding feedback for performing rule-oriented behaviors, which may be interpreted as a way to stimulate the development of a rule-oriented safety culture: positively reinforcing employees' rule-oriented behavior may stimulate rule generalization, i.e., when employees' rule-oriented behavior is reinforced in the presence of a rule, the rule-oriented behavior is subsequently performed even in the presence of other rules.

The results of Paper I can also be interpreted as describing stimulus generalization processes that may become prominent when leaders do not provide contingent-rewarding feedback on employees' rule-oriented behaviors. One informant concisely described what can occur if a manager carefully communicates safety rules and regulations to employees (i.e., antecedent stimuli), but then leaves them to their own devices, omitting monitoring and feedback:

> When we [i.e., the managers] turn our backs on them [i.e., the employees], they do as they see fit.

When employees' rule-oriented behaviors are not subjected to positive reinforcement, the rules can be expected to induce a stimulus generalization process whereby, in the presence of rules, non-compliant behaviors are reinforced, because such behaviors are typically subjected to substantial positive consequences, such as employees being more comfortable without personal protective equipment, getting the work done quickly, staying on schedule, and being rewarded for productivity.

However, high safety levels and low injury rates are not solely dependent on safety-related behavior among employees. If the physical environment at the construction site is unsafe, injuries can occur even when employees exhibit exceptionally safe work behavior. In Paper III, rule-oriented leadership was found to be mainly associated with construction site safety climate ($\beta = 0.40$, Table 3 in Paper III) and injury occurrence (OR = 0.78, Table 3 in Paper III), and not as much with safe work behavior among employees ($\beta = 0.15$, Table 3 in Paper III).

In terms of possible mechanisms whereby managers influence occupational safety, understanding why rule-oriented leadership seem more effective for developing safety climate and reducing injuries, than for developing safe work behaviors of individuals, calls for a closer look at the questionnaire items. The questionnaire scale measuring rule-oriented leadership included descriptions of leaders' safety compliance behavior such as acting in accordance with *rules*, *regulations* and *plans*. Leadership behaviors in accordance with *rules* and *regulations* in the construction industry are likely to include planning and organizing the physical environment at construction sites in a safe manner (e.g., making sure safety barriers are installed and maintained), typically resulting in safe work conditions for construction employees and reducing the likelihood of injuries (56). Similarly, construction site managers producing and adhering to *plans*, likely entail leadership behaviors related to coordinating subcontractors, thereby ensuring that transportations and work at the construction site progresses in a smooth, orderly, and safe fashion; also reduce the likelihood of injuries.

By understanding the results of Paper III concerning rule-oriented leadership in terms of possible mechanisms whereby managers influence safety at the group level, rule-oriented leadership behaviors (e.g., acting in accordance with rules, regulations and plans) can be seen as comprising observational learning, i.e., managers that adhere to rules may become role models for safe work behavior for individuals and workgroups at the construction site.

In conclusion, rule-oriented leadership appears to be the single most important aspect of safety leadership at construction sites in Sweden and Denmark, particularly when it comes to promoting construction site safety climate and reducing injury occurrence. By formulating, implementing, enforcing, supporting, and acting in accordance with rules, regulations, and plans, managers may create safer working environments, improve construction site safety climate, and reduce the number of occupational injuries in the construction industry.

4.2 Participative leadership

The importance of participative leadership for occupational safety was already identified in Paper I. The informants described participative leadership as essential for achieving high safety standards in the construction industry. One manager described participative leadership as the fastest route to safety:

> Participatory management – that I'm invited to voice suggestions and to participate in decision-making – this generates much faster safety improvements.

Using the expertise and knowledge of construction employees when deciding how construction work should be planned and executed was perceived to generate more efficient and safer work procedures.

In Paper III, participative leadership was found to be positively associated with both construction site safety climate ($\beta = 0.28$, Table 3 in Paper III) and safe work behavior among employees ($\beta = 0.24$, Table 3 in Paper III). In addition to having independent importance for safe work behavior among employees, participative leadership was also found to moderate the effect of rule-oriented leadership on safe work behavior ($\beta = 0.10$, Table 4 in Paper III). This finding suggests that participative leadership augments the effect of rule-oriented leadership on safe work behavior, i.e., when rules, regulations and plans are formulated and enforced collectively, their effect on safe work behavior may be amplified. However, participative leadership did not moderate the effects of rule-oriented leadership on construction site safety climate or on injuries, suggesting that the moderating impact of participative leadership on rule-oriented leadership is limited to the safety-related work behaviors of individuals.

By understanding the results of Papers I and III concerning participative leadership in terms of possible mechanisms whereby managers influence the safety-related behaviors of individuals and groups, participative leadership behaviors can be seen as providing employees with both antecedent stimuli and positive reinforcement. Antecedent stimuli provided by the managers included prompting employees to voice their opinions and suggestions, and providing opportunities for participative decision-making. Subsequently, employees' opinions and active participation in problem-solving and decision-making also appeared to be positively reinforced by site managers, for example, by attending to employees' suggestions and using the information provided by employees when making decisions. Participative leadership seems to involve behaviors that exemplify the operant learning mechanism outlined in the introduction, by presenting antecedents and consequences in a stringent and coherent manner (see Figure 5). In relation to trust, i.e., consistently pairing antecedents with consequences, participative leadership can be expected to build trust by first indicating that employees' suggestions will be appreciated (antecedents), and subsequently appreciating their suggestions (consequences).

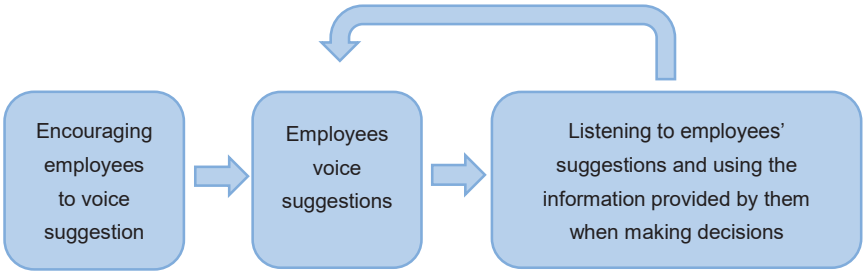

Figure 5. The influence of participative leadership behavior on employee behavior through antecedent stimuli and contingent consequences.

The results of Papers I and III can also be interpreted as describing stimulus generalization processes: participative leadership behaviors such as inviting employees to participate in managing deviations from standards and other work-related problems, combined with positively reinforcing the activated participative behaviors among employees, can induce stimulus generalization, so that the next time the employees encounter similar deviations or work-related problems at the construction site, they are more likely to respond with participative problem-solving behaviors. Such stimulus generalization may in the long run contribute to the sustainable participative safety culture with high safety performance levels outlined in Paper I.

4.2.1 Participative implicit leadership theories (ILTs)

In Paper II, the participative ILTs of students were found to increase during VET. On a scale ranging from 1 to 6, the students' ILTs increased on average by 0.14 per year (i.e., the parameter estimate of the fixed effect of "Time" in the growth curve model presented in Table 4 in Paper II). In the cross-sectional analysis, the students' ILTs were found to be associated with the participative leadership of their construction site supervisors but not with the participative leadership of their teachers at school. However, when assessed longitudinally, neither of these leadership sources was found to be associated with the increase in the students' ILTs.

By understanding these results in terms of possible learning mechanisms, the increase in the students' ILTs can be interpreted as mirroring the process of the socialization of construction industry leadership practices. Expectations of participative leadership seemed to increase as future construction managers and employees were educated and trained in construction VET. However, the increase in ILTs did not seem related to role modeling and imitation as mechanisms for learning leadership practices. On the other hand, the cross-

sectional comparisons between supervisors and teachers suggest that, to the extent to which the leaders that the students' encounter during VET are indeed role models for leadership, the relevant leaders are more likely to be supervisors at the training companies than teachers at the schools.

4.3 Transformational leadership

In Paper III, transformational leadership was found to be associated with construction site safety climate (β = 0.21-0.26, Table 3 in Paper III) and safe work behavior among employees (β = 0.22-0.29, Table 3 in Paper III). The association between transformational leadership and safety climate was confirmed in Paper IV when the transformational leadership behaviors were visually observed by third-party experts (explained inter-group variation in safety climate = 33%, Table 2 in Paper IV). Furthermore, as indicated by the results of Paper III, the effect of transformational leadership on safety does not seem to be moderated by national context, suggesting that the importance of transformational leadership for safety performance is general. Bass et al. (21) reached the same conclusion regarding the effect of transformational leadership on other organizational outcomes.

4.3.1 Intellectual stimulation

In Paper IV, intellectual stimulation was identified as the most common transformational leadership behavior used by the construction site managers, accounting for 65% of all observed transformational behaviors (Table 1 in Paper IV). Intellectual stimulation behaviors were typically observed in problem-solving situations in which site managers made sure that different perspectives were taken into account, by facilitating discussions of various solutions among multiple employees with different competences, and by introducing complementary perspectives for consideration, such as quality, safety, economic factors, and work operations sequencing.

Aligning the results concerning intellectual stimulation from Papers III and IV with the results concerning participative leadership from Papers I and III indicate that intellectual stimulation leadership behaviors overlap with participative leadership behaviors in the leadership practice of construction site managers. Both intellectual stimulation and participative leadership seem to involve recognizing the competence and knowledge of construction employees and subcontractors, and utilizing their competence and knowledge to solve problems more efficiently. Although the factor analysis conducted in Paper III (p. 378) indicated that these two leadership behavior categories should be considered distinct factors, they were the two factors displaying the highest

bivariate correlation, suggesting that intellectual stimulation behaviors and participative behaviors are indeed closely related.

4.3.2 Individualized consideration

In Paper IV, individualized consideration was identified as the second most common transformational leadership behavior used by the construction site managers, accounting for 18% of all observed transformational behaviors (Table 1 in Paper IV). Individualized consideration behaviors were observed when the managers took advantage of their specific knowledge of employees' individual characteristics in assigning work tasks, acknowledging employees' individual problems, and modifying work tasks to fit the current capabilities of individual employees.

4.3.3 Inspirational motivation

In Paper IV, inspirational motivation was identified as the second least common transformational leadership behavior used by the construction site managers, accounting for only 10% of all observed transformational behaviors (Table 1 in Paper IV). Inspirational motivation behaviors observed among the site managers involved talking to construction employees and subcontractors about the importance of work tasks, working procedures, and planning in successfully realizing a project and its goals. The inspirational motivation behaviors of the construction managers illustrated for employees and subcontractors how specific tasks were essential for the success of the construction projects as a whole.

4.3.4 Idealized influence

In Paper IV, idealized influence was identified as the least common transformational leadership behavior used by the construction site managers, accounting for only 6% of all observed transformational behaviors (Table 1 in Paper IV). The few idealized influence behaviors observed among the site managers involved talking about overarching visions related to team spirit, safety, and service mindedness. Idealized influence behaviors also included imaginary modeling (i.e., telling vivid anecdotes of outstanding personal achievements), evoking admiration and imitative responses among employees and subcontractors.

4.3.5 Possible mechanisms in transformational influence

The results concerning transformational leadership presented in Papers III and IV may benefit from being discussed in terms of possible learning mechanisms

whereby managers influence the safety-related behaviors of individuals and groups (particularly because the mechanisms behind such influence have not been comprehensively described in previous research). In the framework of full-range leadership theory, transformational leadership behaviors are typically described in terms of motivating employees by providing them with antecedent stimuli to safe behavior, while the management of reinforcement contingencies is referred to as contingent reward leadership behavior (21, 74). Accordingly, most of the transformational behaviors observed in Paper IV were antecedent leadership behaviors. However, Bass has also contrarily suggested that "psychological" contingent reinforcement is indeed an important aspect of transformational leadership (62). Full-range leadership theory may need to clarify its concepts by acknowledging the importance of reinforcement contingencies and embracing the diversity of how managers' responses to employees' behaviors influence their future behavior.

In Paper III, the regression weights on construction site safety climate for rule-oriented ($\beta = 0.40$, Table 3 in Paper III) and participative leadership ($\beta = 0.28$, Table 3 in Paper III), both entailing antecedent stimuli and contingent consequences, were higher than the regression weights for transformational leadership ($\beta = 0.21$-0.26, Table 3 in Paper III). In addition, previous safety research indicates that safety-related behavior among employees is primarily influenced by contingent consequences and only secondarily by antecedent stimuli (18, 56). To quote Daniels (3), "An effective antecedent gets a behavior to occur once. It is the role of a consequence to get it to occur again" (p. 23). Future transformational leadership research may therefore gain from paying more attention to the reinforcement contingencies of employees' behavioral responses to antecedent transformational leadership stimuli: *intellectual stimulation* behaviors may stimulate employees to contribute their opinions in discussions; *inspirational motivation* behaviors may stimulate employees to put in extra effort; while *individualized consideration* behaviors may stimulate employees to care more for themselves and others. Providing employees' behaviors like these with positive reinforcement, such as attention, approval, appreciation, encouragement, and the implementation of employees' suggestions, will probably augment the effects of these antecedent transformational leadership behaviors on safe work behavior among employees. Also, the effects of role modeling outlined in the introduction of this thesis may exemplify how *idealized influence* can be elevated by combining antecedent stimuli with reinforcement contingencies. In addition, even if these subsequent contingent reinforcing leadership behaviors are not measured as transformational behaviors, transformational managers probably do provide employees with positive reinforcement, so unambiguously incorporating the contingent reinforcing leadership behaviors that correspond

to associated antecedent transformational leadership behaviors, into the conceptual theoretical framework of transformational leadership in full-range leadership theory, may be beneficial.

4.4 Active transactional leadership

In Paper III, active transactional leadership was found to be positively associated with construction site safety climate ($\beta = 0.09$-0.32, Table 3 in Paper III) and with safe work behavior among employees ($\beta = 0.16$-0.28, Table 3 in Paper III). However, the association between active transactional leadership and safety climate was not confirmed in Paper IV when the active transactional leadership behaviors were visually observed by third-party experts ($p = 0.726$). Although this ambiguity should be recognized, the more established and stringent study design and data analysis method used in Paper III, as well as previous research into safety leadership in the construction industry, suggests that contingent reward, and to some extent also active management by exception, probably encompasses safety-promoting leadership behaviors (15).

4.4.1 Contingent reward

In Paper IV, contingent reward was identified as the most common leadership behavior used by the construction site managers, accounting for 38% of all observed leadership behaviors (Table 1 in Paper IV), and present in most interactions in which the managers were involved. Contingent reward behaviors observed among the site managers were typically related to planning and coordination, and primarily consisting of assigning work tasks and providing drawings, materials, and instructions. The subsequent rewards provided by the site managers seem to be both material, such as paying for work performance and supplying ongoing employment, and psychological, such as verbally acknowledging the standard or quality of the performed task, including verbal behaviors such as saying "good job", "well done", and "that looks nice."

4.4.2 Active management by exception

In Paper IV, active management by exception was identified as the second most common leadership behavior used by the construction site managers, accounting for 28% of all observed leadership behaviors (Table 1 in Paper IV). The site managers practiced active management by exception leadership by monitoring work and following up on earlier agreements, checking whether the established standards of quality, progression, and safety were met. These behaviors encompassed: correcting faulty planning/coordination of work activities; correcting employees' behavior (e.g., late arrivals); correcting

deficient/lacking safety measures/materials/personal protection equipment; monitoring the quality of material (e.g., the hardening of poured concrete); correcting carelessness in material handling; correcting faulty implemented work; and addressing subcontractors' problems in terms of their levels of staffing and staff competence.

4.4.3 Possible mechanisms in transactional influence

By understanding these results of Papers III and IV in terms of possible mechanisms whereby managers may influence occupational safety, the bulk of the contingent reward leadership behaviors of construction site managers can be seen as related to organizing, planning and coordinating the on-site work activities. Making sure that employees and subcontractors know what they are expected to do and when they are expected to do it may prevent ineffective logistical and physical arrangements at construction sites; performing these transactional behaviors efficiently may help maintain a safe physical environment on site. Similarly, managers proactively monitoring and correcting potential deviations from quality, productivity, and safety standards can help increase the overall standard of construction work at the construction site.

Interestingly, the contingent reward leadership behavior identified in Paper IV seem to be mainly related to the management of antecedent stimuli (e.g., assigning work tasks and providing instructions, drawings, materials, and safety barriers), and management-by-exception leadership seem primarily related to leadership behaviors contingent on external stimuli (e.g., correcting faulty planning/coordination of work activities, lacking safety measures/materials/personal protection equipment, carelessness in material handling, and faulty carried out work). However, active management-by-exception also seem to include antecedent leadership behaviors such as prompting construction employees to be more cautious and vigilant for potential deviations.

While the importance of contingent reward for safety performance has been generally supported (15, 30), the influence of active management by exception is still disputed. A recent article by Willis et al. (75) found that the effect of active management by exception on safety-related work behavior among employees was moderated by the likelihood of injuries. Willis et al.'s results indicate that active management by exception leadership, i.e., attending to exceptions and deviations, may be more appropriate in work environments characterized by relatively high risk, such as construction sites.

The influence of active management by exception leadership on safety may also depend on how the exceptions are managed. Exceptions can be managed by providing employees with aversive stimuli (i.e., punishment) – a blunt and rather ineffective way to reduce the occurrence of unsafe behavior (3). Threats of aversive stimuli may negatively reinforce safe work behavior among employees, but typically only to a level of performance that is just enough to get by, and negative reinforcement may in addition have negative side effects on employees' performance (56). On the other hand, if the exceptions are addressed early on, when deviations are not yet irrevocable but still contain functional aspects, these functional aspects can be subjected to rewarding feedback, possibly bringing about learning situations for construction employees. By managing exceptions in this gentler and more constructive way (76), management by exception leadership can probably be more effective in promoting safety.

4.5 Passive/avoidant leadership

In Paper IV, passive/avoidant leadership was identified as the least common leadership behavior used by the construction site managers, accounting for only 16% of all observed leadership behaviors (Table 1 in Paper IV). Passive management by exception behaviors among construction site managers entailed correcting mistakes and deviations from standards identified by employees, subcontractors, and customers. These deviations were generally related to: progress, planning, drawings, and work tasks (e.g., employees' and subcontractors' lack of relevant knowledge/competence for performing a task); problems related to production flow (e.g., anticipated or unexpected production stops); insufficient and missing materials; limited access to work areas; and lack of coordination between subcontractors.

In Paper III, passive/avoidant leadership was found to be negatively associated with construction site safety climate (β = -0.40, Table 3 in Paper III). This negative association was confirmed in Paper IV when the passive/avoidant leadership behaviors were visually observed by third-party experts (explained inter-group variation in safety climate = 21%, Table 2 in Paper IV). Furthermore, as indicated by the results of Paper III, the effect of passive/avoidant leadership on safety was not moderated by national context, suggesting that the negative association between passive/avoidant leadership and safety performance is general.

The crucial difference between active management by exception and passive leadership is that active management by exception is proactive, including vigilance and monitoring behaviors, ensuring that standards are met to prevent

deficiencies, while passive leadership is reactive, including corrective behaviors that are performed only after non-compliance, mistakes, and deviations have occurred.

Similar to the mechanism in active management by exception, the influence of passive management by exception on safety is probably also related to how the exceptions are managed. However, the maneuvering room is more restricted in passive management by exception, because the exceptions have already caused significant problems and the manager is working uphill from the start.

4.6 Cultural differences in safety leadership

The best-documented difference in safety leadership practice between Swedish and Danish construction site managers was found in participative leadership behavior. The results of Papers I and III ($\beta = 0.34$, Table 6 in Paper III) indicate that participative leadership is probably more practiced at Swedish then Danish construction sites. In addition, among the future construction managers and employees examined in Paper II, the participative ILTs were more prevalent among the Swedes. On a scale ranging from 1 to 6, the Swedish students scored 0.23 higher on participative ILTs than did the Danish students (i.e., the parameter estimate of the fixed effect of "Country" in the growth curve model presented in Table 4 in Paper II).

Rule-oriented leadership was also found to be more practiced among Swedish than Danish construction managers in Papers I and III ($\beta = 0.32$, Table 6 in Paper III).

Concerning transformational and active transactional leadership, the results are ambiguous. Perhaps the most thorough test of national differences was conducted in Paper III, revealing differences in one of the five transformational/transactional leadership subscales: active management by exception was found to be more practiced by Danish than Swedish construction managers ($\beta = 0.28$, Table 6 in Paper III). In Paper IV however, active transactional leadership, i.e., active management by exception *and* contingent reward, was observed more frequently among the Danish managers ($\beta = 0.13$, Table 3 in Paper IV), while transformational leadership was more frequently observed among the Swedish managers ($\beta = 0.14$, Table 3 in Paper IV). The prudent interpretation is that active management by exception is the only transformational/transactional leadership behavior that differs consistently between Swedish and Danish construction sites, being found in both papers to be more practiced by Danish than Swedish construction managers.

Why participative leadership was found to be more common at the studied Swedish construction sites and active management by exception at the Danish construction sites may be related to the fact that the Swedish managers likely shared behavioral learning histories (i.e., culture) with other Swedish managers and that the Danish construction managers likely shared behavioral learning histories with other Danish managers. Shared behavioral learning histories among managers implies that the same kind of leadership behavior performed by different managers in the same culture is contingently rewarded in similar ways. Rule-oriented and participative leadership behaviors performed by construction site managers may be more accepted, appreciated, and acknowledged by senior construction managers and subordinate construction employees at Swedish than at Danish construction sites. Through the subsequent stimulus generalization processes and internalization of contingent rewards (i.e., developing self-administered reinforcement), managers with similar behavioral learning histories will likely develop similar behavioral habits in performing leadership.

Also, shared observational behavioral learning histories and the imitation of other leaders encountered throughout the careers of the construction managers may stimulate Swedish construction managers to develop similar behavioral habits in performing leadership, and Danish construction managers likewise to develop similar leadership habits. In Paper II, the data did not support the hypothesis that the changes in the mental cognitive structures (i.e., ILTs) of the VET students were related to the leadership practices of the teachers or managers that the students encountered during their socialization to become construction managers or employees. However, imitation may be an automatic way of learning new behaviors that typically occurs without conscious awareness (1). If future construction managers observe participative leadership behaviors in role models during socialization, they may be more likely to engage in such behaviors as construction managers. Unpublished data from the study reported in Paper II indicate that participative leadership may be more common among the Swedish than the Danish teachers and managers, i.e., leaders whom the students observe during their VET. In addition, previous research into imitation among young people indicates that imitation may be more pronounced among individuals identified as leaders (77). Modeling and imitation may therefore, after all, be important factors in forming leadership behaviors among future construction managers.

In Paper III, national context was found to moderate only two of the 24 assessed associations between leadership behaviors and safety outcomes, suggesting that, in general, the importance of leadership behavior for safety performance is not dependent on culturally specific establishing operations, at

least not in largely culturally similar countries. However, the effect of participative leadership on construction site safety climate was found to be moderated by national context ($\beta = 0.19$, p. 380 in Paper III), indicating that participative leadership may stimulate safety climate to a higher extent at Swedish than Danish construction sites. The importance of participative leadership for organizational outcomes appears to be dependent on cultural factors, as also concluded by Dorfman et al. (78). The effect of active management by exception leadership on construction site safety climate was also moderated by national context ($\beta = 0.22$, p. 380 in Paper III), indicating that active management by exception leadership may stimulate safety climate at the Danish but not the Swedish construction sites. The importance of active management by exception for organizational outcome also appears to be dependent on cultural factors. Dorfman et al (78) similarly concluded that the effect on performance of leadership behaviors such as voicing displeasure and providing negative feedback contingent on poor performance, may differ depending on the cultural context in which the behavior is performed.

Why participative leadership seems more effective at Swedish construction sites and active management by exception seems more effective at Danish construction sites may be related to the kind of leadership Swedish and Danish construction employees are accustomed to. Social cognitive research describes how people tend to react positively to events to which they are accustomed (28). If employees are accustomed to certain leadership behavior, such behavior is more likely to positively influence organizational outcomes. Because participative leadership was found to be more practiced by Swedish than Danish construction managers in Papers I and III, this may explain why participative leadership is more beneficial for safety outcomes at the Swedish than the Danish construction sites. Similarly, because active management by exception may be more practiced by Danish than Swedish construction managers, this may explain why active management by exception is more beneficial for safety outcomes at the Danish than the Swedish construction sites.

Research into the effects of ILTs similarly suggests that people tend to react more positively to leadership behaviors that correspond to their ILTs (79). The results of Paper II indicate that participative ILTs are more prevalent in the Swedish than the Danish construction industry. Participative leadership behavior may therefore have a stronger positive influence on behavioral and organizational outcomes in Sweden than in Denmark.

5 CONCLUSIONS

This thesis has examined the kind of leadership that may be needed to attain high safety standards in the construction industry. Previous safety leadership research was the natural point of departure in this endeavor. Transformational and active transactional leadership behaviors were assessed and found to be positively related to safety outcomes, and passive/avoidant leadership was assessed and found to be negatively related to safety outcomes in the context of the Swedish and Danish construction industries. A new method for observing leadership behaviors was developed and systematic observations were conducted concerning how transformational, active transactional, and passive/avoidant leadership practices are enacted in every-day interactions by construction site managers at Swedish and Danish construction sites. These observations of transformational and passive/avoidant leadership were found to explain a reasonable proportion of the inter-group variation in construction employees' ratings of construction site safety climate.

The more innovative research approach, namely cross-cultural comparisons between the leadership practices of construction site managers in Sweden and Denmark, also yielded some possibly new insights. Rule-oriented and participative leadership practices were highlighted as aspects of safety leadership that may be particularly important in the construction industries in Sweden and Denmark. A high prevalence of rule-oriented and participative leadership behaviors among construction site managers may help to explain the relatively low injury rates in the Swedish construction industry.

Construction safety leadership research has increased significantly since the constituent papers of this thesis were originally designed. The results of the papers have therefore been discussed in light of more recent construction safety leadership research. The leadership behaviors of construction site managers were conceptualized by discussing how specific leadership behaviors can influence the work conditions and safety-related behaviors of individuals and groups. This discussion has shed some light on mechanisms that may underlie the associations between leadership behaviors and behavioral and organizational outcomes described in the constituent papers of the thesis.

Human behavior may be primarily motivated by its subsequent consequences. In much previous leadership research, the consequences of behavior have been too narrowly defined in terms of contingent material reward. This thesis highlights the importance of understanding the consequences of behavior more broadly, to better comprehend the potentially vast impact leaders can have on

employee behavior and safety. Social rewards include approval, appraisal, recognition, and endorsement, but also "simple" attention behaviors such as smiles, eye contact, and encouraging feedback. Looking at and actively listening to employees as they speak, is to provide them with positive consequences for voicing behaviors. Using employees' suggestions on how to better organize the work, is to provide them with positive consequences for participative behaviors. By building our understanding of how organizational behavior is motivated by its subsequent consequences, organizational leadership research can continue to provide valuable insights into occupational safety.

6 FUTURE PERSPECTIVES

The leadership behaviors identified here were primarily performed in human interactions and belong to the domain of direct relational leadership (80). A substantial part of managers' leadership may be indirect (81-83) and related to planning, boundary spanning, coordination, implementing and altering programs, structures, systems, etc. Direct and indirect leadership can be intertwined, because shortcomings in the indirect leadership of a site manager (e.g., in planning and organizing work activities at a construction site) may cause the manager' direct leadership to become more controlling and corrective as he/she monitors potential deviations or corrects deviations possibly resulting from his/her shortcomings in indirect leadership. Observational methods for measuring leadership behaviors may be further developed to include non-relational leadership (i.e. indirect leadership) behaviors as well. A future paper, based on interviews conducted with the site managers observed in Paper IV, will focus on the indirect leadership behaviors of those managers.

For a thorough assessment of the causal effects of construction site managers' leadership behaviors on safety outcomes, longitudinal research is needed, preferably with experimental designs. Promising results concerning the effect of participative leadership on safety in the construction industry are already being attained through non-randomized intervention studies by Choudhry (18), Kines et al. (25), Wu et al. (36), and Marín and Roelofs (84). The next step to thoroughly assess the influence of participative leadership on safety outcomes is randomized controlled intervention studies.

Acknowledging the importance of antecedent stimuli and contingent reinforcement, and understanding culture in terms of individuals' shared behavioral learning histories, may provide future research with a theoretical framework embedded in empirical research and suited as a point of departure for future endeavors in managerial leadership research.

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