DEVELOPMENT AND TEST OF A FIREFIGHTER SAFETY CLIMATE MODEL

by

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(Under the Direction of David M. DeJoy)

ABSTRACT

Each year more than 100 firefighters die in the line of duty and over 80,000 are injured. Despite advances in technology, protective equipment, medical care and safety legislation, there has been no sustained improvement in the number of fatalities during the past 25 years. Today, there is a growing body of research linking safety climate to reduced injury, where the effects of safety climate on injury are partially mediated through safety behaviors. The purpose of this study was to develop and test a model linking perceptions of safety climate, safety behaviors and injury within firefighters.

Data were collected from 398 professional firefighters in Georgia. Structural equation modeling (SEM) was used to test the model and the proposed relationships. The results indicated that safety climate, as a higher order factor, was composed of four factors including safety communication, management commitment to safety, safety programs/policies and supervisor support for safety. An examination of the relationships associated with safety climate illustrated that both safety compliance behaviors and safety citizenship behaviors were significantly, positively associated with safety climate.

With regard to injury, both safety compliance behavior ($B = -5.02$, p=0.00) and safety citizenship behavior ($B = -3.21$, p=0.00) were deemed protective when controlling for the other factors. It was determined that for each incremental increase in safety compliance behavior, there was a 99% reduction in injury (*RR* = 0.00662) and for each incremental increase in safety citizenship behavior, there was a 96% (*RR* = 0.04) reduction in injury.

Safety climate relations to injury were interesting, but somewhat ambiguous. Safety climate significantly predicted membership in the "always zero" group. Thus, the higher the safety climate score, the more likely the firefighter is a member of the "always zero" group. But, for those not in the "always zero" group, the relationship between safety climate and injury was positive. This result was not completely surprising as direct relationships between safety climate and injury have been insignificant and have been opposite to predictions in studies using retrospective data. The issues of non-significance and unexpected positive relationships may be attributed to the issue of reverse causation.

INDEX WORDS: Safety climate, firefighter, occupational injury, occupational safety, safety behavior

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RESEARCH OVERVIEW

This chapter provides an overview of the proposed dissertation research project. The chapter initially describes the public health problem associated with firefighter injuries and then highlights the significance of this study, its specific purpose and the research questions to be examined.

Statement of the Problem

The Firefighter Injury Problem

Occupational injuries, illnesses and fatalities suffered by firefighters are a significant public health problem. Firefighters are injured, suffer work-related illnesses, are hospitalized, are forced into early retirement or die at higher rates than most workers in the United States (Lee, Fleming, Gomez-Marin, LeBlanc, 2004; IAFF, 2001; & U.S. Department of Labor, 2006) making it one of the most hazardous occupations in the United States. Each year approximately 100 firefighters die and more than 80,000 are injured (U.S. Fire Administration, 2002) producing economic consequences into the billions of dollars (TriData, 2005). Fatality rates for firefighters are estimated to be four times worse than the general working population at a rate of approximately 17.0 workers per 100,000 (U.S. Department of Labor, 2006) and injury rates are 3.3 times that of workers in private industry (IAFF, 2001).

Despite advances in technology, personal protective equipment, engineering controls, environmental management, medical care and safety legislation, firefighter fatalities remain unchanged from year to year (U.S. Fire Administration, 2002 & U.S. Fire Administration, 2007). Additionally, firefighters continue to suffer non-fatal injuries at high rates (Walton, Conrad, Furner & Samo, 2003; Lee, Fleming, Gomez-Martin & LeBlanc, 2004) and are burdened with chronic health conditions and diminished well-being (Del Ben, Scotti, Chen & Fortson, 2006; Rosenstock & Olsen, 2007; Kales, Soteriades, Christophi & Christiani, 2007 & Soteriades, Hauser, Kawachi, Liarokapis, Christiani & Kales, 2005).

Firefighter and Safety Climate Background Information

Call for Transformation in Firefighter Organizations

Multiple stakeholders associated with firefighter organizations and advocacy groups have discussed the need to transform the culture of firefighter organizations. From 1996 to 1998, the Wildland Firefighter Safety Awareness studies were completed. These studies were focused on identifying and correcting organizational culture, leadership, human factors and other influences impacting firefighter safety. The final phase of the program established recommendations for implementing culture changes for safety in wildland firefighting (TriData Corporation, 1996; TriData Corporation, 1997 & TriData Corporation, 1998).

Other initiatives since have continued to focus on the need to change firefighter culture, especially with respect to structural firefighting organizations. In 1999, the Fire

Service Needs Workshop was conducted with fire and safety stakeholders. This group recognized the need to create a culture of safety instead of a culture that rewards and glamorizes unsafe behaviors (Walton, Bryner, Madrzykowski & Lawson, 2000). In 2004 and 2007, Firefighter Life Safety Summits were conducted. The 2004 Summit was an unprecedented gathering of American fire service leadership to focus on the question of how to prevent line-of duty deaths (NFFF/USFA, 2004). The working groups produced recommendations that were consolidated into a set of key initiatives and implementation strategies (www.everyonegoeshome.org). The most fundamental point of agreement was the need for the American fire service to change its culture of accepting the loss of firefighters as normal and advocate for culture change within the fire service related to safety, leadership, management, supervision and accountability. The 2007 Summit, similar to the 2004 Summit, addressed shared objectives of enhancing fire service culture, improving investigation of all firefighter fatalities, injuries and near-misses, and establishing a national research agenda (NFFF, 2007).

As is evident, the fire service industry has been forthright in their desire to change. In fact, the International Association of Fire Chiefs, in April of 2008, announced the theme of *Committed to Long-Term Results* for their 2008 Safety, Health and Survival Week, with an ultimate goal to institute a strong culture of health and safety within fire service organizations (IAFC, 2008). In addition to calls from the firefighter community, scientific studies of firefighter fatalities have also advocated the need for changes or improvements in the organizational and cultural aspects of firefighting organizations (Hodous, Pizatella, Braddee, & Castillo, 2004; MMWR, 2006).

Safety Culture and Safety Climate

For more than two decades, there has been growing interest in exploring the contribution of organizational factors to workplace safety. In fact, the attention given to organizational factors has expanded to the extent that Hale and Hovden (1998) refer to it as the third age of safety with the first two ages being technical controls and human factors, respectively. Much of this attention and work has focused on the constructs of safety culture and safety climate (DeJoy, Schaffer, Wilson, Vandenberg & Butts, 2004). The term safety culture gained prominence in the aftermath of the Chernobyl disaster (Pidgeon & O'Leary, 2000) as an inadequate safety culture was identified as an underlying factor for the incident (Zohar, 2003). Subsequent high profile disasters served to focus both public and scientific attention on the role that organizational factors play in the etiology of such events (Weick, Sutcliffe, & Obstfeld, 1999). Unfortunately such scenarios have continued to occur. For example, inadequate safety culture was identified as an underlying factor in the 2003 *Columbia* space shuttle disaster (CAIB, 2003) and the 2005 BP Texas City explosion (Baker, et al. 2007).

Safety culture has been defined in a variety of ways (Pidgeon, 1991; Guldenmund, 2000; Wiegnann, Zhang, von Thaden, Sharma, & Gibbons, 2004), but most definitions highlight the shared norms, values, and assumptions in organizations, which serve to shape safety attitudes and behaviors within the organizations. The distinction between safety culture and safety climate remains a source of some debate and confusion within the safety field (Guldenmund, 2000; Zohar, 2003; Wiegmann et al., 2004). This debate has been associated with the conceptual ambiguity that exists in the literature as researchers have failed to discriminate between safety culture and safety climate (Zohar, 2003). Zohar notes that safety culture and safety climate must be clearly distinguished on the grounds of discriminant validity. Given this statement, it is apparent that each represents a separate construct and should not be interchangeable in research and in the literature.

In most instances, safety climate is used to refer to the observable or surface manifestations of culture (Schneider, 1975; Zohar, 1980; Flin, Mearns, O'Connor & Bryden, 2000). Organizational researchers make a fairly clear distinction between the two constructs. Schneider and Gunnarson (1991), for example, define climate as the visible practices, procedures, and rewarded behaviors that characterize an organization. They define culture as the basic assumptions, values, and philosophies that give meaning to the events that occur in an organization. Today, the majority of research specific to workplace safety falls within the purview of safety climate, in that, the main focus is on assessing employee perceptions regarding safety (Flin, Mearns, O'Connor, & Bryden, 2000; Neal & Griffin, 2004; Zohar, 2003). The extensive use of questionnaire methodologies, as opposed to more qualitative or ethnographic methodologies, also adds credence to this categorization (DeJoy, Schaffer, Wilson, Vandenberg, & Butts, 2004).

Safety climate research remains at the forefront of occupational safety and health research. Evidence continues to grow linking safety climate to a number of safety-related outcomes, including safety knowledge and motivation (Griffin & Neal, 2000), performance of safe work practices (Clarke, 2009; Seo, 2005; Cooper & Phillips, 2004; Griffin & Neal, 2000 & DeJoy, Murphy & Gershon, 1995), safety-related activities/program effectiveness (Cheyne, Cox, Oliver & Tomas, 1998 & Zohar, 1980), safety performance (Zohar, 2000 & Hofmann & Stetzer, 1996) and accidents and other safety-related events (Dedobbeleer & Beland, 1991, Barling, Kelloway & Loughlin, 2002 & Clarke, 2009). Of major practical significance is the idea that safety climate can serve as a leading indicator of safety performance (Flin, Mearns, O'Connor & Bryden, 2000). In contrast to "lagging" indicators (e.g. fatality counts, incident rates, etc.), safety climate, as a leading indicator, is predictive and can be used to monitor safety conditions so that corrective measures or remedial action can be taken to prevent safety incidents. This proactive assessment is extremely important within high-hazard industries and high-reliability organizations.

Safety Climate in Firefighting Organizations

While there is no universally accepted definition of safety climate, there is broad acceptance that safety climate involves the shared perceptions among members of an organization concerning the importance of workplace safety (DeJoy et al, 2004; Flin et al, 2000 & Zohar, 2003). A number of safety climate models have been presented in the literature. Consistently though, management commitment to safety and perceptions of policies, procedures and practices appear to be core aspects of safety climate (Zohar, 2003; Barling, Loughlin & Kelloway, 2002 & Griffin & Neal, 2000).

Safety climate perceptions ultimately shape behavior-outcome expectations (Zohar, 2003). Thus, a strong and positive safety climate should support and reinforce positive safety behaviors. Today, safety-related behaviors are generally classified into two broad categories: compliance-oriented behaviors and contextual behaviors. Compliance-oriented behaviors include adhering to safety procedures and carrying out work tasks as required. Contextual behaviors are those that would be considered citizenship behaviors, extra-role behaviors or participation behaviors such as promoting the safety program within the workplace, assisting co-workers and putting in extra work to improve safety (Neal, Griffin & Hart, 2000). These behaviors are considered above-and-beyond compliance-oriented behaviors.

In the context of firefighting, compliance-oriented behaviors include using necessary safety equipment and following correct safety procedures while performing line-of-duty operations. Examples of contextual behaviors by firefighters include promoting safety within the fire department and exerting extra effort to improve safety.

Significance of the Study

For more than two decades, there has been growing interest in exploring the contribution of organizational factors to occupational safety. Much of this attention and work has focused on the constructs of safety culture and safety climate (DeJoy, Schaffer, Wilson, Vandenberg & Butts, 2004). Despite many admonitions and recommendations calling for organizational research in firefighting, very little systematic research has been completed, especially in the area of safety culture and safety climate.

While there is an extensive body of research linking safety climate to safety performance in various work organizations and work groups, we do not know the extent to which safety climate is linked to important safety outcomes in firefighters. This research is significant as it is the first known study to specify and test a safety climate model in firefighters. Thus, this study will be the first to directly explore the relationships between perceived safety climate, safety behaviors and firefighter injury. The outcomes of this study will provide direction on how to manage safety in fire organizations and will provide guidance on how to reduce firefighter injuries and fatalities. This is especially important as it appears that traditional safety techniques and methods have reached their limit as firefighter fatalities remain essentially unchanged year to year (U.S. Fire Administration, 2002 & U.S. Fire Administration, 2007).

Overview of the Study

The general purpose of this dissertation research is to develop and test a model linking perceptions of safety climate and firefighter safety outcomes, including safety behaviors and firefighter injury. This area of research is of vital importance given the severity of the injury problem in the firefighting community. This research will explore direct and indirect relationships between safety climate, firefighter safety behaviors and firefighter injury. Both compliance-oriented and contextual safety behaviors will be assessed. Contextual behaviors will be assessed with measures of safety-citizenship or participation behaviors. It is expected that a positive safety climate, derived of management commitment, support for safety in the fire organization, safety communication and general safety programs and policies will be positively associated with firefighter safety behaviors. These outcomes will then be associated with reduced firefighter injury.

Structural equation modeling (SEM) is a statistical method well-suited to assess an array of hypotheses in research (MacCallum & Austin, 2000). SEM is used for specifying and estimating models of linear relationships among measured and/or latent variables that are arranged in a hypothesized pattern of directional and non-directional relationships (MacCallum & Austin, 2000). Structural equation modeling will be used to assess the hypothesized model and hypotheses indicated for this study. The hypotheses will be examined through interpreting the parameter estimates or path coefficients derived from the data. Significance and directionality will both be assessed. The data utilized within the study will be collected through questionnaires completed by professional firefighters in north-eastern Georgia. The specific hypotheses, as illustrated in Figure 1, include:

H1: Perceived safety climate will positively influence firefighter compliance-oriented safety behavior.

H2: Perceived safety climate will positively influence firefighter safety contextual behaviors.

H3: Perceived safety climate will have a negative influence on firefighter injury.

H4: Compliance-oriented safety behavior will be negatively associated with firefighter injury incidents.

H5: Contextual behaviors will be negatively associated with firefighter injury incidents.

CHAPTER 2

LITERATURE REVIEW

This chapter provides a review of the literature that is relevant to the proposed research. The chapter and literature summarized provides the theoretical support for the proposed model and hypotheses. Structural equation modeling will be utilized to assess the theoretical model and research hypotheses proposed in this study. One critical requirement for model development and testing through structural equation modeling is that the model must be based on theory (Bentler & Chou, 1987).

This chapter is comprised of six sections. Five sections will describe the literature, which supports the development of a safety climate model for the present study. The final section provides an overview of the present study with hypothesized relationships between safety climate, safety behavior and injury in firefighters. The first section will discuss the significance of occupational injury in firefighters as a public health problem. The epidemiologic evidence will illustrate the need for the proposed study. The second section of the review will highlight the call for transformation in firefighting organizations with a focus on changing safety culture and resultant firefighter safety behaviors. The third section will review the safety culture and safety climate literature and will present an argument for the importance of safety climate in this area of research. The fourth section will discuss safety climate in the context of firefighting. Further, this section will delineate the dimensions of safety climate to be explored in this study. The fifth section of the literature review will discuss relationships between safety climate, safety behaviors and injury outcomes. The last section is an overview of the present study, an illustration of the developed model and presentation of hypothesized relationships in the present study.

Firefighter Injuries and Fatalities

Occupational safety and health management and the prevention of occupational injury remains an important concern for both researchers and practitioners as injuries suffered in the course of employment remains a significant public health problem. Each year nearly 6,000 workers die and millions of workers are injured in the United States alone. The consequences of these fatalities and injuries are vast, including a wide array of social and economic consequences (Dembe, 2001; Weil, 2001; Boden et al., 2001).

Occupational injuries and fatalities suffered by firefighters are a significant part of the overall occupational injury conundrum. While firefighters work in a dangerous profession, the rates of firefighter deaths and injuries suffered in the line of duty are generally considered to be excessive and should not be accepted as a normal part of the job function. Firefighters are injured, suffer work-related illnesses, are hospitalized, are forced into early retirement, or die at higher rates than most other workers in the United States (Lee, Fleming, Gomez-Marin, LeBlanc, 2004; IAFF, 2001; & U.S. Department of Labor, 2006). Each year, approximately 100 firefighters die in the line of duty and more than 80,000 are injured (USFA, 2002; Karter & Molis, 2008). These incidents result in economic losses that total billions of dollars (TriData, 2005). The fatality rate for firefighters is approximately 17.0 workers per 100,000 (U.S. Department of Labor, 2006), which is four times worse than the general working population. The injury rate for firefighters according to Karter and Molis (2008) equaled 7.0 injuries per 100 firefighters. This number is similar to the injury rate reported by Reichard and Jackson (2010) for data from years 2000 - 2001 where the injury rate was 7.4 injuries per 100 full-time firefighters. The rate for private industry, in general, is approximately 4.0 injuries per 100 full-time workers (U.S. Department of Labor, 2009).

National surveillance systems offer only limited data on non-fatal occupational injuries. Injuries and injury rates among emergency responders, including firefighters, are often not compiled because these workers are mostly employed by governmental organizations and their data are not consistently captured by the Bureau of Labor Statistics (Reichard & Jackson, 2010). To date, the U.S. Fire Administration and the National Fire Protection Association have been responsible for compiling data, completing surveys to collect injury data, and providing some insight into injury rates and trends associated with firefighter injury incidents.

In 2002, the U.S. Fire Administration (USFA, 2002) presented an overview of firefighter injury statistics using injury data compiled from the National Fire Protection Association (NFPA) and the National Fire Incident Reporting System (NFIRS). There were 88,500 firefighter injuries in 1999; the majority occurred at emergency scenes and 85% occurred at structural fires. While the majority of the injuries occurred at residential structure fires, non-residential structure fires account for the greatest risk and produce the highest incidents measured by injuries per 1000 fires. The work activity accounting for the majority of these injuries is fire suppression. Despite advances in technology, personal protective equipment, engineering controls, environmental management, medical care and safety legislation, firefighter fatalities still remain unchanged from year to year, with little improvement over the past 25 years (U.S. Fire Administration, 2002 & U.S. Fire Administration, 2007). In fact, recent data illustrates some regression as firefighter fatality rates have been increasing since the early 2000's (U.S. Fire Administration, 2010).

Transformation in Firefighting Organizations

With no significant reduction in firefighter injury and fatality over the past several years, multiple stakeholder groups associated with firefighter operations and occupational safety and health have discussed the need to transform the culture of firefighter organizations. From 1996 to 1998, the Wildland Firefighter Safety Awareness studies were completed. These studies were focused on identifying and correcting organizational culture, leadership, human factors and other factors impacting firefighter safety. The final phase of the program established recommendations for implementing culture changes for safety in wildland firefighting (TriData Corporation, 1996; TriData Corporation, 1997 & TriData Corporation, 1998).

Other initiatives have continued to focus on the need to change firefighter culture, especially within structural firefighting organizations. In 1999, the Fire Service Needs Workshop was conducted with fire and safety stakeholders. This group recognized the need for change in the fire service culture, especially with creating a culture of safety instead of a culture that rewards and glamorizes unsafe behaviors (Walton, Bryner, Madrzykowski & Lawson, 2000). In 2004 and 2007, two major Firefighter Life Safety

Summits were conducted. The 2004 Summit was an unprecedented gathering of American fire service leadership to focus on the question of how to prevent line-of duty deaths (NFFF/USFA, 2004). The working groups created recommendations that were consolidated into a set of key initiatives and implementation strategies (www.everyonegoeshome.org). The most fundamental issue agreed upon was the need for the American fire service to change its culture of accepting the loss of firefighters as normal and to advocate for culture change within the fire service related to safety, leadership, management, supervision and accountability. The 2007 Summit, similar to the 2004 Summit, addressed shared objectives of enhancing fire service culture, enhancing investigation of all firefighter fatalities, injuries and near-misses and the establishing a national research agenda among other initiatives (NFFF, 2007). During this same time period, the 2005 National Fire Service Research Agenda Symposium (NFFF, 2005) also identified culture change as a high priority research area and concluded that the current culture within the fire service acts as a barrier to improving the safety and health of firefighters.

The International Association of Fire Chiefs, in similar fashion, announced the theme of *Committed to Long-Term Results* for their 2008 Safety, Health and Survival Week, with an ultimate goal to institute a strong culture of health and safety within fire service organizations (IAFC, 2008). In addition to calls from the firefighter community, scientific studies of firefighter fatalities have also advocated the need for changes or improvement in the organizational and cultural aspects of firefighting organizations (Hodous, Pizatella, Braddee, & Castillo, 2004; MMWR, 2006).

Safety Culture and Safety Climate

For more than two decades there has been growing interest in the contribution of organizational factors to work-related injuries. This area of study has progressed to illustrate that organizational factors benefit safety beyond the achievements garnered through traditional control strategies. Hale and Hovden (1998) indicated that the current interest in understanding the role of organizational factors is the “third age of safety,” which progressed from hazard control approaches and human factor approaches. Currently, much of the research in this domain or “third age of safety” has focused on the constructs of safety culture and safety climate (Clarke, 2006; DeJoy, Schaffer, Wilson, Vandenberg & Butts, 2004; Zohar, 2003).

Interest in safety culture and safety climate was brought to the forefront after the Chernobyl disaster as inquiry into this catastrophic event identified inadequate safety culture as a major underlying factor for the accident (Pidgeon & O’Leary, 2000). Subsequent high profile disasters served to further focus both public and scientific attention on the role that organizational factors play in the etiology of such events (Weick, Sutcliffe, & Obstfeld, 1999). Unfortunately this scenario has continued to occur in recent years. Inadequate safety culture and organizational factors were identified as underlying factors to the 2003 *Columbia* space shuttle disaster (CAIB, 2003) and the 2005 BP p.l.c. Texas City explosion (Baker, et al. 2007).

Today, safety culture and safety climate research remains at the forefront of occupational safety and health research. However, this emergence has also produced a certain amount of debate and confusion (Flin, Mearns, O’Connor, & Bryden, 2000;

Guldenmund, 2000; Wiegmann et al., 2004; DeJoy et al., 2004). One area of considerable confusion involves the distinction between safety culture and safety climate (Zohar, 2003).

Schein defines organizational culture as the assumptions and beliefs that are shared by members of an organization, which operate unconsciously in guiding the behavior of its members (1985). The term safety culture is a derivative of this definition. Safety culture refers to the shared norms, values and assumptions that exist in organizations pertaining to safety (Guldenmund, 2000). The concept of safety culture is broader than the concept of safety climate, just as organizational culture is broader than the construct of climate. Climate is commonly defined as the perception of formal and informal organizational policies, practices and procedures (Ostroff, 1993; Reichers & Schneider, 1990). Safety climate similarly refers to perceptions related to safety in the workplace (Zohar, 2003 & Neal & Griffin, 2002). While there is no universally accepted definition of safety climate, a consistent working definition of the concept is the shared perceptions among members of an organization concerning the importance of workplace safety and safety policies, procedures practices (DeJoy et al, 2004; Flin et al, 2000; Zohar, 2003).

As a measurement, safety climate is an assessment of surface level manifestations of an organization's safety culture (Cox and Flin, 1998). Safety climate is typically assessed through questionnaires and surveys. This methodology is preferred as questionnaires and surveys are used to tap into climate and not culture (Ostroff, 1993).

Currently, much of the impetus in safety research and practice is in the area of safety climate. Researchers and practitioners alike are interested in assessing employee perceptions regarding safety (Flin et al., 2000; Neal & Griffin, 2004; Zohar, 2003). Perceived safety climate is the term used to refer to the individual's perception of safety climate. This term is derived from psychological climate, which refers to individual perceptions of the work environment (James & James, 1989; Neal & Griffin, 2006). Much of the interest in safety climate is driven by the idea that it functions as a leading indicator of safety performance that has predictive value with regard to subsequent safety outcomes and injury. Safety climate has been linked to a number of safety-related outcomes, including performance of safe work practices (e.g., Cooper & Phillips, 2004; DeJoy, Murphy & Gershon, 1995; Griffin & Neal, 2000 & Seo, 2005), safety-related activities/program effectiveness (e.g., Cheyne, Cox, Oliver & Tomas, 1998 & Zohar, 1980), interpretations of accidents (e.g., Hofmann & Stetzer, 1998) and accidents and other safety-related events (e.g., Dedobbeleer & Beland, 1991 & Hofmann & Stetzer, 1996).

Key Safety Climate Factors

A number of safety climate models have been presented in the literature. However, no absolute consensus has been reached concerning the principal or most important factors of safety climate (Guldenmund, 2000; Neal & Griffin, 2004; Seo, Torabi, Blair & Ellis, 2004; Griffin & Neal, 2000; Huang, Ho, Smith & Chen, 2006). This lack of consensus is not surprising since researchers have used different safety climate instruments and because researchers completed studies in a wide variety of different industries with different hazards, workplace conditions, situations and operational complexities (Griffin & Neal, 2000; Seo et al., 2004). Further, climate factors have mostly been determined through the use of factor analysis, which leaves the naming of obtained factors to the discretion of the researcher. Thus, similar dimensions may receive different names and differing factors may be inappropriately labeled as the same factor.

Despite the lack of consensus, the safety climate literature as a whole does reveal some consistencies in terms of the factors that may be most important and relevant to a variety of differing work settings. Seo et al. (2004) reviewed 16 safety climate studies published between 1980 and 2003. Management commitment and supervisor safety support were the most common dimensions present within the scales utilized in these studies. They identified five core dimensions in safety climate research: management commitment to safety, supervisor safety support, coworker safety support, employee participation in safety-related decision making and activities, and competence level of employees with regard to safety. Flin et al. (2000) completed a similar review. They reviewed 18 safety climate studies published between 1980 and 1998. Perceptions of manager and supervisor attitudes and behaviors; perceived effectiveness of safety systems and perceptions of/attitudes toward risk were the most prominent dimensions across the 18 studies. Another review by Guldenmund (2000) identified management attitudes, risk, safety arrangements, procedures, training, and work pressure as frequently occurring dimensions.

Following these published reviews, Griffin and Neal (2000) identified management values, safety communication, safety practices, safety training and safety equipment as significant factors of a higher-order safety climate measure. Similarly, Evans, Glendon and Creed (2007) produced and confirmed a three factor model of safety climate that included management commitment and safety communication, safety training, and equipment maintenance. More recently, Pousette, Larsson and Torner (2008) identified four dimensions associated with a higher-order safety climate factor. These four dimensions included safety priority, safety management, safety communication and work group safety involvement.

Safety climate has also been assessed in high reliability organizations (HROs). HROs are organizations that perform highly complex and hazardous missions yet have very few safety-related failures. HROs are characterized as having a continuous and high level of safety consciousness as hazardous situations are ever present and failure could occur at any time. Examples of HROs include aircraft carriers, the nuclear power industry, and commercial aviation. Based on safety research in HROs (Gaba, Singer, Sinaiko, Bowen & Ciavarelli, 2003; Singer, Gaba, Geppart, Sinako, Howard, & Park, 2003; Roberts, 1990; Rochlin, 1999), eight safety characteristics stand out: commitment to safety articulated at the highest levels of the organization; necessary resources, incentives, and rewards provided by the organization to allow this commitment to occur; safety valued as the primary priority, even at the expense of production or efficiency; continuous safety mindfulness; the rarity of unsafe behavior even under production pressures; communication throughout the organization, which is frequent and candid; an openness about errors and problems, and regular reporting of such; and organizational learning is valued. Research on HROs may particularly applicable to firefighting.

Together, the general safety climate literature and the HRO literature do reveal some commonalities as to the key dimensions of safety climate. The dimensions or factors that have emerged across studies and work settings include: management commitment, supervisor safety support, safety priority; effective communication and effective safety management programs. These safety management programs address programs, policies and procedures to ensure resource adequacy, continuous training, learning opportunities and coordinated team efforts.

Somewhat surprising, there are no published studies that specifically examine the construct of perceived safety climate within firefighter organizations. However, it is possible to propose safety climate as a higher order factor, composed of more specific first-order factors that reflect the extent to which employees believe that safety is valued within the fire organization. These first-order factors are based on firefighter work activities and organization, previous research on firefighter injuries and illnesses, and the commonalities identified in the review of the general safety climate literature and the HRO literature presented above. Safety climate, in the context of firefighting, is proposed to include perceptions of four main factors: management commitment to safety, supervisor support for safety, safety communication and occupational safety policies and programs. These safety climate factors are explained and supported in the following sections.

Management Commitment to Safety

Management commitment is the extent to which management is perceived to place a high priority on safety and consistently act upon that priority in an effective manner (Neal and Griffin, 2004). Management commitment is generally acknowledged to be a key ingredient of safety climate. Analyses and reviews of safety climate research indicate that management commitment is perhaps the single most dominant theme and has a significant influence on employees' perceptions of the importance of safety (Clarke, 2009; Zohar, 2008; Flin et al., 2000; Guldenmund, 2000; Zohar, 2003; Neal and Griffin 2004; Zohar 1980).

Firefighter organizations are military-like in terms of their command structure, rank, indoctrination and group cohesion. As such, firefighter socialization and assimilation emphasizes group cohesion, trust, and loyalty. Within this culture, firefighters look to management for direction, guidance and performance expectations. If fire department management is committed to safety, it sets the tone that safety is valued and is important. Conversely, if management is not committed to safety it delimits the importance of safety and generally emphasizes competing priorities such as fire extinguishment at all expense instead of safety. Given its significance in the general safety climate literature and its importance in fire organizations, management commitment is presumed to be a major factor of firefighter safety climate.

Supervisor Support for Safety

Supervisor support is the extent to which direct supervisors are perceived to place a high priority on safety, respond to safety concerns and provide support to those complying with safety practices and participating in safety activities (Neal and Griffin, 2004). A review of the organizational and safety literature shows that supportive supervisors and actions that attend to workers' safety concerns are associated with improved safety performance (Clarke, 2009; Mearns, Rundmo, Flin, Gordon & Fleming, 2004; Guldenmund, 2000; Hofmann & Morgeson, 1999; Hofmann, Morgeson and Gerras, 2003; Parker, Axtell, & Turner, 2001; Torp, Grogaard, Moen and Bratveit, 2005; Zohar, 2002). This improved safety performance is often explained in the context of social exchange theory (Blau, 1964; Eisenberger, Huntington, Hutchinson & Sowa, 1986; Rhoades & Eisenberger, 2002). Social exchange theory suggests that as one acts in ways to benefit another, an implicit obligation for reciprocity is created (Gouldner, 1960), thus resulting in the desired performance or outcome. In summary, when an employee perceives his/her supervisor supports safety and is concerned, he/she reciprocates by working or performing in a safe manner.

In the general literature, supervisor support for safety has been identified as a contributing factor to overall safety climate perceptions. Seo et al. (2004) found that both management commitment to safety and supervisor safety support were the most common dimensions assessed in a review of 16 different safety climate instruments. Supervisor support appeared in two-thirds of the instruments assessed. Further, Seo et al. determined that five major factors, including supervisor support for safety, appeared to constitute safety climate. These factors were also deemed less likely to be affected by site specificities. Thus, these factors appear to be generalizable to a variety of industries and occupations.

The basic organization of work in fire organizations provides a strong case for including supervisor support as a principal component of safety climate in firefighting. Ultimately, safety-related priorities, programs, policies and procedures adopted within fire organizations must be implemented, maintained and reinforced at the group level. This is particularly true in firefighting, where much of the direct work activity is carried out by small, highly cohesive workgroups. While workgroup supervisors have long been recognized as playing a key role in the safety performance of workgroups, this is especially true within risky or high-hazard operations such as firefighting. If safety is not a priority, is not executed rigorously and is not supported in risky operations, safety climate perceptions will be low (Zohar, 2003).

Lastly, in the context of firefighting, supervisors must also be trusted and have the confidence of firefighters in order for safety to be positively assessed. The importance of trust was clearly illustrated in the Mann Gulch disaster where 27 wildland firefighters perished because they were reluctant to follow the instructions of a supervisor who they did not know and trust (Weick, 1996). Supervisor support plays a role in achieving trust and confidence. Supportive leadership may increase stress resistance, acceptance of the leader, trust of the leader and willingness to perform extra roles for the leader (Yukl, 2006).

Safety Communication

Communication and information sharing has emerged as an important aspect of safety climate (Pousette, Larsson & Torner, 2008; DeJoy et al., 2004; Zacharatos, Barling & Iverson, 2005; Griffin & Neal, 2000; Evans, Glendon & Creed; 2007; Hofmann

& Stetzer, 1998). Effective communication is germane to a host of work organizations and is particularly important in high hazard work environments (Rochlin, 1999; Reason, 1997). Communication similarly appears to be of great importance in firefighting. Inadequate communication is frequently cited as a contributing factor in many firefighter injury incidents (Thiel, 1999). Similarly, results from firefighter fatality investigations (Ridenour et al., 2008) point to poor communication between individual firefighters and between the firefighters and the incident command structure as important contributing factors to injurious events and fatalities.

During line-of-duty operations, firefighters operate concomitantly with incident commanders and other groups or individuals reacting to the fire situation, the environment, other firefighter members or groups and the command structure. The fire situation and environment are unpredictable and often change rapidly. Firefighters and incident commanders work interactively to combat the fire situation and while doing so must maintain a shared situational awareness. Throughout the firefight, there remains the need for a shared situation awareness and understanding of the present state of the environment to be controlled and the goals to be achieved (Clancy, Elliott, Ley, Omodei, Wearing, McLennan & Thorsteinsson, 2003). According to Clancy et al., this shared situational awareness is not possible without appropriate communication among the members of the hierarchy. Communication throughout the hierarchy (up, down and across) is essential to situation appraisal, decision-making in time-limited circumstances and injury prevention.

To curtail firefighter fatalities and injuries, the United States Fire Administration has indicated that fire departments should promote a culture in which it is acceptable to ask for help, clarify messages and report problems (Thiel, 1999). Within fire departments, the degree and openness of communication likely illustrates the importance of safety within the department. Since safety communication and information sharing has emerged as an important aspect of safety climate and because of its significance in firefighting, safety communication is assumed to be an important dimension of firefighter safety climate.

Safety Programs and Policies

Measures of safety climate should reflect perceptions associated with factors such as training, available resources for protection and personal safety, and the active involvement of management in safety programs. Safety programs and policies have been recognized as a major component or contributor to safety climate (DeJoy et al. 2004; Diaz & Diaz-Caberra, 1997; Hayes, Peranda, Smecko & Trask, 1998; Evans, Glendon & Creed, 2007; Mohamed, 2002). In fact, safety programs and policies have been reported as the largest contributor to safety climate in some studies (DeJoy et al.; Diaz & Diaz-Caberra; Zohar, 2003).

The importance of establishing and supporting safety programs and policies is essential to perceptions of safety climate in fire organizations. It is generally accepted that firefighting organizations with a positive safety climate feature clear and comprehensive safety programs and policies, including safety training programs. Safety training is one of the most practiced techniques in safety management (Zacharatos et al., 2005). Safety training is essential to promoting safety knowledge, skills and behaviors and is a key element in successful organizations (Montgomery & Gil, 2009).

Formal safety training is particularly important in firefighter organizations given the extensive hazards and exposures encountered on the fireground and during line-of-duty operations. For firefighters to perform their jobs safely, training must be continuous and sophisticated, similar to that of high reliability organizations (Weick, Sutcliff & Obstfeld, 1999). This training provides the necessary skills and knowledge to perform operations in a safe manner and will also provide a means to cope with unanticipated circumstances, failures and new risks, which require the ability to improvise. If firefighters perceive their training to be deficient in any manner, their perceptions regarding the importance of safety programs may be compromised.

Firefighting is an equipment intensive activity. Equipment such as personal protective equipment, PASS (Personal Alert Safety System) devices, personal radios, turnout gear and thermal imaging cameras are essential to effective firefighter operations. The National Institute for Occupational Safety and Health has repeatedly recommended programs and procedures for the provision, operation and maintenance of equipment to prevent firefighter fatalities and injuries (Hodous, Pizatella, Braddee & Castillo, 2004; Ridenour, Noe, Proudfoot, Jackson, Hales, & Baldwin, 2008). In a similar fashion, having adequate staffing and available personnel to perform line-of-duty operations reflects the importance of safety. Adequate staffing is important to safety outcomes in the fire industry (Lawrence, 2001). Adequate numbers of firefighters and adequate deployment procedures are necessary to safely perform line-of-duty operations and to rescue lost or trapped firefighters (Ridenour et al., 2008).

The Safety Climate-Behavior-Injury Model Applied to Firefighters

The benefits of a positive safety climate have been demonstrated in various work environments. However, empirical evidence is lacking with respect to firefighting. While epidemiologic research has explored firefighter health problems (Rosenstock & Olsen, 2007; Kales, Soteriades, Christophi & Christiani, 2007; Soteriades, Hauser, Kawachi, Liarokapis, Christiani & Kales, 2005 & Del Ben, Scotti, Chen & Fortson, 2006) personal injury factors (Lee, Fleming, Gomez-Martin & LeBlanc, 2004 & Liao, Arvey, Butler & Nutting, 2001) and situational factors to accidents (Rosmuller & Ale, 2007; Lusa, Hakkanen, Luukkonen & Juntura, 2002; & Fabio, Ta, Strotmeyer, Li & Schmid, 2002), virtually no attention has been given to organizational factors, specifically the role of climate-culture.

Safety climate studies in other work environments have provided evidence for and illustrated the means by which safety climate reduces accidents and injury outcomes. The literature illustrates that there are direct effects between safety climate and injury outcomes (Zacharatos, 2005; Zohar, 2000; Clarke & Ward, 2006). However, there is general agreement that reductions in injury are mostly indirect and are partially mediated by safety behaviors and follow a climate-behavior relationship model (Zohar, 2003).

The climate-behavior relationship model posits that safety climate plays an important role in shaping behavior-outcome expectations in work environments (Zohar, 2003; Zohar, 2008). These expectancies have been shown to predict actual behavior (Zohar, 2008; Bandura, 1986; Vroom, 1964) and thus serve to present the reasoning for a positive relationship between safety climate and safety behaviors. The literature supports this notion as positive perceptions of safety climate have been shown to support and reinforce both compliance and contextual behaviors and reduce the likelihood of unsafe acts (Clarke, 2006; Hofmann & Stetzer, 1996; Cheyne, Cox, Oliver & Tomas, 1998; Neal, Griffin & Hart, 2000).

In the context of firefighting, compliance-oriented behaviors exhibited by firefighters include obeying rules, following standard operating procedures, using appropriate equipment and the like. Examples of contextual or safety-citizenship behaviors by firefighters include promoting and supporting safety, going beyond the required safety standards and taking initiative for health and safety through extra-role behaviors or organizational citizenship behavior such as addressing unsafe co-worker behavior or providing upward safety communication despite rank. Within firefighter organizations, using the safety climate-behavior-injury model as exemplar, positive perceptions of safety climate presumably produce compliance-oriented and contextual or safety citizenship behaviors in firefighters, both of which should ultimately reduce injury outcomes.

Overview of the Present Study

A theoretical model of safety climate should specify the link between safety climate perceptions and organizational injury, where safety climate influences safety behaviors and safety behaviors influence the injury outcome (Zohar, 2003). The theoretical model guiding the present study is shown in Figure 1.

Safety climate in this model was conceptualized as a higher order factor. Researchers have argued that safety climate should be conceptualized as a higher-order factor, with more specific first-order factors, so that the higher-order factor ultimately reflects the extent to which employees believe that safety is valued within the organization (Griffin & Neal, 2000). The proposed model features four first order factors: management commitment to safety, supervisor support for safety, safety communication and safety programs and policies. Within the firefighter safety climate-behavior-injury model, it is postulated that the perceptions of safety climate will be positively associated with safety behaviors in firefighters. Following Griffin and Neal (2000), two categories of safety behaviors are featured: safety compliance behaviors and contextual or safety-citizenship behaviors. Further, these behaviors are expected to be negatively associated with injury experience.

There are five major hypotheses guiding the present study. The relationships posited include: (1) Perceived safety climate will positively influence firefighter safety compliance behavior. (2) Perceived safety climate will positively influence firefighter safety-citizenship behavior. (3) Perceived safety climate will have a negative influence on firefighter injury. (4) Safety compliance behavior will be negatively associated with firefighter injury incidents. (5) Safety-citizenship behavior will be negatively associated with firefighter injury incidents. It is hypothesized that safety compliance behaviors and safety-citizenship behaviors will partially mediate the relationship between perceived safety climate and firefighter injury.

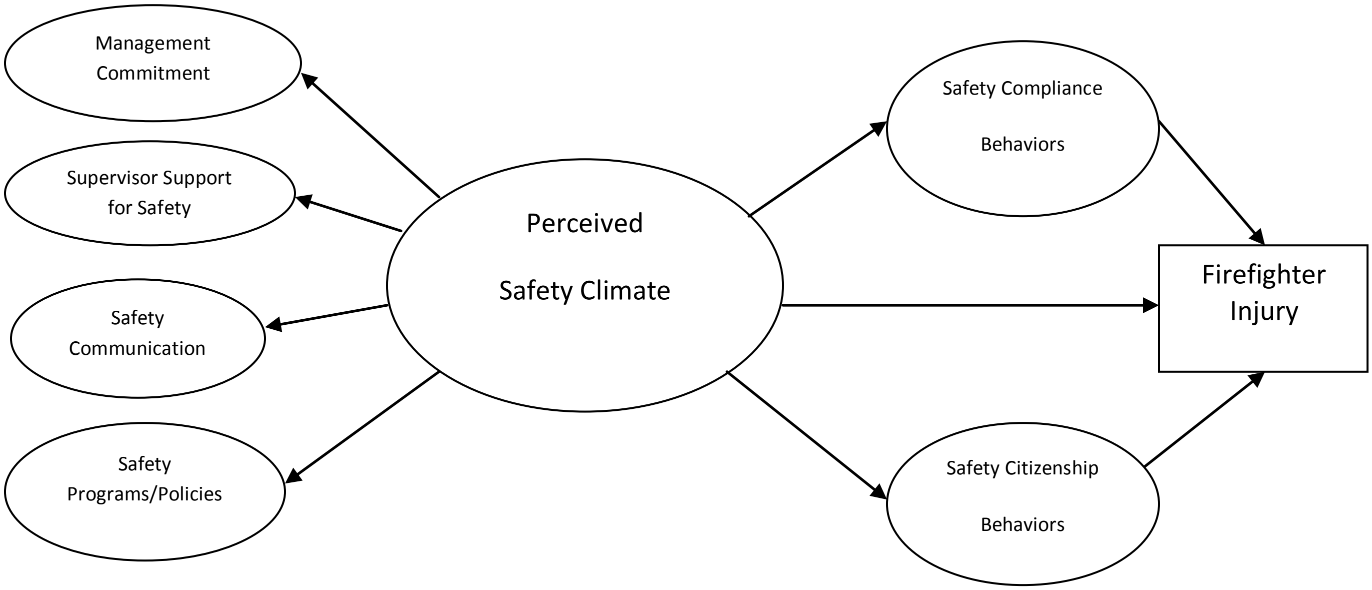

Figure 1. Proposed Partially-mediated Model

CHAPTER 3

RESEARCH OVERVIEW

The general purpose of this dissertation research was to develop and test a model linking perceptions of safety climate, firefighter safety behaviors and firefighter injury outcomes. This research is important as both the firefighting and scientific communities are interested in curtailing the firefighter injury problem, especially since significant progress has not been made with reducing firefighter fatalities and injuries over the past quarter-decade. Both groups are interested in identifying avenues to enhance firefighter safety and want to prevent firefighter injuries, including fatalities. Safety climate and its influences may serve as a means to accomplish these objectives.

Research Design and Sample

To complete the objectives of this study, a cross-sectional study was completed. Data were collected from professional firefighters, aged 18 or older, through a respondent-completed questionnaire. The use of structural equation modeling in non-experimental studies, such as this cross-sectional study, is common (MacCallum & Austin, 2000); however, only rough guidelines for sample size are present at this time (Kline, 2005). While some researchers are reluctant to recommend rules of thumb regarding sample size (MacCallum and Austin), Kline recommends that sample size in SEM studies be greater than 200 cases for large studies. Further, Kline states that studies should not be executed with less than 100 cases as the results would be unsound.

Professional firefighters for this study were recruited from Hall County, Georgia, Athens-Clarke County, Georgia and the City of Gainesville Fire Department. The total professional firefighter population for these three agencies located in north-eastern Georgia was 522. To obtain the needed 200 firefighters, an overall response rate of approximately 39% across the departments was needed. A total of 398 firefighters from the three departments participated in the research study accounting for a total participation rate of 76 percent.

In lieu of an individual monetary incentive for participation, an incentive program was utilized. The program was based on the premise that firefighters perceive themselves as family or a strong social network anchored with a strong sense of camaraderie (Del Ben, Scotti, Chen & Fortson, 2006; Yarnal, Dowler & Hutchinson, 2004). Incentives in the study consisted of contributions in the name of the fire department to the Georgia Firefighters Burn Foundation. The program structure indicated that a donation in the amount of $50 would be made in the name of the departments meeting the 50% participation target and an additional $50 donation would be made if departments were able to obtain a 70% participation rate. One-hundred dollar donations were made in the name of three departments based on the participation rates obtained.

During data collection, each firefighter was given a copy of the questionnaire to complete. The questionnaire (see Appendix A) utilized for this study solicited information regarding demographic data, work characteristic data (e.g. rank) and included questions associated with the following constructs: management commitment, supervisor support for safety, safety communication, occupational safety programs and policies and safety behaviors. Each of these measures is described below.

Firefighters were asked to self-report the number of workplace incidents in which they had been involved over the past 12 months and to self report the number of injuries suffered over the past 12 months. For those reporting an injury, they were asked to report the length of lost workdays, transferred workdays and restricted workdays. The questionnaire, which consisted of 111 questions, took firefighters approximately 15 minutes to complete.   As is evident in the questionnaire in Appendix A, there are additional items for constructs not included within the dissertation research and additional questions associated with health outcomes and injury measures including near-misses. Additional information was collected to supplement reports that are being generated for the fire departments that participated in this research study. These additional items and factors were of interest both to the fire chiefs and the researcher.

Socio-demographic items included gender, age, weight, height, education, race and ethnicity and relationship status. Work characteristic questions included years of service, rank and secondary employment status. The items are asked in Section M of the survey instrument. Injury outcome measures and construct measures are summarized below. Injury measures were asked in Section L of the survey.

Incident and Injury Outcome Measures

Self-report injury data for line-of duty (LOD) operations was collected as a part of the questionnaire. Line-of-duty (LOD) refers to a firefighter being involved in operations at the scene of an emergency, regardless of whether it is a fire or non-fire incident, responding or returning from an incident, or performing other officially assigned duties such as training, maintenance, public education, inspection, or investigation (Moore-Merrell et al., 2008). Firefighters were asked if they were involved (yes/no) in an accident during the previous 12 months while performing line-of-duty operations and duties. The interpretation of accident was left to the firefighter. During the subject matter expert reviews, reviewers did not exhibit concern with this item or question and felt that it was self explanatory. Firefighters that responded "yes" were asked to indicate the number of accidents they were involved in while performing firefighter line-of-duty operations and duties during the previous 12 months.

Further, firefighters were then asked if they experienced (yes/no) any line-of-duty injuries during the past 12 months. For the purposes of this study, an injury was defined as any physical damage to the body, requiring first aid or medical treatment, whether it was obtained or not. Those firefighters that responded "yes" to suffering an injury were asked to indicate the number of injuries experienced during the past 12 months while performing line-of-duty operations and duties.

For those reporting an injury or injuries, they were asked to report the number of workdays lost during the past 12 months as a result of their injury(ies). To further assess disability, firefighters were asked to report the number of days their work was limited as a result of their injury(ies). This measure would assess restricted duties, alternative duties or transferred duties (OSHA, 2005). In addition to injurious incidents, firefighters were asked to report the number of near-miss incidents they experienced over the past 12 months. Near-miss incidents were defined according to the National Fire Fighter Near-Miss Reporting System (http://www.firefighternearmiss.com/). A near-miss event according to the system was defined as an unintentional unsafe occurrence that could have resulted in an injury, fatality or property damage, but did not.

Perceived Safety Climate

Perceived safety climate for the purposes of this study was assessed as a higher-order factor, with four first order latent constructs as factors. First order factors consisted of constructs associated with management commitment to safety, supervisor support for safety, safety communication, and safety programs and policies. The scales for these latent constructs are summarized below. Coefficient alpha (Cronbach, 1951) values derived for the scales are presented below to illustrate reliability of the measures in prior studies.

<u>Management Commitment to Safety</u>

Management commitment to safety was measured using seven items adapted from Zohar's (1980) safety climate scale. Firefighters were asked to rate their agreement with statements on a 5-point Likert-type scale from strongly disagree to strongly agree. Sample items for this scale include "management in this fire department is always willing to invest money and effort to improve the safety level here" and “management in this fire department is always willing to adopt new ideas for improving the safety level.” These items are the final seven questions in Section I of the survey instrument.

For nearly three decades, researchers have successfully used versions of Zohar’s scale in various studies. Some of the most recent studies include Michael, Evans, Jansen and Haight (2005) and Huang, Ho, Smith and Chen (2006). These studies reported alphas of .86 and .71, respectively.

Supervisor Support for Safety

Supervisor support for safety was assessed using a four item scale from Thompson, Hilton and Witt (1998). These four items were be assessed on a 5-point Likert-type scale ranging from strongly disagree to strongly agree. The alpha reported by Thompson et al. was adequate at .85. Sample items for this scale include “my supervisor shows personal concern about firefighter safety” and “my immediate supervisor tries to make my job as safe as possible.” The four items for the scale are the first four items in Section I of the survey instrument.

Safety Communication

Safety communication, as a latent construct, was assessed with the 6-item scale utilized by Michael, Guo, Wiedenbeck and Ray (2006). This scale, which produced an alpha of .80, was derived from the 7-item scale developed and used by Hofmann and Stetzer (1998). Hofmann and Stetzer had reliability estimates of .79 and .81 for their scale. The items were assessed using a 5-point Likert type scale ranging from strongly disagree to strongly agree. The scale includes items such as "I feel comfortable discussing safety issues with my supervisor" and "My immediate supervisor encourages open communication about safety." The wording of the items was modified slightly as they initially inquired about the extent to which the communication atmosphere existed. The scales were previously rated on a scale from a very small extent to a great extent. The six questions comprise Section B of the survey instrument.

<u>Occupational Safety and Health Programs and Policies</u>

DeJoy and colleagues' (2004) 5-item measure for occupational safety and health programs and policies was used to measure the extent to which the firefighter's organization has specific safety policies and programs aimed at protecting firefighter safety. The scale used by DeJoy et al. had an alpha level of .91. The items used by DeJoy et al. were derived from prior research on safety program effectiveness (e.g., Cohen, 1977) and the core elements and functions that are typically considered to be part of good occupational safety programming (Hagan, Montgomery & O'Reilly, 2009). Given the importance of having adequate resources and adequate personnel in firefighting (Ridenour, Noe, Proudfoot, Jackson, Hales, & Baldwin, 2008), two items were added to the measure to assess whether programs were in place to ensure adequate resources and personnel to perform firefighting operations. Firefighters were asked about the extent to which their organization has specific programs and policies related to such matters as safety training, safety equipment and related resources. The items were assessed using a 5-point Likert-type scale ranging from strongly disagree to strongly agree. The seven items used in this scale are located in Section E of the survey instrument.

Safety Behaviors

Safety compliance behaviors and safety citizenship behaviors were assessed in this study. Items associated with these two categories of behaviors were drawn from Neal and Griffin (2006). Items were rated on a 5-point Likert-type scale from strongly disagree to strongly agree. Items associated with safety compliance behaviors included "I use all the necessary safety equipment to do my job," "I use the correct safety procedures for carrying out my job" and "I ensure the highest levels of safety when I carry out my job." Contextual or safety citizenship behaviors included "I promote the safety program within the organization," "I put in extra effort to improve the safety of the workplace" and "I voluntarily carry out tasks or activities that help improve operational safety." Internal consistencies garnered by Neal and Griffin included an alpha of .92 for compliance-oriented behavior and .86 for safety-citizenship behavior. Safety compliance questions are the first three items in Section F of the survey and safety citizenship questions are the fourth, fifth and sixth items in Section F of the survey.

Data Collection

Prior to data collection, approval for the use of human subjects was obtained from the Institutional Review Board at the University of Georgia. Approval was granted in March 2010. Data were collected during May 2010 using the survey instrument in Appendix A.

Before data collection activities were performed, the survey instrument was refined through the use of a group of subject matter experts. The use of subject matter experts to review questionnaires, aid in questionnaire development and test questionnaires is a distinct approach from other methods typically used with members of the respondent population (Ramirez, 2002). The use of subject matter experts is especially applicable in special populations on technical subjects (Ramirez, 2002) such as firefighters. Information was gathered from firefighter officers and administrative officers within a county fire department, a research scientist and a safety professional.

Following general guidance presented by Ramirez (2002), directions were provided to the reviewers with how to complete the review. Both verbal and/or written feedback was obtained from the reviewers. A copy of the directions presented to the subject matter experts and the questions asked of the reviewers is in Appendix B. The general consensus by the reviewers was that little information needed changed within the questionnaire. They generally felt the items were easy to understand, wording was appropriate for the firefighter community, terminology was easy to understand and additional definitions were not needed. They also believed the time burden to complete the survey was satisfactory. There was consensus that I needed to clearly define the term supervisor within the questionnaire. Based upon this feedback, items were re-written to emphasize the level of supervisor within the questions. Supervisor terms were qualified by indicating the level such as “immediate supervisor.” This terminology was based upon guidance from the subject matter experts. No other major changes were made to the questions within the survey; however, some items were worded differently to refer specifically to firefighters or the context of firefighting. This helped clarify some of the questions since the items were previously used in different industries and were asked in a more general format in previous studies.

For the purposes of this study, a cross-sectional survey was completed. Data collection dates, locations and data collection activities were coordinated with the fire chiefs from each of the three participating departments. Efforts were made to combine sites when feasible to limit the travel and data collection trips.

During data collection visits, each firefighter was given a copy of the questionnaire to complete. Instructions regarding how to complete the questionnaire were presented to all participating firefighters at the same time. Further, directions were noted on the survey. A script was utilized when presenting the questionnaire and directions to the participating firefighters to ensure consistency and clarity. As the researcher, I was available to answer questions during the survey process. Firefighters answered the items without discussion. The firefighters mostly completed the questionnaires while seated in “day rooms” or “community rooms” within the fire stations. Informed consent was obtained through a consent statement included within the survey, where respondents acknowledge the statement and gave consent by completing the questionnaire. A copy of the consent statement is located in the questionnaire located in Appendix A.

After respondents finished answering the questionnaire, I collected the completed survey and placed it in a file box that I carried to each facility. The box remained in my possession at all times. After all the data were collected, I entered the data from the questionnaires into a data set in SPSS 17.0.

Data Analysis

Once data were entered into the SPSS data set, data screening procedures and analyses were completed using SPSS 17.0, LISREL, version 8.8 and MPlus, version 5.2. The data screening process assessed and corrected for outliers, missing data, multicollinearity, univariate normality and multivariate normality as recommended by Kline (2005). Prior to running these analyses, a review of descriptive statistics was completed to assess whether data entry errors were made. Also, some item responses were reverse coded to align with the intention of other items within the projected scale. Details regarding the analyses, actions taken and results are presented in Chapter 4 within the discussion of the results.

An examination for outliers was completed through DeCarlo's norm test procedure (DeCarlo, 1997) using SPSS 17.0. The researcher evaluated outlier candidates based on Mahalanobi's distances generated during the norm test procedure. The researcher removed the outlier cases after a review of the cases and responses.

Multivariate normality was assessed during the data screening activities. Multivariate normality was assessed through the examination of the relative multivariate kurtosis statistic obtained from a PRELIS examination in LISREL 8.8. Data were transferred to a PRELIS file in LISREL 8.8 from the SPSS dataset.

Univariate normality was assessed through examining skewness and kurtosis within SPSS 17.0. Values recommended by Kline (2005) were utilized as criterion for the evaluation. Kline recommends values less than I3.0I for skewness and I8.0I for kurtosis. The injury outcome measure was presumed to be zero-inflated with skewness and kurtosis beyond normal levels. This was confirmed in the analysis. Given the results associated with the injury variable, zero-inflated Poisson regression analysis was completed within MPlus to assess the hypothesized model.

Multicollinearity occurs when intercorrelations among variables are too high. In other words, multicollinearity occurs when measured variables are highly related and essentially redundant (Weston & Gore, 2006). Multicollinearity can be problematic in structural equation modeling (Kline, 2005) and statistical operations may not function properly (Weston & Gore, 2006). The correlation matrix for all variables was screened to assess whether bivariate correlations exceeded .85, as bivariate correlations greater than r = .85 may be problematic (Kline, 2005).

Missing values might result in biases in statistical inferences. For analyses completed within MPlus, the full information maximum likelihood (FIML) procedure was used to treat missing data. Under ignorable missing data conditions including missing completely at random (MCAR) and missing at random (MAR), FIML is a better method for dealing with missing data in structural equation modeling (Enders & Bandalos, 2001). While FIML was used with the MPlus analyses, SPSS analyses including assessment of Cronbach's alpha and assessments of descriptive statistics utilized the default listwise deletion procedure since there was very little missing data.

Scale Assessment

Reliability analyses were completed through assessing the internal consistency of each scale using SPSS 17.0. Cronbach's alpha (Cronbach, 1951) was computed for each scale. Each of the scales had alphas of .80 or above indicating good internal consistency. In addition, confirmatory factor analysis using maximum likelihood estimation was completed to assess the factor structure of the scales and to ensure that they were representative of the latent constructs proposed. MPlus, version 5.2 was used to complete the analysis.

Within the confirmatory factor analysis, the items were restricted to load on their respective conceptual factors only and restricted to zero on all other factors. Model assessment was examined by assessing the overall fit of the model, parameter estimates, statistical significance for the factor loadings, and an examination of r-squared values. With regard to model fit, lower valued, non-significant chi-square values are indicative of a good fit. The chi-square statistic can however be influenced by sample size and large correlations between variables and should not be used as a stand-alone measure (Bentler, 1990). Thus, the overall fit was assessed with multiple fit indices against criterion established by Hu and Bentler (1999), Vandenberg and Lance (2000) and Marsh, Balla and McDonald (1988). Fit indices assessed included the model chi-square, the root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMSR), the comparative fit index (CFI) and the Tucker and Lewis index (TLI). All of these indices were generated by MPlus. Table 1 illustrates the criteria for an acceptable fit.

Table 1: Fit Indices and Criterion for Acceptable Fit

Fit Index	Name	Criteria for Acceptable Fit
SRMSR	Standardized root mean square residual	.08 or less (Hu & Bentler, 1999)
RMSEA	Root mean square error of approximation	.06 or less (Hu & Bentler, 1999) .08 or less (Vandenberg & Lance, 2000)
NNFI or TLI	Non-normed fit index or Tucker-Lewis Index	.95 or higher (Hu & Bentler, 1999) .90 or higher (Marsh, Balla & McDonald, 1988)
CFI	Comparative Fit Index	.95 or higher (Hu & Bentler, 1999) .90 or higher (Marsh, Balla & McDonald, 1988)

Structural Equation Modeling

Structural equation modeling (SEM) is a sophisticated and powerful method, well-suited to address an array of hypotheses in organizational and psychological research (MacCallum & Austin, 2000; Vandenberg & Lance, 2000). SEM is used for specifying and estimating models of linear relationships among measured and/or latent variables that are arranged in a hypothesized pattern of directional and non-directional relationships (MacCallum & Austin, 2000). One critical requirement for model development and testing through SEM is that the model must be based on theory (Bentler & Chou, 1987).

The overarching goal of this research study was to develop and test a firefighter safety climate model. A model was developed based on the general safety climate and firefighter safety literature. Structural equation modeling was utilized to assess the theoretical model and the research questions proposed in this study. Analyses were completed with MPlus, version 5.2. The analysis was guided by the two-stage process described by Anderson and Gerbing (1988), which included the test of the measurement model, followed by the assessment of the structural model and hypothesized relationships.

The results of the study indicate useful information in the prevention of firefighter injury. The results for all analyses, including structural equation modeling are detailed in Chapter 4.

CHAPTER 4

RESULTS

This chapter presents quantitative statistical results obtained during the study. The first section of the chapter provides a description of the data and details preliminary analyses, data screening procedures and preparation for the measurement analyses. The subsequent section describes the results of the measurement model examination and the findings related to the hypotheses that were tested through structural equation modeling analyses.

Preliminary Analyses

Three fire departments located in north-eastern Georgia participated in the study. Data were collected from 398 full-time professional firefighters aged 18 or older accounting for a total participation rate of approximately 76%. Participation rates for each of the three departments were: 76% (130 of 170) at Athens-Clarke County Fire Department, 73% (203 of 280) at Hall County Fire Services and 90% at the City of Gainesville Fire Department (65 of 72). For the purposes of this study, the sample was restricted to firefighters performing fire service operations, including station lieutenants and captains based on their active role in fire suppression and service activities alongside lower ranking firefighters. Administrative personnel above the rank of captain (n=9) were not included in the final analyses and those respondents that did not identify their rank (*n*=28) were removed from the analyses providing a sample of 361 respondents. As discussed later in this section, twelve outlier cases were identified within the data set. These outlier cases were removed from the data set. Thus, the final data set included data from 349 respondents.

Of the 349 respondents included in the analysis, 50 (14.3%) were firefighters from the City of Gainesville, 115 (33%) were firefighters from Athens-Clarke County Fire Department and 184 (52.7%) were firefighters from Hall County Fire Services. The mean age of the firefighters was 36.45 (*SD* = 9.08) with a range from 19 to 60.

Approximately 93% of the firefighters were White (326), 3% were Black (9) and 1% (3) were American Indian or Alaskan Native. Two firefighters (< 1%) were Asian and two firefighters (< 1%) rated their race as Other. Seven firefighters failed to select their race category, but indicated their ethnicity as Hispanic. One White respondent also reported his/her ethnicity as Hispanic.

A total of 267 firefighters (77%) were either married or living with a partner, while approximately 10% (34) had been married, but were currently separated or divorced. Forty-seven of the firefighters (~14%) were single and one firefighter did not answer the marital status question. Firefighters had various educational backgrounds. Sixty-six percent of the respondents reported some college or technical/vocational training beyond high school (*n*=230). Fifty-three firefighters (15%) completed a high school degree, 36 completed an Associate's degree (10%), 27 completed an undergraduate college degree (~8%) and one firefighter completed a Master's degree. One firefighter also reported some postgraduate work beyond a Bachelor's degree.

With regard to years of service, firefighters reported service levels from less than one year to more than 25 years. Years of service reported by respondents is illustrated in Figure 2. The majority of the firefighters have more than two years of service indicating that most respondents have progressed into the role of firefighter or beyond and are no longer considered probationary firefighters. The number and percentage of firefighters in each of the ranks included within the study were as follows: Firefighter I (79, 23%), Firefighter II or Corporal (118, 34%), Firefighter III or Sergeant (85, 24%), Lieutenant (53, 15%) and Captain (14, 4%).

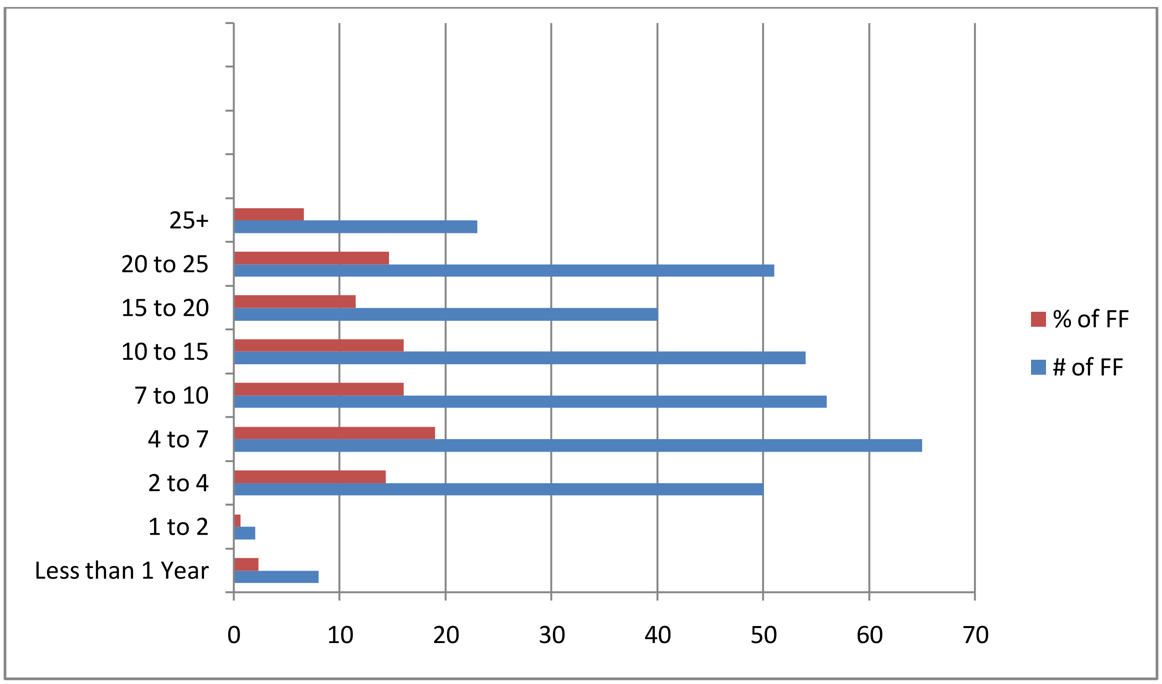

Figure 2. Firefighter Years of Service.

Lastly, firefighters were asked to report whether they had a second job and how many hours they worked each week if they did have a second job. Eighty-one percent of the firefighters indicated they had a second job (*n*=282). The mean hours worked by firefighters at their second job was 23.31 hours (*SD* = 15.94).

Once data were entered into the SPSS 17.0 data set, data preparation and screening procedures were completed. Initially, two items including SCOMM2 (Do you generally try to avoid talking about safety-related issues with our supervisor?) and SCOMM6 (Are you reluctant to discuss safety-related problems with your supervisor?) were reverse coded for the analyses. The reverse coding was completed to align positively with the intention of the items and the Safety Communication scale which they were hypothesized to load as factor items. Following this recoding, a review of descriptive statistics was completed. A few data entry errors were identified during an assessment of minimum and maximum values. Data entry was cross-checked with the respondents' surveys and the correct information was replaced in the data set.

Data preparation and screening is crucial when performing structural equation modeling studies (Kline, 2005). Data preparation and screening procedures recommended by Kline were completed and are highlighted below. The procedures addressed outliers, univariate normality, multivariate normality, multicollinearity and missing data as recommended by Kline (2005).

Outliers

An examination for outliers was completed by conducting DeCarlo's norm test procedure (DeCarlo, 1997). As a result of this examination, it was determined that eight cases had Mahalanobis distances that exceeded the critical values (Bonferroni) for a single multivariate outlier. Each of these eight cases had values that exceeded the critical value of *F*(.05/n) = 64.46, *df* = 31,324. These cases were examined for data entry errors, but none were noted. Some response patterns did seem illogical (e.g. all items weighted strongly agree, all items weighted neutral, high variation for items within scales). Based upon the potential effect outliers can produce, these eight outlier cases were removed and the DeCarlo norm test was again conducted. The DeCarlo norm test then showed an additional four cases with Mahalanobis distances greater than the critical value of $F(.05/n) = 64.31$, $df = 31{,}316$. Similarly, these four cases were removed. The DeCarlo norm test was performed a third time and it was determined that no cases had a value that exceeded the critical value $F(.05/n) = 64.24$, $df = 31{,}312$. With the removal of outlier cases, the population utilized for the study was n = 349.

Normality

Univariate normality was assessed through examining skewness and kurtosis within SPSS 17.0. Values recommended by Kline (2005) were utilized as criterion for the evaluation of normality. Kline recommends values less than I3.0I for skewness and I8.0I for kurtosis. All values aside from the injury outcome (NUMINJ) were below the criterion for the evaluation of normality (see Table 2). It was previously assumed that the injury outcome measure would be zero-inflated and would likely have a skewness and kurtosis beyond normal levels. This was confirmed in the analysis as skewness was 3.44 and kurtosis was 12.95 for the injury outcome variable. No transformations or changes were made to the injury outcome variable since it is a count and is one of the main outcome variables. Since the variable is a count and because the response was heavily zero-inflated (87%) a zero-inflated Poisson analysis in MPlus was used to assess the hypotheses associated with this study.

Multivariate normality was also assessed during the data screening and preparation activities. Data were transferred to a PRELIS file in LISREL 8.80, where multivariate normality was assessed through an examination of the PRELIS reported relative multivariate kurtosis, which was satisfactory at 1.116, compared to a level of concern at 2.0.

Table 2: Item Statistics

Variable	**N**	**Missing**	**Mean**	**SD**	**Skewness**	**Kurtosis**
Safety Communication (SCOMM)						
SCOMM1	349	0	4.56	.61	-1.23	1.59
SCOMM2	349	0	4.26	.81	-1.11	1.18
SCOMM3	349	0	4.50	.62	-1.02	.68
SCOMM4	349	0	4.43	.67	-1.00	.74
SCOMM5	349	0	4.26	.86	-1.25	1.65
SCOMM6	349	0	4.18	.97	-1.34	1.54
Management Commitment (MGTC)						
MGTC1	349	0	3.28	1.07	-.37	-.33
MGTC2	349	0	3.46	.99	-.35	-.19
MGTC3	349	0	3.69	.94	-.50	-.07
MGTC4	348	1	3.86	.80	-.49	.29
MGTC5	348	1	3.65	.93	-.41	.00
MGTC6	349	0	3.94	.80	-.63	.91
MGTC7	349	0	3.75	.92	-.59	.37
Supervisor Support for Safety (SUPR)						
SUPR1	349	0	4.36	.67	-.68	-.09
SUPR2	349	0	3.96	.81	-.39	-.39
SUPR3	349	0	4.31	.67	-.69	.35
SUPR4	349	0	4.40	.74	-1.13	1.13
Safety Programs and Policies (PGM)						
PGM1	348	1	3.62	.75	-.24	-.20
PGM2	349	0	4.31	.62	-.61	.87
PGM3	349	0	4.13	.72	-.71	.80
PGM4	349	0	4.08	.69	-.70	1.45
PGM5	348	1	3.87	.85	-.75	.71
PGM6	348	1	4.12	.77	-1.10	2.27
PGM7	349	0	3.28	1.15	-.27	-.82
Safety Compliance Behavior (COMP)						
COMP1	349	0	4.38	.60	-.73	1.74
COMP2	349	0	4.32	.57	-.10	-.63
COMP3	349	0	4.33	.58	-.20	-.65

Safety Citizenship Behavior (CTZ)						
CTZ1	349	0	4.01	.80	-.62	.42
CTZ2	349	0	3.73	.82	-.43	.23
CTZ3	349	0	3.72	.84	-.42	.27
Number of Injuries (NUMINJ)	349	0	0.16	.48	3.44	12.95

Multicollinearity

Multicollinearity occurs when intercorrelations among variables are too high. This can be problematic in structural equation modeling (Kline, 2005; Weston & Gore, 2006). The correlation matrix for all variables in the study was screened to assess whether intercorrelations between variables exceeded .85, which Kline suggests may be problematic. The correlation matrix for all variables is available in Appendix C. The assessment determined that there were no bivariate correlations greater than .85.

Missing Data

Missing values may be problematic in statistical analyses as missing data might result in biases in statistical inferences. For the data used in this study, there were very few missing data. Only five values were missing in the entire data set. One value was missing in each of the following variables: MGTC4, MGTC5, PGM1, PGM5 and PGM6. Each missing value was by a different respondent. While the number of missing values was not great, procedures were utilized in the measurement model and structural equation model analyses to address the missing values.

Within regression and structural equation modeling studies, researchers have indicated that mean imputation methods for missing data have resulted in biased parameter estimates under both missing completely at random and missing at random assumptions (Brown, 1994; Wothke, 2000; Enders & Bandalos, 2001). Thus, the full information maximum likelihood (FIML) procedure within MPlus was used to treat missing data as FIML should be a superior method for dealing with missing data in structural equation models (Enders & Bandalos, 2001). While FIML was utilized with the MPlus analyses, SPSS analyses including assessment of Cronbach's alpha and assessment of descriptive statistics utilized the default listwise deletion procedure.

Scale and Model Measurement Analyses

A confirmatory factor analysis (CFA) was completed after the data were screened and prepared for analyses to assess and confirm the scale structures. CFA models are often used in measurement applications to include construct validation (MacCallum & Austin, 2000). The CFA model for this study was analyzed using MPlus, version 5.2 (Muthen & Muthen, 1998-2007). The correlation matrix for the latent variables is presented in Table 3. All the latent variables utilized in the CFA analysis were significantly, positively correlated (*p* < .01, two-tailed).

Table 3: Correlation Matrix for Latent Variables

	SCOMM	**MGTC**	**SUPR**	**PGM**	**COMP**	**CTZ**
SCOMM	1.00					
MGTC	0.27*	1.00				
SUPR	0.53*	0.47*	1.00			
PGM	0.36*	0.72*	0.52*	1.00		
COMP	0.37*	0.51*	0.45*	0.50*	1.00	
CTZ	0.26*	0.42*	0.36*	0.37*	0.66*	1.00

**p*<.01, Abbreviations and scale names are illustrated in Table 2.

Maximum likelihood estimation was utilized in the MPlus confirmatory factor analysis. There were no irregularities encountered and no warnings obtained. To assess fit, multiple fit indices were utilized. Lower valued, non-significant chi-square values are indicative of a good fit; however, the chi-square statistic can be influenced by a variety of factors and should not be used as a stand-alone measure (Bentler, 1990). Thus, the overall fit was assessed with multiple fit indices. In examination of fit indices, it was determined that the overall fit was satisfactory as $\chi 2 = 840.35$, *df* = 390, *p*= 0.00, RMSEA = 0.058, SRMSR = .054, CFI = .93 and TLI = .92. While CFI and TLI statistics were slightly lower than recognized cut-offs for excellent model fit (.95 or greater) by Hu & Bentler (1999), the statistics for RMSEA and SRMSR were appropriately below Hu and Bentler's suggested cut-off values for acceptable model fit, which include .06 or below for RMSEA and .08 or less for SRMSR. Further, the result of the RMSEA appears to be a quality statistic. Vandenberg and Lance (2000) concluded that a RMSEA value of .08 can be viewed as an upper limit of reasonable model fit. Further argument that the model is satisfactory is that while TLI and CFI values are slightly lower than those delineated by Hu and Bentler, they are better than the recommended lower-bound values (.90 or higher) for good model fit by Marsh, Balla, and McDonald (1988).

Parameter values or factor loadings were assessed to examine the paths in the CFA model to assess whether items appropriately fit their intended scale. Unstandardized path values, standard errors, *t*-values, *p*-values and R^2 are included in Table 4. For each factor, the unstandardized loading of the first indicator variable was set to 1.0, which is the default method in MPlus and the recommended technique for confirmatory factor analysis studies (Kline, 2005). To assess significance, the t-test statistic for each factor loading was examined to determine whether the factor loading was significantly different from 0. Significance was evaluated against a critical value of 1.96 (two-tail, p = 0.05). The MPlus output also provides the p-value, which can also be used to assess significance. Standard error, t-value and p-value are not calculated for the first unstandardized loading set to 1.0.

Table 4: Proposed Measurement Model Statistics

Latent and Observed Variables	**Unstandardized Factor Loading**	***SE***	***T***	***P***	R^2
Safety Communication					
SCOMM1	1.00	-	-	-	.75
SCOMM2	0.96	0.08	12.77	0.00	.40
SCOMM3	1.06	0.05	21.83	0.00	.79
SCOMM4	1.02	0.06	17.82	0.00	.64
SCOMM5	0.90	0.08	10.77	0.00	.31
SCOMM6	0.96	0.10	9.91	0.00	.27
Management Commitment					
MGTC1	1.00	-	-	-	.60
MGTC2	1.01	0.06	17.54	0.00	.72
MGTC3	1.01	0.06	18.26	0.00	.78
MGTC4	0.81	0.05	16.50	0.00	.68
MGTC5	0.92	0.06	16.31	0.00	.67
MGTC6	0.81	0.05	16.68	0.00	.69
MGTC7	0.91	0.06	16.56	0.00	.68
Supervisor Support					
SUPR1	1.00	-	-	-	.74
SUPR2	1.02	0.07	15.54	0.00	.53
SUPR3	1.02	0.05	20.03	0.00	.76
SUPR4	1.08	0.06	18.60	0.00	.69
Safety Programs and Policies					
PGM1	1.00	-	-	-	.40
PGM2	0.81	0.08	9.77	0.00	.78
PGM3	1.16	0.10	11.48	0.00	.60
PGM4	1.12	0.10	11.81	0.00	.65
PGM5	1.33	0.12	11.37	0.00	.55
PGM6	0.96	0.10	9.37	0.00	.35
PGM7	1.12	0.15	7.59	0.00	.21
Safety Compliance Behavior					
COMP1	1.00	-	-	-	.43
COMP2	1.18	0.10	11.56	0.00	.63
COMP3	1.25	0.12	10.69	0.00	.59
Safety Citizenship Behavior					
CTZ1	1.00	-	-	-	.62
CTZ2	1.09	0.08	14.20	0.00	.71
CTZ3	1.08	0.08	12.95	0.00	.55

As Table 4 illustrates, all items loaded onto their respective factor and were statistically significant with statistical significance based on an examination against the t-test critical value and assessment of the p-value. Examination of R^2 values for each of the variables provided information with regard to how the items performed. While most of the observed variables had acceptable r-squared levels, the variance explained by a few of the variables illustrated low to moderate levels of variance explained including PGM7 ($R^2 = .21$), SCOMM5 ($R^2 = .31$) and SCOMM6($R^2 = .27$).

Along with the confirmatory factor analysis, Cronbach's alphas were computed to assess internal consistency reliability estimates for each of the scales utilized in the study. As is evident in Table 5, all scales had satisfactory alpha levels indicating good reliability. All scales had alphas of .80 or above. Further, the scale statistics illustrate good levels of skewness and kurtosis. All skewness and kurtosis statistics were below I1.0I.

Table 5: Scale Reliability Measures and Statistics

	Safety Communication	**Management Commitment to Safety**	**Supervisor Support for Safety**	**Safety Programs and Policies**	**Safety Compliance Behavior**	**Safety Citizenship Behavior**
Items (#)	6	7	4	7	3	3
Cronbach's α	.84	.94	.89	.83	.80	.83
Cronbach's Standardized α	.86	.92	.89	.85	.80	.83
Mean	26.18	25.63	17.03	27.43	13.03	11.46
SD	3.43	5.53	2.50	3.99	1.48	2.13
Skewness	-.837	-.439	-.724	-.399	-.115	-.468
Kurtosis	.565	.172	.321	.373	-.691	.342

SEM Analyses and Testing of Hypotheses

Structural equation modeling (SEM) was used to test the hypothesized firefighter safety climate model. The analysis was guided by the two-stage process described by Anderson and Gerbing (1988), which included the test of the measurement model, followed by an examination of the structural model and hypothesized associations among the constructs. The SEM analysis was also completed using MPlus, version 5.2. Given the zero-inflated injury outcome (a count), zero-Inflated Poisson analysis was completed in MPlus. Zero-inflated Poisson analysis has been the preferred method of analysis in injury studies compared to other methods including zero-inflated negative binomial analysis since models with excess zeros are modeled more appropriately by zero-inflated Poisson analysis (Karazsia & van Dulmen, 2008; Carrivick, Lee & Yau, 2003; Wang, Lee, Yau & Carrivick, 2003; Yau & Lee, 2001). As is evident in Table 6, 306 respondents reported zero injuries. Thus nearly 88% of the respondents reported no injury. Thirty-two respondents reported one injury, 8 reported two injuries and 3 reported three injuries.

Table 6: Firefighter Injury Outcome Frequencies

Number of Injuries	**Frequency of Occurrence**	**Percentage of Respondents (%)**
0	306	87.7
1	32	9.2
2	8	2.3
3	3	0.9

Zero-inflated Poisson analysis in MPlus uses MLR or maximum likelihood estimation with robust standard errors as the estimator. The MLR estimator does not provide standard fit index statistics that are normally presented with ML or the maximum likelihood estimator as part of the output. Therefore, model fit is not assessed against published recommended fit indexes. Nested models can be compared, if necessary, through an examination of the likelihood ratio test.

For the purposes of this study, hypotheses were assessed through an examination of the statistics generated by the model assessment. The statistics are included in Table 7.

Table 7: Proposed Partially-mediated Firefighter Safety Climate Model Statistics

Path	**Unstandardized Path Coefficient**	***SE***	***T***	***p***	R^2
Safety Climate					
Safety Communication	**1.00**	**0.00**	-	-	**0.24**
SCOMM1	1.00	0.00	-	-	
SCOMM2	0.96	0.07	13.22*	0.00	
SCOMM3	1.06	0.06	17.97*	0.00	
SCOMM4	1.01	0.08	13.45*	0.00	
SCOMM5	0.89	0.08	11.07*	0.00	
SCOMM6	0.96	0.09	10.38*	0.00	
Management Commitment	**2.46**	**0.33**	**7.45***	**0.00**	**0.60**
MGTC1	1.00	0.00	-	-	
MGTC2	1.01	0.04	23.85*	0.00	
MGTC3	1.01	0.05	21.17*	0.00	
MGTC4	0.81	0.06	14.51*	0.00	
MGTC5	0.92	0.06	15.52*	0.00	
MGTC6	0.81	0.06	14.33*	0.00	
MGTC7	0.90	0.06	15.81*	0.00	
Supervisor Support	**1.47**	**0.16**	**9.48***	**0.00**	**0.44**
SUPR1	1.00	0.00	-	-	
SUPR2	1.03	0.07	15.59*	0.00	
SUPR3	1.03	0.05	20.79*	0.00	
SUPR4	1.09	0.05	19.96*	0.00	
Safety Programs/Policies	**1.42**	**0.22**	**6.37***	**0.00**	**0.62**
PGM1	1.00	0.00	-	-	
PGM2	0.81	0.09	9.50*	0.00	
PGM3	1.19	0.13	9.47*	0.00	
PGM4	1.15	0.11	10.03*	0.00	
PGM5	1.36	0.13	10.87*	0.00	
PGM6	0.97	0.11	8.56*	0.00	
PGM7	1.09	0.14	7.57*	0.00	

To Safety Compliance Behavior from Safety Climate	1.09	0.13	8.174*	0.00	0.50
To Safety Citizenship Behavior from Safety Climate	1.396	0.21	6.96*	0.00	0.33
Zero-Inflated Poisson Regression Injury (Always Zero):					
Safety Compliance Behavior	-4.51	1.38	-3.28*	0.00	
Safety Citizenship Behavior	-0.85	0.84	-1.01	0.31	
Safety Climate	6.71	2.21	3.04*	0.00	
Zero-Inflated Poisson Regression Number of Injuries (Count):					
Safety Compliance Behavior	-5.02	0.27	-18.65*	0.00	
Safety Citizenship Behaviors	-3.21	0.16	-20.18*	0.00	
Safety Climate	10.30	0.57	18.17*	0.00	

Note: Values significant at p<.05, two-tailed t-test (I1.96I), are indicated by *.

The proposed structural model for this study is a partially mediated model. This model suggests that safety climate, as a higher order factor, positively influences safety compliance behaviors, safety citizenship behaviors and also has a direct effect on firefighter injury. The partially mediated model also hypothesizes that both safety compliance behaviors and safety citizenship behaviors have a negative relationship with firefighter injury.

The proposed model, shown in Figure 1, hypothesizes the following:

(1) Perceived safety climate will positively influence firefighter compliance-oriented safety behavior.

(2) Perceived safety climate will positively influence firefighter safety-citizenship behavior.

(3) Perceived safety climate will have a negative influence on firefighter injury.

(4) Compliance-oriented safety behavior will be negatively associated with firefighter injury incidents.

(5) Safety-citizenship behavior will be negatively associated with firefighter injury incidents.

The structural equation modeling analysis illustrated that safety climate, as a higher order factor, was adequately composed of four first order factors including Safety Communication, Management Commitment to Safety, Supervisor Support for Safety and Safety Programs and Policies. Consistent with the confirmatory factor analysis, the first-order factors were satisfactorily comprised of the manifest variables with all variables having significant factor loadings. The statistics for both the manifest variables and the first-order factors in the SEM analysis are presented in Table 7.

An examination of hypothesized relationships associated with safety climate illustrated that safety compliance behavior (B = 1.09, p=0.00) was positively associated with safety climate and safety citizenship behavior (B = 1.40, p=0.00) was positively associated with safety climate. Thus, Hypothesis 1 and Hypothesis 2 were confirmed in that the relationships between safety climate and the behaviors were significant and in the appropriate direction (i.e. positive relationships).

As is evident in Table 7, MPlus generated two outcome measures for firefighter injury. The outcome distribution is approximated by two components that include a logistic model for the “always zero” and “not always zero” dichotomous aspect of the outcome and a count portion of the model (Atkins & Gallop, 2007). The count portion of the model predicts the extent of injury frequency for individuals in the “not always zero” group. In zero-inflated Poisson models, the exponential of the regression coefficient is expressed as an odds–ratio interpretation for the dichotomous variable and a risk ratio for the count variable. The risk ratio provides an illustration of risk factor (>1) or protective factor (<1).

An examination of the relationship between safety climate and injury indicated that safety climate is a significant predictor of the dichotomous outcome (B = 6.71, p=0.00) and predicted membership in the "always zero" category (no injury group). For each unit increase in the safety climate score, the odds of being in the "always zero" group increased by a factor of $e^{6.706}$ or 817.30. Thus, the higher the safety climate score, the more likely the firefighter is a member of the "always zero" group. In addition to safety climate, safety compliance behavior emerged as a predictor of the dichotomous outcome. However, the result for safety compliance behavior indicates that an individual's chance for membership in the "always zero" group (no injuries) decreased by a factor of 0.01 ($e^{-4.502}$) for every one unit increase in safety compliance behavior with all other variables held constant. Safety citizenship behavior did not significantly predict membership in the "always zero" group.

To further assess the injury outcome, the injury count outcome for those in the "not always zero" group was assessed. Both safety compliance behavior (B = -5.02, p=0.00) and safety citizenship behavior (B = -3.21, p=0.00) were deemed protective when controlling for the other factors. Thus, it was determined that Hypothesis 4 and Hypothesis 5 were supported since both safety compliance behavior and safety citizenship behavior were negatively associated with firefighter injury. It was determined that for each incremental increase in safety compliance behavior, there was a 99%

reduction in injury (*RR* = 0.00662) and for each incremental increase in safety citizenship behavior, there was a 96% (*RR* = 0.04) reduction in injury.

An interesting phenomenon, safety climate (*B* = 10.30, *p*=0.00) was determined to have a rather large risk ratio (*RR* = 29,792) based on the exponential of the coefficient (10.302) indicating that for those individuals not in the "always zero" group an increase in safety climate perceptions increased their risk of injury. With regard to Hypothesis 3, the outcome is difficult to explain given the ambiguous results. While safety climate strongly emerged as a significant predictor of the "always zero" group or no injury group, increased positive perceptions of safety climate for firefighters in the "not always zero" group appeared to increase the extent of injury frequency. Thus, Hypothesis 3 was not fully confirmed, but received partial support.

CHAPTER 5

DISCUSSION

This chapter is organized into three main sections. The first section describes the overall findings and discusses the findings in the context of the safety climate literature and firefighter safety literature. Next, limitations associated with the research study are presented. Lastly, implications for future research and practice in the area of firefighter safety and health and safety climate are discussed.

Summary of Findings

Despite appeals and recommendations for organizational research in firefighting, very little systematic research has been completed, especially in the area of safety climate. The aim of this research was to develop and test a model linking perceptions of safety climate and firefighter safety outcomes, including safety behaviors and firefighter injury. This research explored both direct and indirect relationships between safety climate, firefighter safety behaviors and firefighter injury. Both safety compliance and contextual safety behaviors (safety citizenship behaviors) were assessed. Further, this study sought to examine whether four key attributes associated with firefighter safety would derive a higher order factor of safety climate within the firefighter population.

The original model (see Figure 3 below) proposed was a partially-mediated model where positive safety climate, derived of management commitment to safety, supervisor support for safety in the fire organization, safety communication and safety programs and policies, was posited to be positively associated with firefighter safety behaviors and negatively associated with firefighter injury. The model also proposed that safety behaviors would be negatively associated with injury. The model was derived from the general safety climate literature and the literature associated with high-reliability organizations.

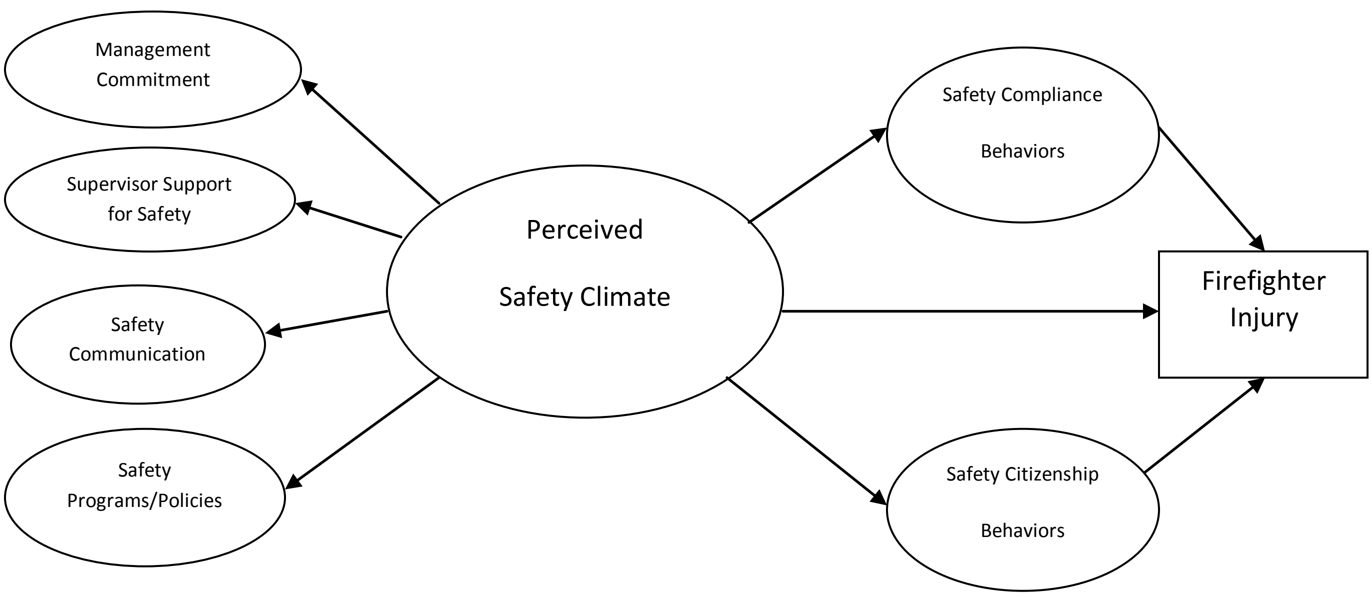

Figure 3. Partially-mediated Model

Of the approximately 1.15 million firefighters in the United States, approximately 322,000 are considered career firefighters (USFA, 2010b). The firefighters recruited for this study were representative of career firefighters. Most career firefighters are between the ages of 30 and 39, with 90% of career firefighters falling between the ages of 20 and 59 (USFA, 2010b). Firefighters from three fire departments in northeastern Georgia participated in this research study. All firefighters were career firefighters and were age 18 or older. The mean age of the firefighters was 36.45 (SD = 9.08) with a range from 19 to 60 years old, which is representative of career firefighters throughout the United States. Further evidence to support that the study sample typifies United States career firefighters is the fact that all three participating fire departments in this study serve populations in excess of 25,000 people. The United States Fire Administration (2010b) reports that 75% of all career firefighters serve in communities that protect populations of 25,000 or more.

Safety Climate

A number of safety climate models have been developed and tested since Zohar (1980) completed one of the first studies in the area of safety climate. However, based on a review of the general literature, none of these studies were found to focus on the context of firefighter safety climate. Although several studies have been completed throughout the years, researchers still believe it is important to conduct context or industry-specific studies in order to enhance research and intervention initiatives within specific populations (Zohar, 2010; Huang, Chen & Grosch, 2010). In fact, a major goal of a recent journal special issue was to identify different challenges and findings associated with occupation and industry specific safety climate studies (Huang, Chen & Grosch, 2010).

Given this study was completed specifically within a representative sample of American, career firefighters and was theoretically specified to this population, the outcomes of this novel study provide guidance and direction for researchers, safety practitioners, public administrators and fire service managers with means to enhance firefighter safety and to prevent firefighter injuries. The findings in this study provide the first known empirical guidance on how firefighter safety behaviors may be enhanced and how injury exposures may be reduced in the context of a safety climate-behavior-injury outcome model. The fact that organizational-related variables, particularly safety climate, can influence firefighter safety outcomes is important, especially since traditional safety techniques and methods seemed to have reached their limit as firefighter fatalities remain unchanged year to year (U.S. Fire Administration, 2002 & U.S. Fire Administration, 2007).

Confirmatory factor analysis and structural equation modeling were utilized to test the proposed model (see Figure 3) and the hypotheses generated for this research study. These analyses were completed with MPlus, version 5.2. One critical requirement for model development and testing through structural equation modeling is that the model must be based on theory (Bentler & Chou, 1987). The proposed model and hypotheses were based upon the general safety climate literature, firefighter literature and the high reliability organization literature.

Prior to structural equation modeling analyses and the examination of hypotheses, a confirmatory factor analysis, using maximum likelihood estimation was completed to confirm the scales and latent constructs associated with the study. An assessment of reliability through an examination of Cronbach's alpha was also completed to assess the scales and latent constructs associated with the study. These initial analyses identified noteworthy findings.

Safety climate in this study was conceptualized as a higher order factor. Researchers have argued that safety climate should be conceptualized as a higher-order factor, with more specific first-order factors, so that the higher-order factor ultimately reflects the extent to which employees believe that safety is valued within the organization (Griffin & Neal, 2000). This thinking is aligned with that of the general organizational literature and discussions associated with psychological climate perceptions (James & McIntyre, 1996; Parker et al., 2003). The confirmatory factor analysis in this study confirmed that each of the four first-order factors were distinct factors and the reliability analysis illustrated quality levels of internal consistency. Subsequent structural equation modeling analyses substantiated the latent construct of safety climate in firefighters. Four first-order factors including management commitment to safety, supervisor support for safety, safety communication and safety programs and policies were confirmed to be significant contributors to the higher-order safety climate factor in the SEM analyses. This finding supports the conceptualization that safety climate is a multi-dimensional construct and addresses context specific safety climate analyses, which are needed to improve industry specific theory development and testing (Zohar, 2010). While this study does not point to all possible constructs of safety climate in firefighter organizations, it provides initial evidence to important factors associated with safety climate within this population.

While each of the four first-order factors or dimensions were found to be significant and important components of safety climate, management commitment to safety, safety programs and policies and supervisor support were found to be the most dominant and most important components of firefighter safety climate. Safety communication was a statistically significant component of safety climate, but had the lowest explained variance (R^2 = .24) and the weakest unstandardized path coefficient (see Table 7). While safety communication is vastly important within the context of firefighting, it could be argued that the importance of this factor may be captured within some of the other constructs and vice versa. An examination of the correlation matrix (Appendix C) did not indicate problems with multicollinearity and did not point to safety communication items being equivalent to other items in other constructs, but the high correlation between some variables provides some support for this argument. For example, question 4 of the safety communication scale states “my immediate supervisor encourages open communication about safety.” This item was highly correlated with the items from the supervisor support scale. While the safety communication construct was supported in this study, the wording does show consistency with the premise of supervisor support for safety and could point to some of the measurement error for this scale.

Management commitment to safety is the extent to which management is perceived to place a high priority on safety (Neal and Griffin, 2004). Previous studies and reviews of safety climate research indicate that management commitment is likely the most prominent dimension of safety climate and has a significant influence on employees’ perceptions of the importance of safety (Clarke, 2009; Zohar, 2008; Huang, Ho, Smith & Chen, 2006; Flin et al., 2000; Guldenmund, 2000; Zohar, 2003; Neal and Griffin 2004; Zohar 1980). Management commitment to safety was identified as the strongest first-order factor within the safety climate construct in this study. It had the largest path coefficient and its R^2 was .60, similar to that found by Huang et al., 2006.

This finding further supports the argument that management commitment is one of the most dominant themes within safety climate and extends the population to which this component of safety climate is generalized.

In the context of firefighting, the finding that management commitment to safety is a strong component of safety climate is important. Firefighter organizations are military-like in terms of their hierarchical command structure, rank, indoctrination and group cohesion. Within this culture, firefighters look to management for direction, guidance and performance expectations. A strong commitment to safety by management, as part of safety climate, establishes the expectation that safety is important, valued and should be a component of the culture that exists within the fire organization. This finding however does not bode well for fire organizations where management commitment to safety is weak. Firefighter socialization and assimilation emphasizes group cohesion, trust, and loyalty, which are usually beneficial. However, these traits could have detrimental consequences in terms of safety as firefighters may not be committed to safety performance in the context of weak management commitment to safety.

Safety programs and policies also emerged in this study as a leading dimension of firefighter safety climate. Similar to management commitment to safety, safety programs and policies have been substantiated as a major component of safety climate (DeJoy et al. 2004; Diaz & Diaz-Caberra, 1997; Mohamed, 2002; Evans, Glendon & Creed, 2007; Hayes, Peranda, Smecko & Trask, 1998). This finding in the context of firefighting further substantiates the importance of safety programs and policies as part of safety climate across multiple disciplines or occupations. More importantly though, this finding indicates that firefighter perceptions of the importance of safety are partially indicated by how well fire department management establishes and utilizes safety programs including training, education, resource adequacy and the provision of personnel and equipment.

Firefighting is an equipment intensive operation. Providing and maintaining firefighting equipment enables safer firefighting operations and reflects management commitment to the importance of safety. The findings in this study indicate that if equipment and resources are not provided and maintained, safety climate perceptions may diminish. The National Institute for Occupational Safety and Health has repeatedly recommended programs and procedures for the provision, operation and maintenance of equipment to prevent firefighter fatalities and injuries (Hodous, Pizatella, Braddee & Castillo, 2004; Ridenour, Noe, Proudfoot, Jackson, Hales & Baldwin, 2008). The findings in this study support these recommendations based not only on the fact that safety and health risks would be minimized with appropriate equipment and resources, but the provision and maintenance of equipment and resources improves safety climate perceptions and related safety outcomes, especially improved safety compliance behaviors and safety citizenship behaviors, which may further reduce injury likelihood. Further, if fire department management provides applicable training and effectively administers safety management programs and policies, safety climate perceptions will be enhanced. This finding is congruent with the argument that commitment-based safety practices are positively associated with positive perceptions of safety (Barling & Hutchinson, 2000; Zacharatos, Barling & Iverson, 2005).

Lastly, within this study, supervisor support for safety was also confirmed as a significant dimension of the safety climate higher-order factor in the context of firefighting. This finding reiterates the importance of supervisor support as a safety climate dimension and is congruent with the findings obtained by Seo, et al. (2004). The research finding that supervisor support is a dimension of safety climate is especially significant in the context of firefighting given the influence direct supervisors have within the firefighting community. Within the context of firefighting, similar to other high-risk or high-hazard operations, the direct supervisor has long been recognized as playing a key role in safety performance. Supervisors are responsible for implementing, maintaining and reinforcing safety programs, polices, procedures and other safety initiatives. If these activities are carried out effectively then safety is seen as a priority and firefighters are likely to reciprocate (Gouldner, 1960) through positive safety performance based on the premise of social exchange theory (Blau, 1964; Eisenberger, Huntington, Hutchinson & Sowa, 1986; Rhodes & Eisenberger, 2002). If safety is not a priority, is not executed rigorously, and is not supported by supervisors, then safety climate perceptions will be negatively affected (Zohar, 2003). As determined in this study, more negative perceptions of safety climate would be associated with more negative firefighter safety outcomes.

Safety Behaviors

In this study, safety behaviors were posited to encompass two distinct forms of behavior particularly important to firefighting including safety compliance behavior and contextual behaviors or safety citizenship behaviors. The results of this research support a distinction between these behaviors similar to other studies (Griffin & Neal, 2000; Neal & Griffin, 2006). The discrimination between these two behaviors is the first known distinction of safety behavior types within firefighters. In addition to the confirmatory analysis, the structural equation modeling analysis further confirmed the two distinct safety behavior constructs. Further, the SEM analysis provides evidence regarding the associations between safety climate, firefighter safety behaviors and firefighter injuries.

Safety Climate-Behavior-Injury Relationships

The structural equation modeling analysis of the proposed partial-mediation model (see Figure 3) corroborated most of the proposed hypotheses. The analysis confirmed that positive perceptions of safety climate predicted both safety compliance behavior and safety citizenship behavior. These results support the notion that positive safety climate perceptions enhance both safety compliance and safety citizenship behaviors in firefighters. This finding is similar to conclusions made by other researchers that have claimed positive relationships between safety climate and multi-factor safety performance outcomes (Christian, Bradley, Wallace & Burke, 2009; Clarke, 2006; Neal, Griffin & Hart, 2000; Neal & Griffin, 2006). Also, the findings support the framework where safety climate is indicated to influence safety behaviors (Zohar, 2003; Zohar, 2008).

These results provide direction for enhancing firefighter safety behaviors and are relevant to establishing interventions beyond traditional engineering approaches. A recent examination of firefighter injuries indicated that up to 41% of injury incidents were associated with behavioral factors including breeches of standard operating procedures, breeches of protocol and inadequate use of protective equipment, such as personal protective equipment (PPE) and seat belts (Moore-Merrell, Zhou, McDonald-Valentine, Goldstein and Slocum, 2008). The problem with firefighters not following standard procedures, including the lack of seat belt usage was also addressed by Ridenour et al., (2008). The findings from this study indicate that fire departments could counter these risky behaviors by focusing on efforts that would enhance safety climate perceptions.

Theoretical models linking safety climate to injury, generally specify that the link between safety climate and injury outcome is indirect and is partially mediated by safety behaviors (Zohar, 2003; Zohar, 2008). Although, there is some evidence that direct effects between safety climate and injury exists (Zacharatos, 2005; Zohar, 2000; Clarke & Ward, 2006). Future studies could be conducted to examine competing models such as a fully-mediated model or a non-mediated model. However, a non-mediated model, where the paths between safety behavior factors and injury are removed from the model, does not appear to be theoretically justified.

In the context of the model, the findings of this study show that positive safety climate perceptions are positively associated with safety behaviors. The findings also suggest that both safety compliance behaviors and safety citizenship behaviors are negatively associated with firefighter injury for those firefighters not in the "always zero" or no injury group. While these behaviors did not have a large impact on predicting membership in the "always zero" group, both safety behaviors were considered protective and were associated with large reductions in injury risk. These findings confirm that both safety compliance behaviors and safety citizenship behaviors are indeed important to reducing individual firefighter injury experience. While this is a substantial finding, the influence of these behaviors, especially safety citizenship behavior, may also extend beyond protecting the individual firefighter. These behaviors can also enhance the safety of others, the work unit, the work environment and the work organization (Griffin & Neal, 2000).

An examination of the direct relationship between safety climate and injury yielded somewhat ambiguous findings. Safety climate strongly predicted membership into the "always zero" injury group in the dichotomous assessment, but had a positive relationship associated with injury for those firefighters in the "not always zero" group. Despite the ambiguity, this outcome was not completely surprising. Direct relationships between safety climate and injury have been insignificant and have been opposite to predictions in studies using retrospective data (Huang, Ho, Smith & Chen, 2006; Clarke 2006). The issues of non-significance and unexpected positive relationships may be attributed to the issue of reverse causation, which hypothesizes that an individuals' injury experience may influence safety climate perceptions (Clarke, 2006; Beus, Payne, Bergman & Arthur, 2010). Desai, Roberts and Ciavarelli (2006) provide evidence of this phenomenon with a justification that accidents and injuries may prompt investments in safety and may enhance motivation within individuals so that the workplace safety climate seems improved. Since cross-sectional data were used within this study, as in most safety climate studies to date, the causal pathway cannot be confirmed. However, this may potentially explain the ambiguity within the results obtained.

Limitations

While the results of this study are informative, the findings and interpretation of this study need to be evaluated with the consideration that some limitations potentially exist in the study. This section of the chapter presents limitations associated with the firefighter population that participated in the study, the research design utilized for the study and common method biases associated with the data collection procedures utilized during the study.

Firefighter Population

First, the population utilized in this study included firefighters from a specific geographical region. Participating firefighters were recruited from fire departments located in northeast Georgia. These fire departments were located mostly in urban areas; however, a few of the stations serviced rural areas within their jurisdictions. While the fire departments were mostly located in urban areas, the fire departments were not located in high density metropolitan areas. Based upon fire department operations performed by these stations and based on the fact that all firefighters were from one geographic region, the results may not be generalized to all other firefighters working in the United States and may not be generalized to certain firefighter populations that operate within large cities or high density metropolitan areas. Injury exposures and risks encountered by firefighters within high density metropolitan areas may differ as these firefighters may respond to more frequent fire service calls and may have to fight fires in different structures (e.g. high-rise buildings).

Firefighters participating in this study were career firefighters aged 18 or older. Volunteer firefighters were not included in this research study. Given the differences between full-time and volunteer fire service operations and management, these results may not be generalizable to volunteer firefighter departments and operations.

Research Design Limitations

With regard to research design, this study utilized a cross-sectional design. The cross-sectional study format, with all data collected during the same time period, limits the extent to which causal inferences can be made. While the use of structural equation modeling in cross-sectional designs is common, there are limitations with regard to the specification of directional influences among variables since some amount of time is generally needed to suggest directional influence (MacCallum & Austin, 2000; Gollob & Reichardt, 1987; Gollob & Reichardt, 1991). Further, the retrospective injury data collected in the present study further limits the interpretations associated with injury predictors. While retrospective injury data collection is regularly performed in occupational safety related studies, it limits causal inferences associated with injury outcomes (Clarke, 2006). While most research has examined the influence of safety climate and behavior factors on injury outcomes, some recent research suggests that injury may be a strong predictor of safety climate (Beus, Payne, Bergman & Arthur, 2010; Desai, Roberts and Ciavarelli, 2006). This influence could have affected the results in this study since data were collected retrospectively. An additional limitation associated with retrospective data collection is with injury recall, especially over the 12-month time frame. The 12-month time frame was utilized though to capture a suitable outcome and to enable the exposure time to be of significance as fire services are performed at greater frequency during fall and winter months, which would not have been captured during a 3 or 6-month recall time frame.

Data Collection Limitations

Other limitations associated with this study stem from the data collection procedures. Common method variance and measurement error are a potential limitation within psychological and behavior research (Podsakoff, MacKenzie, Lee & Podsakoff, 2003; Schmidt & Hunter, 1996). However, some researchers believe that concerns with common method bias may be over-exaggerated (Spector, 2006). The extent of this limitation is not fully known in this study. Some biases may have influenced the respondents despite considerations and techniques implemented to control common method biases.

Common method biases including comprehension, response selection and response reporting were addressed in the design of the study. The researcher collected all data by visiting various fire stations throughout the municipalities that participated in the research. A brief introduction was made and the presentation was scripted so that all respondents were presented with the same information regarding the purpose of data collection. The introduction to the questionnaire was introduced as a study to examine safety factors within firefighter organizations. The introduction did not specifically indicate the research intention of examining injury predictors. To further minimize the effect of injury and related mood states on the assessment of psychological and organization factors or constructs, the injury items were presented toward the end of the questionnaire. This order helped minimize the influence that recall of injury may exert on answering items.

With regard to the injury items, definitions were provided within this section of the questionnaire to ensure consistency of response. Safety research tends to employ a wide array of definitions for injury (Beus, Payne, Bergman & Arthur, 2010). Providing the definitions helped ensure measurement consistency. One additional limitation associated with the injury items is that injury measures were not obtained from multiple sources. Respondents self-reported injury occurrence and frequency. Future researchers may be able to obtain data at the group or organization level and assess it against individual reporting within the group to remedy some of the potential error and biases in self-reporting. This, however, would require a much larger study sample.

A paper-and pencil questionnaire was provided to participants. This format did help minimize some of the limitations associated with research that requires face-to-face interviewing. Further, the researcher was present within the rooms where data collection was completed. Very few respondents had questions. One responded asked about his interpretation of one item. He asked "by immediate supervisor, do you mean my station-officer?" I confirmed his assumption. One other firefighter asked for clarification regarding the question associated with personal safety (see Section D in the survey instrument in Appendix A). General guidance with regard to the question was provided to this one firefighter. This item was not utilized in the dissertation research.

With the researcher being present, the respondents did not discuss items or potential answering schemes. Individuals completed the questionnaire and provided the finished document to the researcher. Incentives were not provided to the individuals at the time the questionnaires were completed.

Item ambiguity can be problematic and a limiting factor associated with common method biases. Efforts were made prior to data collection to ensure the questionnaire was not ambiguous, difficult to comprehend and could be completed in a timely manner without assistance. These measures were taken as part of the subject matter expert review completed before data collection activities. To further minimize limitations associated with the items, response selection was sometimes altered. Some reverse-coded items were included to minimize consistency motif and scale anchors were different for some items and scales to minimize item-context induced anchoring effects. Further, the removal of outliers likely helped address some of the measurement issues associated with acquiescence biases where respondents may agree or disagree with items independent of their content (Podsakoff et al., 2003).

During data collection, firefighters may have potentially been concerned with social desirability and the effect of their responses on their careers and work outcomes, which is a common method biases. Efforts were taken to control this potential cause of bias and to minimize apprehension that may be present with answering items honestly and openly. During data collection, the researcher emphasized that all information was anonymous and that no personal identifying information (e.g. name, social security number) would be collected. The gender item was removed from the questionnaire before data collection due to the small number of female firefighters within the population to minimize the risk of identification. Additionally, a decision was made to not collect station-level information or identifiers so not to identify any one individual at a specific station.

Implications

The research findings associated with this study enhance and expand the literature in the areas of occupational safety, occupational health psychology, public health and organizational sciences. The research also significantly contributes to the empirical literature in the area of firefighter safety as very little research has been conducted with this population. Both the scientific community and the firefighting community are genuinely interested in establishing avenues to enhance firefighter safety, health and well-being and are interested in curtailing the firefighter injury problem. Given the novelty of this research, there are numerous implications for both research and practice.

The general purpose of this dissertation research study was to develop and test a novel model linking perceptions of safety climate, firefighter safety behaviors and firefighter injury outcomes. While the proposed partially-mediated model provided insight into the relationships associated with these factors, it should be considered a speculative model (Hoyle & Panter, 1995). Thus, future research should focus on testing the partial-mediation model in a different firefighter population in order to assess the model. The inclusion of a more diverse firefighter population, including firefighters from cities and high density metropolitan areas would strengthen the firefighter safety climate model. Findings from a study using a larger, more diverse population would allow the model to be further generalized to more firefighters.

As presented within the limitations section of this chapter, the use of retrospective data collection is commonplace within occupational safety and occupational injury research. Nevertheless, it is restrictive and somewhat problematic with regard to declaring causal relationships. Future research associated with examining the firefighter safety climate model would benefit from collecting injury data in a prospective manner. In other words, baseline data collection would assess the factors associated with safety climate and safety behaviors and future analyses would assess the injury outcome. This methodology certainly would not prevent and abate all threats to validity, but would incorporate the time differential needed to suggest directional influence (MacCallum & Austin, 2000; Gollob & Reichardt, 1987; Gollob & Reichardt, 1991). Prospective data collection would also minimize the threat of injury potentially influencing firefighter perceptions of climate factors and would address concerns associated with reverse causation (Clarke, 2006). Lastly, prospective data collection would also allow future researchers to minimize potential biases as injury data could be collected from multiple sources, including self-reported data, fire department injury records and where required, Occupational Safety and Health Administration logs. Even if prospective measures are utilized and if injury is collected from multiple sources, the use of injury data is still somewhat problematic as injuries are often under-reported by individuals and organizations (Probst, Brubaker & Barsotti, 2008).

Although this study did not explore mediating factors between safety climate and safety behaviors, other researchers have presented evidence that mediators exist in this relationship. In prior studies, the relationship between safety climate and safety behaviors has been mediated by various factors including motivation (Neal, Griffin & Hart, 2000; Griffin & Neal, 2000), knowledge (Neal, Griffin & Hart, 2000; Griffin & Neal, 2000), job satisfaction (Clarke, 2009) and organizational commitment (Clarke, 2009).

Since mediating factors such as those identified above were not included within the examination of this model, future analyses might test models that include possible mediators between safety climate and safety behaviors to explore their application within firefighters. These factors may lead to other mechanisms that enhance safety behaviors within firefighters. For example, if motivation, job satisfaction and organizational commitment influence positive safety behaviors in firefighters, this may point to other antecedents of safety performance aside from safety climate such as compensation systems (Sinclair & Tetrick, 2004) and high performance work practices or high commitment human resource practices (Whitener, 2001; Zacharatos & Barling, 2004).

Lastly in the context of research implications, this research study concluded that individual perceptions of safety climate enhanced firefighter safety behaviors. These compliance-oriented safety behaviors and safety citizenship behaviors had a significant association with reduced injury. Given the significant relationships within the model, the model may provide guidance for future intervention research that could be aimed at bolstering safety climate, which would in turn improve firefighter safety behaviors and injury outcomes. Four dimensions or factors of safety climate within the firefighter population were identified within the study. Each of these factors was found to be significant and was deemed to be an important component of the safety climate construct within firefighters. A close examination of the four dimensions illustrates important areas where improved supervisory safety practices could be implemented through interventions to enhance safety climate perceptions.

Of major practical significance is the idea that safety climate can serve as a leading indicator of safety performance (Shannon & Norman, 2009; Flin, Mearns, O'Connor & Bryden, 2000). Safety climate, as a leading indicator, is predictive and can be used to monitor safety conditions so that corrective measures or remedial action can be taken to enhance safety behaviors and minimize the risk of injury. In practice, the questionnaire from this study may be incorporated into survey efforts within fire organizations as an effort to assess loss potential. If deficiencies are identified, efforts should be made to enhance the organizational factors that comprise safety climate. Thus, the responsibility to enhance safety should lie within the management personnel at the station-level and department-level and should ultimately focus on improvement within the management of safety. Further, given the results of this study, commitment based safety efforts should be made in lieu of control based techniques (Barling & Hutchinson, 2000) within fire organizations. This may however be a challenge to the historical traditions and hierarchical nature of firefighting organizations.

REFERENCES

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*, 411-423.

Atkins, D.C. & Gallop, R.J. (2007). Rethinking how family researchers model infrequent outcomes: A tutorial on count regression and zero-inflated models. *Journal of Family Psychology, 21*(4), 726-735.

Baker, J. Levenson, N., Bowman, F., Priest, S., Erwin, G., Rosenthal, I., Gorton, S., Tebo, P., Hendershot, D., Wiegmann, D., & Wilson, L. (2007). *The report of the BP U.S. refineries independent safety review panel.*

Bandura, A. (1986). *Foundations of thought and action.* Englewood Cliffs: Prentice Hall.

Barling, J., & Hutchinson, I. (2000). Commitment vs. control based safety practices, safety reputation, and perceived safety climate. *Canadian Journal of Administrative Sciences, 17*(1), 76-84.

Barling, J., Kelloway, E. K., & Loughlin, C. (2002). Development and test of a model linking safety-specific transformational leadership and occupational safety. *The Journal of Applied Psychology, 87*(3), 488-496.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2), 238-246.

Bentler, P. M., & Chou, C. (1987). Practical issues in structural equation modeling. *Sociological Methods and Research, 16*(1), 78-117.

Beus, J.M., Payne, S.C., Bergman, M.E. & Arthur, W. (2010). Safety climate and injuries: An examination of theoretical and empirical relationships. *Journal of Applied Psychology, 95*(4), 713-727.

Blau, P.M. (1964). *Exchange and power in social life*. New York: Wiley.

Boden LI, Biddle EA, Spieler EA. 2001. Social and economic impacts of workplace illness and injury: Current and future directions for research. *American Journal of Industrial Medicine, 40,*(4), 398-402.

Brown, R. L. (1994). Efficacy of the indirect approach for estimating structural equation models with missing data: A comparison of five methods. *Structural Equation Modeling, 1,* 287–316.

Carrivick, P., Lee, A.H., & Yau, K.W. (2003). Zero-inflated poisson modeling to evaluate occupational safety interventions. *Safety Science, 41*(2003), 53-63.

Cheyne, A., Cox, S., Oliver, A., & Tomás, J. M. (1998). Modeling safety climate in the prediction of levels of safety activity. *Work & Stress, 12*(3), 255-271.

Christian, M.S., Bradley, J.C., Wallace, J.C., & Burke, M.J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology, 94*(5), 1103-1127.

Christoffel, T., & Gallagher, S. S. (2006). *Injury prevention and public health: Practical knowledge, skills, and strategies.* Jones & Bartlett Publishers.

Clancy, J. M., Elliot, G. C., Ley, T., Omodei, M. M., Wearing, A. J., McLennan, J., et al. (2003). Command style and team performance in dynamic decision-making tasks. In S. L. Schneider & J. Shanteau (Eds.), *Emerging Perspectives on Judgment and Decision Research* (pp. 713): Cambridge University Press.

Clarke, S. (2009). An integrative model of safety climate: Linking psychological climate and work attitudes to individual safety outcomes using meta-analysis. *Journal of Occupational and Organizational Psychology.*

Clarke, S. (2006). The relationship between safety climate and safety performance: A meta-analytical review. *Journal of Occupational Health Psychology, 11*(4), 315-327.

Clarke, S., & Ward, K. (2006). The role of leader influence tactics and safety climate in engaging employees' safety participation. *Risk Analysis, 26*(5), 1175-1185.

Cohen, A. (1977). Factors in successful occupational safety programs. *Journal of Safety Research, 9,* 168-178.

Columbia Accident Investigation Board (CAIB). (2003). *Columbia accident investigation board report.* Vol. 1. Washington, DC.

Cooper, M.D., & Phillips, R.A. (2004). Exploratory analysis of the safety climate and safety behavior relationship. *Journal of Safety Research, 35*, 497-512.

Cox, S., & Flin, R. (1998). Safety culture: Philosopher’s stone or man of straw? *Work and Stress, 12*(3), 189-201.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297-334.

DeCarlo, L. T. (1997). On the meaning and use of kurtosis. *Psychological Methods, 2*(3), 292-307.

Dedobbeleer, N., & Béland, F. (1991). A safety climate measure for construction sites. *Journal of Safety Research, 22*(2), 97-103.

Dedobbeleer, N., & Béland, F., (1998). Is risk perception one of the dimensions of safety climate? In A.M. Feyer & A. Williamson (Eds.), *Occupational injury: Risk, prevention, and intervention* (pp. 73-81). London: Taylor-Francis.

DeJoy, D.M., Murphy, L.R., & Gershon, R.M. (1995). The influence of employee, job/task, and organizational factors on adherence to universal precautions among nurses. *International Journal of Industrial Ergonomics*, *16*, 43-55.

DeJoy, D. M., Schaffer, B. S., Wilson, M. G., Vandenberg, R. J., & Butts, M. M. (2004). Creating safer workplaces: Asessing the determinants and role of safety climate. *Journal of Safety Research, 35*(1), 81-90.

DeJoy, D. M., Searcy, C. A., Murphy, L. R., & Gershon, R. R. (2000). Behavioral-diagnostic analysis of compliance with universal precautions among nurses. *Journal of Occupational Health Psychology, 5*(1), 127-141.

Del Ben, K. S., Scotti, J. R., Chen, Y., & Fortson, B. L. (2006). Prevalence of posttraumatic stress disorder symptoms in firefighters. *Work & Stress, 20*(1), 37-48.

Dembe AE. 2001. The social consequences of occupational injuries and illnesses. *American Journal of Industrial Medicine, 40*(4), 403-417.

Desai, V., Roberts, K., & Ciavarelli, A. (2006). The relationship between safety climate and recent accidents: Behavioral learning and cognitive attributions. *Human Factors,48*(4), 639-650.

Diaz, R.I., & Diaz-Cabrera, D. (1997). Safety climate and attitude as evaluation measures of organizational safety. *Accident Analysis and Prevention, 29,* 643-650.

Eisenberger, R., Huntington, R., Hutchison, S., & Sowa, D. (1986). Perceived organizational support. *Journal of Applied Psychology, 71*(3), 500-507.

Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling, 8*(3), 430-457.

Evans, B., Glendon, A. I., & Creed, P. A. (2007). Development and initial validation of an Aviation Safety Climate Scale. *Journal of Safety Research, 38*(6), 675-682.

Fabio, A., Ta, M., Strotmeyer, S., Li, W., & Schmidt, E. (2002). Incident-level risk factors for firefighter injuries at structural fires. *Journal Of Occupational And Environmental Medicine, 44*(11), 1059-1063.

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: Identifying the common features. *Safety Science, 34*(1-3), 177-192.

Gaba, D. M., Singer, S. J., Sinaiko, A. D., Bowen, J. D., & Ciavarelli, A. P. (2003). Differences in safety climate between hospital personnel and naval aviators. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 45*(2), 173-185.

Gollob, H.F., & Reichardt, C.S. (1987). Taking account of time lags in causal models. *Child Development, 58*, 80–92.

Gollob, H.F., & Reichardt, C.S. (1991). Interpreting and estimating indirect effects assuming time lags really matter. In L.M. Collins (Ed.), *Best Methods for the Analysis of Change* (pp. 243–259). Washington, DC: APA.

Gouldner, A. W. (1960). The norm of reciprocity: A preliminary statement. *American Sociological Review, 25*(2), 161-178.

Griffin, M. A., & Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation. *Journal of Occupational Health Psychology, 5*(3), 347-358.

Guldenmund, F. W. (2000). The nature of safety culture: A review of theory and research. *Safety Science, 34*(1), 215-257.

Hagan, P., Montgomery, J., & O'Reilly, J. (Eds.). (2009). *Accident prevention manual for business and industry: Administration and programs.* (13th ed.). Itaska, IL: National Safety Council.

Hale, A. & Hovden, J. (1998). Management and culture: The third age of safety. A review of approaches to organizational aspects of safety, health and environment. In A.M. Feyer & A. Williamson (Eds.), *Occupational injury: Risk, prevention and intervention* (pp.129-165). London: Taylor-Francis.

Hayes, B. E., Perander, J., Smecko, T., & Trask, J. (1998). Measuring perceptions of workplace safety: Development and validation of the work safety scale. *Journal of Safety Research, 29*(3), 145-161.

Hogan, J. & Roberts, B.W. (1996). Issues and non-issues in the fidelity-bandwith trade-off. *Journal of Organizational Behavior, 17,* 627-637.

Hodous, T. K., Pizatella, T. J., Braddee, R., & Castillo, D. N. (2004). Fire fighter fatalities 1998–2001: Overview with an emphasis on structure related traumatic fatalities. *Injury Prevention, 10*(4), 222-226.

Hofmann, D. A., & Morgeson, F. P. (1999). Safety-related behavior as a social exchange: The role of perceived organizational support and leader-member exchange. *Journal of Applied Psychology, 84*(2), 286-296.

Hofmann, D. A., Morgeson, F. P., & Gerras, S. J. (2003). Climate as a moderator of the relationship between leader-member exchange and content specific citizenship: Safety climate as an exemplar. *Journal of Applied Psychology, 88*(1), 170-178.

Hofmann, D.A., & Stetzer, A. (1996). A cross-level investigation of factors influencing unsafe behaviors and accidents. *Personnel Psychology, 49,* 307-339.

Hofmann, D. A., & Stetzer, A. (1998). The role of safety climate and communication in accident interpretation: implications for learning from negative events. *Academy of Management Journal, 41*(6), 644-657.

Hoyle, R.H. & Panter, A.T. (1995). Writing about structural equation models. In R.H. Hoyle (Ed.), *Structural equation modeling: Concepts, issues, and applications.* (pp. 158-176). Thousand Oaks: Sage.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55.

Huang, Y., Ho, M., Smith, G. S., & Chen, P. Y. (2006). Safety climate and self-reported injury: Assessing the mediating role of employee safety control. *Accident Analysis & Prevention, 38*(3), 425-433.

Huang, Y., Chen, P., & Grosch, J. (2010). Safety climate: New developments in conceptualization, theory, and research. *Accident Analysis & Prevention, 42*(5), 1421-1422.

IAFC. (April 2008). *2008 Safety, health and survival week theme announced: Committed to long-term results.* Retrieved October 01, 2008, from http://www.iafc.org/displayindustryarticle.cfm?articlenbr=36174

IAFF. (2001). *2000 Death and injury survey*. Washington, DC: International Association of Firefighters.

James, L. A., & James, L. R. (1989). Integrating work environment perceptions: Explorations into the measurement of meaning. *Journal of Applied Psychology, 74*(5), 739-751.

James, L. R., & McIntyre, M. D. (1996). Perceptions of organizational climate. In K. Murphy (Ed.), *Individual differences and behavior in organizations* (pp. 416–450). San Francisco: Jossey-Bass.

Kales, S. N., Soteriades, E. S., Christophi, C. A., & Christiani, D. C. (2007). Emergency duties and deaths from heart disease among firefighters in the United States. *The New England Journal Of Medicine, 356*(12), 1207-1215.

Karazsia, B.T., & van Dulmen, M. (2008). Regression models for count data: Illustrations using longitudinal predictors of childhood injury. *Journal of Pediatric Psychology, 33*(2008), 1076–1084.

Karter, M. J., & Molis, J. L. (2008). *NFPA reports: Firefighter injuries for 2007 - overview of 2007 firefighter injuries.* Retrieved November 19, 2008, from http://www.nfpa.org/publicJournalDetail.asp?categoryID=1692&itemID=40969&src=NFPAJournal&cookie_test=1.

Kline, R. *Principles and practice of structural equation modeling (2005)* New York: Guilford Press.

Lee, D. J., Fleming, L. E., Gomez-Marin, O., & Leblanc, W. (2004). Risk of hospitalization among firefighters: the National Health Interview Survey, 1986-1994. *American Journal Of Public Health, 94*(11), 1938-1939.

Liao, H., Arvey, R. D., Butler, R. J., & Nutting, S. M. (2001). Correlates of work injury frequency and duration among firefighters. *Journal of Occupational Health Psychology, 6*(3), 229-242.

Lusa, S., Häkkänen, M., Luukkonen, R., & Viikari-Juntura, E. (2002). Perceived physical work capacity, stress, sleep disturbance and occupational accidents among firefighters working during a strike. *Work & Stress, 16*(3), 264-274.

MacCallum, R. C., & Austin, J. T. (2000). Applications of structural equation modeling in psychological research. *Annual Reviews in Psychology, 51*(1), 201-226.

Marsh, H. W., Balla, J. R., & McDonald, R. P. (1988). Goodness-of-fit indexes in confirmatory factor analysis - The effect of sample-size. *Psychological Bulletin, 103,* 391-410.

Mearns, K., Whitaker, S. M., & Flin, R. (2003). Safety climate, safety management practice and safety performance in offshore environments. *Safety Science, 41*(8), 641-680.

Mearns, K., Rundmo, T., Flin, R., Gordon, R., & Fleming, M. (2004). Evaluation of psychosocial and organizational factors in offshore safety: A comparative study. *Journal of Risk Research, 7*(5), 545-561.

Michael, J. H., Evans, D. D., Jansen, K. J., & Haight, J. M. (2005). Management commitment to safety as organizational support: Relationships with non-safety outcomes in wood manufacturing employees. *Journal of Safety Research, 36*(2), 171-179.

Michael, J. H., Guo, Z. G., Wiedenbeck, J. K., & Ray, C. D. (2006). Production supervisor impacts on subordinates' safety outcomes: An investigation of leader-member exchange and safety communication. *Journal of Safety Research, 37*(5), 469-477.

MMWR. (2006). Fatalities among volunteer and career firefighters - United States, 1994-2004. *MMWR: Morbidity & Mortality Weekly Report, 55*(16), 453-455.

Mohamed, S. (2002). Safety climate in construction site environments. *Journal of Construction Engineering and Management, 128*, 375.

Montgomery, J., & Gil, T. (2009). Safety and health training. In P.E. Hagan, J.F. Montgomer & J.T. O'Reilly (Eds.), *Accident prevention manual for business and industry: Administration and programs, 13th ed.* (pp. 875-902). Itasca, IL: National Safety Council.

Moore-Merrell, L., Zhou, A., McDonald-Valentine, S., Goldstein, R., & Slocum, C. (August 2008). *Contributing factors to firefighter line-of-duty injury in metropolitan fire departments in the United States*. International Association of Firefighters.

Muthén, L.K. and Muthén, B.O. (1998-2007). *Mplus User's Guide. Fifth Edition*. Los Angeles, CA: Muthén & Muthén

Neal, A., & Griffin, M. A. (2004). Safety climate and safety at work. . In M. R. Frone & J. Barling (Eds.), *The psychology of workplace safety* (pp. 15–34). Washington, DC: American Psychological Association.

Neal, A., & Griffin, M. A. (2002). Safety climate and safety behaviour. *Australian Journal of Management, 27*(2)

Neal, A., & Griffin, M. A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of Applied Psychology, 91*(4), 946-953.

Neal, A., Griffin, M.A., & Hart, P.M. (2000). The impact of organizational climate on safety climate and individual behavior. Safety Science, 34, 99-109.

NFFF. (2005). *National Fire service research agenda symposium: Report of the national fire service research agenda symposium. June 1 – 3, 2005.* Emmitsburg, Maryland. Emmitsburg, MD: National Fallen Firefighters Foundation.

NFFF. (2007). *2007 National firefighter life safety summit:. March 3-4, 2007*. Emmitsburg, MD.

NFFF/USFA. (2004). *Firefighter life safety summit initial report:. April 14, 2004.* Emmitsburg, MD.

Occupational Safety and Health Administration (OSHA). (2005). *OSHA recordkeeping handbook.* Washington, DC: US DOL.

Ostroff, C., Kinicki, A. J., & Tamkins, M. M. (2003). Organizational climate and culture. In W. C. Borman, D. R. Ilgen, & R. J. Klimoski (Eds.), *Comprehensive handbook of psychology, Volume 12: Industrial and organizational psychology* (pp. 365-402). Mahwah, N. J.: Erlbaum.

Parker, C. P., Baltes, B. B., Young, S. A., Huff, J. W., Altmann, R. A., Lacost, H. A., & Roberts, J. E. (2003). Relationships between psychological climate perceptions and work outcomes: A meta-analytic review. *Journal of Organizational Behavior, 24*(4), 389-416.

Parker, S. K., Axtell, C. M., & Turner, N. (2001). Designing a safer workplace: Importance of job autonomy, communication quality, and supportive supervisors. *Journal Of Occupational Health Psychology, 6*(3), 211-228.

Pidgeon, N. F. (1991). Safety culture and risk management in organizations. *Journal of Cross-Cultural Psychology, 22*(1), 129.

Pidgeon, N., & O'Leary, M. (2000). Man-made disasters: Why technology and organizations (sometimes) fail. *Safety Science, 34*, 15-30.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *The Journal of Applied Psychology, 88*(5), 879-903.

Pousette, A., Larsson, S., & Torner. (2008). Safety climate cross-validation, strength and prediction of safety behavior. *Safety Science,* 398-404.

Probst, T.M., Brubaker, T.L., & Barsotti, A. (2008). Organizational injury rate underreporting: The moderating effect of organizational safety climate. *Journal of Applied Psychology, 93*(5), 1147-1154.

Ramirez, C. (2002, November). *Strategies for Subject Matter Expert Review in Questionnaire Design*. Paper presented at the Questionnaire Design, Evaluation and Testing Conference, Charleston, SC. Retrieved April 9, 2010 from http://www.jpsm.umd.edu/qdet/final_pdf_papers/ramirez.pdf.

Reason, J. (1997). *Managing the risks of organizational accidents*. Ashgate: Burlington, VT.

Reichard, A. A., & Jackson, L. L. (2010). Occupational injuries among emergency responders. *American Journal of Industrial Medicine, 53*(1), 1-11.

Reichers, A. E., & Schneider, B. (1990). Climate and culture: An evolution of constructs. *Organizational Climate and Culture,* , 5–39.

Rhoades, L., & Eisenberger, R. (2002). Perceived organizational support: A review of the literature. *The Journal of Applied Psychology, 87*(4), 698-714.

Ridenour, M., Noe, R. S., Proudfoot, S. L., Jackson, J. S., Hales, T. R., & Baldwin, T. N. (September, 2008). *NIOSH firefighter fatality investigation and prevention program: Leading recommendations for preventing fire fighter fatalities, 1998–2005*: Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

Roberts, K. H. (1990). Some characteristics of one type of high reliability organization. *Organization Science, 1*(2), 160-176.

Rochlin, G. I. (1999). Safe operation as a social construct. *Ergonomics, 42*(11), 1549-1560.

Rosenstock, L., & Olsen, J. (2007). Firefighting and death from cardiovascular causes. *The New England Journal of Medicine, 356*(12), 1261-1263.

Rosmuller, N., & Ale, B. J. M. (2008). Classification of fatal firefighter accidents in the Netherlands: Time pressure and aim of the suppression activity. *Safety Science, 46*(2), 282-290.

Schein, E.H. (1985). *Organizational culture and leadership.* San Francisco: Jossey-Bass.

Schmidt, F. L., & Hunter, J. E. (1996). Measurement error in psychological research: Lessons from 26 research scenarios. *Psychological Methods*, *1*, 199-223.

Schneider, B. (1975). Organizational climates: An essay. *Personnel Psychology, 28*, 447-479.

Schneider, B., & Gunnarson, S. (1991). Organizational climate and culture: The psychology of the workplace. In J. W. Jones, B. D. Steffy & D. W. Bray (Eds.), *Applying psychology in business* (pp. 542-551). Lexington, MA.

Seo, D.C. (2005). An explicative model of unsafe work behavior. *Safety Science, 43*(3), 187-211.

Seo, D.C., Torabi, M. R., Blair, E. H., & Ellis, N. T. (2004). A cross-validation of safety climate scale using confirmatory factor analytic approach. *Journal of Safety Research, 35*(4), 427-445.

Shannon, H. & Norman, G. (2009). Deriving the factor structure of safety climate scales. *Safety Science, 47*(2009), *327-329.*

Sinclair, R. & Tetrick, L. (2004). Pay and benefits: The role of compensation systems in workplace safety. In Barling & Frone (Eds.), *The psychology of workplace safety* (pp. 203-222). Washington, DC: APA.

Singer, S. J., Gaba, D. M., Geppert, J. J., Sinaiko, A. D., Howard, S. K., & Park, K. C. (2003). The culture of safety: Results of an organization-wide survey in 15 California hospitals. *Quality and Safety in Health Care, 12*(2), 112-118.

Soteriades, E. S., Hauser, R., Kawachi, I., Christiani, D. C., & Kales, S. N. (2008). Obesity and risk of job disability in male firefighters. *Occupational Medicine (Lond), 58*(4), 245-250.

Spector, P. E. (2006). Method variance in organizational research: Truth or urban legend? *Organizational Research Methods, 9*, 221-232.

Thiel, A. (1999). *Special report: Improving firefighter communications*. Emmitsburg, MD: U.S. Fire Administration.

Thompson, R. C., Hilton, T. F., & Witt, L. A. (1998). Where the safety rubber meets the shop floor: A confirmatory model of management influence on workplace safety. *Journal of Safety Research, 29*(1), 15-24.

Torp, S., Grogaard, J. B., Moen, B. E., & Bratveit, M. (2005). The impact of social and organizational factors on workers' use of personal protective equipment: A multilevel approach. *Journal of Occupational and Environmental Medicine / American College of Occupational and Environmental Medicine, 47*(8), 829-837.

TriData Corporation. (1996). *Wildland firefighter safety awareness study: Phase I - identifying the organizational culture, leadership, human factors, and other issues impacting firefighters Safety*. Arlington, VA.

TriData Corporation. (1997). *Wildland firefighter safety awareness study: Phase II - setting new goals For the organizational culture, leadership, human factors, and other areas impacting firefighter safety*. Arlington, VA.

TriData Corporation. (1998). *Wildland Firefighter safety awareness study: Phase III - implementing cultural changes for safety*. Arlington, VA.

TriData Corporation. (2005). *The economic consequences of firefighter injuries and their prevention. Final report.* Arlington, VA.

U.S. Department of Labor. (2006). *National census of fatal occupational injuries in 2005.* Washington, D.C.: United States Government Printing Office.

U.S. Department of Labor. (2009). *Workplace injuries and illnesses - 2008.* Retrieved February 25, 2010 from http://www.bls.gov/news.release/osh.nr0.htm.

USFA. (2002). *Firefighter fatality retrospective study*. Emmitsburg, MD: United States Fire Administration.

USFA. (2002). *Firefighter injuries in structures*. Emmitsburg, MD: United States Fire Administration.

USFA. (2007). *Firefighter fatalities in the United States in 2006*. Emmitsburg, MD: United States Fire Administration.

USFA. (2010a). *Firefighter Casualties, 1999-2008.* Retrieved February 25, 2010 from http://www.usfa.dhs.gov/fireservice/fatalities/statistics/casualties.shtm.

USFA. (2010b). *Firefighters.* Retrieved July 23, 2010 from http://www.usfa.dhs.gov/statistics/firefighters/index.shtm.

Vandenberg, R. J. & Lance, C. E. (2000). A review and synthesis of the measurement invariance literature: Suggestions, practices, and recommendations for organizational research. *Organizational Research Methods, 3,* 4-69.

Vroom, V.H. (1964). *Work and motivation*. New York: Wiley.

Walton, W. D., Bryner, N., Madrzykowski, D., Lawson, J. R., & Jason, N. H. (2000). *Fire research needs workshop proceedings: San Antonio, Texas, October 13-15, 1999*.

Walton, S. M., Conrad, K. M., Furner, S. E., & Samo, D. G. (2003). Cause, type, and workers' compensation costs of injury to fire fighters. *American Journal of Industrial Medicine, 43*(4), 454-458.

Wang, K., Lee, A.H., Yau, K.W., & Carrivick, P. (2003). A bivariate zero-inflated Poisson regression model to analyze occupational injuries. *Accident Analysis and Prevention, 35*(2003), 625-629.

Weick, K. E. (1996). Drop your tools: An allegory for organizational studies. *Administrative Science Quarterly, 41*(2), 301-313.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (1999). *Organizing for high reliability: Processes of collective mindfulness*. Greenwich, CT: JAI Press.

Weil D. 2001. Valuing the economic consequences of work injury and illness: A comparison of methods and findings. *American Journal of Industrial Medicine 40*(4):418-437.

Weston, R. & Gore, P.A. (2006). A brief guide to structural equation modeling. *The Counseling Psychologist, 34*(5): 719-751.

Whitener, E. M. (2001). Do" high commitment" human resource practices affect employee commitment? A cross-level analysis using hierarchical linear modeling. *Journal of Management, 27*(5), 515.

Wiegmann, D. A., Zhang, H., von Thaden, T. L., Sharma, G., & Gibbons, A. M. (2004). Safety culture: An integrative review. *International Journal of Aviation Psychology, 14*(2), 117 - 134.

Wothke, W. (2000). Longitudinal and multi-group modeling with missing data. In T. D. Little, K. U. Schnabel, & J. Baumert (Eds.), *Modeling longitudinal and multiple group data: Practical issues, applied approaches and specific examples* (pp. 219–240). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Yarnal, C. M., Dowler, L., & Hutchinson, S. (2004). Don't let the bastards see you sweat: Masculinity, public and private space, and the volunteer firehouse. *Environment and Planning A, 36*(4), 685-699.

Yau, K., & Lee, A.H. (2001). Zero-inflated Poisson regression with random effects to evaluate an occupational injury prevention programme. *Statistics in Medicine, 20*, 2907–2920.

Yukl, G. (2006). *Leadership in organizations (6th edition).* Upper Saddle New Jersey: Pearson Prentice Hall.

Zacharatos, A., Barling, J., & Iverson, R. D. (2005). *The Journal of Applied Psychology, 90*(1), 77-93.

Zacharatos, A. & Barling, J. (2004). High-performance work systems and occupational safety. In Barling & Frone (Eds.), *The psychology of workplace safety* (pp. 203-222). Washington, DC: APA.

Zohar, D. (1980). Safety climate in industrial organizations: Theoretical and applied implications. *Journal of Applied Psychology,65*(1), 96-102.

Zohar, D. (2000). A group-level model of safety climate: Testing the effect of group climate on microaccidents in manufacturing jobs. *Journal of Applied Psychology, 85*(4), 587-596.

Zohar, D. (2002). The effects of leadership dimensions, safety climate, and assigned priorities on minor injuries in work groups. *Journal of Organizational Behavior, 23*(1), 75-92.

Zohar, D. (2003). Safety climate: Conceptual and measurement issues. In J.C. Quick & L.E. Tetrick (Eds.), *Handbook of occupational health psychology*. Washington, DC: American Psychological Association.

Zohar, D. (2008). Safety climate and beyond: A multi-level multi-climate framework. *Safety Science, 46*(3), 376-387.

Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis and Prevention, 42*(2010), 1517-1522.

APPENDIX A

FIREFIGHTER SAFETY SURVEY

Firefighter Work Safety Questionnaire

1785

The University of Georgia ®

To Participating Firefighters:

I am a doctoral candidate in the Department of Health Promotion and Behavior, at the University of Georgia, studying under the direction of Dr. David DeJoy. I invite you to participate in a doctoral dissertation study associated with firefighter safety and health. Research within fire organizations has been very limited. Currently, we do not know how perceptions of safety influence important safety and health outcomes in fire organizations. The proposed research seeks to address these knowledge gaps. This information may ultimately serve to provide direction toward preventing firefighter injuries and fatalities.

Participation in this study is strictly voluntary. You may choose not to participate or to stop at any time without penalty or loss of benefits to which you are otherwise entitled. If you volunteer to take part in this study, you will complete a questionnaire with questions that are associated with firefighter safety and questions associated with firefighter safety outcomes including safety behaviors, participation in safety, and line-of-duty injuries. It is important that you answer all questions; however, if there is a question you would rather not answer, you may skip it and go on to the next question. Completing this questionnaire should only take about 15 minutes.

No discomfort, stress, or risks are foreseen and completing or not completing this questionnaire will not affect your job standing. Your participation will be anonymous. No personally identifiable information will be obtained in the questionnaire. All records will be maintained by the researcher and the University of Georgia and end results will be reported in aggregate (summary form only). By completing this questionnaire you are agreeing to participate in the above described research project.

Incentives for your participation in the study will consist of a contribution in the name of your fire department to the Georgia Firefighters Burn Foundation. A donation in the amount of $50 will be made in the name of the departments meeting the 50% participation target.

Thank you for your time and for participating in this study. This study has been reviewed and approved by the Institutional Review Board at the University of Georgia. If you have any questions about this research project, please feel free to call or email me or contact Dr. David DeJoy.

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Research at the University of Georgia that involves human participants is overseen by the Institutional Review Board. Questions or problems regarding your rights as a research participant should be addressed to The Chairperson, Institutional

Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address IRB@uga.edu.

GENERAL INSTRUCTIONS: *Please answer each question or statement by circling the number of* THE RESPONSE *which best represents your opinion. If none of the choices fits exactly, choose the option that comes closest. Please answer all questions in each part of the survey. There are no right or wrong answers, and it is very important that you answer each question as honestly as possible.* **YOUR RESPONSES WILL BE KEPT STRICTLY CONFIDENTIAL.**

SAMPLE QUESTION:

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

Proper lifting techniques are important to reduce the risk of back injuries.	1	2	3	(4)	5

Section A

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

In my fire department, new firefighters learn quickly that they are expected to follow good health and safety practices.	1	2	3	4	5
In my fire department, firefighters are told when they do not follow good safety practices.	1	2	3	4	5
Where I work, firefighters, supervisors and management work together to ensure the safest possible working conditions.	1	2	3	4	5
In my department, there are no significant compromises or shortcuts taken when firefighter health and safety are at stake.	1	2	3	4	5
The health and safety of firefighters is a high priority with management where I work.	1	2	3	4	5
I feel free to report safety problems or violations where I work.	1	2	3	4	5

Section B

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

I feel comfortable discussing safety issues with my immediate supervisor.	1	2	3	4	5
I generally try to avoid talking about safety-related issues with my immediate supervisor.	1	2	3	4	5
I feel free to discuss safety-related issues with my immediate supervisor.	1	2	3	4	5
My immediate supervisor encourages open communication about safety.	1	2	3	4	5
My immediate supervisor openly accepts ideas for improving safety.	1	2	3	4	5
I am reluctant to discuss safety-related problems with my immediate supervisor?	1	2	3	4	5

Section C

This section asks for your perceptions and feelings about your job as a firefighter and about working for your fire department. Please answer each question as it applies to <u>your current work situation</u>.

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

I feel a strong sense of belonging to my fire department.	1	2	3	4	5
I feel personally attached to my fire department.	1	2	3	4	5
I am proud to tell others I work at my fire department.	1	2	3	4	5
Working at my fire department has a great deal of personal meaning to me.	1	2	3	4	5
I would be happy to work at my fire department until I retire.	1	2	3	4	5
I really feel that problems faced by my fire department are also my problems.	1	2	3	4	5
I am satisfied with the kind of work that I do.	1	2	3	4	5
At least for now, my current position is well suited to my needs.	1	2	3	4	5
I would not recommend working here to others.	1	2	3	4	5

I think about getting a different job.	1	2	3	4	5
Generally speaking, I am very satisfied with my job as a firefighter.	1	2	3	4	5
I am generally satisfied with the kind of work I do in this job.	1	2	3	4	5
I frequently think of quitting my job.	1	2	3	4	5
Most people in my job are very satisfied with the job (*If no one has exactly the same job, think of the job which is most similar to yours).*	1	2	3	4	5
People in my job often think of quitting *(If no one has exactly the same job, think of the job which is most similar to yours).*	1	2	3	4	5

Section D

1 = Very unsafe 2 = Moderately unsafe 3=Neutral 4. Moderately safe 5=Very safe

All in all, how would you rate your current work situation in terms of your personal exposure to safety and health hazards?	1	2	3	4	5

Section E

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

My fire department has specific policies and/or programs in place to accomplish each of the following:

Obtain the active involvement of department management in occupational safety and health programming.	1	2	3	4	5
Provide ready access to personal protective equipment and other safety equipment.	1	2	3	4	5
Encourage employees to report workplace safety and health problems to immediate supervisor and department management.	1	2	3	4	5
Inform employees about job-related hazards and how they can be reduced.	1	2	3	4	5
Provide applicable safety and health training.	1	2	3	4	5
Provide adequate resources to perform firefighting operations	1	2	3	4	5
Provide adequate personnel to perform firefighting operations	1	2	3	4	5

Section F

1 = Never 2 = Rarely 3 = Sometimes 4 = Usually 5 = Always

I use all the necessary safety equipment to do my job.	1	2	3	4	5
I use the correct safety procedures for carrying out my job.	1	2	3	4	5
I ensure the highest levels of safety when I carry out my job.	1	2	3	4	5
I promote the safety program within the fire department.	1	2	3	4	5
I put in extra effort to improve the safety of the department.	1	2	3	4	5
I voluntarily carry out tasks or activities that help improve operational safety.	1	2	3	4	5
I feel that it is worthwhile to put in effort to maintain or improve my personal safety.	1	2	3	4	5
I feel that it is important to maintain safety at all times.	1	2	3	4	5
I believe that it is important to reduce the risk of accidents and incidents in firefighting.	1	2	3	4	5

Section G

These items describe the leadership style of your supervisor. Use the rating scale below to answer the items.

1 = Not at all 2 = Once in a while 3 = Sometimes 4 = Fairly often 5 = Frequently, if not always

My immediate supervisor expresses satisfaction when I perform my job safely.	1	2	3	4	5
My immediate supervisor makes sure that we received appropriate rewards for achieving safety targets on the job.	1	2	3	4	5
My immediate supervisor provides continuous encouragement to do our jobs safely.	1	2	3	4	5
My immediate supervisor shows determination to maintain a safe work environment.	1	2	3	4	5

My immediate supervisor suggests new ways of doing our jobs more safely.	1	2	3	4	5
My immediate supervisor encourages me to express my ideas and opinion about safety at work.	1	2	3	4	5
My immediate supervisor talks about his/her values and beliefs of the importance of safety.	1	2	3	4	5
My immediate supervisor behaves in a way that displays a commitment to a safe workplace.	1	2	3	4	5
My immediate supervisor spends time showing me the safest way to do things at work.	1	2	3	4	5
My immediate supervisor would listen to my concerns about safety on the job.	1	2	3	4	5
My immediate supervisor avoids making decisions that affect safety on the job.	1	2	3	4	5
My immediate supervisor fails to intervene until safety problems become serious.	1	2	3	4	5
My immediate supervisor waits for things to go wrong before taking action.	1	2	3	4	5

Section H

1 = Never 2 = Almost Never 3 = Sometimes 4 = Fairly Often 5 = Very Often

In the last month, how often have you been upset because of something that happened unexpectedly at work?	1	2	3	4	5
In the last month, how often have you felt that you were unable to control the important things at work?	1	2	3	4	5
In the last month, how often have you felt nervous and stressed because of work?	1	2	3	4	5
In the last month, how often have you found that you could not cope with all the things you had to do at work?	1	2	3	4	5
In the last month, how often have you been angered because of things that had happened at work that were outside of your control?	1	2	3	4	5
In the last month, how often have you felt that difficulties at work were piling up so high that you could not overcome them?	1	2	3	4	5

Section I

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

My immediate supervisor tries to make my job as safe as possible.	1	2	3	4	5
My immediate supervisor often tells fire department management about unsafe situations.	1	2	3	4	5
My immediate supervisor shows personal concern about firefighter safety.	1	2	3	4	5
My immediate supervisor places firefighter safety as a top priority.	1	2	3	4	5
My coworkers are prepared to stop others from working dangerously.	1	2	3	4	5
My coworkers are ready to talk to fellow firefighters who fail to use safety equipment/procedures.	1	2	3	4	5
My colleagues encourage each other to work safely.	1	2	3	4	5
Top management in this fire department is willing to invest money and effort to improve the safety level here.	1	2	3	4	5
Our fire department management is well informed about safety problems and it quickly acts to correct them.	1	2	3	4	5
Managers in this fire department really care and try to reduce risk levels as much as possible.	1	2	3	4	5
Our managers in this fire department view safety regulations very seriously even when they have resulted in no apparent damage.	1	2	3	4	5
I think safety issues are assigned high priority in fire department management meetings.	1	2	3	4	5
When a manager in this department realizes that a hazardous situation has been found, he/she immediately attempts to put it under control.	1	2	3	4	5
Management in this department is always willing to adopt new ideas for improving the safety level.	1	2	3	4	5

Section J

1 = Poor 2 = Fair 3=Good 4. Very good 5=Excellent

In general, would you say your health is:	1	2	3	4	5

Section K

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

I use appropriate personal protective equipment during firefighting operations.	1	2	3	4	5
I correctly inspect and test all personal protective equipment.	1	2	3	4	5
I appropriately report line-of-duty injuries, illnesses or near-misses.	1	2	3	4	5
I follow applicable standard operating procedures to reduce exposures to hazards.	1	2	3	4	5
I help teach safety procedures to new firefighters.	1	2	3	4	5
I assist others to make sure they perform their work safely.	1	2	3	4	5
I get involved in safety activities to help my fellow firefighters work more safely.	1	2	3	4	5
I make safety related recommendations about work activities.	1	2	3	4	5
I speak up and encourage others to get involved in safety matters.	1	2	3	4	5
I tell other firefighters to follow safe working procedures.	1	2	3	4	5
I try to change policies and procedures to make them safer.	1	2	3	4	5
I make suggestions to improve the safety of a mission.	1	2	3	4	5

Section L

Please answer the following questions about injuries and accidents while performing line-of-duty operations. Definitions are indicated below to provide a description of the terms utilized in the questions. You may refer back to these definitions at any time.

<u>Definitions</u>

Line-of-duty (LOD) refers to a firefighter being involved in operations at the scene of an emergency, regardless of whether it is a fire or non-fire incident, responding or returning from an incident, or performing other officially assigned duties such as training, maintenance, public education, inspection, or investigation.

Injury is defined as any physical damage to the body, requiring first aid or medical treatment, whether it was obtained or not.

A **near-miss event** is defined as an unintentional unsafe occurrence that could have resulted in an injury, fatality or property damage, but did not.

1. During the past 12 months, have you been involved in any accidents while in the line-of-duty?

[ ] No (skip to Question 3)
[ ] Yes

2. If yes, how many accidents have you been involved in during the past 12 months?

[ ] One
[ ] Two
[ ] Three
[ ] Four
[ ] Five or more (please specify the number of accidents________________)

3. Did you experience any line-of-duty injuries during the past 12 months?

[ ] No (you may skip questions 4 through 7)
[ ] Yes

4. If yes, how many injuries have you experienced during the past 12 months?

[ ] One

[ ] Two
[ ] Three
[ ] Four
[ ] Five or more (please specify the number of injuries_______________)

5. How many days were you out of work because of a line-of-duty injury or injuries during the past 12 months?

[ ] None
[ ] Days ________________

6. During the past 12 months, has the kind or amount of work you are able to do been limited because of any type of line-of-duty injury?

[ ] No (you may skip question 7)
[ ] Yes

7. If the kind or amount of work has been limited, how many days were you on restricted duty or on alternative or transferred duties during the past 12 months?

_________________ days

8. During the past 12 months, have you been involved in any near-miss events while in the line-of-duty?

[ ] No
[ ] Yes

9. If yes, how many near-miss events have you been involved in during the past 12 months?

[ ] One
[ ] Two
[ ] Three
[ ] Four
[ ] Five or more (please specify the number of accidents_______________)

Section M

Please answer each item by filling in the blank, checking the appropriate box or by circling the number of the response that best represents your answer.

1. How old are you? ________ years
2. What is your height in feet and inches? _______ feet _______ inches
3. What is your weight in pounds? ________ lbs.
4. Do you consider yourself Hispanic or Latino? 1. Yes 2. No
5. What is your race? 1. Black or African American 2. Asian 3. American Indian or Alaska Native 4. Native Hawaiian or other Pacific Islander 5. White 6. Other ____________________
6. What is your highest educational background? 1. Some high school 2. High school graduate or GED 3. Some college or technical/vocational training 4. Associate's degree (2 years) 5. Bachelor's degree (4 years) 6. Postgraduate work 7. Master's degree 8. Terminal degree (PhD, MD, etc.)
7. What is your marital status? 1. Single 2. Divorced/Separated 3. Widowed 4. Married/Living with Partner
8. Years of service [ ] Less than 1 [ ] 1 year or more, but less than 2 [ ] 2 years or more, but less than 4 [ ] 4 years or more, but less than 7 [ ] 7 years or more, but less than 10 [ ] 10 years or more, but less than 15 [ ] 15 years or more, but less than 20 [ ] 20 years or more, but less than 25 [ ] 25 years or more

9. Do you have a second job? 1. Yes If yes, how many hours each week do you work at your 2nd job? _________ 2. No	
10. Rank (please complete the group that best represents your department structure) [ ] Firefighter/EMT I [ ] Firefighter/EMT II [ ] Firefighter/EMT III [ ] Lieutenant [ ] Captain [ ] Battalion Chief [ ] Asst Chief [ ] Chief [ ] Other _________________________________	 [ ] Firefighter [ ] Corporal [ ] Sergeant [ ] Lieutenant [ ] Captain [ ] Battalion Chief [ ] Asst Chief [ ] Chief [ ] Other ________________________
11. As part of your job responsibilities, do you supervise others? 1. Yes 2. No	

Thank you very much for taking the time to complete this survey.

APPENDIX B

SUBJECT MATTER EXPERT REVIEW DOCUMENT

Firefighter Safety Climate Study - SME Review

Thank you for participating in the Subject Matter Expert (SME) review for the Firefighter Work Safety Questionnaire. This survey has been reviewed and approved by the Institutional Review Board at the University of Georgia. This survey will be used in a dissertation study completed by Todd Smith, a doctoral candidate in the Department of Health Promotion and Behavior, at the University of Georgia, studying under the direction of Dr. David DeJoy. The dissertation study is associated with firefighter safety and health. Research within fire organizations has been very limited. This information may ultimately serve to provide direction toward preventing firefighter injuries and fatalities.

Directions for SME Review
Please complete the Firefighter Work Safety Questionnaire. While completing the survey, please circle, highlight or mark anything confusing. Please make a note as to why it is confusing. Please make suggestions or comments for improvement.
Following the completion of the questionnaire, please provide comments, if you have any, to the items below.

1) Did you understand the wording of the items?

2) Was the wording appropriate for the firefighter community?

3) Did you understand all the terminology?

4) Should additional definitions be added?

5) In your opinion, will most firefighters be able to answer the questions as written?

6) Is the time burden for completing the survey satisfactory? Did it take too long?

7) With regard to the questions, do we need qualifying terms regarding “supervisor”?

APPRENDIX C

CORRELATION MATRIX

	SCOMM1	SCOMM2	SCOMM3	SCOMM4	SCOMM5	SCOMM6	MGTC1	MGTC2	MGTC3	MGTC4	MGTC5	MGTC6	MGTC7
SCOMM1	1	.549**	.792**	.671**	.476**	.416**	.131*	.152**	.200**	.257**	.195**	.237**	.201**
		.000	.000	.000	.000	.000	.015	.005	.000	.000	.000	.000	.000
SCOMM2	.549**	1	.575**	.457**	.294**	.509**	.134*	.119*	.156**	.193**	.147**	.228**	.117*
	.000		.000	.000	.000	.000	.013	.027	.004	.000	.006	.000	.031
SCOMM3	.792**	.575**	1	.719**	.441**	.476**	.115*	.148**	.157**	.227**	.163**	.231**	.146**
	.000	.000		.000	.000	.000	.033	.006	.003	.000	.002	.000	.007
SCOMM4	.671**	.457**	.719**	1	.566**	.391**	.189**	.207**	.250**	.278**	.262**	.279**	.267**
	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000
SCOMM5	.476**	.294**	.441**	.566**	1	.274**	.142**	.101	.146**	.153**	.147**	.157**	.146**
	.000	.000	.000	.000		.000	.008	.062	.007	.004	.006	.003	.007
SCOMM6	.416**	.509**	.476**	.391**	.274**	1	.043	.027	.075	.072	.001	.088	.054
	.000	.000	.000	.000	.000		.428	.616	.166	.181	.984	.102	.317
MGTC1	.131*	.134*	.115*	.189**	.142**	.043	1	.770**	.706**	.627**	.620**	.611**	.615**
	.015	.013	.033	.000	.008	.428		.000	.000	.000	.000	.000	.000
MGTC2	.152**	.119*	.148**	.207**	.101	.027	.770**	1	.786**	.685**	.659**	.672**	.756**
	.005	.027	.006	.000	.062	.616	.000		.000	.000	.000	.000	.000
MGTC3	.200**	.156**	.157**	.250**	.146**	.075	.706**	.786**	1	.759**	.720**	.723**	.703**
	.000	.004	.003	.000	.007	.166	.000	.000		.000	.000	.000	.000
MGTC4	.257**	.193**	.227**	.278**	.153**	.072	.627**	.685**	.759**	1	.734**	.733**	.672**
	.000	.000	.000	.000	.004	.181	.000	.000	.000		.000	.000	.000
MGTC5	.195**	.147**	.163**	.262**	.147**	.001	.620**	.659**	.720**	.734**	1	.724**	.682**
	.000	.006	.002	.000	.006	.984	.000	.000	.000	.000		.000	.000
MGTC6	.237**	.228**	.231**	.279**	.157**	.088	.611**	.672**	.723**	.733**	.724**	1	.722**
	.000	.000	.000	.000	.003	.102	.000	.000	.000	.000	.000		.000
MGTC7	.201**	.117*	.146**	.267**	.146**	.054	.615**	.756**	.703**	.672**	.682**	.722**	1
	.000	.031	.007	.000	.007	.317	.000	.000	.000	.000	.000	.000	

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

	SUPR1	SUPR2	SUPR3	SUPR4	PGM1	PGM2	PGM3	PGM4	PGM5	PGM6	PGM7
SCOMM1	.403**	.296**	.357**	.403**	.120*	.240**	.278**	.286**	.149**	.255**	.037
	.000	.000	.000	.000	.026	.000	.000	.000	.005	.000	.496
SCOMM2	.262**	.233**	.257**	.268**	.071	.138*	.220**	.188**	.056	.118*	.040
	.000	.000	.000	.000	.187	.010	.000	.000	.300	.029	.464
SCOMM3	.381**	.286**	.346**	.336**	.068	.178**	.250**	.240**	.091	.211**	.001
	.000	.000	.000	.000	.209	.001	.000	.000	.093	.000	.988
SCOMM4	.536**	.420**	.437**	.498**	.167**	.240**	.360**	.373**	.253**	.254**	.060
	.000	.000	.000	.000	.002	.000	.000	.000	.000	.000	.269
SCOMM5	.318**	.251**	.322**	.362**	.078	.125*	.218**	.270**	.204**	.183**	.058
	.000	.000	.000	.000	.150	.021	.000	.000	.000	.001	.282
SCOMM6	.189**	.160**	.197**	.189**	-.023	.091	.113*	.083	-.005	.064	-.020
	.000	.003	.000	.000	.676	.091	.035	.126	.928	.240	.717
MGTC1	.316**	.287**	.264**	.268**	.394**	.334**	.364**	.376**	.373**	.401**	.485**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
MGTC2	.337**	.327**	.276**	.236**	.472**	.349**	.429**	.477**	.441**	.482**	.487**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
MGTC3	.395**	.317**	.316**	.329**	.474**	.389**	.437**	.481**	.428**	.429**	.481**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
MGTC4	.377**	.369**	.359**	.376**	.438**	.402**	.445**	.487**	.448**	.433**	.432**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
MGTC5	.376**	.336**	.363**	.398**	.483**	.414**	.445**	.464**	.428**	.465**	.425**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
MGTC6	.344**	.325**	.342**	.313**	.470**	.432**	.470**	.497**	.412**	.423**	.383**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
MGTC7	.321**	.343**	.314**	.276**	.452**	.405**	.462**	.524**	.472**	.494**	.406**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

	COMP1	COMP2	COMP3	CTZ1	CTZ2	CTZ3	NUMINJ
SCOMM1	.309**	.279**	.257**	.228**	.195**	.170**	-.060
	.000	.000	.000	.000	.000	.002	.264
SCOMM2	.236**	.208**	.152**	.260**	.212**	.213**	-.022
	.000	.000	.005	.000	.000	.000	.691
SCOMM3	.260**	.261**	.178**	.207**	.134*	.132*	-.016
	.000	.000	.001	.000	.013	.014	.768
SCOMM4	.302**	.273**	.265**	.271**	.207**	.219**	.050
	.000	.000	.000	.000	.000	.000	.355
SCOMM5	.230**	.173**	.190**	.141**	.106*	.138*	-.022
	.000	.001	.000	.009	.049	.011	.678
SCOMM6	.162**	.065	.094	.154**	.058	.024	.059
	.003	.232	.081	.004	.281	.662	.278
MGTC1	.242**	.303**	.312**	.319**	.225**	.266**	-.085
	.000	.000	.000	.000	.000	.000	.117
MGTC2	.302**	.326**	.306**	.397**	.290**	.242**	-.033
	.000	.000	.000	.000	.000	.000	.547
MGTC3	.337**	.341**	.346**	.366**	.306**	.286**	-.040
	.000	.000	.000	.000	.000	.000	.463
MGTC4	.359**	.342**	.350**	.349**	.320**	.336**	-.003
	.000	.000	.000	.000	.000	.000	.959
MGTC5	.299**	.296**	.303**	.310**	.336**	.338**	-.108*
	.000	.000	.000	.000	.000	.000	.045
MGTC6	.359**	.334**	.340**	.335**	.292**	.291**	-.036
	.000	.000	.000	.000	.000	.000	.502
MGTC7	.328**	.299**	.337**	.349**	.302**	.271**	-.071
	.000	.000	.000	.000	.000	.000	.190

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

	SCOMM1	SCOMM2	SCOMM3	SCOMM4	SCOMM5	SCOMM6	MGTC1	MGTC2	MGTC3	MGTC4	MGTC5	MGTC6	MGTC7
SUPR1	.403**	.262**	.381**	.536**	.318**	.189**	.316**	.337**	.395**	.377**	.376**	.344**	.321**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SUPR2	.296**	.233**	.286**	.420**	.251**	.160**	.287**	.327**	.317**	.369**	.336**	.325**	.343**
	.000	.000	.000	.000	.000	.003	.000	.000	.000	.000	.000	.000	.000
SUPR3	.357**	.257**	.346**	.437**	.322**	.197**	.264**	.276**	.316**	.359**	.363**	.342**	.314**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SUPR4	.403**	.268**	.336**	.498**	.362**	.189**	.268**	.236**	.329**	.376**	.398**	.313**	.276**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PGM1	.120*	.071	.068	.167**	.078	-.023	.394**	.472**	.474**	.438**	.483**	.470**	.452**
	.026	.187	.209	.002	.150	.676	.000	.000	.000	.000	.000	.000	.000
PGM2	.240**	.138*	.178**	.240**	.125*	.091	.334**	.349**	.389**	.402**	.414**	.432**	.405**
	.000	.010	.001	.000	.021	.091	.000	.000	.000	.000	.000	.000	.000
PGM3	.278**	.220**	.250**	.360**	.218**	.113*	.364**	.429**	.437**	.445**	.445**	.470**	.462**
	.000	.000	.000	.000	.000	.035	.000	.000	.000	.000	.000	.000	.000
PGM4	.286**	.188**	.240**	.373**	.270**	.083	.376**	.477**	.481**	.487**	.464**	.497**	.524**
	.000	.000	.000	.000	.000	.126	.000	.000	.000	.000	.000	.000	.000
PGM5	.149**	.056	.091	.253**	.204**	-.005	.373**	.441**	.428**	.448**	.428**	.412**	.472**
	.005	.300	.093	.000	.000	.928	.000	.000	.000	.000	.000	.000	.000
PGM6	.255**	.118*	.211**	.254**	.183**	.064	.401**	.482**	.429**	.433**	.465**	.423**	.494**
	.000	.029	.000	.000	.001	.240	.000	.000	.000	.000	.000	.000	.000
PGM7	.037	.040	.001	.060	.058	-.020	.485**	.487**	.481**	.432**	.425**	.383**	.406**
	.496	.464	.988	.269	.282	.717	.000	.000	.000	.000	.000	.000	.000

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

	SUPR1	SUPR2	SUPR3	SUPR4	PGM1	PGM2	PGM3	PGM4	PGM5	PGM6	PGM7
SUPR1	1	.640**	.749**	.703**	.321**	.277**	.405**	.381**	.342**	.336**	.227**
		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SUPR2	.640**	1	.624**	.576**	.212**	.197**	.396**	.350**	.224**	.278**	.173**
	.000		.000	.000	.000	.000	.000	.000	.000	.000	.001
SUPR3	.749**	.624**	1	.744**	.255**	.198**	.410**	.363**	.314**	.244**	.161**
	.000	.000		.000	.000	.000	.000	.000	.000	.000	.003
SUPR4	.703**	.576**	.744**	1	.234**	.232**	.394**	.343**	.291**	.289**	.212**
	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
PGM1	.321**	.212**	.255**	.234**	1	.390**	.456**	.484**	.520**	.373**	.334**
	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000
PGM2	.277**	.197**	.198**	.232**	.390**	1	.511**	.482**	.435**	.457**	.256**
	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000
PGM3	.405**	.396**	.410**	.394**	.456**	.511**	1	.701**	.552**	.460**	.275**
	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000
PGM4	.381**	.350**	.363**	.343**	.484**	.482**	.701**	1	.652**	.472**	.270**
	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000
PGM5	.342**	.224**	.314**	.291**	.520**	.435**	.552**	.652**	1	.525**	.321**
	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
PGM6	.336**	.278**	.244**	.289**	.373**	.457**	.460**	.472**	.525**	1	.481**
	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000
PGM7	.227**	.173**	.161**	.212**	.334**	.256**	.275**	.270**	.321**	.481**	1
	.000	.001	.003	.000	.000	.000	.000	.000	.000	.000	

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

	SCOMM1	SCOMM2	SCOMM3	SCOMM4	SCOMM5	SCOMM6	MGTC1	MGTC2	MGTC3	MGTC4	MGTC5	MGTC6	MGTC7
COMP1	.309**	.236**	.260**	.302**	.230**	.162**	.242**	.302**	.337**	.359**	.299**	.359**	.328**
	.000	.000	.000	.000	.000	.003	.000	.000	.000	.000	.000	.000	.000
COMP2	.279**	.208**	.261**	.273**	.173**	.065	.303**	.326**	.341**	.342**	.296**	.334**	.299**
	.000	.000	.000	.000	.001	.232	.000	.000	.000	.000	.000	.000	.000
COMP3	.257**	.152**	.178**	.265**	.190**	.094	.312**	.306**	.346**	.350**	.303**	.340**	.337**
	.000	.005	.001	.000	.000	.081	.000	.000	.000	.000	.000	.000	.000
CTZ1	.228**	.260**	.207**	.271**	.141**	.154**	.319**	.397**	.366**	.349**	.310**	.335**	.349**
	.000	.000	.000	.000	.009	.004	.000	.000	.000	.000	.000	.000	.000
CTZ2	.195**	.212**	.134*	.207**	.106*	.058	.225**	.290**	.306**	.320**	.336**	.292**	.302**
	.000	.000	.013	.000	.049	.281	.000	.000	.000	.000	.000	.000	.000
CTZ3	.170**	.213**	.132*	.219**	.138*	.024	.266**	.242**	.286**	.336**	.338**	.291**	.271**
	.002	.000	.014	.000	.011	.662	.000	.000	.000	.000	.000	.000	.000
NUMINJ	-.060	-.022	-.016	.050	-.022	.059	-.085	-.033	-.040	-.003	-.108*	-.036	-.071
	.264	.691	.768	.355	.678	.278	.117	.547	.463	.959	.045	.502	.190

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

	SUPR1	SUPR2	SUPR3	SUPR4	PGM1	PGM2	PGM3	PGM4	PGM5	PGM6	PGM7
COMP1	.320**	.263**	.299**	.357**	.258**	.197**	.284**	.348**	.322**	.247**	.169**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002
COMP2	.224**	.274**	.246**	.306**	.253**	.193**	.291**	.288**	.275**	.227**	.244**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
COMP3	.317**	.250**	.273**	.339**	.287**	.184**	.265**	.285**	.278**	.211**	.249**
	.000	.000	.000	.000	.000	.001	.000	.000	.000	.000	.000
CTZ1	.244**	.275**	.267**	.247**	.292**	.194**	.315**	.297**	.281**	.224**	.205**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
CTZ2	.237**	.257**	.231**	.261**	.293**	.174**	.266**	.250**	.216**	.198**	.165**
	.000	.000	.000	.000	.000	.001	.000	.000	.000	.000	.002
CTZ3	.236**	.258**	.288**	.275**	.287**	.184**	.245**	.233**	.240**	.203**	.098
	.000	.000	.000	.000	.000	.001	.000	.000	.000	.000	.070
NUMINJ	-.050	-.028	-.088	-.012	-.144**	-.002	-.068	-.047	-.092	-.048	-.035
	.359	.599	.102	.820	.008	.967	.209	.380	.087	.372	.515

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

	COMP1	COMP2	COMP3	CTZ1	CTZ2	CTZ3	NUMINJ
COMP1	1	.550**	.510**	.383**	.280**	.298**	-.066
		.000	.000	.000	.000	.000	.222
COMP2	.550**	1	.677**	.459**	.407**	.372**	-.020
	.000		.000	.000	.000	.000	.712
COMP3	.510**	.677**	1	.485**	.417**	.352**	-.007
	.000	.000		.000	.000	.000	.891
CTZ1	.383**	.459**	.485**	1	.634**	.537**	.051
	.000	.000	.000		.000	.000	.350
CTZ2	.280**	.407**	.417**	.634**	1	.653**	.002
	.000	.000	.000	.000		.000	.973
CTZ3	.298**	.372**	.352**	.537**	.653**	1	-.023
	.000	.000	.000	.000	.000		.677
NUMINJ	-.066	-.020	-.007	.051	.002	-.023	1
	.222	.712	.891	.350	.973	.677	

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).