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May, 2015

LINKING SAFETY KNOWLEDGE TO SAFETY PERFORMANCE: A MODERATED  
MEDIATION MODEL OF SAFETY PRIORITY, SUPERVISOR FEEDBACK, AND  
SUPERVISORS' SAFETY ATTITUDES

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A Dissertation

Presented to

The Faculty of the Department

of Psychology

University of Houston

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In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

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## ABSTRACT

The thousands of deaths and disabilities due to workplace accidents and injuries in the United States each year make occupational safety a significant issue. Occupational safety research has contributed to identifying antecedent factors of safety outcomes by integrating previous and contemporary findings. Despite such integrated safety models, little is known about why and how safety knowledge leads to safety performance and how personal and situational factors interact to promote occupational safety. The present study examines the relationship between workers' safety knowledge and safety performance, as well as mediating (safety priority) and moderating (supervisor feedback and supervisors' safety attitudes) variables of these relationships. Data were collected from workers ( $N=197$ ) and supervisors ( $N=62$ ) in an oil construction company at two time points. Results indicate general support for this moderated mediation model, demonstrating that workers' safety priority partially mediated the relationship between safety knowledge and safety performance. Moreover, when workers received more supervisor feedback, the positive effects of safety knowledge on safety performance and safety priority were stronger. When supervisors had positive attitudes toward safety, both the relationship between safety priority and safety performance and the indirect relationship between safety knowledge and safety performance were stronger. Theoretical and practical implications for occupational safety are discussed.

*Keywords:* occupational safety, safety knowledge, safety priority, feedback, safety attitude, safety performance

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## Linking Safety Knowledge to Safety Performance: A Moderated Mediation Model of Safety Priority, Supervisor Feedback, and Supervisors' Safety Attitudes

Occupational safety is a significant issue in that thousands of deaths and disabilities due to workplace accidents and injuries occur each year in the United States. The United States (U.S.) Bureau of Labor Statistics (BLS, 2014) reported that in 2013, there were 4,405 fatalities, particularly 3,929 fatal injuries in private industry in the U.S. alone and the construction industry had the highest count of fatal injuries (i.e., 796 injuries). For U.S. full-time workers, the rate of fatal job-related injuries was 3.2 per 100,000 employees (BLS, 2014). Although those numbers have been decreasing over the last 5 years, workplace injuries remain at an unacceptably high level. Consequently, both organizations and society as a whole have spent vast amounts of resources on injured workers' compensation (BLS, 2013). According to the Liberty Mutual Workplace Safety Index (Liberty Mutual Research Institute for Safety, 2013), nonfatal workplace injuries and illnesses amounted to more than 55 billion dollars in injured employees' compensation in 2011, and those compensation costs have been increasing since 2009 (Liberty Mutual Research Institute for Safety, 2011; 2013). Hence, human and economic costs associated with workplace injuries and illnesses are extremely high and have severe negative impacts on employees, employers, society, and national economies (Clarke, 2012). Accordingly, there is an imperative to conduct further occupational safety research to identify and understand the factors that can increase occupational safety for employees, employers as well as for society as a whole.

Recent theoretical and methodological advances in occupational safety research have contributed to identifying antecedent factors of safety outcomes by integrating previous and contemporary findings (Christian, Bradley, Wallace, & Burke, 2009). As such, a growing body of research is concerned with identifying antecedents of workplace safety performance,

accidents, and injuries. In addition to these areas, researchers are also interested in gaining knowledge on how situation-related factors (e.g., safety climate and leadership) and person-related factors (e.g., safety knowledge and safety motivation) influence occupational safety (Burke, Sarpy, Tesluk, & Smith-Crowe, 2002; Smith-Crowe, Burke, & Landis, 2003; Zohar, 2002). Safety performance has been defined as behaviors that promote the safety and health of employees, the public, and environment (Burke et al., 2002). A recent meta-analysis found that proximal person-related factors (i.e., safety knowledge and safety motivation) were more strongly related to safety performance than distal situation-related factors (e.g., safety climate and leadership) (Christian et al., 2009). Particularly, safety knowledge, defined as safety-relevant information that helps employees successfully navigate hazardous conditions and evaluate risks (Smith-Crowe et al., 2003), has emerged as a significant antecedent to employee safety performance (Christian et al., 2009; Neal & Griffin, 2004).

Although the linkage between safety knowledge and safety performance has been recognized, research has generally been limited in terms of furthering our understanding of *why* and *how* safety knowledge influences workers' safety performance (Griffin & Neal, 2000; Neal & Griffin, 2004). Most safety integrative frameworks, based on Campbell and colleagues' (1993) theory of performance, have consistently shown that there was a direct path of safety knowledge to safety performance (Christian et al., 2009; Neal & Griffin, 2004). However, given the application of existing safety models, there is relatively little research applying the theoretical rationale to investigate the mechanism underlying the relationship between safety knowledge and safety performance. Furthermore, various safety trainings and organizational safety interventions are designed to improve and change organizational safety by influencing worker behaviors. This is particularly relevant because most workplace accidents and injuries have a behavioral

component (Luria, Zohar, & Erev, 2010). Despite recent meta-analytic studies suggesting that both person-related and situation-related factors impact safety performance (Christian et al., 2009; Clarke, 2006; Nahrgang, Morgeson, & Hofmann, 2011), there is a relative dearth of research examining how personal factors and situational factors interact to increase occupational safety (Westaby & Lee, 2003). From a practical perspective, it is particularly important to identify what organizational factors can increase the effectiveness of safety knowledge in increasing safety performance and reducing the likelihood of workplace injuries. Hence, gaining a better understanding of organizational factors that facilitate the transfer of safety knowledge to the job would likely prove beneficial.

In the present study, I address these gaps and contribute to the occupational safety literature in two primary ways. First, given the predominant focus on the main effect of safety knowledge on safety performance, the present study focuses on investigating the attitudinal mechanism that links safety knowledge and safety performance. Specifically, based on the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), I propose that safety knowledge has an impact on safety performance through workers' safety priority, which is defined as the extent to which workers' emphasize safety at times when production goals are pressuring workers to focus on production-enhancing behaviors (Rundmo & Hale, 2003; Zohar, 2002). Safety priority is a significant dimension of safety attitudes because it pertains directly to workers' attitudes towards safety-productivity tradeoffs (Rundmo & Hale, 2003). Accordingly, I posit that workers' safety knowledge enhances the priority they place on safety, which in turn may increase their safety performance. Second, I examine the moderating roles of supervisor feedback and supervisors' safety attitudes. I expect that supervisor feedback functions as a boundary condition on the direct effect of worker safety knowledge on safety performance and

safety priority, and the indirect effect of workers' safety knowledge on safety performance. I further anticipate that supervisors' safety attitudes moderates the direct effects of workers' safety knowledge and safety priority on their safety performance as well as the indirect effect of workers' safety knowledge on safety performance. Overall, I propose a moderated mediation model (Edwards & Lambert, 2007; Preacher, Rucker, & Hayes, 2007) that is depicted in Figure 1. This moderated mediation model jointly examines: (a) workers' safety priority as the mediating mechanism, and (b) supervisor feedback and supervisors' safety attitudes as the moderator of the relationships between workers' safety knowledge, safety priority, and safety performance.

### **Safety Performance, Safety Knowledge, and Safety Priority**

Safety performance has become an important criterion of organizational performance because of its impacts on costs of health and safety to employees, organizations, and governments (Clarke, 2012). Safety performance refers to "actions or behaviors that individuals exhibit in almost all jobs to promote the health and safety of worker, clients, the public, and the environment" (Burke et al., 2002, p.432). Particularly, safety performance has been identified as a significant antecedent of workplace accidents and injuries by meta-analytic studies (Clarke, 2006; Nahrgang et al., 2011). In a recent meta-analytic study, both person-related and situation-related antecedents of safety performance were examined. Christian et al. (2009) found that safety knowledge and safety motivation (i.e., person-related factors) were most strongly related to safety performance, followed by safety climate (i.e., situation-related factor). Safety knowledge refers to the amount of safety-related information workers possess (Smith-Crowe et al., 2003), and safety motivation refers to the extent to which an individual has willingness to enact safety behaviors (Neal & Griffin, 2006). In addition, safety performance was more strongly

related to safety knowledge than safety motivation (Christian et al., 2009). More specifically, workers who have more information regarding safety should be more inclined to demonstrate high safety concerns, increase safety performance, and decrease injuries (Hofmann & Morgeson, 1999; Westaby & Lee, 2003; Rosenbloom, Haviv, Peleg, & Nemrodov, 2008). Accordingly, several comprehensive evaluations of safety frameworks have demonstrated that safety knowledge was strongly related to safety performance which, in turn, was related to workplace accidents and injuries (Christian et al., 2009; Griffin & Neal, 2000; Neal & Griffin, 2004; Smith-Crowe et al., 2003). Hence, most safety trainings and interventions have been conducted in effort to provide employees knowledge on safety to reduce the likelihood of workplace accidents and injuries (Burke et al., 2011; Harrington & Walker, 2009; Jiang, Yu, Li, & Li, 2010).

However, existing research provides only limited information of how and why safety knowledge relates to safety performance. For instance, it is unclear whether safety knowledge relates to safety outcomes because enhanced safety knowledge relates to improved safety attitudes, such as safety priority (Christian et al., 2009; Griffin & Neal, 2000; Neal & Griffin, 2004). Research findings from other areas demonstrates that knowledge can critically influence attitude-behavior relations (Fabrigar, Petty, Smith, & Crites, 2006). Research has also repeatedly supported that knowledge about a consequence of a given behavior determines attitudes toward the behavior (e.g., Ajzen, Joyce, Sheikh, & Cote, 2011; Smith, Fabrigar, MacDougall, & Wiesenthal, 2008). Typically, safety knowledge, which can help workers estimate the extent that workplace injuries could affect their life and the likelihood of workplace injuries if they perform a particular behavior, may influence their attitudes toward safety outcomes. From a social psychological perspectives, the attitude-relevant knowledge/belief can be viewed as a structural property of individuals' attitudes (Fishbein & Ajzen, 1975; Krosnick & Petty, 1995). Typically,

research has found that increases in attitude-relevant knowledge are related to a greater influence on attitude formation (Fabrigar et al., 2006; Kanengoni & Murugan, 2013). In support of this notion, researchers have argued that there is a relationship between safety knowledge and attitudinal factors (e.g., Flotta, Rizza, Bianco, Pileggi, & Pavia, 2012; Harrington & Walker, 2009). Accordingly, I propose that safety knowledge is related to safety priority. Through increasing safety knowledge, workers will develop a more positive attitude towards safety and display high safety priority.

The relationships between safety knowledge, safety priority and safety performance can be better understood through the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and the knowledge, attitude, and behavior (KAB) approach (e.g., Fabrigar et al., 2006). The theory of reasoned action states that individuals' intention to perform a particular behavior is determined by two factors: (a) the individuals' attitude toward the behavior which represents the individual's evaluation of performing the particular behavior, and (b) subjective norms which refer to the perceived social pressure to perform or not to perform a behavior. In the theory of reasoned action, an individual's belief is based on the relevant information that determines an individual's attitude, which in turn influences subsequent behaviors. Knowledge has typically been defined as the number of relevant beliefs and information that could be used when encountering the target (Davidson, 1995). Typically, the accumulation of knowledge can estimate the consequence of a given behavior to develop individuals' attitudes towards certain behavior (White, Charles, & Nelson, 2008). Subsequently, this particular attitude impacts their behavioral intentions and displays of behavior (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). Specifically, knowledge involves the deliberation of whether the outcome of certain behavior is likely to be favorable or unfavorable (Bell, Harrison, & McLaughlin, 2000).

Moreover, the KAB approach, which has been applied in prevention and intervention in various fields, including occupational safety, suggests that increases in knowledge are related to greater impacts of attitude on behavior (Fabrigar et al., 2006). The premise of the KAB approach is that people will behave in ways that accord with those facts they are given (Bettinghaus, 1986). In addition, it postulates that based on positive or negative attitude toward a particular behavior, people will change their behaviors to match the attitude (Bettinghaus, 1986). Through elaboration based on relevant knowledge, individuals tend to develop a positive attitude toward the behavior that can result in desirable consequences or develop a negative attitude toward the behavior that is potentially linked to undesirable consequences (Fabrigar et al., 2006). For instance, if people acquire knowledge through convincing information/materials, they tend to create a positive attitude about exercise for health, and this positive attitude will lead people to exercise (Hagger, Chatzisarantis, & Biddle, 2002). Moreover, research found that persuasive information/arguments about affirmative information action programs (AAP) could be successful in changing AAP attitude which could in turn predict intentions to perform AAP behaviors in recruiting employees and students (Bell et al., 2000; White et al., 2008). In this fashion, an individual's attitude is determined by his/her knowledge regarding the anticipated consequence of performing such behavior (Fishbein & Ajzen, 1975). Based on this theoretical rationale, workers who have high safety knowledge are expected to demonstrate a positive safety attitude in the workplace and value safety issues in order of priority (i.e., safety priority). Thus, I hypothesize the following:

*Hypothesis 1: Worker safety knowledge will be positively related to safety priority.*

Workers' safety priority is likely to be associated with their safety performance. In line with the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975),



individuals' intention to perform a particular behavior are influenced by individuals' attitudes toward the behavior and subjective norm. Hence, workers who have a positive attitude toward a particular behavior which leads to an expected outcome would be more inclined to display such behavior. A number of research studies found that an individual's behavior is determined by his/her attitude toward the behavior (Ajzen, 2011; Glasman & Albarracín, 2006; Judge, Thoresen, Bono, & Patton, 2001); especially, the main effect of attitude on individuals' behaviors was stronger than the main effect of subjective norm (Terry & Hogg, 1996). Rundmo's work (1992) indicated that attitude is one of the strongest predictor of workers' risk behaviors. Additional work has found that safety attitudes were positively related to safety behaviors (Chang & Liao, 2008). Particularly, safety priority is associated with engaging in safety regulations and displaying safety behavior (Rundmo & Hale, 2003). Accordingly, workers based on relevant knowledge recognize that safety is important because it leads to decreased workplace accidents and injuries and positively considers a safety behavior (e.g., wearing a helmet) which increases occupational safety and decreases injuries. Consequently, such workers may develop a positive evaluation of the safety behavior and develop a positive attitude to perform their safety behaviors in order of priority. Finally, workers should decide to display high safety performance to avoid workplace injuries as their expected consequence.

The KAB approach may provide additional theoretical foundation to support linkages between safety knowledge, safety priority, and safety performance. Consistent with the assumption of KAB approach, research reported that the amount of relevant knowledge can influence attitude-behavior consistency (Holbrook, Berent, Krosnick, & Visser, 2005). Specifically, attitudes based on high amounts of relevant knowledge were more strongly correlated with subsequent behavior than attitudes based on low amount of relevant knowledge

(Kallgren & Wood, 1986). Typically, individuals consider the amount of relevant knowledge underlying their attitudes before deciding to perform a behavior (Fabrigar et al., 2006). Overall, the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and previous findings provide a theoretical rationale explaining why safety priority is related to safety performance and how safety knowledge influences workers' safety performance to avoid workplace injuries. That is, safety knowledge will influence workers' safety priority which in turn may have an impact on their safety performance. Hence, I anticipate that safety priority would partially mediate the effect of safety knowledge because safety performance is a broad construct that is influenced by factors (e.g., safety motivation) other than safety attitudes (Christian et al., 2009; Rundmo & Hale, 2003). Accordingly, I expect a partial rather than a complete mediation. Thus, I hypothesize the following:

*Hypothesis 2: Workers' safety priority will be positively related to safety performance.*

*Hypothesis 3: Workers' safety priority will partially mediate the relationship between safety knowledge and safety performance.*

### **The Moderating Role of Supervisor Feedback**

Feedback has been found to influence individuals' behaviors, motivation, and attitudes to increase performance (Vancouver & Tischner, 2004; Van Dijk & Kluger, 2004). Feedback involves in guiding, motivating, and emphasize job-related behaviors (Cianci, Klein, & Seijts, 2010). The primary purpose of feedback is to urge workers to correct or maintain on-task behaviors that lead to organization expectations and decrease errors (Goodman, Wood, & Hendrickx, 2004). Therefore, the effectiveness of various types of feedback interventions on task performance has been investigated (Van Dijk & Kluger, 2011). Feedback intervention refers to actions taken by other persons to provide relevant information regarding aspects of workers' task

performance (Kluger & DeNisi, 1996). In organizations, supervisors usually have supervisory responsibilities and can wield various powers (i.e., reward, legitimate, coercive, expert, and referent) over other workers (French & Raven, 1959). Generally, supervisors are authorized to express and manage organizational policies, expectations, and the allocation of incentives to regulate and motivate workers for compliance the organization's expected outcomes (Wayne & Ferris, 1990). As such, supervisors play a critical role in influencing workers' motivation, attitudes, and behaviors (Elangovan & Xie, 1999; Farmer & Aguinis, 2005; Ilgen, Peterson, Martin, & Boeschen, 1981; Pichler, 2012).

Supervisor feedback is positively related to workers' behavior improvement effort (Fedor, Davis, Maslyn, & Mathieson, 2001), and it can direct workers' attention and awareness that lead to expected behaviors (Goodman et al., 2004). Particularly, more specific feedback from supervisors should result in more immediate improvement in workers' behaviors than less specific feedback (Goodman et al., 2004). That is, if supervisors clearly communicate anticipated objectives and what specific behaviors are necessary when performing tasks, workers can better understand what they need to accomplish and implement behaviors and knowledge accordingly (Bakker, Demerouti, & Euwema, 2005; Schmidt, Roesler, Kusserow, & Rau, 2014; Tubre & Collins, 2000). Hence, supervisor feedback forces workers to focus on organizational goals (i.e., organizational expectations) through developing new knowledge or skills and managing behaviors, attitudes, and motivation. When a supervisor provides negative feedback to a worker, it demonstrates that there are discrepancies between the worker's behaviors and organizational goals, and his/her behaviors are expected to be modified and redirected to reduce these discrepancies (Cianci et al., 2010; Fedor et al., 2001; Wofford & Goodwin, 1990).

Through supervisor feedback workers can clarify organizational norms, manage expected performance, increase job-relevant knowledge, and display positive job-related attitudes. Workers view supervisor feedback as an opportunity to clarify the goal in an organization and decrease discrepancies between their behaviors and organizational goals (Cianci et al., 2010; Wofford & Goodwin, 1990). In general, supervisor feedback is the most common and effective method to evaluate workers' behaviors, correct misunderstandings, identify strengths, improve weaknesses, and provide future suggestions (Atwater, Ostroff, Yammarino, & Fleenor, 1998; Fletcher & Perry, 2002). Hence, the reception of supervisor feedback for workers could be viewed as a learning process to correct and increase necessary job-related knowledge and enhance personal development (Beehr, Ivanitskaya, Hansen, Erofeev, & Gudanowski, 2001; Mount, Judge, Scullen, Sytsma, & Hezlett, 1998). Moreover, the major component of feedback involves information of job task and knowledge of results, such that receiving feedback contributes to increase the effect of workers' job-relevant knowledge (Kluger & DeNisi, 1996; Shipper, Hoffman, & Rotondo, 2007). Subsequently, this should influence workers' attitude and expected behaviors (Fletcher & Perry, 2002). Therefore, I expect the following:

*Hypothesis 4:* Supervisor feedback will moderate the relationship between safety knowledge and safety performance. Specifically, the relationship will be stronger when the reception of supervisor feedback is high compared to when the reception of supervisor feedback is low.

Through the reception of feedback an individual can effectively increase an error-free performance to decrease the likelihood of frequent errors (Van Dijk & Kluger, 2011). For example, in high-risk industries and professions occupational safety is a primary concern for organizations and supervisors. In these organizations, supervisors play key roles in propagating

occupational safety (Zohar, 2000; 2002). Through supervisor feedback workers effectively recognize organizational safety norms to reduce errors, learn how to perform their job tasks safely, and have a positive attitude toward safety (Zohar, 2002; Zohar & Luria, 2003). Based on their frequent monitoring in related to safety practices, supervisors can provide workers relevant feedback to reward their safety behaviors and substantially influence workers' safety knowledge on their job attitude toward safety (Clarke, & Ward, 2006; Simard & Marchand, 1995; Zohar, 2002; Zohar & Luria, 2003). Accordingly, I anticipate the effect of worker safety knowledge on safety priority is stronger when the reception of supervisor feedback is high compared to when the reception of supervisor feedback is low. Thus, I hypothesize the following:

*Hypothesis 5:* Supervisor feedback will moderate the relationship between safety knowledge and safety priority. Specifically, the relationship will be stronger when the reception of supervisor feedback is high compared to when the reception of supervisor feedback is low.

Supervisor feedback includes task-relevant information on the behaviors that are performed incorrectly (Goodman et al., 2004). That is, supervisor feedback suggests a discrepancy between goals and behaviors and indicates how to correct unexpected behaviors. Overall, supervisor feedback should result in improvement in expected behaviors. Assuming supervisor feedback moderates the relationship between safety knowledge and safety priority, it is also likely that received supervisor feedback will conditionally influence the strength of the indirect relationship between safety knowledge and safety performance. Therefore, I expect the following:

*Hypothesis 6:* Supervisor feedback will moderate the indirect effect of safety knowledge on safety performance. Specifically, the indirect relationship of safety knowledge with safety

performance via safety priority will be stronger when the reception of supervisor feedback is high, compared to when the reception of supervisor feedback is low.

### **The Moderating Role of Supervisors' Safety Attitudes**

In most organizations, supervisors are generally regarded as representatives of the organizations in communicating and conveying organizational norms and policies to workers (Eisenberger, Huntington, Hutchison, & Sowa, 1986; Richard, Ismail, Bhuiyan, & Taylor, 2009; Stinglhamber & Vandenberghe, 2003). Thus, supervisors are charged with establishing and managing regulations, expectations, and reward systems to ensure worker compliance in efforts to achieve expected outcomes (Wayne & Ferris, 1990). As such, workplace supervisors are in a critical position to manage organizational norms that regulate workers' behaviors by frequently expressing the central values to them, especially to the group members (Dineen, Lewicki, & Tomlinson, 2006). Thus, workers' attitudes and behaviors are susceptible to being influenced by their supervisors.

Organizational norms may influence workers' behaviors in the workplace. According to the theory of reasoned action, (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), a behavior can be influenced by the subjective norm which refers to individuals' perception of the extent to which others who are important to them expect they should perform the behavior. The subjective norm is determined by the perceived expectations of an important person or group. Indeed, relying on the theory of reasoned action, the subjective norm is a significant factor that can influence individuals' attitude-behavior relations (Ajzen & Fishbein, 2005; Trafimow & Fishbein, 1994). Specifically, the organizational norm is subjectively represented as an organizational prototype that describes expected beliefs, attitudes, and behaviors (Pansu, 1997). Terry and Hogg (1996) found that norms influenced the relationship between attitudes and behaviors. Thus, if

supervisors convey anticipated objectives and value what specific behaviors are necessary when performing tasks, workers should understand what they are expected to accomplish and implement behaviors and expectations accordingly (Tubre & Collins, 2000). For example, in high-risk industries and professions occupational safety is a primary concern for organizations and supervisors (Hofmann, Morgeson, & Gerras, 2003). In these organizations, supervisors play key roles in propagating beliefs or values or information in terms of occupational safety (Zohar, 2000; 2002).

Supervisor safety orientation has also been viewed as a significant indicator of supervisor support for safety as well as safety norms or policies in the workplace (Barling, Loughlin, & Kelloway, 2002; Clarke & Ward, 2006; Zohar & Polachek, 2014). Supervisors' job attitudes are able to influence workers' job beliefs, values, and work behaviors (O'Driscoll & Beehr, 1994; Wayne & Ferris, 1990). Particularly, a supervisor's safety attitude refers to a supervisor attitude contributing to enhanced occupational safety (Díaz & Cabrera, 1997; Rundmo & Hale, 2003). Rundmo (1996) maintained that supervisors' safety attitudes are the salient factor related to worker safety rule violations as well as unsafe behaviors. In addition, there is agreement that supervisor's safety attitudes (Rundmo & Hale, 2003) and their support for safety (Christian et al., 2009) contribute to decreased workplace accidents and injuries. Thus, the supervisor who has a positive safety attitude will: (a) frequently detect workplace hazards, (b) have sufficient resources to find solutions to control hazards, (c) prioritize safety over production, (d) monitor and reward employees' safety performance, and (e) apply effective management to increase work safety (Rundmo & Hale, 2003; Zohar & Luria, 2003). Thus, I expect the following:

*Hypothesis 7:* Supervisors' safety attitudes will moderate the relationship between safety knowledge and safety performance. Specifically, the relationship will be stronger when supervisors' safety attitude is positive compared to when supervisors' safety attitude is negative.

Furthermore, supervisor concern for work safety influences job attitudes regarding the priority of safety among workers in the group (Zohar, 2000, 2002; Zohar & Luria, 2003). For instance, supervisors' attitudes toward safety can influence workers' attitudes toward using protective equipment (Cavazza & Serpe, 2009). The perception of supervisors' safety attitudes for workers serves to clarify supervisory expectations of safety practices which, in turn, strengthen workers' safety beliefs, such as safety priority, and expected behaviors related to safety (Hofmann et al., 2003; Zohar; 2000; 2002). Hence, based on perceptions of supervisors' safety attitudes, workers recognize a referent standard for performing behaviors and they can expect their behaviors to correspond to supervisory expectations (Cooper & Phillips, 2004; Zohar & Luria, 2004; 2005).

The current study suggests that supervisors' safety attitudes will moderate the relationship between safety priority and safety performance. Specifically, I expect the effect of safety priority on safety performance will be more positive when supervisors demonstrate a positive safety attitude in contrast to when supervisors demonstrate a negative safety attitude. I base this expectation on the following rationales of supervisors' safety attitudes. First, supervisors who have a positive safety attitude tend to monitor more closely whether workers are adhering to safety policies and procedures (Zohar, 2000). Through monitoring workers' behaviors, supervisors can directly correct unsafe behaviors and reward expected safety behaviors to encourage workers to better regulate their safety behaviors (Christian et al., 2009; Hofmann & Morgeson, 2004). Second, supervisors who are actively concerned with safety issues are more



likely to communicate safety issues to workers in efforts to clarify ambiguity of safety regulations and practice (Zohar, 2000; Zohar & Luria, 2003). By providing instructions to workers, supervisors can guide those workers regarding expected safety performance and workers can learn how to perform accurate safety behaviors (Michael, Guo, Wiedenbeck, & Ray, 2006; Vredenburg, 2002). Third, supervisors' safety attitudes demonstrate supervisory expectations regarding safety issues and as a result, workers should demonstrate consistent job attitudes toward safety based on their perceptions of such supervisory expectations (Hofmann & Stetzer, 1998; Wallace, Popp, & Mondore, 2006). Through interactions with supervisors who emphasize safety issues, workers can display high safety concerns, correct errors, and perform particular safety behaviors to increase safety in the workplace.

Overall, supervisors who have a positive safety attitude will establish and manage safety norms or policies which in turn influence worker beliefs, attitudes toward safety, and safety behavior. Specifically, supervisors' positive safety attitude has a positive impact on workers' attitudes toward safety which in turn increase safety behavior (Cavazza & Serpe, 2009). In sum, supervisors who value safety provide detection, guidance, and resources which influence workers' safety attitudes as well as safety behavior (Dineen et al., 2006). Accordingly, I expect the effect of safety priority on safety performance is more positive when supervisors have a positive safety attitude compared to when supervisors have a negative safety attitude. Thus, I hypothesize the following:

*Hypothesis 8:* Supervisors' safety attitudes will moderate the relationship between safety priority and safety performance. Specifically, the relationship will be stronger when supervisors' safety attitude is positive compared to when supervisors' safety attitude is negative.

As noted above, supervisors' job orientation is able to influence workers' knowledge, attitudes, and behaviors in the workplace. Supervisors who demonstrate a positive safety attitude tend to convey safety norms, monitor workers' behaviors, instruct safety knowledge, and correct unsafe behaviors. Griffin and Neal (2000) found that supervisors' safety orientation is positively associated with worker safety knowledge and safety performance. On the basis of the theory of reasoned action and the KAB approach research, I argued that worker safety priority would mediate the relationship between safety knowledge and safety performance. As supervisors' positive safety attitude increases, workers may increase the perception of safety norms that impact their attitude and subsequent behavior. Assuming supervisors' safety attitudes moderate the relationship between safety priority and safety performance, it is also likely that supervisors' safety attitudes will conditionally influence the strength of the indirect relationship between safety knowledge and safety performance. Therefore, I expect the following:

*Hypothesis 9:* Supervisors' safety attitudes will moderate the indirect effect of safety knowledge on safety performance (via safety priority). Specifically, the indirect relationship of safety knowledge with safety performance via safety priority will be stronger when supervisors' safety attitude is positive compared to when supervisors' safety attitude is negative.

## **Method**

### **Participants and Procedure**

Hierarchically nested data were collected from multiple sources (workers and supervisors) at two time points separated by one year. The company is a mid-sized global construction contractor specializing in energy infrastructure serving the oil, gas and power industry in the Southern U.S. The services of this company include both upstream and downstream operations:

procurement and construction, refinery turnarounds, pipeline construction, pipeline integrity management, engineering, geographic information system consulting, and other specialty services. Workers and their supervisors were asked to complete the surveys at their worksite during work hours. The surveys took approximately 10 to 20 minutes to complete. At Time 1, workers responded to the measures of safety knowledge and supervisor feedback. One year later, at Time 2, supervisors rated their safety attitudes in their work teams and workers rated their safety priority and safety performance. Before the data were collected, the researchers explained the purpose of the research and guaranteed that all responses would be kept confidential. In addition, participants were instructed that no individual worker and supervisor responses would be reported back to the organization (i.e., the data would be presented using an aggregated format). To ensure confidentiality, once the workers and supervisors completed their respective surveys they were instructed to seal their questionnaires in prepared envelopes and post them in a box that was directly returned to the researchers. Neither the organization nor supervisors were provided access to workers' responses.

There were 249 workers (response rate = 59 %) and 62 first-line supervisors (response rate = 85%) who completed the questionnaire from 16 work units at Time 1 and 197 workers (retention rate= 79 %) and 62 supervisors (retention rate = 100%) who completed the survey at Time 2. Each team had 3.18 workers and team sizes ranged from 1 to 20 members. Among the workers, 76.6% were males, average age was 45.92 years ( $SD = 12.02$ ) ranging from 23 to 71 years, and average job tenure with the organization was 9.15 years ( $SD = 8.46$ ). For supervisors, 91.2% were males, average age was 45.50 years ( $SD= 10.83$ ), and average work tenure with the organization was 12.15 years ( $SD = 10.40$ ).

## **Measures**

Except for the measures of the control variable, participants responded to all the items using a 5-point Likert-type response scale (ranging from 1 = strongly disagree to 5 = strongly agree). Data were collected from different sources and time points to reduce common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Spector, 2006). Specifically, the researchers asked supervisors to rate their safety attitudes (Time 2) and asked workers to report their safety knowledge, supervisor feedback, safety priority, and safety performance (Time 1 and Time 2, respectively).

**Safety knowledge.** Safety knowledge was measured using an edited 3-item scale of Griffin and Neal's (2000). A sample item was "I know and understand my safety responsibilities." The internal consistency of the scale as represented by Cronbach's alpha was .80.

**Supervisor feedback.** To capture the extent to which a supervisor would provide performance feedback in the team, workers rated three items developed for the present study. Sample items were "Supervisors often let me know how well they think I'm performing on the job" and "My supervisors let me know how well I'm doing on the job." All responses were aggregated to create group-level the reception of supervisor feedback. Supporting aggregation, the estimated  $r_{wg}$  value was .81, indicating strong levels of agreement (James, Demaree, & Wolf, 1984; LeBreton & Senter, 2008). The internal consistency of the scale as represented by Cronbach's alpha was .80

**Safety priority.** Safety priority was measured using a 3-item scale developed by Henning, Stuft, Payne, Bergman, Mannan, & Keren (2009). Sample items were "Sometimes it is necessary to take risks to get a job done," "Sometimes it is necessary to take shortcuts," and "Sometimes it is necessary to depart from safety requirements for the sake of production." The internal consistency of the scale as represented by Cronbach's alpha was .86.

**Supervisor safety attitudes.** Supervisors reported their safety attitudes using 4 items developed by Henning et al. (2009). Sample reverse items were “Reporting safety breaches is an unnecessary hassle,” “Safety rules and instructions sometimes make it difficult to keep up with production targets,” and “Good proposals on how to improve safety should be dropped if they cost too much.” The internal consistency of the scale as represented by Cronbach’s alpha was .72.

**Safety performance.** The worker’s safety performance was measured using 8 items developed by Burke et al. (2002). The researchers asked workers to rate the extent to which they agreed that they have demonstrated each of the eight safety-related behaviors. Sample items included “I always wear personal protective equipment while performing hazardous work,” “I report safety problems to my supervisor whenever I see safety problems,” and “I always correct safety problems to ensure accidents will not occur.” The internal consistency of the scale as represented by Cronbach’s alpha was .88.

**Control variables.** I controlled for several variables related to safety-related variables that could have effects on workers’ safety performance. Previous studies has suggested that females compared to males, older employees compared to younger employees, and those with more job tenure were more likely to engage in expected behaviors (Åkerstedt & Kecklund, 2001; Chen, 2009; Lu & Yang, 2011; Tesluk & Jacobs, 1998). Thus, in the present study, gender, age, and job tenure were included as control variables in all analyses.

### **Analytic Strategy**

To test the hypotheses in the present study, I examined direct, indirect, moderating, and moderated mediating effects. These are described in more detail below.

**Tests of direct and indirect effects.** I tested direct effects (Hypotheses 1-2) and indirect effects (Hypothesis 3) using hierarchical linear modeling (Raudenbush & Bryk, 2002). Control variables (gender, age, and tenure) were entered in the first step. In the next step, the direct effect (safety knowledge) was entered, followed by the mediator (safety priority). Moreover, to test indirect effects I used a recommended bootstrapping approach to obtain confidence interval estimates (MacKinnon, Lockwood, & Williams, 2004). Specifically, I used Preacher & Hayes' (2008) approach (i.e., a bootstrap approach) to estimate the indirect effect of safety knowledge on safety performance (through safety priority).

**Tests of moderation effects.** I tested the group-level moderation effects (Hypotheses 4, 5, 7, and 8) by means of hierarchical linear modeling (Raudenbush & Bryk, 2002) using HLM 6.08 (Raudenbush, Bryk, & Congdon 2004). To assess the moderating effects of supervisor feedback and supervisors' safety attitudes, I entered safety performance (Hypotheses 4, 7, and 8) and safety priority (Hypothesis 5) as the outcome variables. The other variables were entered according to the following steps: (1) control variables (i.e., gender, age, and tenure), (2) predictor (e.g., safety knowledge), (3) moderator (i.e., supervisor feedback and supervisors' safety attitudes), and (4) the interaction term (e.g., safety knowledge x supervisor feedback). In addition, to alleviate issues in terms of multicollinearity, I grand-mean centered all variables in the proposed multilevel model prior to running my analyses.

Furthermore, due to the nested nature of the data, I applied analysis of variance to calculate the intra-class correlation coefficient (ICC) to determine whether clustering would influence the results. Moreover, I used the chi-square statistic to assess the significance of the between-group variance indicating whether the dependent variable varied across groups.

**Tests of moderated mediation.** To test Hypotheses 6 and 9 (i.e., moderated mediation effects), I utilized Bauer, Preacher, and Gil's (2006) approach to examine the effects of moderated mediation in multilevel models. Moreover, the recommended bootstrapping methods were used to examine the significance of the conditional indirect effect on the outcome variables at different values of the group-level moderator (i.e., +1 standard deviation and -1 standard deviation of moderator).

## Results

Means, standard deviations, reliabilities, and intercorrelations among the variables are presented in Table 1. Workers' safety knowledge was positively related to workers' safety priority ( $r = .20, p < .01$ ). Workers' safety priority was positively correlated to safety performance ( $r = .38, p < .01$ ). These bivariate results provided preliminary support for the hypothesized relations.

### Testing Main Effects and Mediation Effects

Table 2 presents unstandardized coefficient estimates for Hypotheses 1-3. The direct effect of safety knowledge on safety performance was significant ( $\gamma = .31, SE = .06, p < .01$ ), consistent with previous research (Christian et al., 2009; Neal & Griffin, 2004). In Hypothesis 1, I predicted a positive relationship between workers' safety knowledge and their safety priority. Supporting Hypothesis 1, workers' safety knowledge was positively associated with their safety priority ( $\gamma = .22, SE = .07, p < .01$ ), indicating that workers with higher levels of safety knowledge demonstrated higher levels of safety priority. Thus, Hypothesis 1 was supported.

In Hypothesis 2, I anticipated a positive relationship between workers' safety priority and their safety performance. Supporting Hypothesis 2, workers' safety priority was positively associated with their safety performance ( $\gamma = .39, SE = .06, p < .01$ ), suggesting that workers who

have higher levels of safety priority were more likely to report higher safety performance. Thus, Hypothesis 2 was supported.

In Hypothesis 3, I posited that workers' safety priority would partially mediate the relationship between safety knowledge and safety performance. After controlling for safety priority as a mediator, the effect of safety knowledge on safety performance was reduced ( $\gamma = .26$ ,  $SE = .01$ ,  $p < .01$ ), providing evidence of a partial mediation. Further, bootstrapping results indicated that the indirect effect was significant, with a bootstrapped 95% CI (the *estimate of an indirect effect* = .06; 95% CI=.0268, .1187; Preacher & Hayes, 2008). This result indicates that workers' safety knowledge was positively related to safety performance through their safety priority, providing support for Hypothesis 3.

### **Testing Group-Level Moderation Effects**

The ICC (1) for safety performance was .07 ( $\chi^2(61) = 102.40$ ,  $p < .01$ ), indicating that 7% of the variance in safety performance was explained by the group level (James, 1982; Muthén, 1994). These results consistently indicated that the ICC value was at acceptable levels (Bliese, 2000; Cheung & Au, 2005), and between-group variances were significantly different from zero. Thus, I used hierarchical linear modeling to test cross-level moderation effects.

Table 3 presents unstandardized coefficient estimates for Hypotheses 4-5. In Hypothesis 4, I predicted that supervisor feedback would moderate the relationship between safety knowledge and safety performance. Results showed that the interaction between workers' safety knowledge and supervisor feedback on safety performance was significant ( $\gamma = .30$ ,  $SE = .13$ ,  $p < .05$ ). More specifically, as shown in Figure 2, the simple slope analysis (Aiken & West, 1991) demonstrated that the relationship between workers' safety knowledge and safety performance was stronger



when the reception of supervisor feedback was high ( $t = 4.94$   $p < .01$ ) than when the reception of supervisor feedback was low ( $t = .87$ ,  $p = .39$ ). Thus, Hypothesis 4 was supported.

In Hypothesis 5, I posited that supervisor feedback would moderate the relationship between workers' safety knowledge and safety priority. Results revealed the interaction between workers' safety knowledge and supervisor feedback on safety priority was significant ( $\gamma = .33$ ,  $SE = .16$ ,  $p < .05$ ). Specifically, as shown in Figure 3, the simple slope analysis (Aiken & West, 1991) showed that the relationship between workers' safety knowledge and safety priority was stronger when the reception of supervisor feedback was high ( $t = 3.60$   $p < .01$ ) than when the reception of supervisor feedback was low ( $t = .07$ ,  $p = .94$ ). Thus, Hypothesis 5 was supported.

In Hypothesis 6, I posited that received supervisor feedback would moderate the indirect effect of workers' safety knowledge on safety performance via safety priority. I used Bauer et al.'s (2006) method to estimate the indirect effect of workers' safety knowledge on safety performance via supervisor feedback at higher (+1 standard deviation) and lower levels (-1 standard deviation). Results showed that the indirect effect was not significant when supervisor feedback was high ( $Estimate = -.34$ ,  $SE = 1.22$ ,  $p = .78$ ) and when it was low ( $Estimate = -.29$ ,  $SE = 1.02$ ,  $p = .78$ ). Thus, Hypothesis 6 was not supported.

Table 4 presents unstandardized coefficient estimates for Hypotheses 7-8. In terms of Hypothesis 7, I expected that supervisors' safety attitudes would moderate the relationship between safety knowledge and safety performance. However, the interaction term of safety knowledge and supervisors' safety attitudes on safety performance was not significant ( $\gamma = .002$ ,  $SE = .18$ ,  $p = .99$ ), thereby failing to support Hypothesis 7.

With regard to Hypothesis 8, I anticipated that supervisors' safety attitudes would moderate the relationship between workers' safety priority and their safety performance. Results

indicated a significant interaction effect of workers' safety priority and supervisors' safety attitudes on workers' safety performance ( $\gamma = .57, SE = .16, p < .01$ ; see Table 4). More specifically, as shown in Figure 4, the simple slope test (Aiken & West, 1991) revealed that the relationship between workers' safety priority and safety behaviors was stronger when supervisors have a positive safety attitude ( $t = 6.50, p < .01$ ), compared to when supervisors have a negative safety attitude ( $t = 2.67, p < .05$ ). Thus, Hypothesis 8 was supported.

To test Hypothesis 9, I utilized Bauer et al.'s (2006) approach to estimate the conditional indirect relationships of workers' safety knowledge on safety performance via safety priority at positive (+1 standard deviation) and negative states (-1 standard deviation) of supervisors' safety attitudes as a group-level moderator. Results indicated that the indirect effect was stronger when supervisors' safety attitude was positive (*Estimate* = .11, *SE* = .05,  $p < .05$ ) than when supervisors' safety attitude was negative (*Estimate* = .04, *SE* = .04,  $p = .33$ ). Moreover, bootstrapping results revealed that the indirect effect from workers' safety knowledge on safety performance (through workers' safety priority) was significant when supervisors had positive attitudes toward safety (95% bootstrap CI = .03; .20), and were not significant when supervisors attitudes towards safety were less positive (95% bootstrap CI = -.03; .10). Therefore, Hypothesis 9 was supported, indicating that when supervisors' safety attitude was positive, the relationship between workers' safety knowledge and safety performance via safety priority was stronger.

## **Discussion**

The purposes of the present study were to shed light into how and why workers' safety knowledge has positive impact on their safety performance and identify what organizational factors can strengthen this relationship. To extend our understanding of occupational safety, I built on the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and the

KAB approach (Fabrigar et al., 2006) to propose that research should include workers' safety priority as a mechanism underlying the relationship between safety knowledge and safety performance in the existing integrative safety model. In so doing, this study examined the relationships between workers' safety knowledge, safety priority and safety performance. Specifically, I predicted that workers' safety knowledge would have a positive impact on their safety priority, which in turn would increase workers' safety performance. Moreover, I also anticipated that supervisor feedback and supervisors' safety attitudes could strengthen the relationships between workers' safety knowledge, safety priority, and safety performance.

With some exceptions, the results generally support my hypotheses. First, my findings indicate that workers' safety knowledge was positively related to their safety priority, which in turn had a positive influence on their safety performance. Second, consistent with my expectations, supervisor feedback moderated the relationship between workers' safety knowledge and safety performance. Specifically, workers' safety knowledge was more strongly related to their safety performance when they received more supervisory feedback. Further, as predicted, the positive effect of workers' safety knowledge on their priority of safety was stronger when workers acquired more feedback from their supervisors. Unexpectedly, results of the moderated mediation in multilevel modeling did not suggest that supervisor feedback moderated the indirect relationship between workers' safety knowledge and safety performance. Third, contrary to my expectation, the moderating effect of supervisors' safety attitudes on the relationship between workers' safety knowledge and safety performance was not significant. However, consistent with my predictions, supervisors' safety attitudes moderated the relationship between workers' safety priority and safety performance. Specifically, workers' safety priority was more strongly associated with their safety performance when their supervisors demonstrated

a positive safety attitude. Moreover, the results demonstrate that supervisors' safety attitudes strengthened the indirect relationship between workers' safety knowledge and safety performance. I discuss theoretical and practical implications of these findings in the proceeding sections.

### **Theoretical and Practical Implications**

The results of the current study contribute to the occupational safety literature by corroborating and extending previous findings in several ways. First, the significant findings of the mediating role of workers' safety priority on the safety knowledge-safety performance relationship might extend the existing integrative safety model and the attitude theory (i.e., theory of reasoned action). Past research has devoted attention to the linkage between safety knowledge and safety performance, and to my knowledge, relatively little research has investigated the mechanism underlying this linkage. In a recent meta-analytic research, Christian and colleagues (2009) found that safety knowledge is a significant determinant of safety performance which relates to the likelihood of workplace injuries and accidents. Their results suggest that workers who know why safety is important and how to perform safely can enact their safety behaviors to decrease the risks of accidents and injuries in the workplace. However, there has only been a limited understanding of the mechanism of the safety knowledge-safety performance relationship. The present study is one of the first attempts to investigate why and how workers' safety knowledge influences their safety performance. The theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and KAB approach (e.g., Fabrigar et al., 2006) posit that the information individuals own influences their attitudes toward the target outcome, which in turn impacts their behaviors. Consistent with this theoretical rationale, my findings demonstrate that workers who had high safety knowledge tended to display high priority

of safety, and this high safety priority resulted in increased safety performance. This finding is important because it suggests that safety priority, a significant dimension of safety attitude, is a proximal factor of safety performance and can explain why and how safety knowledge leads to safety performance. That is, the relationship between safety knowledge and safety performance is mediated by workers' safety priority. Therefore, my findings, which were built on attitude theory, might advance our understandings of the integrative model of occupational safety (Christian et al., 2009; Neal & Griffin, 2004).

Second, my findings are also important because they indicate that the reception of supervisor feedback is a cross-level moderator that can strengthen the direct effects of workers' safety knowledge on safety performance as well as safety priority to decrease workplace accidents and injuries. Prior research has identified that leaders' safety expectations and safety orientation are important in enhancing occupational safety (Barling et al., 2002; Inness, Tuner, Barling, & Stride, 2010). Through interaction with supervisors, workers can effectively improve their safety behaviors and decrease frequencies of workplace injuries and accidents (Zohar & Luria, 2003). For instance, increased safety-oriented interaction (e.g., safety-specific discussion or feedback) between supervisors and subordinates can result in decreased injury rates (Zohar, 2002). Based on role theory, through supervisors, workers can increase their understanding of their expected safety behaviors, which in turn increase their safety behaviors (Hofmann & Morgeson, 1999; Hofmann, Morgeson, & Gerras, 2003). Consistent with this evidence regarding the importance of supervisor feedback on occupational safety, my findings suggest that when supervisors provide more feedback, workers who possess high levels of safety knowledge will engage in higher safety performance because they view safety priority as more crucial. Unexpectedly, I obtained non-significant findings regarding the moderating effect of supervisor

feedback on the indirect relationship between safety knowledge and safety performance. One of the possible reasons for this is that the variance of safety priority explained by group-level factors is only 1%. Thus, lack of adequate variance fails to support the moderated mediation effect.

Third, the findings of the moderating role of supervisors' safety attitudes also contribute to the research on supervisors' safety behaviors. Consistent with the assumptions of safety-specific leadership research (e.g., safety-specific transformational leadership) and the theory of reasoned action, supervisors' attitudes and behaviors influence workers' perception of organizational norms (e.g., safety norms) and expectations (e.g., safety expectations) which may affect their attitudes and subsequent behaviors (e.g., safety behaviors). Previous research suggested that supervisors' safety attitudes influence workers' attitudes toward safety and their subsequent safety behaviors (Cavazza & Serpe, 2009; McLain, 2014). Supervisors' safety attitudes represent safety norms and safety-related policies in the workplace (Zohar & Polachek, 2014). Perceived safety norms have a significant impact on workers' safety behaviors and occupational injuries (Fugas, Meliá, & Silva, 2011; McGonagle, Walsh, Kath, & Morrow, 2014). The findings in the present study show that supervisors' positive safety attitude is a significant factor that can increase both the direct effect of safety priority on safety performance and the indirect effect of safety knowledge on safety performance. Unexpectedly, the results showed non-significant findings regarding the moderating effect of supervisors' safety attitudes on the direct relationship between safety knowledge and safety performance. Perhaps this expected interaction effect did not emerge because safety knowledge is explicit task-based information rather than an implicit organizational/group norm. Workers with high levels of task-based knowledge might be better positioned to demonstrate high safety performance. However,

supervisors' attitudes represent beliefs in the group and informal policies/rules. Thus, due to different components, it is possible that the results did not yield support for the moderating effect of supervisors' safety attitudes on this relationship.

Despite that, the direct path of leaders' behaviors on safety-related outcomes has been identified in occupational safety literature (Zohar, 2002; Zohar & Luria, 2003; Zohar & Polachek, 2014). The findings in the present study advance our knowledge of supervisors' behaviors on occupational safety and suggest that supervisor feedback and supervisors' safety attitudes as group-level factors can increase the relationship between proximal person-related factors (e.g., safety knowledge and safety priority) and subsequent safety performance (e.g., Christian, et al., 2009). Overall, the present study is important because my findings of moderation and moderated mediation help clarify how personal factors and situational factors interact to increase occupational safety (Westaby & Lee, 2003)

The current study also has numbers of practical implications. First, the results demonstrate that workers' safety knowledge relates to their safety performance through the priority of safety. My findings suggest that organizations concerned with occupational safety should consider including the evaluation of workers' priority of safety in the workplace and providing workers with the results of the evaluation to increase safety performance and decrease accidents and injuries (Zohar & Polachek, 2014). Second, my findings suggest that supervisor feedback interventions can play an important role in improving occupational safety. Safety-related feedback interventions can direct workers' attention and awareness toward safety that can then lead to improvements in safety performance. Through frequent discussion and communication regarding safety actions and expectations with supervisors, workers can efficiently improve their safety performance (Zohar, 2002; Zohar & Polachek, 2014). Therefore,

organizations concerned with occupational safety should develop a safety-oriented feedback system to monitor workers' unsafe behaviors, discuss expected safety behaviors, and decrease the likelihood of workplace accidents and injuries. Third, results of the present study indicate that when supervisors have positive attitudes toward safety, both the direct effect of safety priority on safety performance and the indirect effect of safety knowledge on safety performance are more positive. Consistent with prior research (Ford & Tetrick, 2011; Zohar, 2002), supervisors' safety action is a significant factor which influences workers' safety performance. Thus, my findings also suggest a training intervention targeting supervisors' safety orientation, including their safety attitudes, safety behaviors, and safety-specific leadership.

### **Limitations and Future Research**

As with any study, this research is not without limitations. First, my model investigates the relationship between safety knowledge, safety priority, and safety performance and the moderating effects of supervisor feedback and supervisors' safety attitudes on these relationships. In order to more adequately test and extend the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), Ajzen (1990) suggested that perceived control belief, representing an individual's belief about how easy or difficult performance of the behavior is likely to be, is also a significant determinant of intentions and behavior (i.e., the theory of planned behavior). Additionally, the quality of the relationship between supervisors and subordinates may affect subordinates' attitudes, behaviors, and job performance (Wang, Law, Hackett, Wang, & Chen, 2005). For instance, research found that trust in the relationship between supervisors and workers has a significant impact on the effectiveness of supervisors' safety-specific behaviors on workers' safety performance (Conchie, 2013; Conchie & Donald, 2009). Thus, future research that attempts to replicate or extend the current research should



consider control beliefs and supervisor credibility that might influence the effects of supervisor-relevant variables on safety outcomes.

Although one of the strengths of the present study is that the data were collected from multiple sources at different time points to eliminate common method variance (Podsakoff, MacKenzie, Lee & Podsakoff, 2003), it is necessary for future research to further utilize different methods to collect objective data to decrease a distortion and oversimplification of true measures. Specifically, in the present study, supervisors did not rate workers' safety behaviors. Instead, workers rated their own safety performance. It is important to reduce measure bias (e.g., social desirability and leniency biases) to influence response on items as well as focal relationships (Podsakoff, MacKenzie, & Podsakoff, 2012). As such, future research can provide a more rigorous empirical examination in occupational safety literature to avoid the potential for method variance to emerge (Spector, 2006). For instance, researchers can consider using behavioral observation data to assess workers' safety performance rather than self-report measures.

Third, the construct of safety performance can be operationalized as two types of safety behaviors (Christian et al., 2009; Griffin & Neal, 2000): (a) *safety compliance* refers to the core activities that individuals need to meet minimum safety standards to maintain workplace safety, and (b) *safety participation* refers to behaviors that involve participation in voluntary safety activities. Due to different constructs of safety performance, the effects of various factors on safety participation and safety compliance would be varied. For example, leaders' behaviors (e.g., transformational leadership) have great impact on motivation influences (i.e., safety participation), and individual differences are most strongly related to in-role behaviors (i.e., safety compliance) (Inness et al, 2010). However, I examined safety performance as a unitary

construct, and the present study is unable to identify the specific aspects of safety performance. Thus, future research should examine different types of safety behaviors that might have unique relations with antecedents.

Fourth, given that the present study was conducted in an oil construction context with male workers as the majority of participants, I caution to generalize my findings to other workplace contexts. However, according to the United States (U.S.) Bureau of Labor Statistics, construction workers had the highest number of fatal injuries of any occupation in 2013 (BLS, 2014). Therefore, my findings still contribute to enhancing workers' safety performance and decreasing workplace injuries and accidents. To ascertain the generalizability of results from the present study, future research that attempts to extend the current research framework in different occupations, organizations, and cultures will allow for a better understanding of the application of these finding to a wider range of work contexts.

Lastly, although theoretical arguments developed here, based on previous research (e.g., Christian et al., 2009; Neal & Griffin, 2004), suggest that safety knowledge is more likely to relate to safety performance and safety priority, the reverse relationship cannot be completely ruled out. Workers rated their safety knowledge at Time 1 and their safety performance and safety priority at Time 2. It might be possible that safety performance at Time 1 would result in safety knowledge and safety priority at Time 2. For example, workers who demonstrate low safety performance at Time 1 may receive safety-related feedback to increase safety-specific knowledge and priority of safety at Time 2. However, the present study is unable to test this possible reverse causation. Hence, future research should clarify whether this reverse relationship could be supported.

## **Conclusions**

Although a linkage between safety knowledge and safety performance has been found, it is imperative to understand why and how safety knowledge leads to safety performance. To my knowledge, this is the first study to address the existing research gap by identifying workers' safety priority as a mechanism underlying this linkage. My findings demonstrate workers' safety knowledge is positively related to safety priority, which in turn enables workers to demonstrate high safety performance. Moreover, the present study highlights the identification of the interaction between personal factors (e.g., safety knowledge) and situational factors (e.g., supervisors' safety attitudes) as a way to increase occupational safety. My findings show that supervisor feedback can strengthen the effects of workers' safety knowledge on safety performance and safety priority. Moreover, when supervisors demonstrate positive safety attitudes, both the direct effect of workers' safety priority on safety performance and the indirect effect of workers' safety knowledge on safety performance are stronger. My findings also provide organizations the practical implication that safety interventions aimed at promoting occupational safety should develop a safety-specific feedback system and target supervisors' safety-oriented training.

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Table 1

*Means, Standard Deviations, and Bivariate Correlations among Studied Variables*

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8
Level 1										
1. Gender <sup>a</sup>	1.23	.42	—							
2. Age	45.92	12.02	-.18*	—						
3. Tenure	9.15	8.46	-.17*	.46**	—					
4. Safety knowledge	4.12	.57	-.04	-.13	-.04	(.80)				
5. Safety priority	4.54	.60	-.14	.15*	.10	.20**	(.86)			
6. Safety performance	4.09	.53	-.11	.001	-.02	.38**	.42**	(.88)		
Level 2										
7. Supervisor feedback	3.60	.67							(.80)	
8. Supervisors' safety attitudes	4.16	.41							.13	(.72)

*Note.* Reliability coefficients are in parentheses along the diagonal. The correlations among Level 1 variables are based on 197 workers ( $N = 197$ ). The coefficients of supervisor safety priority as the Level 2 variable are based on 62 supervisors ( $N = 62$ ). <sup>a</sup> Gender was coded as 0 =Female, 1=Male.

\* $p < .05$ . \*\* $p < .01$ .

Table 2

*Hierarchical Linear Modeling Results for the Relationships among Safety Knowledge, Safety Priority, and Safety Performance*

Predictor	Safety priority				Safety performance							
	Model 1		Model 2		Model 1		Model 2		Model 3		Model 4	
	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>
Intercept	4.57***	.04	4.57***	.04	4.10***	.05	4.09***	.04	4.09***	.04	4.07***	.04
Step 1: Control variables												
Gender	-.12	.12	-.12	.11	-.19	.10	-.15	.09	-.14	.09	-.10	.09
Age	.01	.01	.01*	< .01	< .01	< .01	< .01	.01	-.01	< .01	< .01	< .01
Tenure	< .01	.01	< .01	.01	< .01	.01	< .01	.01	-.01	.01	-.01	.01
Step 2: Direct effect												
Safety knowledge			.22**	.07			.31***	.06			.26***	.05
Safety attitudes									.39***	.06	.33***	.06
$R^2$	.16		.21		.15		.24		.40		.46	
$\Delta R^2$			.05				.09		.25		.06	

Note.  $N = 197$ . \*  $p < .05$ . \*\*  $p < .01$ .

Table 3

*Hierarchical Linear Regression Results for Testing Moderating Effects of Supervisor Feedback*

Predictor	Safety performance				Safety priority			
	Model 1		Model 2		Model 3		Model 4	
	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>
Intercept	4.09**	.04	4.07**	.04	4.57**	.04	4.55**	.04
Control variables								
Gender	-.15	.09	-.15	.09	-.13	.11	-.14	.11
Age	< .01	< .01	< .01	< .01	.01	< .01	.01	< .01
Tenure	< .01	.01	< .01	.01	< .01	.01	< .01	.01
Direct effect								
Safety knowledge (SK)	.30**	.06	.30**	.06	.24**	.08	.23**	.08
Supervisor feedback (SF)	.03	.08	.06	.08	-.14	.08	-.13	.08
Interaction effect								
SK x SF			.30*	.13			.33*	.16

*Note.* Level-1  $N = 197$ . Level-2  $N = 62$ . \* $p < .05$ ; \*\* $p < .01$ .

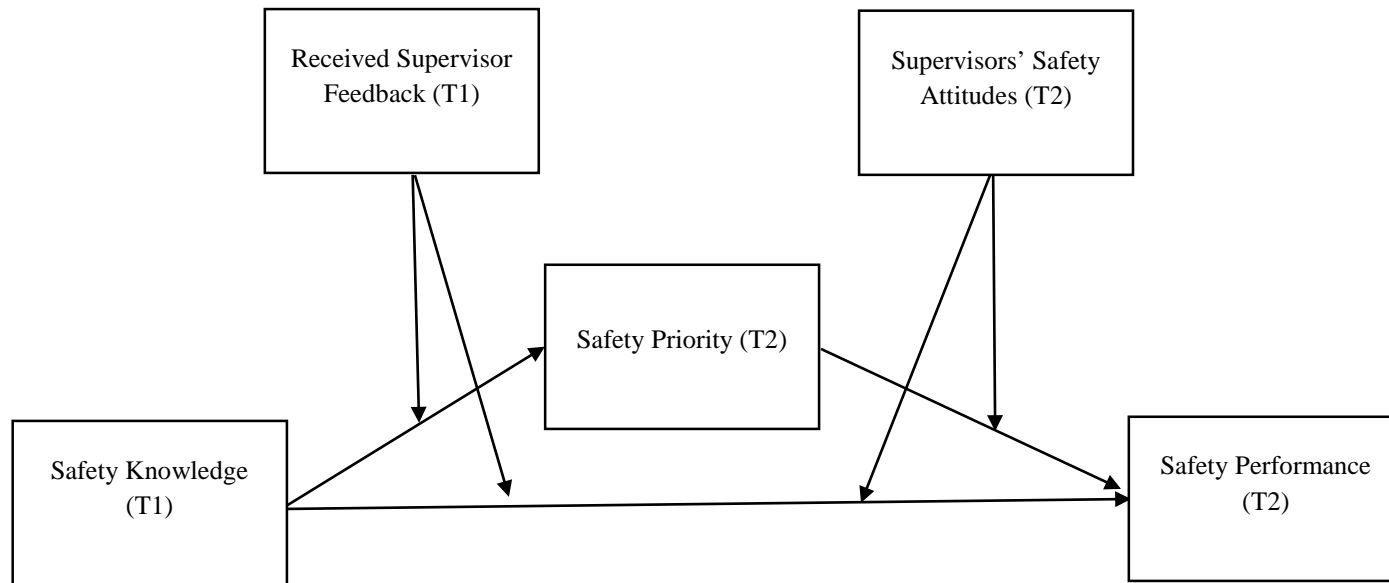
Table 4

*Hierarchical Linear Modeling Results for Testing Moderating Effects of Supervisors' Safety Attitudes on Safety Performance*

Predictor	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>	<i>Estimate</i>	<i>SE</i>
Intercept	4.09**	.04	4.20**	.04	4.10**	.04	4.09**	.04	4.09**	.04	4.05**	.04
Control variables												
Gender	-.15	.09	-.17	.09	-.17	.09	-.14	.09	-.15	.09	-.10	.09
Age	< .01	< .01	< .01	< .01	< .01	< .01	-.01	< .01	-.01	< .01	-.01	< .01
Tenure	< .01	.01	< .01	.01	< .01	< .01	-.01	.01	-.01	.01	< .01	.01
Level-1 Direct effect												
Safety knowledge (SK)	.31**	.06	.31**	.06	.31**	.06						
Safety priority (SP)							.39**	.06	.37**	.06	.44**	.06
Level-2 Direct effect												
Supervisors' safety attitudes (SSA)			.29*	.11	.29*	.12			.12	.11	.13	.12
Interaction effect												
SK x SSA					.002	.18						
SP x SSA											.57**	.16

Note. Level-1  $N = 197$ . Level-2  $N = 62$ . \* $p < .05$ ; \*\* $p < .01$ .





*Figure 1.*

The conceptual model of the current study

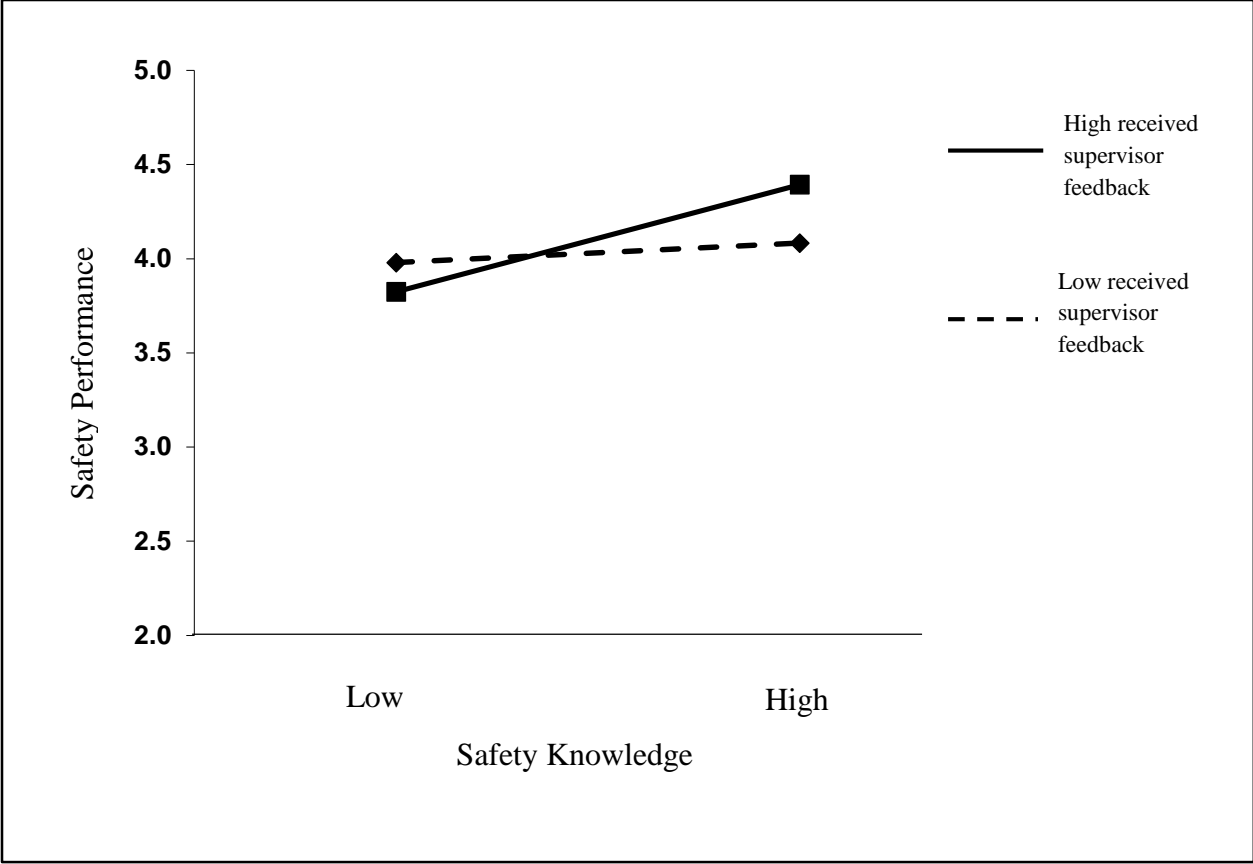


Figure 2. The interaction between workers' safety knowledge and received supervisor feedback on safety performance

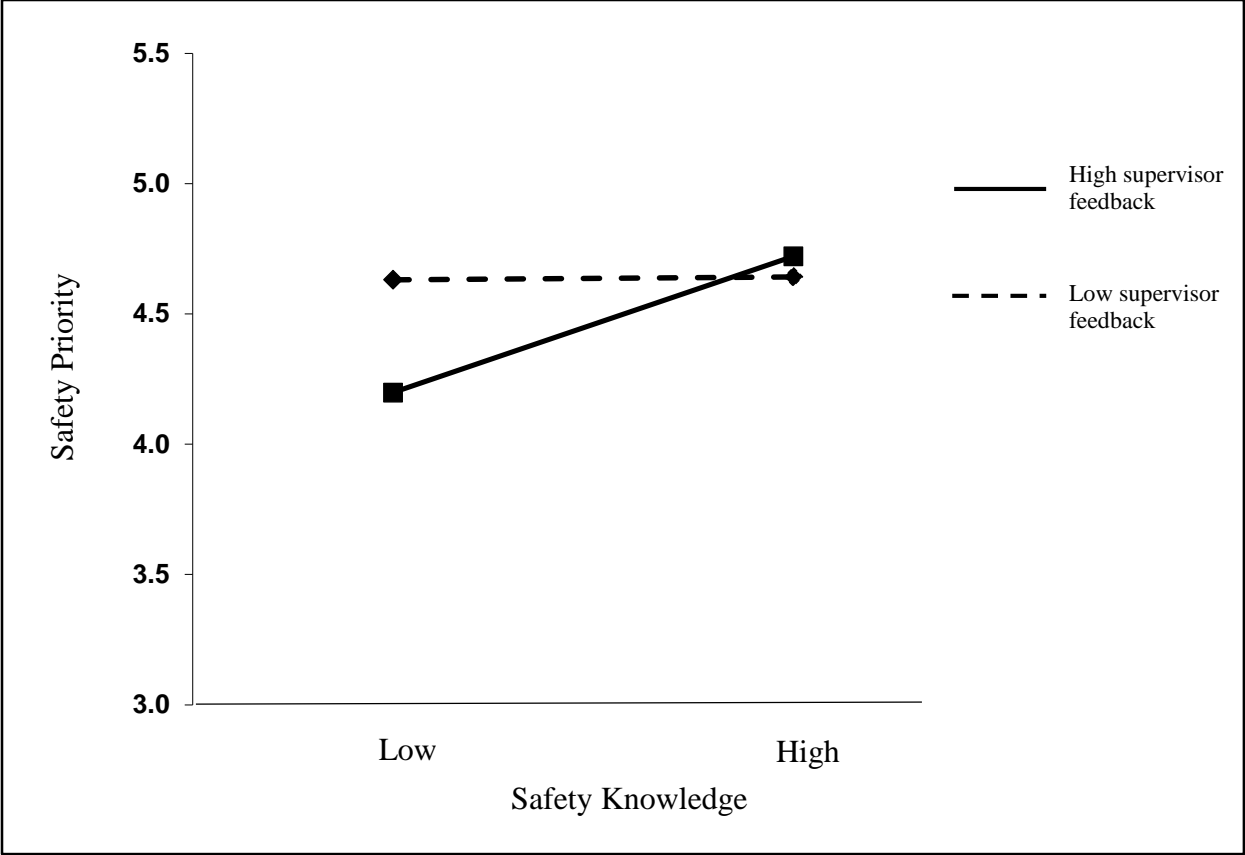


Figure 3. The interaction between safety knowledge and supervisor feedback on workers' safety priority

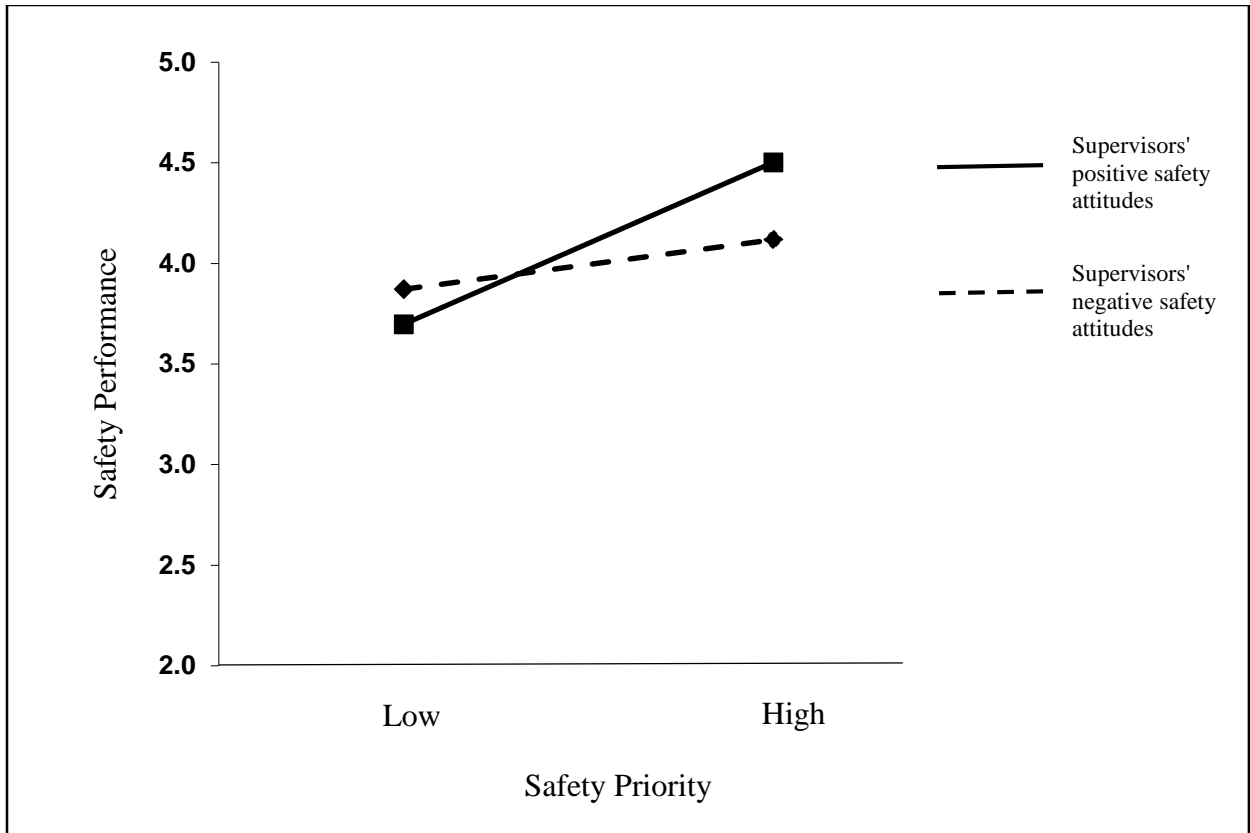


Figure 4. The interaction between workers' safety priority and supervisors' safety attitudes on safety performance

## Appendix

Safety knowledge	I know how to perform my job in a safe manner I know and understand my safety responsibilities I know how to use safety equipment and standard work procedures
Supervisor Feedback	My supervisors let me know how well I'm doing on the job Supervisors often let me know how well they think I'm performing on the job My supervisors almost never give me feedback about how well I'm doing in my work
Safety Priority	Sometimes it is necessary to depart from safety requirements for the sake of production (R) Sometimes it is necessary to take safety risks to get a job done efficiently (R) Sometimes it is necessary to take safety shortcuts to get a job done on time (R)
Safety Attitude	Good proposals on how to improve safety should be dropped if they cost too much (R) Good operational practice often conflicts with personal safety improvement measures (R) Safety rules and instructions sometimes make it difficult to keep up with production targets (R) Reporting safety breaches is an unnecessary hassle (R)
Safety Performance	I inspect and test all personal protective equipment I always wear personal protective equipment while performing hazardous work. I communicate every potential exposure to key personnel responsible for site health and safety. I always notify workers, supervisors, and/or emergency coordinators when emergency conditions arise. I follow all safety procedures regardless of the situation I am in I always encourage coworkers to be safe I report safety problems to my supervisor whenever I see safety problems I always correct safety problems to ensure accidents will not occur