Predicting Safety Performance:
A Meta-analysis of Safety and Organizational Constructs

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ABSTRACT
We meta-analytically summarize the research that investigates factors that influence safety performance. Results indicate safety-related and general organizational antecedents have moderate to strong relationships with safety climate. Leadership and safety climate both demonstrate moderately negative relationships to accidents and injuries and moderately positive relationships with positive safety behavior.

PRESS PARAGRAPH
This article meta-analytically summarizes the research that has investigated a range of factors that may influence safety performance. The article focuses on the relationships between three sets of antecedents (safety-related, general organizational, and safety climate) and two outcomes (safety-related and general organizational). We also examine the individual differences of age, gender, and tenure. Results based on 59 independent samples indicate safety-related antecedents and general organizational antecedents have moderate to strong relationships with safety climate. Results also demonstrate that leadership and safety climate both demonstrate moderately negative relationships to accidents and injuries and moderately positive relationships with positive safety behavior.

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Organizations operating in high risk environments are typically concerned with the safety performance of their workforce. There are ample reasons for such a concern. For example, in 2004 there were 4,900 workplace fatalities and 3.7 million disabling injuries in the United States alone. Production time lost due to these on-the-job injuries totaled 80 million days and production time lost in future years is estimated to be 65 million days. Overall, on-the-job injuries cost an estimated $142.2 billion (National Safety Council, 2006). Finally, these costs do not include the psychological costs (e.g., pain, suffering, grief, and loss) or the damage to an organization's reputation that might negatively impact recruiting and other efforts.

Given these high human and financial costs, many different disciplines have investigated how to improve safety performance. Recently, there has been increased attention given to organizational and management influences on safety performance (e.g., Hofmann, Jacobs, & Landy, 1995; Hofmann & Stetzer, 1996; 1998; Neal, Griffin, and Hart, 2000; Zohar, 2000), with a particular focus on the role "safety climate" plays in the safety performance of an organization. The current research seeks to meta-analytically summarize the research that has investigated a range of factors that may influence safety performance. We chose to summarize the research by calculating a meta-analytic correlation matrix which presents several pieces of information about the population correlation estimates. We focus on the relationships between three sets of antecedents (safety-related, general organizational, and safety climate) and two outcomes (safety-related and general organizational). We also examine the individual differences of age, gender, and tenure.

Antecedents to Safety Performance

Safety-related Antecedents

Researchers in the safety realm have often examined a set of safety-related antecedents. This first is the risks and hazards associated with work itself (e.g. DeJoy, Schaffer, Wilson, Vandenberg, & Butts, 2004; Goldenhar, Williams, & Swanson, 2003). This includes the risk of injury to self and others and the presence of hazards in the workplace. The second concerns a range of safety prevention activities (e.g. Hayes, Perander, Smecko, & Trask, 1998). These activities include the use of safety-related training, implementation of safety policies, rules, and procedures, and the use and availability of personal protection equipment. The third safety-related antecedent concerns the amount of involvement, participation, and communication workers have about safety-related issues (e.g. Hofmann & Stetzer, 1996). It is likely that work with greater risks and hazards will have greater accident and injury rates. Safety prevention activities and safety involvement, on the other hand, will likely lead to lower accidents and injuries as well as more positive safety behaviors.

General Organizational Antecedents

In the last 10 years researchers have become increasingly interested in how the more general organizational factors of job demands, leadership, and commitment can impact safety performance. Job demands involve the range of physical and cognitive demands job place on workers (e.g. Barling, Loughlin, & Kelloway, 2002). This includes the environmental conditions in which the work is performed, scheduling and workload, physical demands of the work, and the overall complexity of work. Leadership involves the way in which workers are managed by their supervisors (e.g. Fogarty, 2004; Hofmann, Morgeson, & Gerras, 2003). This includes the particular style of leadership employed, the relationship between a leader and follower, the accountability established by the leader, and the trust a worker has in his or her leader. Commitment involves the extent to which a worker feels attached to the organization and the job.

It is likely that work with greater job demands will lead to more accidents and injuries and fewer positive safety behaviors. On the other hand, more positive leadership and greater commitment is likely to lead to fewer accidents and injuries and more positive safety behaviors.

Safety Climate

Safety climate has been one of the most frequently studied antecedents of safety performance. Although originally conceived in 1980 (Zohar, 1980), the concept of safety climate did not receive a great deal of attention in the academic research literature until more recently. In general, climate can be defined as the perceptions of the events, practices, and procedures as well as the kind of behaviors that get rewarded, supported and expected in a particular organizational setting (Schneider, 1990). Given this definition, it follows that safety climate encompasses perceptions of safety-related events, practices, and procedures as well as the types of safety-oriented behaviors that get rewarded, supported and expected. Thus, employees might perceive the way in which organizational safety policies and procedures signal a strong or weak commitment to safety. Likewise, employee perceptions of how supervisors respond to safety violations, or how seriously they view these breaches of safety policy would signal whether safety is valued or not. These perceptions are likely to influence positive safety behaviors and the occurrence of accidents and injuries.

Method

Literature Search

A literature search was conducted to identify published articles, conference papers, doctoral dissertations, and unpublished manuscripts that were related to safety climate. The articles were identified through computer-based searches of the *PsychInfo (1887-2005), Web of Science ISI (1970-2005),* and *Medline (1950-2006)* databases. Searches included the terms *safety*

climate and *safety culture.* The electronic search was supplemented with a manual search of reference lists of key empirical and theoretical articles on safety. The searches identified approximately 300 articles.

Inclusion Criteria

The abstracts obtained as a result of this initial search were reviewed for appropriate content and considered for inclusion in the meta-analysis. After reading through the abstracts, studies without data (theoretical work or literature reviews) and studies outside of the context of work were eliminated. This resulted in identifying an initial population that was split among the three authors for review. Overall, the authors examined 208 studies to determine whether the study would be included in the meta-analysis.

A number of decision rules were used to determine which studies would be included in the meta-analysis. First, a study must have investigated at least one relationship from the constructs of interest. Second, studies had to report sufficient results to calculate an effect size for the relationship. Third, the study had to be a unique sample that had not been previously included in the current meta-analysis. When we determined that a dataset had been utilized more than once, we examined the studies to determine whether a study presented unique information and coded any unique relationships. If the study did not present unique information, we did not include both studies in the meta-analysis. These selection criteria reduced our final study population to 59 articles.

All three authors participated in the coding of the studies. Each author coded approximately one-third of the total set of manuscripts. The authors independently coded each manuscript and met weekly, as a group, to discuss the manuscripts coded that week. During the weekly meetings, the authors clarified any ambiguous coding situations (e.g., whether a variable

represented construct A or construct B), discussed whether an article's dataset was unique, and worked to achieve consensus amongst the authors on any disagreements.

In conducting this meta-analysis, we tried to be as comprehensive as possible in capturing all safety related constructs. Our initial set of safety related constructs was derived from reviewing approximately 50 articles. We also examined our population of 208 articles for any additional safety related characteristics. At our weekly meetings, we discussed whether variables found in that week's articles should be coded. At the end of this process, we had a list of 53 total safety related characteristics to be coded.

Given the low *k* (*k* = 59 studies) associated with numerous relationships, after coding, the list of 53 characteristics was collapsed into 18 constructs. The 53 characteristics were collapsed into a narrower set of constructs by the three authors independently. After this independent assessment, the three authors met to discuss and constructs were collapsed into a category if at least two of the three authors agreed on the construct coding.

Meta-Analytic Procedures

We utilized the Schmidt-Hunter psychometric meta-analysis method (Hunter & Schmidt, 2004) to conduct the meta-analytic review. For studies with multiple measures of the same construct, we averaged correlations. This prevented a study being "double-counted" in the meta-analysis. In contrast, studies that included multiple independent samples were separately coded.

Also following previous recommendations, we corrected for unreliability in the measures. The correlations from individual samples were corrected for measurement error in both the predictor and the criterion scores using Chronbach's alpha coefficient. The majority of studies provided Chronbach's alpha coefficient for the measured variables. For the studies missing this reliability coefficient, we used the average value from the other studies (Hunter & Schmidt,

2004).

We present several pieces of information about the population correlation estimates. First, we include both the uncorrected (r) and corrected (r_c) estimates. Second, we include the 95% confidence interval (CI) for each corrected population correlation. Finally, we present the number of studies included in determining the correlation (k) and the total number of participants in the studies (n).

Results and Discussion

Table 1 presents the correlation results for the constructs of interest. The constructs in Table 1 are grouped by safety-related antecedents, general organizational antecedents, safety climate, safety-related outcomes, general organizational outcomes, and individual differences. The safety-related antecedents which include risks and hazards, safety prevention, and safety involvement, have small to moderate correlations with one another. Both safety prevention and safety involvement are negatively correlated to risks and hazards (r_c = -.16; r_c = -.24) and positively correlated with one another (r_c = .39). The safety antecedents are also moderately to strongly correlated with the organizational antecedents of leadership and commitment and demonstrate a small correlation with job demands. As would be expected, risks and hazards negatively correlate with overall safety climate and management safety climate (r_c = -.26; r_c = -.18), whereas safety prevention and safety involvement are positively correlated with the two safety climate constructs. However, risks and hazards is the only safety-related antecedent which correlates with accidents and injuries (r_c = .18). Safety prevention is also the only safety antecedent which demonstrates a meaningful relationship with positive safety behavior (r_c = .37) and the organizational outcomes of well being, satisfaction, and withdrawal behaviors (r_c =.18; r_c = .52; and r_c = -.20).

Among the general organizational antecedents, leadership and commitment are strongly correlated with one another (r_c = .66). Leadership and commitment are also strongly related to overall safety climate (r_c = .61; r_c = .59) and management safety climate (r_c = .75). Leadership also demonstrates moderate relationships with the two safety outcomes of accidents and injuries (r_c = -.27) and positive safety behavior (r_c = .50). Leadership also positively correlates with well being (r_c = .25), and satisfaction (r_c = .58). Commitment also meaningfully correlates to accidents and injuries (r_c = -.40), satisfaction (r_c = .59), and withdrawal behaviors (r_c = -.34).

Overall safety climate and management safety climate are also strongly correlated with one another (r_c = .63). As expected, overall safety climate negatively correlates with accidents and injuries (r_c = -.17) and positively correlates with positive safety behavior (r_c = .45). Management safety climate also demonstrates similar relationships, although a slightly stronger negative relationship with accidents and injuries (r_c = -.23) and a similar positive relationship with positive safety behavior (r_c = .42). The two climate constructs also positively correlate with well being (r_c = .21; r_c = .19) and positively correlate with satisfaction (r_c = .32; r_c = .39).

Interestingly, the safety-related outcomes do not demonstrate a meaningful relationship with each other. However, accidents and injuries negatively correlates with well being (r_c = -.16) and negatively correlates with satisfaction (r_c = -.23). In the organizational outcomes, well being and satisfaction positively correlate with one another (r_c = .26). Finally, the individual differences do not demonstrate meaningful relationships with most of the other constructs. Where they do demonstrate meaningful relationships (e.g. tenure to safety involvement), the relationships are small in magnitude (e.g. r_c = .06).

Discussion

The current research sought to meta-analytically examine a range of safety-related and

general organizational antecedents to safety-related and general organizational outcomes. We found that leadership and commitment have the strongest relationships with accidents and injuries, whereas safety climate and leadership have the strongest relationships with positive safety behavior. Interestingly, these same constructs evidenced meaningful relationship with such general organizational outcomes as well being and satisfaction. This suggests that some of the factors that lead to a safe working environment also produce other organizational benefits.

This research contributes to the research literature in several ways. First, it represents the first meta-analytic test of a range of antecedents of safety performance. Understanding the antecedents of safety performance is important given the high human and financial costs noted earlier. Second, the current meta-analysis clarifies the relationships between organizational and safety-related antecedents and outcomes and provides evidence of which factors are more influential in establishing strong safety performance. Finally, the meta-analysis investigates the role of safety climate, which is one of the most often studied antecedents of safety performance.

There are several limitations associated with the current study. First, for many of the relationships examined, relatively few studies have been conducted. Clearly, additional research needs to be conducted to expand our understanding of safety performance. Second, the low number of studies limited our ability to conduct moderator analysis between relationships. Finally, although we examined bivariate relationships between antecedents and outcomes, there are likely more complex causal models linking antecedents to outcomes. For example, it is possible that safety climate encourages positive safety behaviors, which in turn leads to fewer accidents and injuries.

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Table 1

Interrelationships of Safety and Organizational Constructs

	Risks & Hazards	Safety Prevention	Safety Involvement	Job Demands	Leadership	Commitment	Overall Safety Climate	Management Safety Climate	Accident / Injury	Positve Safety Behavior	Well Being	Satisfaction
	r, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)
Safety-related antecedents												
Risks & Hazards	--											
k, N												
	-0.14, -0.16											
Safety Prevention	(-.27, -.05)	--										
k, N	10, 6544											
	-.21, -.24	.31, .39										
Safety Involvement	(-.38, -.11)	(.29, .48)	--									
k, N	5, 3375	13, 8266										
General organizational antecedents												
	.09, .12	-.03, -.03	.09, .11									
Job Demands	(.05, .19)	(-.12, .06)	(.07, .15)	--								
k, N	8, 4328	9, 4413	5, 2812									
	-.27, -.31	.38, .47	.44, .52	-.03, -.04								
Leadership	(-.46, -.17)	(.40, .54)	(.38, .65)	(-.14, .07)	--							
k, N	7, 6751	13, 5529	9, 3692	6, 3863								
		.45, .64	.50, .62		.54, .66							
Commitment		(.43, .85)	(.32, .91)		(.53, .79)	--						
k, N		4, 995	4, 885		4, 942							
Safety climate												
Overall Safety	-.22, -.26	.40, .48	.45, .54	.09, .11	.52, .61	.48, .59						
Climate	(-.42, -.09)	(.38, .59)	(.39, .68)	(-.02, .25)	(.52, .71)	(.44, .73)	--					
k, N	10, 6091	19, 7139	11, 4378	10, 4801	21, 7788	5, 1049						
Management Safety	-.15, -.18	.39, .53	.43, .54	-.15, -.20	.58, .75		.51, .63					
Climate	(-.29, -.07)	(.45, .61)	(.32, .77)	(-.31, -.08)	(.61, .90)		(.40, .85)	--				
k, N	10, 4521	14, 5241	5, 1499	6, 1773	8, 2270		14, 4580					

	Risks & Hazards	Safety Prevention	Safety Involvement	Job Demands	Leadership	Commitment	Overall Safety Climate	Management Safety Climate	Accident / Injury	Positve Safety Behavior	Well Being	Satisfaction
	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)	r, r_c (95% CI)
Safety-related outcomes												
	.14, .18	-.05, -.07	-.05, -.06	.07, .09	-.22, -.27	-.33, -.40	-.14, -.17	-.19, -.23				
Accident / Injury	(.02, .33)	(-.16, .03)	(-.20, .08)	(.01, .16)	(-.37, -.16)	(-.64, -.17)	(-.26, -.08)	(-.33, -.13)	--			
k, *N*	10, 3306	17, 7832	9, 4410	10, 1607	14, 2441	2, 648	24, 5495	14, 4196				
	.03, .06	.25, .37		-.08, -.15	.33, .50		.33, .45	.29, .42	-.09, -.10			
Positve Safety Behavior	(-.28, .31)	(.32, .42)		(-.46, .16)	(.32, .68)		(.30, .61)	(.23, .61)	(-.39, .19)	--		
k, *N*	4, 2216	5, 1954		3, 1466	4, 1517		6, 2471	5, 2624	2, 53			
General organizational outcomes												
	-.08, -.11	.14, .18	-.10, -.12	.07, .10	.21, .25	-.02, -.03	.18, .21	.16, .19	-0.13, -0.16			
Well Being	(-.25, .03)	(.08, .28)	(-.32, .08)	(0, .20)	(.19, .31)	(-.48, .42)	(.16, .25)	(.02, .35)	(-.22, -.10)		--	
k, *N*	4, 745	3, 1209	2, 538	2, 524	3, 1022	2, 370	5, 1699	2, 652	5, 1527			
	-.02, -.02	.37, .52			.48, .58	.48, .59	.27, .32	.31, .39	-.18, -.23		.21, .26	
Satisfaction	(-.40, .37)	(.41, .63)			(.43, .74)	(.53, .65)	(.17, .47)	(.26, .53)	(-.44, -.02)		(.20, .31)	--
k, *N*	2, 1851	4, 2874			3, 1080	2, 706	7, 2654	5, 3519	7, 3927		3, 1175	
		-.17, -.20				-.30, -.34	-.13, -.17				.04, .05	
Withdrawal Behaviors		(-.31, -.10)				(-.44, -.25)	(-.33, 0)				(-.33, .44)	
k, *N*		2, 334				2, 370	2, 334				2, 370	
Individual differences												
	.02, .02	.03, .03	-.04, -.04	-.03, -.03	-.01, -.02		.02, .02		.12, .15			
Age	(-.20, .24)	(-.06, .11)	(-.14, .05)	(-.07, 0)	(-.07, .04)		(-.05, .08)		(-.07, .38)			
k, *N*	3, 3132	6, 3803	4, 2879	4, 3231	5, 3048		5, 4024		5, 1522			
		-.06, -.07	.07, .08				-.03, -.04	.02, .03	-.07, -.08			
Gender		(-.17, .02)	(.05, .11)				(-.21, .12)	(-.04, .09)	(-.19, .02)			
k, *N*		2, 5289	2, 5289				3, 3180	2, 972	3, 4053			
	.10, .12	-.04, -.04	.05, .06	.17, .21	-.07, -.08		-.02, -.02		-.03, -.04			
Tenure	(.04, .19)	(-.11, .03)	(.01, .11)	(.08, .34)	(-.16, 0)		(-.09, .04)		(-.11, .03)			
k, *N*	2, 2616	6, 3856	4, 2879	4, 3231	6, 3301		7, 4171		7, 1642			

	Withdrawal Behaviors	Age	Gender	Tenure
	r, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)	*r*, r_c (95% CI)
Safety-related outcomes				
Accident / Injury *k*, *N*				
Positve Safety Behavior *k*, *N*				
General organizational outcomes				
Well Being *k*, *N*				
Satisfaction *k*, *N*				
Withdrawal Behaviors *k*, *N*	--			
Individual differences				
Age *k*, *N*		--		
Gender *k*, *N*		.02, .02 (-.02, .06) 2, 2480	--	
Tenure *k*, *N*		.25, .29 (.12, .45) 7, 3655	-.03, -.03 (-.07, 0) 2, 2364	--