Safety Science 84 (2016) 1–11

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

Predicting safety behavior in the construction industry: Development and test of an integrative model

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ARTICLE INFO

Article history:
Received 30 January 2015
Received in revised form 9 October 2015
Accepted 17 November 2015
Available online 12 December 2015

Keywords:
Safety climate
Construction safety
Safety behavior
Structural equation modeling

ABSTRACT

This study develops and tests an integrative model of construction workers' safety behavior with an attempt to better understand the mechanisms by which key safety climate factors (i.e., management safety commitment, social support, and production pressure) and individual factors (i.e., safety knowledge and safety motivation) influence workers' safety behavior. Data were collected from 215 construction workers in New Zealand using a questionnaire. Eight competing models were tested using structural equation modeling (SEM). The results showed that management safety commitment was significantly related to social support and production pressure. Production pressure was identified as a critical factor that has direct and significant effects on safety motivation, safety knowledge, safety participation and safety compliance. Furthermore, social support was found to have the same paths to influence safety behavior as production pressure, except that the effect on safety participation was insignificant. Safety knowledge and safety motivation were significantly and positively related to safety participation. The integrative model suggests a combination of "a safe organization", "safe groups" and "safe workers" strategies to reduce unsafe behavior on sites.

1. Introduction

Despite the fact that improvements in construction safety have been made over the last decades (Guo and Yiu, 2015; Hinze et al., 2013a; Howell et al., 2002), accidents and injuries still occur on construction sites from time to time and it appears that construction safety has reached a plateau (Bhattacharjee et al., 2011; Health and Safety Executive, 2014; Howell et al., 2002; Lingard et al., 2010; Statistics New Zealand, 2013). Those accidents and injuries have resulted in huge personal, social and financial costs (Feng et al., 2015; Veltri, 1990).

To prevent accidents, considerable attention has been paid by researchers to explore their root causes. A classic work of Heinrich's Domino Theory (1931) understood accidents as linear outcomes of unsafe conditions and human errors. It was claimed that over 88% of preventable accidents were caused by unsafe behaviors (Heinrich, 1931). Such an understanding has led to a traditional view on human error, that is, it is a cause of accidents (Dekker, 2002). When accidents happen, workers are often blamed for forgetfulness, inattention, incompetence and lazy attitude. As such, corresponding accident prevention strategies that are based on this traditional view mainly focus on eliminating unsafe behaviors (i.e., errors and procedural violations) of frontline workers (Dekker, 2002). However, this traditional view has been criticized for over-simplifying accident causation processes and leading to a blame culture (Dekker, 2013). Subsequent research efforts shifted towards exploring the effects of organizational factors on accidents. This development has been referred to as the "third age of safety" (Hale and Hovden, 1998). In his famous Swiss Cheese Model (SCM) (Reason, 1997), Reason claimed that accidents can be traced to one or more of four failure domains: organizational factors, supervision, preconditions and specific acts. Underpinned by the SCM is a new view on human error, that is, human error is a symptom of system failures (e.g., management deficiencies) that demands explanation (Dekker, 2002). This new view underscores the roles played by organizational factors in shaping human behavior at the sharp end.

Awareness of the importance of organizational factors in construction safety management has driven the increased interest in safety climate in recent years. A body of work has been conducted to explore the factor structure of safety climate for the construction industry (Dedobbeleer and Béland, 1991; Hon et al., 2012; Lingard et al., 2012). There has been considerable evidence

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http://dx.doi.org/10.1016/j.ssci.2015.11.020
0925-7535/

suggesting a positive link between safety climate and safety performance (Lingard et al., 2012). However, little is known about the mechanisms by which safety climate influences workforce's safety behavior (Clarke, 2006; Griffin and Neal, 2000; Neal et al., 2000). There may be some reasons for this. First, the concept of safety climate is still ambiguous (Zohar, 2010), which is reflected by the fact that there are no agreed safety climate scales for the industries and a wide range of variables and conceptual themes are covered by the concept (Flin et al., 2000; Guldenmund, 2000; Hon et al., 2012). Second, the concept of safety climate, often used interchangeably with safety culture, tends to become a catch-all term for anything related to people's perception of organizational and contextual factors. Despite the solid evidence that safety climate is strongly and positively related to safety performance, a possible risk is that the concept may lose some of its analytic power when determining the mechanisms by which it influences safety behaviors and safety outcomes (DeJoy, 2005; Neal et al., 2000). Therefore, better understanding the mechanisms becomes important, since the main purpose of measuring safety climate is to provide opportunities for improving safety performance of organizations (Cooper and Phillips, 2004). Researchers also emphasized a need for explaining how specific dimensions of safety climate influence safety behavior (Pousette et al., 2008; Prussia et al., 2003; Wirth and Sigurdsson, 2008).

With this background, an empirical study was conducted to develop and validate an integrative model of construction workers' safety behavior. The model was aimed at better understanding the mechanisms by which safety climate predicts safety behavior of the workforce by exploring the effects of core safety climate and individual factors on safety behavior. The rest part of this paper is structured as follows. It begins with a review of the safety climate studies which provide a theoretical basis for the development of the integrative model. Next, the methodology used to empirically test the model is described. The results are then presented, which is followed by a discussion of these results, limitations, and implications for the construction safety management. Finally, the conclusions of this study are presented.

2. Literature review

2.1. Safety climate

The concept of safety climate was originally developed by Zohar (1980). Neal and Griffin defined safety climate as "*individual perceptions of the policies, procedures and practices relating to safety in the workplace*". Safety climate has also been viewed as a current-state reflection of the underlying safety culture (Cox and Flin, 1998; Mearns et al., 2001). A great deal of interest has been given to explore safety climate factors, which resulted in a large number of assessment instruments (Flin et al., 2000). However, safety climate factors are not universally stable and there are inconsistencies in factor structure (Wu et al., 2015). Despite the inconsistencies, safety climate has been empirically proved to be able to influence safety-related behaviors and outcomes across a variety of industries (Brown and Holmes, 1986; Gillen et al., 2002; Johnson, 2007; Lingard et al., 2012; Neal et al., 2000; Zohar, 1980). A general conclusion is that where safety perceptions are more favorable, workers are less likely to behave unsafely and therefore accidents are less likely to occur. As a result, safety climate is often used as a leading indicator of unsafe behavior and accident (Zohar, 2010), although Clarke (2006) reported that the link between safety climate and accidents was weak.

Similar safety climate research patterns can be found in the construction industry. Researchers have made efforts to identify safety climate factors for the construction industry (Choudhry et al., 2009; Dedobbeleer and Béland, 1991; Fang et al., 2006; Glendon and Litherland, 2001; Hon et al., 2012; Lingard et al., 2012; Mohamed, 2002; Zhou et al., 2010). Results of these studies suggested that conceptualizations of safety climate take many different forms (Wu et al., 2015). Notwithstanding the inconsistencies, there has been considerable evidence suggesting that safety climate predicts safety outcomes (Choudhry et al., 2009; Fang et al., 2006; Kapp, 2012; Lingard et al., 2012; Mohamed, 2002).

2.2. Key safety climate factors

2.2.1. Management safety commitment

Management safety commitment (MSC) was considered as one of the most fundamental safety climate factors (Flin et al., 2000; Neal and Griffin, 2004). Neal and Griffin (2004) defined management safety commitment as "*the extent to which management is perceived to place a high priority on safety and communicate and act on safety issues effectively*" (p. 27). The effect of management safety commitment on safety performance has been examined in many studies and its importance has been widely recognized (e.g., Al-Refaie, 2013; Fruhen et al., 2013; Hofmann and Morgeson, 1999; Hofmann and Stetzer, 1996; Michael et al., 2005). The importance of MSC in safety lies in its far-reaching influences on safety management strategies, conflicts between production and safety. When upper managers are perceived as placing a high commitment to safety, supervisors and workers may want to meet upper management expectations by increasing their willingness to involve in daily safety practices. Safety climate studies suggested that these perceptions are socially transmitted to become collective norms and values within various hierarchical levels (Lingard et al., 2012). This proposition has been supported by empirical evidence in the construction industry (Lingard et al., 2012; McDonald et al., 2009; Molenaar et al., 2009).

2.2.2. Social support

Social support was defined as "*verbal and nonverbal communication between recipients and providers that reduces uncertainty about the situation, the self, the other, or the relationship, the functions to enhance a perception of personal control in one's life experience*" (Albrecht and Adelman, 1987). Putting it simply, it refers to safety-related support from supervisors and coworkers. It can be considered as a safety climate factor at the micro organizational level. Previous research indicated that front-line supervisors have significant influence on the safety behaviors of their employees (Hardison et al., 2014; Johnson, 2007; Mohamed, 2002; Zohar, 2002; Zohar and Luria, 2004). The importance of social support in construction safety management has long been realized. Lingard et al. (2012) pointed out that social support has taken on such an importance because of the fact that frontline workers are more likely to be influenced by daily interactions with supervisors and coworkers. Social support, compared to management safety commitment, has distinct roles and is perceived differently by the workforce (Flin et al., 2000). In Haslam et al.'s ConCA model (2005), social support is understood as a behavior shaping factor at the group level, while management safety commitment mainly represents influences from company/project level. Past studies have proved that social support facilitates safety communication and thus is of key importance in improving safety performance (Gillen et al., 2002; Hsu et al., 2010; Parker et al., 2001; Sampson et al., 2014).

2.2.3. Production pressure

Zohar suggested that safety climate perceptions should move beyond an isolated focus on safety, toward an evaluation which incorporates the relative priorities among the various safety policies and procedures and their competing domains (e.g. production)