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Safety culture in the US fire service: an empirical definition

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Abstract

Purpose – The purpose of this paper is to provide a comprehensive model of safety culture for the US fire service.

Design/methodology/approach – Based upon a modified version of Cooper's Reciprocal Determinism Model, the research uses two sets of exogenous variables, labeled Safety Management System and Safety Related Behaviors, to explain a dependent variable called Organizational Safety Climate. The model has been used successfully to improve safety performance in other high risk, high performance organizations. Using survey data collected from over 1,000 firefighters in three medium-sized US municipalities, the theoretical model is tested.

Findings – Results from multiple regression analyses provide strong support for the hypothesis that individual perceptions of safety management and safety behavior predict individual perceptions of safety climate, both at the "fire service" organizational level and at the individual department level.

Research limitations/implications – Limitations of the study include a cross-sectional design, the use of self-reported perceptions for the variables, and the fact that the three mid-sized US fire departments from which data were gathered self-selected to participate in the study.

Practical implications – A practical feature of the theoretical model tested is the ability to create "safety report cards" for each of the 12 dimensions that define the three variables used in the study.

Social implications – This model holds the promise of reducing firefighter injuries and deaths by identifying managerial and behavioral safety improvement areas within US fire departments.

Originality/value – To the authors' knowledge, this research represents the first attempt to both identify and test empirically a safety culture model for the US fire service.

Keywords United States of America, Fire services, Occupational health and safety, Injuries, Death rate, US fire service, Firefighter injury, Fatality rates, Organizational safety culture

Paper type Research paper

Statement of the problem

Firefighter injury and fatality rates in the USA are six times higher than other industrialized nations and both are, albeit slowly, steadily increasing. From 1987 to 2007, more than 1.8 million firefighter injuries occurred and 2,150 firefighters died in the line of duty. With a total economic impact, borne largely by local governments, estimated at 88 billion dollars (Pessemier and England, 2010, p. 14) during the past 20 years, it is little wonder that firefighter deaths and injuries have been recognized as one of the most significant national problems in the US fire service (Frazier, 2005).

Although firefighting is inherently a hazardous occupation, the safety performance of other industrialized nations demonstrates that it is possible for the US fire service to reduce firefighter injury and fatality rates without necessarily lowering performance in the field. An examination of World Fire Statistics Center data comparing operational performance and safety performance appears, in fact, to indicate just the opposite. Higher levels of safety performance result in higher levels of operational performance in many European and Commonwealth nations (Pessemier and England, 2010, pp. 3-5).

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Why has the problem of high rates of firefighter injuries and fatalities in the USA been so persistent? Intuitively, one would predict a decline in both. After all, in the last two decades the fire service as an industry has worked diligently to enhance firefighter safety with significant improvements in apparatus (vehicles), tools, personal protective equipment, operational practices, fire codes, and fire service-related standards. For example, the National Fire Protection Association (NFPA) has developed and published numerous and various standards over the past 20 years on respiratory protection, incident management, hazardous materials, medical examinations, and physical fitness programs. All of these well-publicized efforts focussed on improving firefighter safety and performance. Nevertheless, the problem of large, comparatively speaking, US firefighter injuries and fatalities remains.

Numerous factors contribute to the inability of organizations to adapt. In recent years, the impact of organizational culture on institutional change and performance has been well documented (Marcoulides and Heck, 1993; Deshpande and Farley, 2004; Rose, 2008). Organizational culture is a combination of the practices, values, beliefs, and underlying assumptions that members within a group share about appropriate behavior (Rashid *et al.*, 2004). Increasingly, national and local fire leaders alike have begun to recognize that the organizational culture of the US fire service is a fundamental reason for its relatively low level of safety performance. As such, improvements in safety performance will require a change in organizational culture (Federal Emergency Management Agency (FEMA), 2004).

The purpose of this study is to provide a comprehensive model of safety culture for the US fire service. This model holds the promise of reducing firefighter injuries and deaths by identifying managerial and behavioral safety improvement areas within fire departments. Based upon a modified version of Cooper's (2000) Reciprocal Determinism model, the research uses two sets of exogenous variables labeled safety management system (SMS) and safety-related behaviors (SRBs) to explain a dependent variable called organizational safety climate (OSC). The model has been used successfully to improve safety performance in other high-risk, high-performance organizations, such as offshore drilling for petroleum. Using survey data collected from over 1,000 firefighters in three medium-sized US municipalities, the theoretical model is tested. Before discussing the data findings, we ground the research in the organizational culture literature.

Organizational culture

Organizational culture has been recognized as an important factor in the process of planned organizational change (Parker and Bradley, 2000; Rashid *et al.*, 2004), organizational effectiveness (Smircich, 1983), and successful performance improvement implementation (Detert *et al.*, 2000). Organizational culture also influences individual behavior, which subsequently determines the level of organizational performance (Yin-Cheong, 1989). If management strategies for change and improvement in performance are to be effective, managers must have a greater knowledge and understanding of the culture within their organization (Parker and Bradley, 2000; Balthazard *et al.*, 2006), which, as noted above, seems to have been ignored in the US fire service until recently.

Since organizational culture has a direct influence on organizational performance, it follows that a culture that does not value safety can result in dysfunctional outcomes (Balthazard *et al.*, 2006), such as firefighter injuries and deaths and lower levels of performance (higher property losses and civilian deaths compared to other

industrialized nations). In the fire service, this results from a safety culture defined by the normalization of high risk (e.g. rushing into empty burning buildings) and problematic SRBs (e.g. not wearing seat belts in vehicles, vehicles speeding to fires). Making improvements in dysfunctional outcomes requires organizational change. Organizational change will take place when three conditions are met: first, a problem is identified and the need to resolve the problem is accepted; second, people have an awareness and basic understanding of the nature of the problem; and third, information is available that allows people to define the problem and make appropriate choices between alternative courses of action (Bate, 1984).

Some issues persist and become repetitive despite the acceptance of the people involved that the situation is a problem and undesirable. Bate (1984) suggests that in these circumstances problem solving has become culture bound. The argument here is that fire service organizations are examples of capable and well-intentioned people who are culture bound and unable to solve the problem of safety performance due to a limited understanding of organizational culture. The fire service is in critical need of a model of organizational culture that can lead to greater safety performance. To be useful, this safety culture model must be practical and utilitarian, based on job-related managerial and behavioral factors, and provide results that are easily interpretable and can help fire officials better manage organizational safety. Cooper's modified Reciprocal Determinism model meet these criteria. Before presenting this model, the concept of safety culture as a subset of organizational culture merits discussion.

Safety culture

Safety culture is defined as the shared perceptions of individuals regarding critical behaviors, values and beliefs, and management control systems associated with safety (Clarke, 2000; Griffin and Neal, 2000; Reason, 1998). Clarke (1999) describes safety culture as a subset of organizational culture with specific reference to matters of safety. The concept refers to those factors in high-risk organizations that are important to safety (Parker *et al.*, 2006; Sorensen, 2002) and concerns how people think and behave in relation to safety (Cooper, 2000). Others argue that safety culture is a summary of the interpretations, perceptions, and beliefs of employees about safety that guides day-to-day behavior (Clarke, 2000; Silva *et al.*, 2004; Williamson *et al.*, 1997). This culture captures the essential shared values and beliefs, control systems, and behavioral norms that define an organization (Reason, 1998).

Researchers take different approaches to the study of safety culture depending on whether they view it as a shared pattern of behaviors or a shared pattern of meaning. The larger organizational culture research uses this same behavior-meaning distinction to classify the functionalist and interpretive approaches. The functionalist approach assumes that safety culture consists of critical variables that influence individual behavior and organizational outcomes. These variables create shared patterns of behavior and normative expectations and can be measured using quantitative methods (Naevestad, 2009). The functional approach assumes that safety culture consists of the policies, structures, controls, and practices regarding safety that are manageable to meet organizational interests (Glendon and Stanton, 2000).

In a functionalist model, management provides extrinsic forms of motivation in an attempt to shape safety culture. Research recognizes, however, that while behavioral changes may result from extrinsic motivators, employees may resist attempts by management to change their behaviors (Collinson, 2003). Hudson *et al.* (2004) argues that intrinsic motivations may be more powerful than extrinsic motivations; thus even

if behavioral changes occur, the underlying values and beliefs of individuals may remain unchanged.

From the interpretive approach, safety culture consists of the beliefs, attitudes, and values of the members formed by the interaction of members of the organization over time. Interaction forms shared patterns of meaning that are much deeper and more important because they provide members with a framework for interpreting their beliefs. The development of shared meaning also provides intrinsic motivation, legitimizes behaviors, and forms the basis for organizational identity (Naevestad, 2009). As a result, safety culture becomes the principle medium through which members interpret their collective identity, beliefs, and behaviors (Glendon and Stanton, 2000). From the interpretive view, safety culture is a complex outcome that is not easily changed or manipulated. However, while management cannot impose safety culture, it can change slowly over time as members make new interpretations and develop new meanings (Clarke, 2000).

Researchers disagree over whether the functionalist or interpretive approach is more important with regard to safety performance. Functionalists assert that shared patterns of behavior are more important, that behavior has the strongest influence on performance and that the meaning members attach to behaviors makes little difference. In contrast, proponents of the interpretive approach assert that shared meaning is more important than shared patterns of behavior since perception, interpretation, and meaning precede action. Meaning, so the argument goes, forms identity in organizations, which functions to support and sustain consistent behavioral patterns and subsequent performance.

Cooper (2000) avers that both the functional and interpretive approaches to understanding safety culture are equally important. Managerial strategies, he notes, emerge from social contexts created through a dynamic reciprocal relationship between people and the organizations in which they work. Reason (1998) also agrees that both approaches are essential for achieving a safety culture, but recognizes that the functional approach identifies dimensions of safety culture that are easier to manipulate, that can be shaped by organizational controls, and that can lead to more immediate changes in beliefs. Behaviors are easier to measure and change than values and beliefs because the latter are cognitive or affective states (Naevestad, 2009). As explained, the model used in the present study incorporates both the functional and interpretive approaches to organizational safety culture.

Safety culture attributes

Research generally describes the manifestations of safety culture as broad attributes, dimensions, or measures. These attributes of safety culture create frameworks that promote understanding of how practices and values regarding safety influence individuals and organizations (Glendon and Stanton, 2000). The overall purpose of these frameworks is to develop measures of safety culture to change and improve safety performance (Cooper and Phillips, 2004).

Previous research is instructive on what attributes to measure and how to measure them. Sorensen (2002) argues that the indicators of safety culture should include management practices, attitudes of individual toward safety, and safety practices. Flin *et al.* (2000) includes workforce perceptions of management behaviors, SMSs, attitudes toward risk, work pressure and the balance between safety and production, competence of the workforce, and perceptions of safety rules. Williamson *et al.* (1997) uses eight attributes for safety climate, including safety awareness, safety

responsibility, safety priority, management commitment, safety control, safety motivation, safety activity, and safety evaluation. On the surface, it may appear that the factors or dimensions used in safety culture research have largely depended on the specific definition of safety culture used by the researcher (Yule and Flin, 2007). However, this apparent lack of consensus may be more a matter of terminology than reality. Empirical analyses of safety culture use very similar dimensions, but with slightly different labels and descriptions.

Three general dimensions or attributes of safety culture emerge from the literature. Lund and Aaro (2004) includes attitudes and beliefs, behavioral norms, and organizational context. Reason (1998) asserts that these three dimensions interact to form safety culture: values and beliefs of individuals, behavioral norms with regard to safety practices, and the structure of and the control system used by the organization. Using a model borrowed from social cognitive theory, Cooper (2000) asserts that safety culture consists of a reciprocal relationship between personal factors (attitudes and beliefs), behavioral patterns, and organizational systems that interact to influence actual behaviors.

While much of the research on organizational culture generally and safety as a sub-culture focusses on values and practices, as noted above scholars repeatedly point to the importance of organizational systems as a distinct dimension of safety culture (Fernandez-Muniz *et al.*, 2007). Cooper (2000) defines organizational systems, also called SMSs, as systematic frameworks that include a number of elements, such as policy, goals, strategy, structure, planning, implementation, and performance management. These elements interact in an organized way to ensure that individual engage in appropriate safety behaviors (Santos-Reyes and Beard, 2002). SMSs are an important dimension of safety culture for two reasons. First, the characteristics of an organizations SMS influence individual values and beliefs regarding safety (Fernandez-Muniz *et al.*, 2007). Second, more developed SMSs have been found to correlate with better safety performance in terms of decreased injury rates, lower worker compensation costs, and improved levels of operational performance (Mearns *et al.*, 2003; Robson *et al.*, 2007). Effective SMSs as a set of strategies, functions, roles, and practices related to safety are internally integrated into organizational operations and ensure compliance with external safety-related regulations (Fernandez-Muniz *et al.*, 2007; Robson *et al.*, 2007). Some scholars argue that separating management practices from other behavioral norms provides a more comprehensive perspective on safety culture (Diaz-Cabrera and Hernandez-Fernaud, 2007). Others have found management approaches to safety as the most important dimension of safety culture because perceptions of management systems have the most significant impact on safety performance (Cooper and Phillips, 2004; Hofmann and Stetzer, 1996; O'Toole, 2002).

In sum, previous studies have identified three dimensions underlying organizational safety culture – values, practices, and organizational systems. For purposes of this research, these three dimensions are labeled as follows:

(1) SMS: includes organizational polices and managerial strategies and practices that help define safety in the organization;

(2) SRBs: includes perceptions about the degree to which members of the organization practice safe behaviors; and

(3) OSC: includes attitudes and beliefs about the value of safety in the organization.

Using a modified version of Cooper's (2000) Reciprocal Determinism model, Figure 1 shows the relationships among these three dimensions of variables[1].

In this model, SMS variables represent underlying assumptions about safety shared by organizational members. SRBs are the norms shared by members that guide individuals in making decisions about actual behaviors. These two dimensions are organizational elements of safety culture because they are external to the cognitive and affective aspects of individual members; they represent the functional aspect of organizational safety culture discussed previously. OSC represents values and beliefs of individuals concerning the safety culture of the organization. Variables in this domain are internalized psychological attributes of individuals and illustrate the interpretive component of organization safety culture outlined. Perceptions of organizational policies, rules, standard operating procedures, etc. (SMS), and attitudes about the way members of fire departments actually behave in terms of safety in the organization (SRB) as external variables explain the dependent variable OSC, which are internally held values and beliefs about safety culture in the fire department. Collectively, the three dimensions capture the integrative approach to studying safety culture called for by Cooper (2000) and Reason (1998).

In Cooper's original model, as the name implies, the three dimensions in the model interact in a reciprocal manner. In contrast, we assume that the nature of the relationship between the variables is sequential rather than immediately reciprocal. In other words, efforts to change and improve safety culture within fire service organizations does not begin by trying to change the hearts and minds of firefighters toward being more safe. Rather, fire officers create rules, policies, and procedures that firefighters must follow that promote safety. Organizational leaders change the SMS of the department and request, or demand, compliance. Similarly, in order to ameliorate unsafe firefighter behavior, such as not buckling seat belts en route to a fire, front-line officers will not let the fire truck leave the station until all crewmembers fasten their seat belts. This is an example of organizational (external) efforts to change SRBs. If changes in the SMS and SRBs are successful, the internal values and beliefs of firefighters may change. However, transformation takes time in a tradition-bound service where close-knit groups deliver services out of semi-autonomous fire stations. In the initial effort to understand and change organizational safety culture in the US

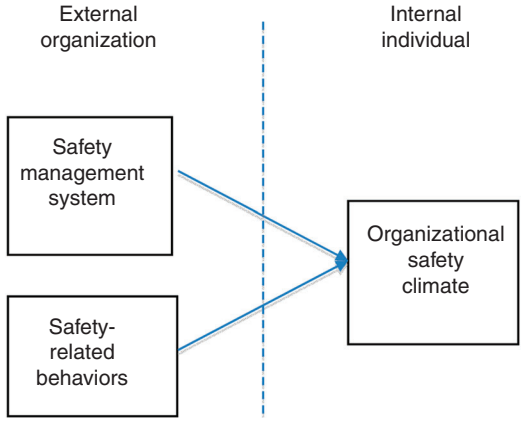

Figure 1.
Organizational safety culture model for the US fire service

fire service, organizational efforts will (and should) focus on external SMS, and SRB variables because they are easier to manage and change than values and beliefs.

The three dimensions of safety culture (SMS, SRB, and OSC) are operationalized using survey instruments used in previous research modified to fit the fire service as an organization. SMS variables are taken from the UK's Health and Safety Executive (HSE) (1997) publication *HSG 65 Successful Health and Safety Management*. Private and public organizations alike use these well-known safety standards to create state-of-the-art SMSs.

SRBs come from an analysis of activities that cause firefighter injuries and fatalities. For example, over 70 percent of firefighter casualties are associated with fire ground operations, responding to alarms, returning from alarms, and training activities. These four activities constitute the critical safety behavior variables in this study. In addition, almost half of the casualties that occur while firefighters are engaged in these activities are associated with some form of cardiac-related problem. The fire service has developed standards for firefighter fitness programs and medical evaluation programs in an effort to reduce the incidence of cardiac-related casualties. Fitness and medical evaluation programs are also included as critical SRBs.

The OSC variable comes from the Safety Climate Assessment Toolkit Questionnaire (HSE, 1997). The HSE and Loughborough University in the UK jointly developed this toolkit as a project to serve several industries in the UK. The questionnaire measures values and beliefs about safety and produces a safety climate profile (a kind of report card) for high-risk occupations. With appropriate modifications to the content and format of the questions, other industries and occupations can easily adapt the questionnaire to their use (HSE, 1999). The questionnaire is well known, highly regarded, and in the public domain.

Measuring safety culture attributes

With few exceptions, research on safety culture uses perception surveys to measure the dimensions (OSC, SRBs, and SMSs) that help define the construct. For example, in a safety performance study of the railroad industry, Bailey and Petersen (1989) used perception surveys to assess worker behaviors, management systems, and individual values and beliefs that affect safety. They concluded that perception-based questionnaires can be effectively used to identify strengths and weaknesses of elements of safety culture and that the human-behavioral approach is effective in making significant improvements in safety performance. A study by Ostrom *et al.* (1993) using attitudinal surveys to assess safety culture in the chemical and nuclear energy fields resulted in similar findings about the efficacy of employing survey research to assess dimensions of safety culture. Additional studies by Clarke (2000), Yule and Flin (2007), Hofmann and Stetzer (1996), Parker *et al.* (2006), O'Toole (2002), and Cooper and Phillips (2004) add further evidence that survey research provides useful and valid measures of organizational safety culture.

Collectively, lessons learned from these studies find perceptions of the dimensions of safety culture are important because they are the initial link in a chain of factors that result in safety performance (Hofmann and Stetzer, 1996). Individuals perceive features of their work environment as interpreted through individual values and beliefs (Brown and Leigh, 1996). People use these interpretations to form meaning, which Brown and Leigh (1996) defines as the motivational and emotional significance of the features that have been perceived. Meaning influences the way that individuals behave, which has a significant impact on safety performance (Yule and Flin, 2007; Parker *et al.*, 2006;

Clarke, 1999). Initial perceptions form meanings that influence unsafe behaviors, which, in turn, affect the frequency of accidents, injuries, and fatalities (Hofmann and Stetzer, 1996). More favorable or positive perceptions of the dimensions of safety culture result in fewer unsafe behaviors and improved safety performance.

Survey instruments used to measure the external dimensions (SMS and SRB) and internal dimension (OSC) of safety culture are different in nature. We measure perceptions of external attributes of the organization work environment using a scale that asks respondents to rate their perceptions of the presence or absence of these dimensions (see James and James, 1989). Internal psychological attributes, such as values and beliefs, are more evaluative than descriptive. Values and beliefs about safety are included in the OSC dimension of the model and are measured using a scale that asks respondents to rate each item in terms of how strongly they agree or disagree with a safety culture-related question. Attention now turns to a more detailed explanation of the data and methods used in the study.

Methodology

The goal of this research is to develop and empirically test a model to improve safety culture in the US fire service. The model selected to achieve this goal is a modified version of Cooper's (2000) Reciprocal Determinism model, shown in Figure 1. This model assumes that two dimensions of exogenous variables, SMS and SRBs, predict or explain a dependent variable called OSC. More specifically, the hypothesis tested here is higher SMS and SRB scores are positively and significantly associated with higher OSC scores.

In order to test this hypothesis, we collected data from three medium-sized municipal fire departments employing 250-600 all career (as opposed to all volunteer or some volunteer and some career) firefighters. The three departments were among six that volunteered to participate in the study. The departments are located in different regions (one each from the west, midwest, and south) and were similar not only in size, and type of department (all career), but also faced similar risk in terms of the age and type of buildings in the city. Each city requested the identity of their department remain anonymous.

All members in each fire department received three surveys to complete. Response rates ranged from 44 percent in Department B to 91 percent in Department C (see Table I). Although participants completed surveys anonymously, placed them in a sealed envelope, and returned them by mail, we did ask each respondent to indicate their rank (firefighter, company officer, or chief officer) and years of service in the organization. An analysis of the distribution of responses to both questions indicates expected group representation. The sample of fire departments represents a convenience sample and findings are generalizable to mid-size, career departments.

The three dimensions (SMS, SRB, and OSC) are measured using perception surveys. Previous safety culture studies have used two of the surveys. The SMS survey is a

Fire department	Total membership	Survey participants	Response rate
Department A	311	239	0.77
Department B	540	238	0.44
Department C	623	566	0.91
Total	1,473	1,043	0.71

Table I.
Response rate for three fire departments

version of one used by the HSE to audit safety management practices in occupations in the UK, including the fire service. The OSC survey comes from the Climate Assessment Toolkit developed for use in offshore drilling organizations and used subsequently to assess safety values and beliefs in other high-risk occupations (HSE, 1999). Assessment of SRBs in the fire service required the development of a new questionnaire.

The NFPA and the US Fire Administration collect data on fire service injuries and fatalities each year. Development of the SBR questionnaire used the main categories of activities that result in firefighter casualties as described by the NFPA in their annual report. These include fire suppression operations, responding to fires, returning from alarms, and training. Physical fitness programs and medical exams are also included because of the high rate of firefighter fatalities that result from cardiac-related problems. Specific items included in the questionnaire were selected from relevant NFPA standards and other published materials considered to represent "best practices" with regard to each of the elements included in the questionnaire. Three medium-sized, geographically dispersed fire departments, which are different from the three sample cities analyzed here, volunteered to pretest the instruments, which resulted in the slight modification of some questions.

All three of the survey instruments use a five-point Likert scale. Each point on the scale includes a semantic description. However, the two semantic scales that measure behaviors (SMS and SRB) are different from the survey instrument that measures values and beliefs (OSC). The instruments that measure management behaviors and safety behaviors use a scale that is descriptive, while the instrument that measures values and beliefs uses a scale that is evaluative (Guldenmund, 2007)[2].

The descriptive scale measures individual perceptions of the extent to which a practice is present in their work environment (Hofstede, 1998). These descriptive behavioral scales also include a numeric anchor that represents the percentage of behaviors represented by the semantic scale. The purpose of including a numeric as well as a semantic point of reference is to reduce the individual variation in the interpretation of the semantic scale. Prior studies of SMSs in health care organizations often include numeric scales (Health and Safety Authority (HSA), 2006). Figure 2 shows an example of one question from the SMS survey.

The evaluative scale, as shown in Figure 3, for survey attitudes toward organizational safety culture attitudes and beliefs measures the positive or negative response of individuals toward safety-related characteristics in their work environment (Hofstede *et al.*, 1990). The five points on the Likert scale range from strongly disagree

Please check the appropriate box to indicate your level of agreement	No evidence	Little evidence	Reasonable evidence	Significant evidence	Full evidence
	0	**25**	**50**	**75**	**100**
Risk assessments are derived from hazard identification		✓			

Figure 2.
Safety management system and safety-related behaviors rating system

Please check the appropriate box to indicate your level of agreement	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
Health and safety issues are very important					✓

Figure 3.
Organizational safety culture rating system

to strongly agree. Previous studies (Hofstede, 1998; Hofstede *et al.*, 1990; Guldenmund, 2007; Grote and Kunzler, 2000; Vrendenburgh, 2002) do not include numerical anchors on survey questionnaires intended to measure values and beliefs.

While space does not allow for the inclusion of each survey instrument[3], a brief overview of the elements and sub-elements that define each dimension will illustrate the types of questions respondents were asked to evaluate. For SMSs 95 items related to the four elements (policy, organizing, planning and implementation, and measuring and reviewing performance) and corresponding sub-elements (e.g. for organizing – structure, cooperation, communication, and competence) constituted the survey instrument:

(1) policy;

(2) organizing:

- structure;
- cooperation;
- communication; and
- competence.

(3) planning and implementation:

- performance standards;
- risk assessment and control;
- hazard identification; and
- planning.

(4) measuring and reviewing performance:

- active monitoring;
- reactive monitoring;
- remedial action; and
- reviewing performance.

For SRBs 85 questions captured attitudes concerning the extent to which organizational members demonstrated safe behaviors across four critical safety areas (fitness and medical, structural firefighting, vehicle safety, and training) and 14 sub-elements (e.g. for fitness and medical – evidence of a fitness program and medical evaluation). These elements and sub-elements are:

(1) fitness and medical:

- fitness program; and
- medical evaluation.

(2) structural firefighting:

- command and control;
- communications;
- accountability; and
- operational risk management.

(3) vehicle safety:

- seat belt use;
- response policy and procedures;

- training; and
- supervision.

(4) training;

- instructors;
- planning;
- facilities; and
- safety requirements.

The OSC survey consists of 43 items captured in the four elements and eight sub-elements:

(1) organizational context:

- management commitment;
- communications; and
- priority of safety.

(2) social environment:

- supportive environment; and
- involvement.

(3) individual appreciation:

- personal priorities and need for safety; and
- personal appreciation for risk.

(4) work environment:

- physical work environment.

Findings

Multiple regression analysis is used to assess the effects of SMS and SRB variables on OSC. The first equation determines these impacts using pooled data from all three departments. The second analysis shows the regression statistics for each department separately. First, however, we justify the aggregation of individual level data to the organizational level.

Aggregation of perception data

The appropriate level of measurement for the construct organizational culture is the individual. Hofstede (1998), van Muijen *et al.* (1999), and van den Berg and Wilderom (2004) aver, however, that it acceptable to aggregate individual perceptions to the organizational level to describe organizational culture (van den Berg and Wilderom, 2004; van Muijen *et al.*, 1999). Organizational culture, they argue, is a characteristic of the organization, not individuals. Individual attitudes and beliefs define organizational safety culture.

The rationale for aggregation of individual level data to higher levels is based on the assumption individuals exposed to the same social context will describe that context in similar ways, which is demonstrated by the level of agreement among different

members of the organization. If agreement is relatively high, then one presumes that members experienced a common set of situational conditions and that these shared perceptions of individuals describe the organizational level of culture (Jones and James, 1979).

Perceptual agreement, in fact, is the principal criterion for deciding whether to aggregate individual perceptions of culture to the organizational level (James, 1982). Researchers commonly use two specific criteria for aggregation. The first is a low level of within organizational variation in mean scores, measured by assessing the intraclass correlation coefficient (ICC) or the standard deviation of scores on measures of organizational culture (Hofmann and Stetzer, 1996; Dickson *et al.*, 2006). A significant ICC score shows substantive support for the aggregation of individual perceptions to the organizational level. The higher the level of correlation, the more reliable the resulting organizational level construct. The second criterion is low levels of within organization variance compared to between organization variance (James, 1982). As analysis shows the realization of one or more of these criteria, researchers can justify the aggregation of individual level data to the organizational level (Hofmann and Stetzer, 1996).

The data in this study meet both of these criteria. The ICC for the variables is significant and sufficiently high to support aggregation. In addition, the results of analysis of variance on the variables across departments show that significant variation exists between departments and that the variation between departments is higher than the variation within departments.

Pooled data analysis

The first regression analysis pools survey data across the three fire departments into a fire service organizational safety culture. In other words, we assume that the US fire service, in general, possesses an organizational culture and a safety sub-culture. The hypothesis of this study is that higher individual perceptions of SMS and SRBs across these three (or 100 fire departments if we had the data) will be positively and significantly associated with higher perceptions of OSC. Simultaneous multiple regression was conducted to determine the independent as well as the overall influence of SMS and SRB variables on OSC.

As Table II shows, the combination of the safety management and safety behavior variables significantly predicts safety climate scores at the 0.001 level. Moreover, both variables make a significant contribution to the prediction and are in the predicting direction. The β weights for the variables suggest that organizational safety behavior perceptions contribute slightly more to the prediction of individual levels of safety climate than do SMS variables. The R^2 value is 0.31, indicating that 31 percent, almost one-third, of the variation in OSC attitudes is explained by the model. For attitudinal data, this is a relatively robust level of explanation (Cohen, 1988).

Variable	*B*	SEB	$\hat{A}$
Safety management system	0.18	0.02	0.29**
Safety-related behaviors	0.22	0.03	0.31**

Notes: $R^2 = 0.31$; $F = 234.62$, $p < 0.001$; **$p < 0.01$; simultaneous multiple regression analysis for safety management system and safety-related behaviors predicting organizational safety climate ($N = 1{,}043$)

Table II.
Regression results for pooled data from three fire departments

Department level analysis

Table III shows the independent and combined impact of the two independent variables (SMS and SRB) on the dependent variable (OSC) for each of the three departments participating in this study. The assumption is that each fire department in the USA, like the fire service in general, possesses an organizational culture and a safety climate sub-culture. Moreover, we assume that perceptions about the nature of the SMSs and SRBs vary from one fire department to the next. Finally, like the pooled data analysis, the hypothesis advanced here is that SMS and SRB variables are positively and significantly associated with OSC. For the most part, the statistics shown in Table III support this hypothesis.

As expected, SMS and SBR variables explain different amounts of variance in the dependent variable, OSC, across the three fire departments. The R^2s range from 39 percent in Department B to 35 percent in Department A to 29 percent in Department C. Like the pooled data equation, the level of explained variation is noteworthy in each city; F-value show that the three regression equations are significant; all variables are related in the predicted direction; and with one exception (SMS in Department B) the two dimensions of external variables (SMS and SRB) are significantly related to the OSC dependent variable. For City A, the standardized β coefficients show that the SMS variables are more powerful predictors than are SRB items. In Cities B and C, the opposite is true. SBR variables alone are significant in Department B and the impact of the SMS and SRB are similar in City C, but the latter is slightly larger (0.31 for SBR and 0.27 for SMS).

The finding of variability in the power of the model to explain attitudes confirms our assumption that organizational safety culture varies across US fire departments. In each of the six fire departments visited (three to pretest the questionnaires and three to gather data), we conducted a large number of interviews with organizational members at all ranks. This qualitative data provided a glimpse at the safety culture of a department. In some departments, the lack of a well-defined departmental safety culture was evident in interviews. In other departments, interviews suggested that

Variable	*B*	SEB	β
Department A (N = 239)			
Safety management systems	0.27	0.05	0.41**
Safety-related behaviors	0.16	0.06	0.22**
$R^2 = 0.35$; $F = 64.63$, $p < 0.001$			
$^*p < 0.05$; $^{**}p < 0.01$			
Department B (N = 238)			
Safety management systems	0.01	0.06	0.03
Safety-related behaviors	0.40	0.06	0.64**
$R^2 = 0.39$; $F = 73.76$, $p < 0.001$			
$^*p < 0.05$; $^{**}p < 0.01$			
Department C (N = 566)			
Safety management systems	0.17	0.03	0.27**
Safety-related behaviors	0.25	0.04	0.31**
$R^2 = 0.29$; $F = 112.77$, $p < 0.001$			
$^{**}p < 0.01$			

Table III.
Regression results for each of the three fire departments

Note: Simultaneous multiple regression analysis summary for safety management systems and safety-related behaviors predicting organizational safety climate

SMSs were stronger than SRBs, and vice versa in other departments. The regression data presented in Table III supports what fire personnel were saying in the six different fire departments, OSC varies across US fire department.

Summary and discussion

Previous studies have successfully used safety culture models in high-risk occupations to assess safety culture and improve safety performance. While recognizing that high injury and deaths rates in the fire service may in part be attributable to the lack of a clear understanding of the importance of organizational safety culture, no research to date has systematically examined the nexus between causalities and safety culture. The purpose of this study is to address this research lacuna by developing a model to assess and improve safety culture in the US fire service.

A modified version of Cooper's (2000) Reciprocal Determinism model serves as the framework used in the study. Three valid and reliable questionnaires operationalize the model. We hypothesize that the two external variables called SMSs and SRBs predict or explain attitudes and beliefs about OSC – the attitudes, beliefs, and values about safety in the fire service or in an individual fire department.

Results from multiple regression analyses provide strong support for the hypothesis that individual perceptions of safety management and safety behavior predict individual perceptions of safety climate both at the "fire service" organizational level and at the individual department level. Perceptions of the SMS and SRBs explain 31 percent of the variance in safety climate for the pooled data and from 29 to 39 percent for the three separate fire departments. In every case but one, predictor variables are statistically significant. In every case the direction of the relationships were in the hypothesized direction.

Regression analysis of the data for each department participating in this study also suggests that each fire department has a unique safety climate. The ability of SMS variables and SRBs to explain attitudes, beliefs, and values about safety in the organization vary. Given the presence of over 30,000 volunteer, career, and combination fire departments in the USA with over one million organizational members, the presence of variability in departmental attitudes seems a safe assumption. Research presented here provides, to the best of our knowledge, the first empirical evidence of this variability.

In order to better manage and improve safety, fire leaders need tools to identify organizational strengths and weaknesses across various safety culture domains. A practical feature of the theoretical model tested here is the ability to create "safety report cards" for each of the 12 dimensions that define the three variables used in the study. Figure 4, for example, shows the organizational safety culture in Department C. The scores come from the attitudinal data collected in the SMS, SBR, and OSC surveys. Cooper (2000) provides a "benchmark" scoring system that makes the "safety radar map" easily interpretable (see Table IV). Mean scores for the elements associated with the variables provide a fire department with a visual representation of their safety culture by presenting the average scores for each element in a radar chart/safety report card. The culture profile for Department C, for example, indicates that several elements of their SMS are relatively low, including policy, organizing, and the planning and implementing elements. On the other hand, the chart clearly shows that organizational members have an appreciation for the risk associated with their positions.

Limitations of this study include the cross-sectional design and the use of self-reported perceptions for the variables (Yule and Flin, 2007). Although samples within

Figure 4.
Illustrative organizational safety culture "radar map" for Department C

	Likert score		
Percentage	Low	High	Rating
0-50	1.00	2.50	Alarming
51-70	2.51	3.50	Average
71-90	3.51	4.50	Good
91-100	4.51	5.00	Excellent

Table IV.
Scoring rubric for safety culture radar screens

the three departments are representative of various functional groups (firefighter, mid-level officer, and senior commander), the three mid-sized departments self-selected to participate in the study. Generalizations of findings are limited. In addition, the four regression equations explain 29-39 percent of the variation in the dependent variable, indicating the model is under-specified.

Despite these limitations, the study makes several important contributions. From a theoretical perspective, for the first time a study identifies and tests empirically a safety culture model for the fire service. From a statistical perspective, the measures and instruments developed to assess safety culture are reliable and valid. Finally, from a practical perspective, the model allows the creation of safety report cards based on survey data that can have a real world impact as fire service personnel in individual fire departments develop safety performance plans to help reduce firefighter injuries and deaths. If this is the single outcome of this research, the result has been worth the time and effort.

Notes

1. Guldenmund (2000) identifies 16 different models used in previous studies to examine organizational safety culture. The model by Cooper (2000) offers the "best fit" to the US fire service for two reasons. First, it is parsimonious compared to other models of safety culture. Second, scholars have used the model to study other high-risk occupations with valid and reliable results (Cooper, 2000).
2. Cronbach's α coefficient tests the reliability of the questionnaires. After dropping several items in the OSC questionnaire that were highly correlated and running a principle axis factor analysis (with varimax rotation), the α coefficients for all variables were 0.70 or above. Analysis of the survey data show both construct and discriminate validity for the questionnaires.
3. Survey instruments are available in original format from William Pessemier by e-mail at wlpessem@mho.net

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