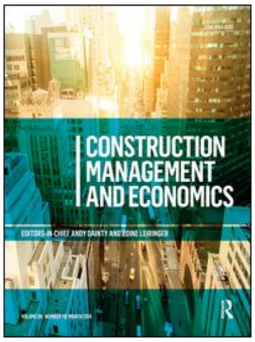

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Social identity, safety climate and self-reported accidents among construction workers

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ABSTRACT
The construction industry has one of the highest frequencies of work-related accidents. We examined whether construction workers predominantly identify themselves in terms of their workgroup or in terms of the construction site. In addition, we examined the associations between social identity and safety climate, and how these constructs are associated with work-related accidents. The analyses were based on questionnaire responses from 478 construction workers from two large construction sites, and the methods involved structural equation modeling. Results showed that the workers identified themselves primarily with their workgroup, and to a lesser degree with the construction site. Social identity and safety climate were related both at the workgroup and construction site levels, meaning that social identity may be an antecedent for safety climate. The association between social identity and safety climate was stronger at the workgroup level than at the construction site level. Finally, safety climate at both levels was inversely associated with self-reported accidents, with the strongest association at the workgroup level. A focus on improving safety climate, particularly by integrating initiatives at both the workgroup and management level, may have the potential to improve safety performance and thus decrease the risk of accidents and injuries on construction sites.

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Safety; management; accidents; work group identity; safety culture; safety leadership

Introduction

The construction industry has one of the highest risks of work-related accidents both in the US and the European Union. In the US, the construction industry is the third most dangerous occupational sector. In 2015, 21.4% of all worker fatalities in private industry were in the construction industry (US Department of Labor Occupational Safety and Health Administration 2016). In Europe, more than one in five (20.9%) fatal accidents at work in 2014 took place within the construction sector (Eurostat 2016), and the construction industry continues to have one of the highest injury incidence rates. Identifying the main causes of accidents and the barriers to safety, technological developments and the implantation of occupational health and safety management systems has led to many improvements in occupational health and safety in the twentieth century (Swuste *et al*. 2012). However, the construction industry does not tend to follow recent safety trends as seen in other sectors. Research has found no relative decrease of injuries in the construction industry in Denmark during the last 30 years (Lander *et al*. 2016).

There is a growing recognition that it is difficult to implement occupational health and safety systems and to achieve workers' commitment to implementation of these plans and policies without taking into account the interplay between social structures and psychological processes at the construction site. This has led researchers and practitioners to focus on organizational and social factors such as social identity (Phua and Rowlinson 2004, Brown and Phua 2011, Sherratt *et al*. 2013, Andersen *et al*. 2015), and group-level safety climate (Zohar 2008, Lingard *et al*. 2009, 2010) at the construction sites to induce positive safety change. However, previous research has examined safety climate and social identity at constructions sites separately. For instance, research on safety climate has mostly focused on prediction of performance, such as fewer injuries, whereas the antecedents of safety climate are unclear (Zohar and Tenne-Gazit 2008). Based on this, this study examines whether construction workers predominantly identify themselves in terms of their workgroup, and examines the influence of social identity on safety climate.

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Safety climate

The concept of safety climate is used to describe employees' perceptions of workplace safety policies, procedures and practice (Zohar 1980). Safety climate at the organizational level refers to workers' perception of management's policies, procedures and practice with safety. The concept of safety climate is important insofar as it predict safety performance within organizations. For instance, in the oil and wood processing industry, studies have found that safety climate perceptions and safety supervision were inversely correlated with accident (Varonen and Mattila 2000, Tharaldsen *et al*. 2008). A longitudinal study in the construction industry in Sweden found that safety climate predicted self-reported safety behaviour seven months later (Pousette *et al*. 2008), and at construction sites in Hong Kong, Choudhry *et al*. (2009) found that management commitment to safety was a significant predictor of workers' safety procedures and work practice (Choudhry *et al*. 2009). Finally, improvements in safety climate through a management-based intervention over three months have been found to reduce the risk of accidents and increase safety (Kines *et al*. 2010, Zohar 2010).

A meta-analytic review based on 32 studies found support for a link between organizational safety climate and employee safety compliance and participation, but the links to work-related accidents and injuries were found to be weak (Clarke 2010). The author of this latter study suggests that there are alternative pathways by which safety climate impacts accident and injuries, for instance through organizational commitment, job satisfaction or intention to stay at work. Another explanation may be that most studies on safety climate focus on the organization as the unit of analysis. Modern organizations, including construction sites, are often large and complex, and the influence of co-workers on attitudes, behaviour and performance is important (Chiaburu and Harrison 2008, Fugas *et al*. 2011). Thus, more specific analysis may be required to assess safety climate. On this background, Zohar and Luria (2005) have proposed a two-level model of safety climate: one that arises from the formal organizational-wide policies and procedures established by the top management, and one that arises from the safety practices associated with the implementation of company policies and procedures within workgroups (Zohar and Luria 2005).

Differences in safety climate among groups of employees within the same organization have been identified in previous research. In the oil industry, a study found that the safety climate varied by oil platform, work area, company type and platform type. The researchers concluded that safety climate was related to actual and natural working units within the organization (Tharaldsen *et al*. 2008). In the road industry, significant differences have been found between the safety climate perceptions of workers in different functional areas within a single road construction company (Glendon and Litherland 2001). Thus, the influence from management may only be indirect, and studies have shown that co-workers' safety climate mediate the relationship between organizational safety climate and safety performance (Meliá *et al*. 2008, Brondino *et al*. 2012).

At the construction site, group safety climate may be an even stronger predictor of safety performance than organizational safety climate, as most workers have little contact with top management, and are more likely to be influenced on a day-to-day basis by interactions with members of their immediate workgroup. Choudhry and Fang (2008) found that when co-workers and supervisors were perceived to be unsupportive of safety, construction workers instead influenced each other, and were more likely to engage in unsafe work practice (Choudhry and Fang 2008). Lingard *et al*. (2009) found that workgroup members develop uniform perceptions concerning safety within their own team, and that these perceptions varied between members of different workgroups, resulting in significantly different safety climate perceptions between members of different workgroups (Lingard *et al*. 2009). Furthermore, subcontracted workers discriminated between safety perception of their own organization and that of the principal contractor (Lingard *et al*. 2010). Thus, there may be variations in safety climate depending on the group-level safety climate within the organization, and it is therefore necessary to distinguish between safety climate at the organizational level and safety climate at the group level. Furthermore, the results illustrate the importance of specifying one or more organizational level as the unit of analysis in safety climate research.

As pointed out by researchers, it is not clear what contributes to the development of group safety climate (Lingard *et al*. 2010). Social interaction among group members must play an incremental role, especially when work teams have high levels of autonomy and where work is decentralized (Zohar and Tenne-Gazit 2008). Construction workers usually work in teams, perceive their co-workers as experts on their tasks and are closer to their co-workers than to the worksite managers (Lingard *et al*. 2011). Although managers have formal power in an organizational hierarchy, construction workers involved in subcontracted companies are only loosely connected with the principal contractor, as well as being relatively isolated from their own company, which may affect the development and impact the safety climate (Meliá *et al*. 2008).

The volume of non-work-related interactions between workgroup members has been found to be a direct predictor of group safety climate strength (Zohar and Tenne-Gazit 2008). Perceived workgroup norms are thus likely to be a more proximal antecedent of workers' safety behaviour than perceived management norms. The development of friendships, social and emotional relationships between members of a workgroup, will increase the extent to which co-workers develop considerate and responsible attitudes towards each other (Burt *et al*. 2008). This influence process is often far from uniform, as socially close individuals exert greater influence on each other than do those who are socially distant (Erickson 1988). The theory of social identification may explain how safety climate at the group level and social interaction in the group may be related, and the theory may explain the transition from individual perceptions of safety climate into a shared perception – thus turning an individual-level construct into a group-level construct.

Social identity at construction sites

The multi-organizational environment at construction sites is ideal for examining the process and effects of social identity plurality, as identification at the social/group level is found to be more dominant in social structures, where groups are clearly differentiated from each other (van Rijswijk and Ellemers 2002, van Rijswijk *et al*. 2006). At construction sites in Denmark, the work is usually organized in small workgroups who work simultaneously yet independently. A workgroup has lunch together in their cars or huts, have breaks together and have minimal interaction and communication with other workgroups and management during the work day (Andersen *et al*. 2015).

When acting in groups, social identity theory proposes that individuals define themselves in terms of their group membership, and perceive their own group values more positively than those of other workgroups. Social identity has been defined as "that part of an individual's self-concept which derives from his (or her) knowledge that his (or her) membership of a social group (or groups) together with the value and some emotional significance attached to that membership" (Tajfel *et al*. 1971). Social identity influences one's self concept, and when social identity is salient, the individual comes to view other in-group members as part of the self. The theory suggests that people perceive themselves as a member of a group, depersonalize the self and base their beliefs and behaviour on the norms of the group. The individual's social identity dominates and guides perceptual, affective and behavioural responses to the surroundings and may be understood as an expression of how committed the individual is to the group, the shared perceptions, norms and values of the group and the ensuing behaviour (Ellemers *et al*. 2002). Studies have demonstrated that the more one perceives of oneself in terms of one's membership of a group, the more likely one is to act in accordance with the group's beliefs, norms and values (Ashforth and Mael 1989, Dutton *et al*. 1994). Such a construed meaning system specifies what is important and legitimate to the group, and the values are created and recreated as members of the group repeatedly behave in a way that seems natural and unquestionable to them, thus constructing a version of risk and safety. Thus, the influence on safety climate perceptions may thus stem more strongly from the workgroup than from the construction site management (Andersen *et al*. 2015).

The social identity perception influences the way workers interact, the frequency of their interactions, with whom they interact and their attitudes towards safety issues and management at the construction site (Baarts 2009, Loosemore *et al*. 2011, Andersen *et al*. 2015). Only a few studies have addressed how psychological and social factors may affect identification and safety perception and performance at construction sites. For instance, one study found that social identity among construction managers negatively influenced the intended outcome of a strategy workshop in such way that the strategy would hardly be embraced (Löwstedt and Räisänen 2014). Another study found that the social identity of a workgroup among construction workers influenced safety behaviour and safety rules implemented from site management (Andersen *et al*. 2015). Finally, a study revealed several different discourses of safety depending on different organizational levels at a construction site (Sherratt *et al*. 2013). These results underline variations in beliefs, attitudes, behaviour and social identity among sub-groups within the organization at construction sites, and that the lack of acknowledgement of such realities may be barriers for the success of safety programmes.

However, the transient nature of construction workers' employment means that the construction workers identify themselves not only with their workgroup, but with the different groups to which they belong (e.g. workgroup, trade, union, company and project). The salience of social identity with a group dominates the behavioural responses to the surroundings, and a study found that construction workers' social identity at the project level negatively moderates the relationship between perceived workgroup norms and safety behaviour (Choi *et al*. 2016, 2017).

The strength of social identity at the workgroup level means that a workgroup's primary focus may be on their own priorities and goals. Consequently, the strength of the organizational safety climate may be weaker than the workgroup-level safety climate, as found by Choi *et al*. (2016), and vice versa.

Thus, social identity theory may potentially enrich the safety climate concept by pointing how social identity processes may be an antecedent for safety climate perceptions by creating compliance or resistance to construction site safety management policies, practices and procedures.

The aim of this paper is to present results from a study with the following hypotheses:

(1) Construction workers identify themselves to a greater degree with their workgroup rather than with the construction site.
(2) Social identity and safety climate are related, and the association between social identity and safety climate is stronger at the workgroup level than at the organizational level.
(3) The association between safety climate and the occurrence of accidents is stronger at the workgroup level than at the organizational level.

Methods

Participants

Workers from two large Danish public hospital construction sites participated in the study during the period 2014–2016. In order to study social identity pluralism, large construction sites were required with many workers and many contractors. Therefore, the client of two large hospitals in Denmark was contacted (one of the five regional administration units in Denmark). The client agreed to participate and support the study, but individual contractors' participation was entirely up to the individual contractor.

During the design and planning phases, engineers divided the construction sites into different plots, and three different phases (e.g. excavation/foundation/framing, the technical phase and the installation phase). Participation was agreed upon with the local supervisor for the main contractor at a phase on a plot ($n = 9$ plots). No main contractor refused to participate. A total of 15 workgroups from 15 different companies participated in the study. The study population consisted of 478 workers specializing in earth and concrete works, carpentry, painting, electricity and bricklaying. They completed a questionnaire during planned lunch meetings at the worksite. Most participants were male (99%).

Due to piece-rate wages and tight production plans, it was not possible to fill out the questionnaire during work time, but only during (unpaid) lunch breaks. A research team member attended these lunch breaks, providing sandwiches for the workers, and the completed questionnaires were returned to the researcher at the end of the break. No workers attending the lunch breaks refused to participate; however, due to tight productions plans and acute working situations, a few workers (approximately 5%) did not turn up for the lunch breaks and thus did not fill in the questionnaire.

The definition of workgroup at this site was a group of carpenters, painters or concrete workers often from different subcontractors working close together to fulfil their duties with minimal dependence and contact with other workgroups. Therefore, some workgroups never meet each other. Furthermore, a co-worker is defined as a member of the same workgroup.

Measures

Social identity

To measure social identity, three items were used from Cameron (2004) and four from Edwards and Peccei (2007). They were formulated towards both the workgroup level and construction site level, e.g. "I share the goals and values of my workgroup" (workgroup level), and "I share the goals and values of the construction site" (site level). The items were measured by means of a six-point Likert scale ranging from "Strongly disagree" to "Strongly agree", and Cronbach's alpha (CA) for the scales was 0.92 and 0.89, respectively.

Safety climate

Safety climate at the management level was measured using six items from dimension one of the Nordic Occupational Safety Climate Questionnaire (Kines *et al*. 2011), and was formulated towards both the foremen and the workgroup boss, e.g. "The foremen encourage us to work in accordance with the safety rules – even when the work schedule is tight", "The workgroup boss encourages us … etc". The same six-point Likert scale was used, and CA for the scales was 0.87 (foremen items) and 0.89 (workgroup boss items), respectively.

Safety climate at the group level was measured using six other NOSACQ-50 items (from dimension 4), e.g. "In our workgroup we take joint responsibility to ensure that the workplace is kept tidy", using the same six-point Likert scale and with CA = 0.89. Safety climate at the "safety coordinator" level was measured using five items developed for this study, based on changing "foremen" to "safety coordinator" e.g. "The safety coordinator at this construction site ensures that we receive detailed feedback regarding safety (e.g. accidents, injuries and near-miss)". The same Likert scale was used with CA = 0.89.

Respondents were asked whether they had been exposed to one or more of eight types of accidents during the last 14 days – "yes" or "no". In this paper, the term "accident" is used for the causal event(s) leading to the harmful exposure of an individual (e.g. slip/trip/fall), whereas we reserve the term "injury" for physical harm as the consequence(s) of such an event.

Statistical analyses

The structural model describes the relationships between latent variables. It is the structural component of the structural model that enables the analyst to make substantive statements about the relations between latent variables and the mechanism underlying a process or phenomenon (Molenaar *et al*. 2009). Quantification of these latent variables enables researchers to better understand the complex nature of the construction industry.

Structural equation model (SEM) analyses were conducted to test confirmatory factor analyses (CFA) and to test all hypotheses in one model. The advantage of SEM over traditional OLS regressions is that a full model can be tested, and SEM deals with measurement errors. MPlus v. 7.4 (Muthén and Muthén 2015) software was applied using Full Information Maximum Likelihood imputation. Robust Maximum Likelihood tests of models were used, as this approach corrects for distributions if they are not perfectly normal. The CFAs were applied to develop and test the psychometric validity of the modified variables of Safety Climate and Social Identification. SPSS version 22 was used for descriptive statistical analyses.

Results

CFAs of the composite variables were conducted to ensure valid psychometric properties. The CFA of Safety Climate did not show satisfactory fit indices ($\chi^2(226) = 1170.225$, RMSEA = 0.094, CFI = 0.757, TLI = 0.728, Scaling Correction Factor (SCF) = 1.194). A model was then tested in which all reverse items of each sub-factor formed its own factor. This resulted in a positive and a negative sub-factor for each reference (management, workgroup, workgroup leader). The fit improved ($\chi^2(223) = 540.969$, RMSEA = 0.094, CFI = 0.757, TLI = 0.728, SCF = 1.185), but the results also revealed that the negative sub-factor of the workgroup (consisting of reverse items) loaded poorly on the overall Climate scale ($\beta = -.27$, $p = 0.004$). The sub-factor was excluded from the Climate scale allowing the workgroup sub-climate to be measured by positive worded items only. The rest of the factor loadings ranged from 0.53 to 0.83. A new model without the negative workgroup sub-factor was tested and showed satisfactory model fit ($\chi^2(164) = 330.731$, RMSEA = 0.046, CFI = 0.951, TLI = 0.943, SCF = 1.199). To test the safety climate referring to the workgroup and the site, the overall climate was split into two. Site safety climate consisted of climate related to the foreman and the safety coordinator, whereas the workgroup safety climate was formed by the workgroup and the workgroup leader. When testing each climate separately in a CFA, Site safety climate was confirmed to be one (superordinate) factor ($\chi^2(42) = 79.072$, RMSEA = 0.043, CFI = 0.981, TLI = 0.975, SCF = 1.088), and Workgroup safety climate was another ($\chi^2(24) = 33.350$, RMSEA = 0.029, CFI = 0.990, TLI = 0.985, SCF = 1.193).

A CFA of site identification showed an unsatisfactory fit ($\chi^2(164) = 330.731$, RMSEA = 0.046, CFI = 0.951, TLI = 0.943, SCF = 1.199). A modification index showed that error correlations with the first item were a problem. This item was eliminated which improved the fit, but not enough. Modification indices revealed that error of item 4 also correlated with other item errors. A satisfactory fit was reached by eliminating this item: ($\chi^2(5) = 11.399$, RMSEA = 0.052, CFI = 0.991, TLI = 0.982, SCF = 1.665). The CFAs of Workgroup Identification similarly revealed that eliminating the first item turned an unsatisfactory fit into an acceptable one ($\chi^2(9) = 19.479$, RMSEA = 0.050, CFI = 0.989, TLI = 0.981, SCF = 1.651). Finally, a "measurement model" consisting of all factors and correlations between factors was tested in order to confirm that the factor and their items were independent from each other. This appeared to be the case as fit indices were satisfactory ($\chi^2(423) = 718.173$, RMSEA = 0.038, CFI = 0.955, TLI = 0.951, SCF = 1.170). Correlation between Site Identification and Workgroup Identification was 0.521; and with Site safety climate was 0.521; and with Workgroup safety climate was 0.413. Workgroup Identification correlated with Workgroup safety climate ($r = 0.558$) and with Site safety climate ($r = 0.368$), and Site safety climate correlated with Workgroup safety climate ($r = 0.770$). The latter high correlation is reasonable as the two variables originally stemmed from one Safety Climate variable.

In conclusion, we developed and validated "identification" scales worded for construction workers to measure identification with the workgroup and construction site, respectively. We also succeeded to measure a Safety Climate construct with references to the Workgroup and the Site, respectively. The structural model included regression analyses of the paths between identification and climate, and logistic regression paths to the binary variable about self-reported accidents (0 indicated no accidents, 1 was one or more accidents). These results can be seen in Figure 1.

As can be seen from Table 1, approximately equal numbers of participants were working in the three different

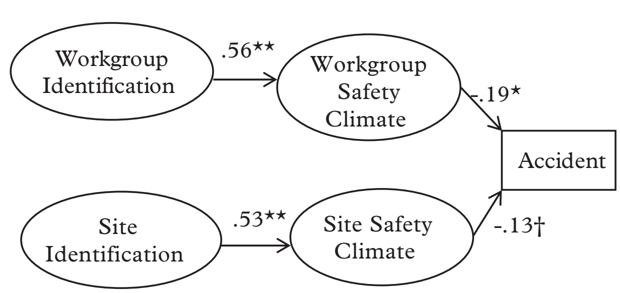

Figure 1. Correlations between construction worker identification, safety climate and accidents at work.
Notes: $^{**}p < 0.01$; $^{*}p < 0.05$; † = 0.10.

Table 1. Phase of construction the construction workers were working on during the study.

	N	%
Foundation and framing phase	170	35.5
Technical phase	165	34.5
Interior phase	143	30.0

Table 2. Construction workers.

	Mean	SD
Years working in same workgroup	2.30	5.01
Identity at the workgroup level	4.81*	0.86
Identity at the site level	4.21*	0.97
Safety climate at the workgroup level	4.38*	0.83
Safety climate at the site level	3.95*	0.89

*Descriptive data, identity and safety climate Likert scale of 1–6 (strongly disagree to strongly agree).

Table 3. Construction workers' social identity at the workgroup level and at the construction site level.

	Identity at the workgroup level			Identity at the construction sites level		
	N	Mean*	SD	*N*	Mean*	SD
All workers	478	4.81	0.86	470	4.21	0.97
Company 1	48	4.87	0.75	46	4.16	0.98
Company 4	28	4.45	0.92	28	3.83	0.95
Company 5	12	4.63	0.99	12	4.12	1.25
Company 6	54	4.84	0.95	56	4.11	1.01
Company 7	10	4.50	1.01	10	4.10	0.92
Company 8	10	4.63	0.76	10	4.59	0.78
Company 9	72	4.90	0.70	72	4.17	0.81
Company 10	38	4.99	0.65	38	3.71	0.90
Company 11	16	4.66	0.75	16	4.02	0.76
Company 12	13	4.32	1.29	13	3.07	1.05
Company 13	23	4.70	1.03	24	4.16	0.81
Company 14	19	5.02	0.49	19	4.22	0.54
Company 16	24	4.50	0.78	24	3.75	0.94
Company 17	88	5.01	0.96	88	4.90	0.91

*Means on a Likert scale of 1–6 (strongly disagree to strongly agree. Only companies with more than 10 worker respondents are shown).

phases of the construction process. Most participants were working in the foundation and framing phase of the construction projects.

As can be seen from Table 2, the workgroup members had been working for several years in the same workgroup (mean = 2.3 years), and more than 15% had been working more than five years in the same workgroup. Furthermore, both social identity and safety climate are higher at the workgroup level compared to the site level.

As can be seen from Table 3, the workers identified themselves to a greater degree with the workgroup than with the construction site. The results are similar across all subcontractors.

As can be seen from Figure 1, the associations between social identity and safety climate at the workgroup level (r = 0.56; p < 0.001) are marginally stronger than at the construction site level (r = 0.53; p < 0.001). Finally, for both levels, safety climate was negatively associated with accidents.

Finally, results of logistic regressions showed that the higher the workgroup safety climate, the lower the risk for accidents, and that this association is statistically significant (Odds Ratio = 0.59; p = 0.028). Similarly, the higher the site safety climate, the lower risk for accidents; however, the association is not statistically significant (Odds Ratio = 0.68; p = 0.072).

Discussion

This study examined the association between social identity and safety climates at the group level and at the construction site level and the association with self-reported accidents. We found that workers on the constructions sites identified themselves at the workgroup as well as at the construction site level. Previous research had also found had construction workers identify themselves with the different groups to which they belong (e.g. workgroup, trade, union, company, project) (Choi *et al*. 2017). However, in all the participating companies in this study, the social identification with the workgroup was stronger than the identification with the construction site. This is in line with a new study that found that project identity was the weakest among several existing identities in construction workers (Choi *et al*. 2017).

Identification with the workgroup seems to be rooted in the social structure at the construction site. Most workgroup members had been working together in their workgroup for a longer time than they had been working at the construction site. In most cases, construction workers are temporarily employed for this specific task in the project, and move to another project after completing their tasks. This condition of temporary employment can undermine workers' social identification with the organization (Johnson and Ashforth 2008, Buonocore 2010), and under such circumstances greater in-group identification could be expected (van Rijswijk *et al*. 2006). Previous research has found that social structures at work can foster a stronger identification with the workgroup than with the organization as a whole (Hennessy and West 1999, Löwstedt and Räisänen 2014). When social influence stems from a social identity process with the group, the individual worker appraises other's views and interpretations that offer a common frame of reference. Social identity with the workgroup influences the way workers interact, and also influences workers' attitudes towards safety issues and management at the construction site (Andersen *et al*. 2015). Influence of significant others on group members depends on the nature of their relationship (Erickson 1988). Thus, based on the close relationship and the number of interactions, it is not surprising that the workers identified themselves to a greater degree with their workgroup than with the construction site. The results of this study add to previous qualitative research that showed how psychological and social factors affect identification and safety performance on construction sites (Andersen *et al*. 2015, Sherratt *et al*. 2013). The results challenge the assumption that large construction sites consist of one organizational culture, which functions as one integrated social entity that has a strong social influence on each organizational member, their values and behaviour (Swuste *et al*. 2012).

Secondly, the results of this study show that safety climate perceptions exist at both the group level as well as at the construction site level. This is in line with previous research that found that distinct workgroup safety climate exists in the construction industry (Lingard *et al*., 2009, 2010). Furthermore, the results of this study show associations between social identity and safety climate at the workgroup level as well and at the construction site level, which means that social identity processes may be antecedents for safety climate at both levels. The associations were strongest at the workgroup level, and these perceptions varied between workgroups, resulting in different social identity and safety climate perceptions between members of different workgroups, which may provide an explanation for why some workgroups perform more safely than others (Lingard *et al*. 2009). The workers discriminated between perceptions of safety climate of their own workgroup and that of the construction site, which may serve as a proximal antecedent of safety perceptions. Proximal antecedent perceptions have been found to have a stronger influence than distal antecedents of safety perceptions (Christian *et al*. 2009). Thus, the individual worker's perceptions of workgroup safety norms are likely to constitute a more powerful antecedent of workers' safety perceptions and behaviour than perceptions of managements' safety norms.

The results indicate an alignment between group-level safety climate and construction site-level safety climate. Some authors have described safety climate as a multi-level construct coming simultaneously from policy and procedural actions from top management, and practice from the nearest supervisors or co-workers (Zohar 2002, Lingard *et al*. 2010). The results of the current study support this broader definition of safety climate including workgroup level. Therefore, it is important in safety climate research to consider the workgroup's values and beliefs, and to distinguish between the influence and role of the supervisor and workgroup.

Finally, the results show that safety climate at the workgroup level diminished the risk for work-related accidents more than safety climate at the site level. Several studies have found that safety climate, especially at the managerial level, is associated with improved safety and fewer accidents, even though the associations seem to be weak (Clarke 2010). However, in this study, safety climate at both the construction site level and workgroup level was associated with lower rates of self-reported accident. The findings suggest that focus on improving safety climate and safety commitment, on both levels at the same time, has the highest potential to improve safety performance and decrease the risk of accidents and injuries. Thus, multifaceted and integrated safety training programmes should target workgroups values, beliefs and behaviour as well as management practice.

Construction sites, like many organizations, consist of sub-groups based on workgroups, departments and divisions, all with their own values and attitudes (Pidgeon 1998). Knowing how safety climate is created and maintained is important for better understanding this construct. This present work highlights group-level dynamics as key antecedents of shared group climate perceptions. Prevention of work-related accidents must take this social identity pluralism into account as well as safety climate at the group level.

Strengths

Though the study supports previous findings that stress the importance of including the workgroup level in studies of organizational safety climate, we also examine antecedents for safety climate. To our knowledge, this is the first study to include the social identity perspective on the workgroup-level perception of safety climate among construction workers. We used a relatively large sample of construction workers working on the same site, and having the same principal contractor, meaning that several background variables were identical. The response rate was rather high even though we do not know the precise response rate due to piece rate waging and work duties. As far as we know, this is the first study using quantitative data to examine social identity on construction sites, and its influence on safety climate and accidents.

These findings deepen and extend prior research on construction safety by clarifying the mechanisms that underlie the link between social identity and safety climate perceptions.

Limitation

This study only used self-report measures. To avoid potential confounding by common method variance of the estimates of the relationships between the measures, future research could obtain independent measures. For instance, future research could obtain objective measures of safety behaviour, accidents and injuries to find out how well the self-report measures reflect the relationship between social identity and safety climate. Most of the participants in this study all work at the same large site. Future research should use larger samples from more construction sites to be able to generalize the results, and to increase the power of the estimates. Finally, the study is based on a cross-sectional design, making the establishment of causal relations unclear. However, the temporary and dynamic nature of construction sites makes longitudinal studies nearly impossible.

Previous research found that group safety climate was relatively unrelated to workgroup injury frequency rate based on lost time and medical treatment (Clarke 2010) However, lost time and medical treatment injury rates may not be sufficiently sensitive measures of safety performance at workgroup level. We used self-reported accidents that included both reportable and non-reportable injuries which may be influenced by recall bias (Andersen and Mikkelsen 2008).

Furthermore, the relation between self-reported workgroup injury frequency rate and safety climate may be spurious. Self-reported injury data were retrospective (14 days), but if safety performance is a consequence of safety climate, then strictly said, safety performance and injuries should be measured after the administration of the safety climate survey (Clarke 2010).

Conclusion

Construction sites are temporary and dynamic workplaces and places of identity pluralism. Based on respondents from 478 construction workers, we found that the workers on construction sites identified themselves to a greater degree with their workgroup, and to a lesser degree with the construction site. Furthermore, we found that social identity and safety climate were associated, and a stronger association was found between social identity and safety climate at the workgroup level than at the construction site level. The social identity process may explain how the identification is an antecedent for safety climate. Finally, a high level of safety climate at both the workgroup and construction site levels was associated with a diminished risk of work-related accidents, and the association was slightly stronger at the workgroup level.

The strong influence from group values and norms on safety climate perception has the practical implication that focus on improving safety climate must integrate initiatives at both the workgroup level and the management level. Approaches to promote positive management norms and workgroup norms would be effective means to improve safety. Such focus may have the potential to improve safety performance and thus decrease the risk of construction site accidents and injuries. Also, managerial actions to strengthen workers' social identification with the construction project, e.g. social arrangements and activities, common canteen and common safety meeting facilities, may lead to the development of a stronger safety climate at the construction site level. This may be a better way to intensify positive social influence rather than focusing on formal controls and punishment of unsafe conditions and behaviour.

The two-dimension safety identity and two-dimension safety climate model found in this study may have implications for organizations and managers, as workgroups can be important channels though which top management support for safety can be translated into improved safety performance. The model suggests a need to focus on communicating the importance of setting high expectations for safety, while also supporting the development of a strong consensus within the workgroup about the importance of safety relative to other project objectives. Finally, construction managers need to pay greater attention to the social aspects of safety behaviour.

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