# THE IMPACT OF SAFETY CULTURE ON WORKER MOTIVATION AND THE ECONOMIC BOTTOM LINE

by

Donna Cangelosi Crossman

MICHAEL H. MCGIVERN, Ph.D., Faculty Mentor and Chair

PHYLLIS CLAYTON, Ed.D., Committee Member

KATHLEEN HENRY, Ph.D., Committee Member

Harry McLenighan, Ed.D., Dean, School of Education

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Abstract

In an effort to reduce injury rates, the U.S. safety industry is urging employers to invest in safety culture. Gilbert's (1978) model of performance engineering may provide guidance for design of culture related interventions. Model testing focused on three contextual variables—communication, resource availability, and incentives—and effects on safety motivation ($n$ = 316). Incentives, which mediated the indirect effects of communication and resource availability, was shown to exert significant influence on safety motivation. A between-group ANOVA was also conducted ($n$ = 19) to determine predictive value of the model relative to injury costs; however no significant relationships were found. Study findings indicate that continued investigation of Gilbert's (1978) theory as a universal model of safety culture is warranted.

Dedication

The family. We were a strange little band of characters trudging through life sharing diseases and toothpaste, coveting one another's desserts, hiding shampoo, borrowing money, locking each other out of our rooms, inflicting pain and kissing to heal it in the same instant, loving, laughing, defending, and trying to figure out the common thread that bound us all together.

*-Erma Bombeck*

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# CHAPTER 1. INTRODUCTION

## Introduction to the Problem

Why are some high-risk occupational environments safer than others? It is a prevailing belief in the safety industry that safety culture is an integral dynamic contributing to the prevention of work-related deaths, injuries, and illnesses. Practitioner faith in the power of safety culture is supported by academic researchers who encourage "high risk industries to reduce their reliance on accident and incident data and to direct health and safety systems toward investigating the culture and climate that may contribute to incidents" (Flin et al., cited in Farrington-Darby, Pickup, & Wilson, 2005, p. 40).

In an effort to advance industry understanding of the fundamentals of safety culture, DeJoy (2004) traced researchers' circuitous path of past empirical inquiry into this workplace phenomenon. Beyond this review, research into the nature of safety culture is ongoing. Various factors comprising safety culture, consistent across industries, have been identified (see Table 1); the size, strength, and direction of some relationships among factors have been established; and a few suggestive links and mediators between variables are documented (Mohamed, 2002; Taylor & Thomas, 2003; Mearns, Rundmo, Flin, Gordon, & Fleming, 2004; Adie, Cairns, Macdiarmid, Ross, Watt, Taylor, et al. 2005; Havold, 2004; Farrington-Darby, Pickup, & Wilson, 2005; Harvey, Erdos, Bolam, Cox, Kennedy, & Gregory, 2005; Ayomoh & Oke, 2006; Ek, Akselsson, Arvidsson, & Johansson, 2006).

Table 1.

*Identified Site Specific Factors of Safety Culture Across Select Industries*

| Industry | Factors | Study Findings |
|---|---|---|
| Shipping<br><br>(Havold, 2005) | Knowledge, management attitude, safety behavior, worker attitude, employee satisfaction, concentration of authority, training, resource availability, stress experience. | Study factor structure and relative importance confirmed research findings in industries other than shipping. |
| Railway Maintenance<br><br>(Farrington-Darby et al., 2005) | Communication, worker and subcontractor teamwork, rule and information dissemination, feedback, supervisor visibility, equipment, risk assessment skill, role model behavior, workplace conditions, working hours, management knowledge, supervisor competency, recruitment methods, safety perception, home/life pressure, peer pressure, reporting methods, training, worker knowledge & understanding, volume of paperwork, perceived purpose of paperwork, worker capacity. | Limited generalizability of factors to other workplace contexts, however, study framework may prove useful in identifying safety related problems. |
| Aviation Maintenance<br><br>(Taylor & Thomas, 2003) | Supervisor-worker trust and communication, company pride; co-worker interpersonal trust, conflict avoidance, stress effects | Factor analyses from five different samples, consisting of workers belonging to various companies, reveal comparable factor structure. |
| Nuclear Power<br><br>(Harvey et al. 2002) | Management style & communication, commitment, risk response, job satisfaction, motivation, responsibility, management quality, risk awareness. | Study suggests that perceptions of safety culture vary between management and workers and among various levels of workers. |

Of late, safety culture development efforts have been applied to supplement behavior based programs in order to strengthen longevity of performance results (DeJoy, 2004). Geller's (2005) *People-Based Safety* series is one example of a value-added culture changing tool, reflecting the evolutionary nature of occupational safety.

Inquiry into the essence and impact of safety culture is primarily motivated by a compelling social agenda—emphasis on safety prevents disabling injuries and saves lives. Moreover, encouraging the growth of positive safety culture is also a strategy for reducing mental stress (e.g., anxiety and fear) typically experienced by workers in high risk work environments (Barling, Iverson, & Kelloway, 2003). Workers who feel safe in the workplace are apt to be more satisfied on the job. As Soediono and Kleiner (2002) have maintained, "a safe workplace is central to our ability to enjoy health, security, and the opportunity to achieve the American dream" (p.37).

A primary underpinning of safety culture is Bandura's (1986) Social-Cognitive theory, a concept based on the premise "that people are both products and producers of their environment" (Cooper, 2000, p.5). In the face of peril, it is typically human to feel powerless--however, Bandura (1986) posited that people, individually and collectively, possess a measure of control over life's circumstances. Social-Cognitive theory is one explanation as to why positive safety culture is motivating, thereby enabling workers to manipulate conditions and situations, exerting power to eliminate or minimize risks that precipitate accidents.

Safety improvement in the U.S. is historically government-driven, through the Occupational Safety and Health Administration (OSHA), a division of the Department of Labor. Established in 1970, OSHA legislation has had a profound impact on safety, resulting in a steady downward trend in fatalities and injuries (Bradbury, 2006). Over the past 38 years under OSHA's guidance, fatality rates have dropped 62% and the occupational injury and illness rate has declined an impressive 40% (OSHA, 2006a). Yet, the distressing fact is that there were 4,085,400 nonfatal workplace illnesses and injuries

in 2008 (Bureau of Labor Statistics) and 5,703 occupational deaths officially recorded in the U.S. (Bureau of Labor Statistics, 2008a). The National Safety Council (2006) calculated that one worker is injured every nine seconds on the job. Even more troubling is the assertion that annual official injury/illness counts may be highly inaccurate. Leigh, Marcin, and Miller (2004) estimated that currently between 33% and 69% of occupational mishaps in U.S. workplaces go unreported. According to the latest global census figures, U.S. safety performance lags behind many other established market economies such as Japan, Australia, and Great Britain (Hamalainen, Takala, & Saarela, 2006). Clearly, any optimistic news surrounding workplace safety in the U.S. is tempered by data to the contrary, suggesting that regulatory agencies need to institute dramatic changes in tactics and approach.

> OSHA has been driven too often by numbers and rules, not by smart enforcement and results. Business complains about overzealous enforcement and burdensome rules. Many people see OSHA as an agency so enmeshed in its own red tape that it has lost sight of its own mission (Soediono & Kleiner, 2002, p.37).

Is it possible that regulatory oversight has perhaps run its course? Under compliance enforcement, meaningful improvements in safety performance may have reached a point of diminishing returns. Rechenthin (2004) pointed to analysis of National Safety Council (NSC) data, which suggests that recent improvements in the occupational death rate may be due to a shift of workers from high risk to lower risk jobs, rather than connected to upgrades in working conditions. Despite the minute overall drop in both injuries and fatalities over the last few years, several industries have experienced dramatic increases in worker deaths. In 2006, fatalities in the coal mining industry have more than doubled,

aircraft-related fatalities rose 44%, and deaths among construction workers increased 3% (NSC, 2007). In an effort to spur substantive reductions in workplace fatalities and injuries, OSHA (as well as other U.S. and International regulatory agencies) has begun encouraging businesses to develop safety programs, which exceed regulatory compliance. It is conjectured that 'beyond compliance' safety agendas will lead to improvements in safety culture, a dynamic thought to be key to sustainable safety excellence (Garner & Horn, 2000).

Aside from the social ramifications associated with workplace injuries and illness, the increased economic liability surrounding safety is also disturbing. Data indicate that although rates of injury and fatality have decreased, the national cost of workplace accidents continues to grow, rising, for example, from $46.1 billion to $49.6 billion in just one year (Liberty Mutual Workplace Safety Index, 2004). Especially hard hit are employers who bear the ever-increasing burden of workers' compensation insurance costs. Employers pay out an average of $27.31 per employee hours worked into state workers' compensation coffers, and this figure has risen 30% over a ten year period with no cap in sight (Bureau of Labor Statistics, 2006b). In today's competitive economy, a primary goal of management, aside from protection of workers, is containment of spiraling workers' compensation costs (Everett & Thompson, 1995; Rechenthin, 2004). Today, the challenge faced by safety practitioners is in managing the double bottom line: simultaneous protection of both people and profits. Beyond compliance safety and its attention to safety culture are touted by industry experts as a strategy for reducing safety-related costs.

Historically, however, it has been difficult to persuade management of the inherent value of culture change initiatives (Soyka & Friedman, cited in Behm, Veltri, & Kleinsorge, 2004). One possible reason behind management resistance is the uncertainty surrounding the fiscal soundness of exceeding governmental standards. Proof of efficacy of safety culture change efforts are at this point in time primarily anecdotal (Veltri, Pagell, Behm, & Das, 2007). Constrained by tight budgets, management is reluctant to fund non-mandated safety initiatives lacking dubious financial return. On economic grounds, the social bottom line is frequently compromised by financial concerns (Behm, Veltri & Kleinsorge, 2004). However, if safety culture is integral to improved performance, an empirically demonstrated link between safety culture and the bottom line can offer necessary proof and impetus for promotion of a beyond compliance mentality that OSHA and other regulatory agencies are so eager to foster (OSHA, n.d.). This study was an effort to fill this particular gap in the research literature.

Though compliance has resulted in considerable improvements in safety, government safety standards have tended to be overly prescriptive, creating a situation whereby most employers willingly obey the letter of the law, but many completely miss the intent (Corcoran & Shackman, 2007). In the face of resistance, the industry is encouraging managers to strive for beyond compliance (Corcoran & Shackman, 2007; Soediono & Kleiner, 2002; Weil, 2001). Yet, beyond compliance is a somewhat nebulous term, and efforts toward attainment frequently consist of isolated interventions, which are disconnected from overall safety and organizational strategies. An ideal beyond compliance process is systemic and comprehensive, empowering performance improvement at all levels. This study was an attempt to unleash the potential of a

phenomenon that has the power to reduce fatalities and injuries beyond its current plateau through cost effective means.

## Background of the Study

In the investigation and analysis of the 1979 nuclear accident at Three Mile Island, the Nuclear Regulatory Commission (NRC) referred to safety culture as a factor needing improvement at the facility (Sorenson, 2002). However, the phrase itself was originally coined by the International Nuclear Safety Advisory Group (INSAG) following the 1986 Chernobyl disaster (Sorenson, 2002; Weigmann, Ahang, von Thaden, Sharma, & Gibbons, 2004; Cooper, 2000). In the U.S., the term safety culture caught on in the aftermath of the Challenger space shuttle failure. According to investigators, a negative safety culture among National Aeronautics and Space Administration (NASA) personnel was labeled an identifiable cause of the Challenger disaster. Years later, in 1991, the expression was mentioned again as the National Transportation Safety Board (NTSB) directly attributed the crash of Continental Express Flight 2574 near Eagle Lakes, Texas to gaps in safety culture (Weigmann et al., 2004).

The theoretical underpinning of the term is both anthropological and psychological in nature (Sorenson, 2002; Weigmann et al., 2004). DeJoy (2004) and Weigmann et al. (2004) connected the development of the concept of safety culture to principles of organizational behavior, a discipline tending toward a psychological interpretation. Derived from Bandura's (1986) Social Cognitive theory, safety culture is characterized by the interplay of factors relating to the job, the individual, and the organization (Cooper, 2000; Sorenson, 2002). Inspired from the top-down, safety culture

incorporates the myths, legends, rituals, artifacts, and fundamental values surrounding an organization (Sorenson, 2002). A dissection of INSAG's report after Chernobyl described safety culture as an intangible manifested in tangible ways (Sorenson, 2002). Signs and characteristics of safety culture are discernable in all facets of the organization: management leadership, the workplace environment, employee mindset, labor-management relations, and work processes (Sorenson, 2002). The most popular methods of measuring safety culture are through quantitative surveys and qualitative ethnographic research (DeJoy, 2004; Weigmann et al., 2004). Ephemeral and frequently experienced on an emotional level, safety culture is contagious and self-perpetuating. New hires who expect to fully matriculate into an organization must quickly and without question adopt the prevailing culture, functioning "like everyone else" to gain acceptance and respect. Because of the profundity and complexity of safety culture, change initiatives can be an arduous process (DeJoy, 2004).

According to Cooper (2000), safety culture is a concept generically understood in all languages and there is eternal hope that research can ultimately produce a homogenous definition and model, universally applicable to all workplaces. Presently, however, no such consensus exists, and among researchers, safety culture is thought of as a heterogeneous, site-specific concept, which varies not only from one organization to another, but also within divisions or departments of the same company (Cooper, 2000). Weigmann et al. (2004) have tracked the evolution of the search for a consensus definition. Across two decades, 25 separate definitions of safety culture have been proposed, rendering systematic study difficult (Weigmann et al., 2004; Cooper, 2000; DeJoy, 2004; Sorensen, 2002). Cooper (2000) concluded, however, that there appears a

commonality among suggested definitions—most deal with either one or both of two facets: how workers behave and/or how workers think. Further clouding the study of the concept is the confusion between the terms safety culture (an objective measure of the phenomenon) and safety climate (a subjective measure of worker perception of the phenomenon). According to Mearns and Flin (1999), safety culture is predicated on the norms, assumptions, and values which drive the organization. Safety climate is a facet of culture, evidenced in the tactical actions and outcomes of the operation. However, in the literature, the two terms are often used interchangeably, while some researchers prefer to differentiate (Zhang, Wiegmann, von Thaden, Sharma, & Mitchell, 2002). *A Concept in Chaos* is how Zhang et al. (2002) refer to the meandering path of inquiry that researchers have followed in the investigation of the phenomenon. Yet, despite fragmentation, explorations of the concept across a variety of industries have revealed interesting patterns among organizations, facilitating distinction between positive and negative safety cultures (Cooper, 2000).

It is the site-specific nature of safety culture that encumbers research and the development of a consensus definition and model (Cooper, 2000). Site specificity issues are particularly evident in the fire service, for example, the industry, which was the object of this study. Among volunteer firefighters, a unique behavioral dimension exists, which impacts safety culture in ways largely absent in other occupations. According to Thompson and Bono (1993), individuals who engage in voluntary activities do so to overcome the alienating nature of capitalistic society "in an effort to achieve a greater degree of self-actualization" (p. 323). Selflessness and concern for others' welfare more than one's own inspires a culture of heroism, placing firefighters, who often push the

envelope of safety, at extreme risk. Generally, in most workplace contexts, worker engagement is a desirable organizational aim. However, in this particular environment, over-engagement can inspire deadly consequences. Hindering the development of a universal model of safety culture is an inability to reconcile the peculiar subtleties, unique to particular industries (Sorenson, 2002).

Nevertheless, the quest for a theoretical consensus is far from a mere academic exercise. All high risk operations especially can greatly benefit from improvements in safety culture. As companies increasingly depend on contract and contingent workers more than permanent employees, it is a growing challenge to build a level of safety culture that supports sustainable performance improvement (Clarke, 2003). In much the same way that immigrants have difficulty acculturating in a foreign land, free agents who move from job to job struggle to periodically readjust to a new set of safety customs and traditions. According to Clarke (2003),

> the temporary nature of contingent work, with little organizational tenure and limited opportunity to develop relationships based on trust, does not provide the stable workforce and frequent interactions that Ouchi and Wilkins (1985) argue are the prerequisites for cultural control (p. 41)

Yet, rather than endure constant cultural flux, contract employees compensate by developing a personal code of safety, resulting in a fixed perception of risk that is individually consistent and comfortable (Adie, Cairns, Macdiarmid, Ross, Watt, Taylor, et al., 2005). In many cases, however, a worker's personal code conflicts with the dominant shared culture within the work context, increasing risk potential.

What's more, the international make-up of the modern day workforce hinders safety culture formation. Mearns, Rundmo, Flin, Gordon, and Fleming's (2004) study of safety perceptions among United Kingdom and Norwegian workers reveal differences attributed to nationality. However, findings also suggest that differences in perceptions of the workplace environment may account for a greater percentage of variance than nationality, a finding that fuels hope for an eventual consensus definition and model. Generally, the growth of safety culture is viewed in the industry as an eventual result of adherence to sound safety practices. Safety culture is seen as the aftermath of good safety management, rather than its primary goal. Yet, faith in safety culture as an impetus to safety improvement is pervasive among practitioners. Across major U.S. safety organizations, there has been a recent emphasis on safety culture development and a push for the development of beyond compliance programs, which encompass safety culture improvement as a primary goal (ASSE, 2002).

Yet, in companies that are financially stable, there is often resistance among management to fund safety efforts beyond compliance (Filer & Golbe, 2003). When insolvency is a real possibility, highly leveraged companies with low operating margins tend to invest more heavily in safety. Such research findings point to the extent to which economic factors, as much as moral and legal obligations, influence decisions regarding safety. To support and enhance fiscal decision-making, more research involving the economic side of safety is needed.

Despite the lack of empirical studies demonstrating and supporting safety's fiscal efficacy (Veltri, Pagell, Behm, & Das, 2007), there is widespread anecdotal proof that effective safety programs underpinned by positive cultures are a worthy investment. Most

recently, OSHA (2006b) launched a webpage entitled *Making the Business Case for Safety*. The site features countless brief, anecdotal case studies illustrating the high potential for return attached to beyond compliance safety programs. Through its Voluntary Protection Program (VPP), OSHA has begun encouraging employers to reach beyond compliance, claiming that safety, once thought to be a liability, is in reality an asset which can save a company money and provide a significant competitive advantage (OSHA, n.d.). The National Safety Council (NSC) is also responding to the trend toward double bottom line thinking in the safety industry. In late 2004, the organization sponsored an international symposium, facilitating researcher collaboration of economic issues facing the occupational safety industry. A central focus of the symposium involved the review of innovative tools and techniques useful for dealing effectively with the socioeconomic conflicts inherent in safety management (Linhard, 2005).

In light of current interest in the economic side of safety, it is clear that more scientific research is required to support anecdotal claims of safety's business advantage. And despite lack of consensus definition and theoretical underpinning, it seems practical and reasonable to pursue empirical study of safety culture's connection to the bottom line, providing a foundation of supporting evidence, which practitioners can refer to when promoting the notion of beyond compliance to executive management.

## Statement of the Problem

Within the last several years, reductions in accidents and injuries have reached a statistical plateau, and it appears that governmental compliance is ineffectual in advancing the cause of safety in the workplace (Rechenthin, 2004). Clearly, further

improvements in U.S. safety performance demand a beyond compliance approach (OSHA, n.d.; ASSE, 2002). Safety culture development is an ideal beyond compliance strategy, which is thought to be simultaneously socially responsible and economically advantageous. However, there is neither a consensus definition nor universal model to guide the formation of positive safety culture. Also, in today's competitive business environment, employers are demanding accountability and return-on-investment for expenditures (Barksdale & Lund, 2001; Phillips, 2003). Despite widespread belief in the power of safety culture and the presence of research results suggestive of a relationship between safety culture and safety performance, there is little empirical proof that safety culture related interventions are a sound fiscal business strategy. Without a universal theory or evidence based data of financial efficacy, employers are reluctant to directly invest in culture building beyond compliance strategies, thereby unnecessarily exposing workers to inherent and subtle risks and hazards that fall outside the scope of compliance regulations.

## Purpose of the Study

Past research efforts have resulted in the discovery of countless suggested cause and effect relationships between safety culture and worker safety performance (Harvey, Erdos, Bolam, Cox, Kennedy, & Gregory, 2005; Mohamed, 2002; Taylor & Thomas, 2003; Mearns, Rundmo, Flin, Gordon & Fleming, 2004; Adie, Cairns, Macdiarmid, Ross, Watt, Taylor, et al. 2005; Havold, 2004; Farrington-Darby, Pickup, & Wilson, 2005; Ayomoh & Oke, 2006; Ek, Akselsson, Arvidsson, & Johansson, 2006). The primary purpose of this study, which explored the link between safety culture, worker motivation,

and the economic bottom line, was to advance knowledge and understanding of the interdependency of factors comprising safety culture from an existing theoretical perspective. Additionally, management has come to expect financial accountability from every business investment, and this study was a step toward meeting those expectations and offering some measure of assurance that funds spent directly on beyond compliance initiatives are truly a wise investment.

Aside from the primary reason for conducting this study, there are secondary purposes underlying this particular research effort. Documented financial efficacy of safety culture initiatives may provoke widespread changes in perspective among employers. Rather than viewing safety as a cost and a liability, employers may begin to see safety initiatives, both compliance and beyond compliance, as investments resulting in outcomes that positively impact the bottom line (OSHA, n.d.; ASSE, 2002). When the financial advantages of safety are scientifically weighed, management will willingly, rather than forcefully, integrate the operation of safety into the core mission of the business, and safety management will gain a place at the boardroom table. Therefore, when budget reductions are necessary, safety will be spared the devastating cutbacks in staff and funding to which the industry has grown accustomed.

The study of safety culture's impact on the bottom line is also an effort to assist employers in reducing the burden of workers' compensation costs, one of today's largest non-discretionary, direct business expenditures. In the face of spiraling workers compensation costs, the true worth of any safety intervention lies in its ability to reduce insurance premiums. The more targeted the intervention, the greater the potential to positively impact the organization's experience modification (ex-mod) factor, an

independent bureau rating, used by insurance companies, to establish premiums (Everett & Thompson, 1995). An organization's ex-mod factor is determined by comparing three past years' of losses with the industry average. As with any other line of insurance, reducing losses through performance improvement efforts is the key to cost savings (Everett & Thompson, 1995). This study is an effort toward connecting safety culture development with reductions in both direct and indirect safety related costs.

The emphasis on safety culture may also lessen the industry's reliance on training for improvement. Of course, compliance training is mandatory, but often, when accidents occur, it is an immediate reaction to re-train. Among solutions, research has demonstrated that training is in many cases the least effective and most expensive remedy for solving problems in the workplace (Piskurich, 2002), and the implementation of non-training interventions (like those related to safety culture development) may bridge gaps unrelated to knowledge and skill, as well or better than formal instructional initiatives.

This study seeks also to drive the exploration of safety culture in a new direction, and create collaboration between researchers and practitioners on the topic. Theoretical tomes of safety culture are of little interest to practitioners, who are more interested in nuts and bolts solutions useful in the field. The investigation of safety culture and its connection to the bottom line serve to integrate the theoretical abstractions and concrete concerns related to the concept, and perpetuate a dialogue between researchers and practitioners pertaining to issues that are pertinent and useful in the development and application of interventions.

Lastly—this study serves to illustrate that discussions involving financials *and* safety responsibility are not antithetical. In today's competitive business environment, the

operation of safety must account for both the protection of the worker and conservation of profits, and neither one nor the other is mutually exclusive.

## Rationale

The rationale for this study is derived from trends, which are currently impacting the safety field and the business world in general. DeJoy's (2004) recommendation for a combined approach to safety management consisting of both a behavioral and a cultural perspective is reflective of a corporate trend toward broad based, systemic management approaches. Behavior based safety, with its narrow focus on the performer, is still predominant in many workplaces, but criticized for having "little regard to how wider organizational variables might affect safety performance" (Parker, Axtell, & Turner, 2001, p. 221). Though touted in the industry as an effective method of safety management, behavior based safety is an expensive initiative and outcomes are frequently questionable in many occupational environments. A combination of behavioral and cultural perspectives is also aligned with the systems view of management practiced in many organizations. Both a system in and of itself as well as a subsystem of the organization (Cooper, 2002), safety culture may well represent the heart around which other system parts revolve. Because of its importance in the structural design of an organization and its potential to impact the bottom line, the concept and its economic ramifications merit study.

Restructuring efforts by many major companies have resulted in changes in the mix of employee types within a single organization. In the face of downsizing, many organizations now employ a combination of permanent, contingent, and contract workers,

thereby complicating the task of fostering a unified, cohesive safety culture (Clarke, 2003). Temporary workers, who move frequently from one job to another, also tend to carry a personal brand of safety culture, commonly in conflict with the predominant, site specific culture inherent in the organization (Adie et al, 2003). Deeper insight into the complexities of safety culture through empirical research may prompt an appreciation for the value that safety culture holds in the restructuring and downsizing process, as well as promote an awareness of the need to deal effectively with culture clash.

The economics of safety is an issue that major safety organizations are now beginning to address. The American Society of Safety Engineers (ASSE), for example, recently released a white paper emphasizing to members "that investment in a SH&E program is a sound business strategy, for any organization regardless of size, and will lead to having a positive impact on the financial bottom line"(ASSE, 2003, p.1). OSHA's office of Regulatory Analysis has quantified the expected cost savings produced by effective safety program interventions (ASSE, 2002):

> Our evidence suggests that companies that implement effective safety and health programs can expect reductions of 20% or greater in their injury and illness rates and a return of $4 to $6 for every $1 invested (p. 3).

This investigation of the economic ramifications of safety culture has added commensurately to the ongoing discussion of safety and the bottom line.

Increasingly, there is evidence that employers are beginning to understand that sustainability of exemplary safety performance help win contracts and retain clients (Rechenthin, 2004). Additionally, in response to the Sarbanes-Oxley Act of 2002, a law providing reform to ensure corporate accountability to shareholders, management is

expected to control safety and health risks, not only because companies have a moral responsibility to protect workers, but also because of the obligation to avert financial disaster (Cable, 2006). This study has produced valuable insight the relationship of factors that comprise safety culture.

## Research Questions and Hypotheses

A non-experimental, quantitative, survey design with a predictive objective was constructed to study the issue of safety culture and its impact on worker motivation and the bottom line within the context of the volunteer fire service. The following research questions and hypotheses served to guide data collection and analysis.

*Quantitative Research Questions.*

1. To what extent is the cultural environment predictive of firefighter safety motivation?
2. How do the combined effects of the cultural environment and worker motivation impact the organization bottom line?

*Hypotheses.*

Based upon these research questions, the following hypotheses were formulated:

*Hypothesis 1.*

$H^1$ (0): The level of communication between management and workers has no effect on worker safety motivation.

$H^1$ (A): The level of communication between management and workers has a positive effect on worker safety motivation.

*Hypothesis 2.*

$H^2$ (0): Resource availability is unrelated to worker safety motivation.

$H^2$ (A): Resource availability is positively related to worker safety motivation.

*Hypothesis 3.*

$H^3$ (0): External incentives have no effect on worker safety motivation.

$H^3$ (A): External incentives have a positive effect on worker safety motivation.

*Hypothesis 4.*

$H^4$ (0): A safety environment marked by effective communication between workers and management, generous resource availability, and positive external incentives has no effect on worker safety motivation.

$H^4$ (A): A safety environment marked by effective communication between workers and management, generous resource availability, and positive external incentives has a positive effect on worker motivation.

*Hypothesis 5.*

$H^5$ (0): An organization characterized by high levels of worker-management communication, availability of resources, and external incentives has no effect on injury related costs.

$H^5$ (A): An organization characterized by high levels of worker-management communication, availability of resources, and external incentives has a positive effect on injury related costs.

*Hypothesis 6.*

$H^6$ (0): Worker safety motivation has no effect on the company bottom line.

$H^6$ (A): Worker safety motivation has an inverse effect on the company bottom line.

## Significance of the Study

There is little argument that improved safety in the workplace is a worthwhile social endeavor, and that employers have a moral duty to protect workers. However, practical concerns shape management decisions involving safety. It is a stark reality that attempts to create a fail-safe workplace is constrained by economics (Filer & Golbe, 2003). The goal of this study was to facilitate establishment of fiscal priorities, enabling employers to allocate funds toward safety culture initiatives that are most rewarding. Funds spent on unsuccessful safety initiatives are a waste of resources. On the other hand, research based, financially sound safety efforts result in the attainment of the primary goals of every safety manager: reduced accidents and injuries and lower workers' compensation costs.

This study was significant for other reasons. Though compliance regulation is a central concern of OSHA, the agency highly endorses and promotes its Voluntary Protection Program (VPP), encouraging employers to reach beyond compliance. At the heart of OSHA's VPP initiative is safety culture formation. This study was an initial step toward identifying a homogenous, universal model. Study outcomes also served to create a systematic and organized action plan for safety culture enhancement.

Moreover, the quest for a consensus definition of safety culture continues. This study provided yet another piece of the puzzle. As safety culture is an abstract, complex, complicated concept (Zhang et al., 2002), every new research effort provides another clue, providing additional conceptual perspective. What was learned about safety culture within the context of this study's population can be evaluated against research conducted across other high risk industries, enabling further identification of patterns and commonalities. Correlated evidence strengthens support for a consensus definition. As safety improvement in the U.S. has reached a plateau (Renchenthin, 2004) and major safety organizations are urging employers to implement programs that extend 'beyond compliance,' it is essential that the study of safety culture take a double prong approach. Continued research into the conceptual aspects of safety culture should be fostered, while investigation of the economics associated with safety culture formation should also be pursued.

The emphasis on safety in the workplace is one part of a holistic effort in the U.S. to create a safer society. The National Safety Council, for example, has initiated a variety of programs, stressing safety in the workplace, behind-the-wheel, and at home (NSC, 2005). The logic underpinning this strategy is that emphasis on safety in one area of life will hopefully transfer to other areas. According to data, accidents that occur off the job also fiscally impact the workplace through lost workdays and increased health insurance costs (Smith, 2003). It is the hope of the researcher that this study has contributed not only to a fuller understanding of safety culture within the workplace setting, but also provided information that can be extrapolated to society at large.

## Definition of Terms

*Accident*.

"An incident in which a non-trivial loss occurs" (Cooke & Rohleder, 2006, p.214).

*American Society of Safety Engineers (ASSE).*

Founded in 1911, the American Society of Safety Engineers is the largest professional safety organization in the U.S. The association's 30,000 managers, supervisors, and consultants practice occupational safety within the context of a variety of settings: industry, insurance, government, and education. The organization provides members with up-to-date information, continuing education, and opportunities for professional and career networking (ASSE, 2007).

*Behavior Based Safety.*

The application of a behavioral approach to safety in the workplace can be traced back to the work of Komaki, Barwick, and Scott (1978). Komaki et al.'s (1978) landmark behavior based safety study was characterized by a process of on the job observation and feedback designed to change unsafe working habits.

*Beyond Compliance.*

The implementation of safety interventions which exceed the scope of governmental regulations and employer obligations as prescribed by OSHA standards (OSHA, n.d.).

*Culture Based Safety.*

A top-down management approach in which the values, perceptions, and attitudes of organizational supervision influence the safety practices of workers. "Organizations

are sometimes characterized as having strong or weak cultures, functional or dysfunctional cultures, rigid or adaptive cultures" (De Joy, 2004, p. 107).

*Disaster*.

"A very serious incident involving loss of life and/or extensive property damage" (Cooke & Rohleder, 2006, p.214).

*Double Bottom Line*.

The outcomes of safety performance, both from a social and financial perspective. The measure of the social bottom line is gauged according to fatality, injury, and illness data collected by the organization on an annual basis. Safety's impact on the financial bottom line can be either direct, through workers compensation costs, or indirect, through lost time statistics, employee turnover data, or production costs. To maintain a healthy bottom line, organizations must ensure alignment among infinite factors which affect performance and profitability (Kaplan & Norton, 2006).

*Experience Modification (ex-mod) Factor*.

A risk rating assigned to an organization by its insurance provider. Ratings used by insurance companies are generally derived through calculations performed by an independent bureau and accepted by state workers' compensation systems. Based on average accidents and injuries claims within a like industry, the average ex-mod factor is 100 and varies plus or minus depending on an organization's loss record from three years past. The ex-mod factor and its resulting premium calculation reflect not only the number of accidents experienced by an organization, but also the severity of cases (Everett & Thompson, 1995).

*Human Resource Development (HRD).*

An essential business process, the focus of which is the cultivation of human capital, for purposes of improving organizational performance (Swanson, 1995).

*Incident.*

"An unexpected or unwanted change from normal system behavior which causes or has the potential to cause a loss" (Cooke & Rohleder, 2006, p.214).

*National Safety Council (NSC).*

A nonprofit, private, international public service organization dedicated to protecting life and promoting health. The National Safety Council boasts a membership of 48,000 businesses, labor organizations, schools, public agencies, private groups and individuals (National Safety Council, 2007).

*Organizational Behavior.*

The study of individuals and group dynamics in an organizational setting, in an attempt to control, predict, and explain behavior (Schein, 1990).

*Performance.*

Outcomes or accomplishments resulting from behavior (Piskurich, 2002).

*Occupational Safety and Health Administration (OSHA).*

The Occupational Safety and Health Administration, a governmental arm of the Department of Labor, was established in 1971 to protect workers from occupational hazards and promote safety in the workplace (OSHA, n.d.).

*Return on Investment (ROI).*

Return on Investment is a ratio representing money lost or gained relative to the funds originally invested. Most generally, ROI indicates annual or annualized rates of return unless otherwise noted (Phillips, 2003).

*Safety Climate.*

A subjective assessment from the worker's point of view, safety climate encompasses situational and environmental factors, often unstable and subject to change, which exist within the context of a particular place and time (Weigmann et al., 2002).

*Safety Culture.*

A system of shared values experienced among organizational members, safety culture, which is a relatively enduring and stable phenomenon, impacting workplace behavior and performance (Weigmann et al., 2002).

*Sarbanes-Oxley Act of 2002.*

Legislation enacted to impose controls to protect organizational shareholders from risks, which threaten the financial health of a company (Cable, 2006).

*Social Cognitive Theory.*

Introduced by Bandura in 1986, social cognitive theory is a departure from stimulus-response models of behavior. Through feedback and reciprocity, reality is created through interaction of the environment and cognition. In addition, through maturation of mental process (i.e. attention span, memory, reasoning skills, etc…) and experience, cognition changes (Brown, 1999).

*Systems Theory.*

A reaction to the scientific approach known as reductionism, systems theory is the study of complexity and interconnectivity among parts. Under systems theory, emphasis is placed, not on separate parts, but on the relationship between parts (Jackson, 2000). Systems theory has been useful in understanding dynamics in the behavioral and social sciences, and has also been pivotal in forming new concepts related to the science of organizational management (Jackson, 2000). In business management, systems theory traces its roots back to the work of W. Edwards Deming, architect of the System of Profound Knowledge, a framework for understanding workplaces as complex systems (W. Edwards Deming Institute, 2000).

*Triple Bottom Line.*

A measure of the economic, environmental, and social success of organizational performance (Savitz, 2006).

*Voluntary Participation Program (VPP).*

OSHA's Voluntary Participation Program, established in 1982, promotes effective worksite-based safety and health through cooperative relationships among management, labor, and government. VPP participants' accident rate is typically 52% below non-participant organizations (OSHA, n.d.).

*Workers' Compensation.*

An insurance fund to which employers contribute in order to provide medical coverage and wage payments in the event a worker is injured on the job (Everett & Thompson, 1995).

## Assumptions and Limitations

### *Assumptions*

This study is based on the following assumptions:

1. Firefighters possess a common general understanding of the term safety culture, as do workers across other high risk industries (Havold, 2002; Thackaberry, 2004). Though researchers consider safety culture a site specific concept, generic patterns of understanding have been identified across occupational settings (Cooper, 2000; Sorenson, 2002). For purposes of this study, it was assumed that firefighters' basic comprehension of the term safety culture is similar to an understanding of the concept in other high risk industries.
2. As survey data was self-reported, the term safety climate, rather than safety culture, was used to describe worker perceptions of tangible manifestations of the workplace culture.
3. For purposes of this study, it was assumed that training within the organizations sampled is adequate and compliant and workers with a capacity for high risk behavior have been effectively eliminated from the worker pool.

### *Limitations*

The following limitations apply to the design of this study:

1. Previous researchers have used the terms 'behavior' and 'performance' interchangeably. This study delineated between the two terms. It was Gilbert (1978) who initially refined the distinction between behavior and performance. According to Gilbert (1978), behavior is not an end, but merely

a means to an end. Performance, maintains Gilbert, is a product of behavior. Behavior is subservient to performance. Behaviors are observable; performance is measurable.

2. To the best of the researcher's knowledge, there are a few studies that have explored the impact of the larger organization on the organizational safety culture. Those aspects, though determined to be influential, were beyond the realm of this study.
3. This study proposed a more systematic way to study safety culture and its impact on the bottom line. However, the population under study possesses unique characteristics likely not found in other work settings. Attempts to generalize study results to other contexts should be carefully considered.

## Nature of the Study, or Theoretical/Conceptual Framework

The theoretical framework of human resource development (HRD) lends support for this study. Traditionally, the function of employee health and safety is managed through the Human Resource department. According to Swanson (1995), the foundation of HRD is derived from existing theories of economics, systems, and psychology. Through the integration of these three disciplines, HRD is considered a major business process, the focus of which is the cultivation and fostering of human capital knowledge, skills, and talent, for purposes of improving organizational performance (Swanson, 1995). At the heart of the HRD process is management of performance at three levels: organizational, process, and individual. Application of HRD principles ensures that systems activities are tied to the core mission and goals of the organization. Additionally,

the value of HRD lies in its capacity to translate system mechanisms into monetary worth (Swanson & Holton, 2001). This study is based on the three HRD theories: economics, systems, and psychology.

As occupational safety has traditionally been a function of Human Resources, the HRD framework is an appropriate lens for exploring safety culture and its organizational impact. According to Swanson and Holton (2001), "human capital theory is considered the branch of economics most applicable to HRD" (p.109). Becker's (cited in Swanson & Holton, 2001) theory of human capital with emphasis on return-on-investment and cost/benefit analysis, provide a unique theoretical perspective from which to investigate the phenomenon of safety culture, its impact on workers, and its relationship to the organizational bottom line.

A second underpinning of this study was that of systems theory. A reaction to the scientific approach known as reductionism, systems theory is the study of complexity and interconnectivity among parts. Under systems theory, emphasis is placed, not on separate parts, but on the relationship between parts (Jackson, 2000). In business management, systems theory traces its roots back to the work of W. Edwards Deming, architect of the System of Profound Knowledge, a framework for understanding workplaces as complex systems (W. Edwards Deming Institute, 2000). Senge's (2006) model of the learning organization, of which systems thinking is a primary component, provides an additional lens through which to view the phenomenon of safety culture and attendant relationships. As learning is one of the original functions of HRD, Senge's (2006) theory is a complement to human capital theory. According to Becker (1993), increased learning results in increased productivity, which ultimately enhances performance. According to

Wang (2004), Senge's (2006) greatest accomplishment is the coupling of systems theory with organizational theory, using learning as the link. Through the learning organization, Senge (2006) has recognized and addressed the human element. Though holistically focused, the individual is at the heart of Senge's (2006) systems model. Senge's (2006) systems model provides a process for helping organizations "move toward the more intangible elements, such as people's deep-seated attitudes and beliefs" (Senge, 2006, p. 93). As workplace safety is ultimately driven by worker attitudes and beliefs, the learning organization is a suitable theory for understanding the system intricacies of safety culture.

The third theoretical underpinning of this study is psychological in nature. Gilbert's (1978) model of behavior engineering, a stimulus-response framework, provides a representation of the interrelationship between the individual and the workplace environment. Gilbert's (1978) framework consists of both behavioral components related to the individual performer (knowledge, capacity, and motivation) and environmental elements (information, resources, and incentives). Perhaps the true value of Gilbert's model lay in the precedent it set for the development of future systems models. Gilbert's approach set the stage for Mager and Pipe (1997), who created a systemic process for performance problem solving; Rummler and Brache (1995) who introduced the white space concept, a systemic interdepartmental process flow; and Kaufman (2000) whose mega planning model involves a systemic planning process with dual focus on the societal and the financial bottom line.

After nearly four decades of scrutiny, Gilbert's (1978) model is still relevant in today's business environment. Ripley's (2003) development of a five factor model of performance improvement, derived from measurements of employee perceptions of

variables related to the workplace environment, are also reflective of Gilbert's six systems factors. In a study of the supermarket industry, Frank, Cox, and Fodness (as cited in Cox, 2005), found 13 factors, affecting employee retention, in alignment with Gilbert's systems model. In a recent study, Cox (2006) surveyed MBA students as to whether there exists contemporary corroboration for Gilbert's (1978) stimulus-response systems model. Findings indicate that present-day business students support Gilbert's contention that a systems approach to performance improvement is more efficient and effective than manipulation of parts. What is the reason behind the long-term survival of Gilbert's model? Basically, the model is intuitive--easily understood by all human beings because it is reflective of the surrounding natural world (Gilbert, 1996).

The operation of safety in the workplace is a subsystem within the larger organization, as well as a system in and of itself. Attempts to create an accepted systemic approach for purposes of exploring occupational safety have resulted in disparate 'parts' awkwardly juxtaposed together. To a great extent, the safety function in many organizations is representative of a system out of balance. Gilbert's (1978) theory may provide a simple systematic framework around which a balanced beyond compliance safety culture system can be built.

## Organization of the Remainder of the Study

The remainder of the study consists of four chapters, the contents of which are outlined below:

Chapter 2 presents a comprehensive review of the literature surrounding the study of safety culture and its factors, establishing a base of current

knowledge about the phenomenon and its impact on various facets of workplace safety. Proposed models of safety culture will be identified, compared and contrasted. An exploration of research will also be conducted as to the potential applicability of Gilbert's (1978) model of human competency to the study of safety culture. Finally, the literature dealing with safety and its impact on the bottom line will be scrutinized to provide a foundation of knowledge on which to explore the relationship between safety culture and organizational financial performance.

Chapter 3 provides an explanation of the population and a rationale for sample selection. Hypotheses will be proposed. Operational definitions for both independent and dependent variables will be specified. In this section, the data collection instrument will be described, and the data collection process will be fully outlined.

The focus of chapter 4 is data analysis. A description of statistical tests performed on data sets will be presented, and results will be reported. Chapter 5 includes both a discussion of study findings and a projection of potential and future implications derived from the study.

# CHAPTER 2. LITERATURE REVIEW

## Safety Culture Factors

A segment of published research relative to safety culture has sought to dissect the concept into elemental factors. Factor analysis is a useful first step in the construction of a definitive theoretical model (Tabachnick & Fidell, 2007). Research has identified and confirmed numerous factors comprising safety culture. Despite differences in terminology, cultural factors common across various industries include worker knowledge, top-down management, worker behavior, worker attitudes, resource availability, working conditions, worker-management communication, and risk awareness (Havold, 2005; Farrington-Darby et al., 2005; Taylor & Thomas, 2003; Harvey et al., 2002). Recent studies have also revealed some unique site specific properties associated with safety culture, which have contributed to a deeper understanding of the concept. According to Havold (2005), international cargo ship workers share a common understanding of the term safety culture; however, subtle nuances in awareness were discovered. Mearns, Rundmo, Flin, Gordon & Fleming (2004) also found worker perceptions of safety culture to be nationality dependent. However, study findings also suggested that variations in worker perceptions of safety and risk may be attributed more to the nature of the workplace environment than nationality. Among workers and management, differences in perception of the relative value of safety culture factors were noted. (Harvey et al., 2002; Farrington-Darby, 2005; Taylor & Thomas, 2003). Yet, despite perceptual dissonance, both management and workers within the context of the airline industry placed high priority on learning from

past mistakes and near misses to correct and improve safety (Ek, Akselsson, Arvidsson, & Johansson, (2007). Past research has identified learning as a fundamental factor underpinning safety culture (Reason, 1997). A proclivity for collecting, maintaining, sharing, and applying information may be a strong driving force behind the formation and maintenance of a unified, cohesive safety culture (Ek et al., 2007; Amendola, 2001; O'Toole, 2002). To the contrary, a reluctance to admit and learn from past mistakes was shown to promote a negative culture among wildland firefighters, creating a work atmosphere ripe for safety mishaps (Thackaberry, 2004). As past research has identified learning as a primary underpinning of behavioral and attitude change at the organizational level (Senge, 2006), learning and safety culture appeared from the literature to be similarly related, facilitating a high ability among management and workers for decision making and problem solving, which in the long term, effect positive changes in performance. Past research has contributed to the formation of a general understanding of safety culture across selected industries.

Yet, sub cultural differences, found among certain industries, served to undermine or subvert the dominant safety culture. Harvey et al. (2002) discovered two negative sub-cultures within the context of the shipping industry, embedded beneath the dominant culture and marked by characteristics of complacency and avoidance of responsibility. Subsequent research confirmed the existence of subversive safety sub-cultures, specifically within the context of the construction industry. In this environment, underground sub-cultures were typified by male machismo, physical toughness, and disregard for personal safety (Iacuone, 2005). Sub-cultures were also noted in the nuclear industry where researchers found significant differences in safety climate perceptions

related to job positions (Findley, Smith, Gorski, & O'neil, 2007), leading to "organizational conflict, increased risk, and degraded safety performance" (p. 885). According to study findings, many first line supervisors, who often feel pressure to produce, exhibited the highest degree of negative safety culture perceptions.

In a positive vein, within the airline maintenance industry, trust has been identified as a critical outgrowth of safety culture (Taylor & Thomas, 2003). This study suggested that trusting relationships, between management and workers and among workers themselves, was a hallmark of positive safety culture. Research illustrates that a two-way avenue of communication served as an unwritten psychological contract, resulting in the development of perceived trust and good will between management and workers (Walker & Hutton, 2006; Taylor & Thomas, 2003). Inherent in a psychological contract, according to Walker and Hutton (2006), are intimations of both employer and employee obligations.

A comprehensive study of safety culture, which produced a 40-item factor framework, was conducted by Farrington-Darby, Pickup, and Wilson (2005). This qualitative grounded theory exploration was a departure from the usual quantitative approach generally used to investigate safety culture. To measure safety culture, researchers, utilized a 'needs assessment' format of sorts, based on Schein's (1990) theory of organizational culture. Despite the study's admitted site specificity and limited generalizability (Farrington-Darby et al, 2005), all factors found appear highly consistent with safety culture factors discovered through quantitative means.

Investigations of safety culture across numerous high-risk industries have produced a set of fundamental factors which have been woven into numerous theoretical

frameworks (Cooper, 2000). However, construction of a universal model is complicated by the existence of site specific factors which are unique, idiosyncratic manifestations of the interactions between workers and the particular environment (Cooper, 2000; Sorenson, 2002).

## Theoretical Constructs of Safety Culture

Supported by two decades of factor analysis, numerous models of safety culture have been proposed and debated in the literature (Zohar, 2000; Griffin & Neal, 2000; Mohamed, 2002; Richter & Koch, 2004; Seo 2005; Parker, Lawrie, & Hudson, 2006; Choudhry, Fang, & Mohamed, 2007). Though each is distinctive in conception and design, suggested models exhibit significant similarities: an interrelationship involving the individual and the environment, the interaction between tangible and intangible factors, and emphasis on multi-dimensions and site specificity. Additionally, all models derive theoretical legitimacy from established paradigms of organizational behavior and the discipline's anthropological and psychological roots (Cooper, 2000; Sorenson, 2002). After several decades of study, there is fairly convincing evidence, at least in high hazard industries (Smith, Huang, Ho, & Chen, 2006), that some measure of relationship exists among factors relative to safety culture/climate, safety behavior, rates of accidents and injuries, and safety performance (Seo, 2005). Table 2 summarizes salient features of proposed models cited above.

Table 2.

*Conceptual Models of Safety Culture/Perceived Safety Climate*

| Authors | Model Description | Industry Application | Recommendations for Future Research |
|---|---|---|---|
| Zohar, D. (2000) | Established empirical link between safety climate and objective injury data; supervisory safety practices as mediator | Manufacturing | Exploration of transaction and transformational leadership relative to safety. |
| Griffin, M. & Neal, A. (2000) | Proposed link between safety climate, consisting of lower order factors, and safety performance. Relationship mediated by knowledge and motivation. | Manufacturing<br><br>Mining | Specific study of shared work group climate dimensions within the work context. |
| Mohamed, S. (2002) | Proposed link between safety climate and safe work behavior, mediated by three constructs: management, safety, and risk. | Construction | Exploration of interaction between independent constructs |
| Richter, A. & Koch, C. (2004) | A multiple configuration characterized by differentiation, ambiguity, and integration. | Manufacturing | Site specificity and changeable nature of safety culture. |
| Seo, D. (2005) | Conceptualization of relationship between perceived climate and unsafe work behavior, mediated by hazard level, work pressure, risk, and barriers. | Grain Industry | Testing of stability of structural relationships, as well as the relative magnitudes of contributing factors. |
| Parker, D., Lawrie, M., Hudson, P. (2006) | Multi-dimensional, dynamic model in which factors of safety culture are embedded in concrete (i.e. management systems) and abstract (i.e. attitudes and behaviors) organizational aspects. | Oil & Gas Industry | Internal consistency and site spcificity. |

Table 2 (Continued)

*Conceptual Models of Safety Culture/Perceived Safety Climate*

| Authors | Model Description | Industry Application | Recommendations for Future Research |
|---|---|---|---|
| Choudhry, R., Fang, D., Mohamed, S. (2006) | Based on Cooper's (2000) model, multi-level analysis involving behavior based management and employee perceptions. | Construction | Measurement of safety climate to determine value for major stakeholders. |
| Bellamy, L., Geyer, T., Wilkinson, J. (2006) | Generic model of integrated system and site specific taxonomy for defining constraints. | Chemical Companies | Validation of model in practical applications. |
| Fernandez-Muniz, B, Montes-Peon, J, Vazquez-Ordas, C (2007) | Proposed model of positive safety culture based on six factors: manager commitment, employee involvement; safety management system, attitudes, behaviors, safety performance | Industrial, Services, and Construction Companies | Replication of model and impact of organizational factors that encourage or hinder formation of safety culture. |

In general, proposed theoretical constructs are indicative of the ongoing struggle to delineate between the terms safety culture (objective measures of the phenomenon) and safety climate (subjective measures of worker perceptions of the phenomenon) (Zhang et al., 2002). Lack of universal nomenclature and unsystematic use of terminology create difficulties when attempting to compare and contrast research findings (Zhang et al., 2002). Nevertheless, it appears that the study of safety culture is presently more reductionistic than systemic, as investigations are generally conducted through analyses of reciprocal relationships which exist between factors relating to two aggregate dimensions--management commitment and worker attitudes and behaviors (Parker, Lawrie & Hudson, 2006; Choudhry, Fang, & Mohamed, 2007; Richter & Koch, 2004).

Furthermore, as model testing is conducted within the context of a particular industry and workplace situation, generalizability limits the applicability of models to other occupational settings. Therefore, the phenomenon of safety culture is viewed by researchers as heterogeneous, varying site specifically depending on the context (Cooper, 2000). Though the prospect of a consensus definition or definitive model appears remote in the near term, the various frameworks, which dominate the literature are general and flexible enough so that each might, at some point in the future, be evaluated in alternate high risk environments, providing opportunities to determine the applicability of models across various industries. However, testing of models individually, one workplace at a time, is a laborious, expensive process, which is rather impractical.

## Safety Culture and Gilbert's Model of Human Competence

As aforementioned, Farrington-Darby et al.'s (2005) 40-factor safety culture framework, which was qualitatively derived, was a departure from the usual quantitative methodology used to study safety culture. This framework is of value not because it so closely aligns with other factors found in the literature, but for the reason that it was a comprehensive dissection. Built upon Schein's (1990) three level theory of organizational culture, the 40-item framework describes thoroughly the social intricacies of safety culture within a particular context.

When examined closely, the Farrington-Darby et al. (2005) framework is also highly consistent with Gilbert's (1978) model of behavioral engineering. In much the same way that Schein's (1990) theories have impacted the field of organizational behavior, Gilbert (1978) provided a foundation for the study of workplace performance

improvement and was an early pioneer of a discipline of study known as Human Performance Technology (HPT) (Brinkerhoff & Dresser, 2004). Unlike traditional stimulus-response models, Gilbert's theory focuses on structuring the environment rather than fixing the employee (Talaq & Ahmed, 2004). According to Gilbert (1978), performance is the product of six dimensions—three of which are rooted in the environment (information, resources, incentives) and three are facets (knowledge, capacity, motivation) related to worker behavior. Intentionally simplistic, Gilbert's (1978) model is illustrative of a balanced system when all six dimensions align and operate interdependently. Figure 1 provides a visual representation of the model.

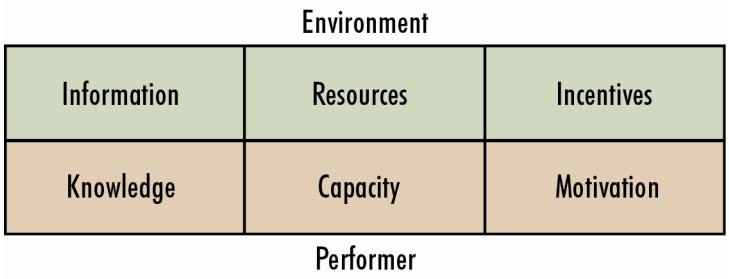


*Figure 1.* Visual representation of Gilbert's (1978) behavior engineering model

In theory, Gilbert's (1978) model charges management with the task of structuring conditions within the working environment, which in turn encourage formation and development of exemplary behaviors and attitudes among workers.. Though conceived nearly half a century ago, Gilbert's (1978) model remains relevant in today's competitive, dynamic business climate. Zacharatos, Barling, and Iverson's (2005) high performance work system (HPWS) is closely aligned with Gilbert's (1978) model.

Knowledge, capacity, information, and incentives were reportedly essential elements found in the HPWS under study. Empirical support for Gilbert's model is mounting. A survey by Cox (2006) of MBA candidates in middle management positions indicated that Gilbert's model is considered a value added strategy for improving performance. Ripley's (cited in Cox, 2006) development of a survey instrument resulted in a factor solution highly consistent with Gilbert's model. Frank, Cox, and Fodness (as cited in Cox, 2006) used Gilbert' model to identify drivers that contributed to employee retention in the supermarket industry; Support for Gilbert's model was also found among 1500 professionals across a wide variety of industries (Dean, as cited in Cox, 2006). "Using the analogy of safety defenses being like slices of Swiss cheese (Reason, 1997), normal accident theory would say that no matter how high you stack the slices it is inevitable that organizational juggling will cause a set of holes to line up eventually and the defenses will be breached" (Cooke & Rohleder, 2006, p.220). Gilbert (1978) refers to the holes in the system as gaps.

It is feasible to fit Farrington-Darby et al.'s (2005) 40 factors, derived from the site specific context of railway maintenance, into Gilbert's six dimensions. Table 3 provides a superimposed representation of Farrington-Darby et al.'s (2005) safety culture framework with Gilbert's (1978) matrix.

Table 3.

*Farrington-Darby et al.'s (2005) Factors and Gilbert's (1978) Matrix*

| Environment | | |
|---|---|---|
| Information | Resources | Incentives |
| Communication on the job | Consistent teams/subcontractors | Peer pressure |
| Rule dissemination | Supervisor's style, visibility, communication, representation of staff | Volume of paperwork |
| Pre-job information dissemination | Equipment | Feedback cycle |
| Feedback messages from managers | Physical conditions/Control of stress | Perceived purpose of paperwork |
| Information pathway flow | Planners knowledge of job resourcing | Perceived purpose of the rule book |
| Manager's communication methods | Practical alternatives to rules | |
| Job feedback to planners | Manager visibility and accessibility | |
| Methods for reporting | Supervisors presence | |
| Information/communication route clarity | Site safety set up | |
| Information systems usefulness | Rule book availability | |
| **Performer** | | |
| Knowledge | Capacity | Motivation |
| Competence capability & certification | Congruity between safety on the job and away from work | Safety role model behavior |
| Real time risk assessment skills | Planners ability to plan | |
| Training needs analysis | Manager's railway knowledge | |
| Track workers knowledge and understanding | Recruitment methods | |
| Training methods | Individual perception of safety | |
| | Social pressure of home life | |
| | Supervisor competencies | |

The high degree of alignment between Farrington-Darby et al's (2005) framework and Gilbert's (1978) matrix suggests an interesting possibility—might safety culture be defined and conceptualized in terms of safety performance?

Efforts to establish a relationship between safety culture and performance are reflective of recent trends in safety research. Griffin and Neal (2000), whose proposed model explores the link between safety climate and performance, found support for the hypothesis that knowledge and motivation (two of Gilbert's dimensions) mediate the impact of safety climate on individual behavior. Griffin and Neal (2000), however, maintained that safety culture and performance are distinct concepts. In the face of traditional definitions of performance, such assertions are accurate, as the terms 'behavior' and 'performance' are frequently used interchangeably in the literature. Nevertheless, it was Gilbert (1978) who initially refined the distinction between behavior and performance. According to Gilbert (1978), behavior is not an end, but merely a means to an end. Performance, contends Gilbert, is a product of behavioral interaction with the environment. Behavior is subservient to performance. Behaviors are observable; performance is measurable.

Gilbert (1978) posited that the root of most organizational problems usually lies among the environmental dimensions (information, resources, incentives), rather than in the behavioral inadequacies exhibited by individual performers. Reason (cited in Rucklin, 2003) agrees with Gilbert's (1978) perspective, signifying the possible value inherent in this framework and its adaptability as a generic model of safety culture:

> A key point Reason makes is that most often the *system* rather than the *person* is to blame for accidents. Reason notes that the best people can make the worst errors as a result of latent conditions. (p.51)

Gilbert (1978) maintains that the behavior engineering model is useful for measuring performance in various contexts—one of which is cultural. As safety culture is likewise an outcome or accomplishment of multi-dimensions manifested at all organizational levels, Gilbert's (1978) framework may offer a useful systematic tool for amalgamating existing knowledge of safety culture into a unified, holistic theory.

## Safety Research and Gilbert's Six Dimensions

Relative to safety, there is an abundance of literature that is closely aligned with Gilbert's (1978) six dimensions. Taken separately, these studies frequently inform the creation of isolated interventions, designed to enhance safety performance. Yet, few attempts have been made to interrelate and connect findings to the overall study of safety culture, thereby deepening the industry's understanding of the concept. Gilbert's model provides a thematic way of viewing safety research

### *Dimension 1. Information*

Gilbert (1978) maintains that access to and transmission of clear, relevant, and timely information within an organization are critical factors, which contribute to positive outcomes and accomplishments. In the safety environment, information is obtained through formal and informal feedback; audits, reviews, analyses, and reporting; and rule dissemination (Farrington-Darby et al, 2005). Throughout safety literature, there is recognition that the top-down, bottom-up, free flow of information between management

and workers is an essential dimension in the formation of a mishap-free culture (Mohamed, 2002; Parker, Lawrie & Hudson, 2006). Thackaberry (2004) indicates that lack of information exchange between fire service management and workers may ultimately impact workplace attitudes toward safety. Research clearly shows that a two-way avenue of communication may well serve as an unwritten psychological contract, resulting in the development of perceived trust and good will between management and workers (Walker & Hutton, 2006; Taylor & Thomas, 2003). Inherent in a psychological contract, according to Walker & Hutton (2006), are intimations of both employer and employee obligations. Communication in the workplace enables sharing of mental models between management and workers, underpinned by positive values and expectations. Such 'meeting of the minds' results in an interdependent relationship, facilitating an ability to jointly prioritize and work in unison to promote safety (O'Toole, 2002; Prussia, Brown, & Willis, 2003) Moreover, the quality and delivery style of information is significant (Parker, Axtell, and Turner, 2001; Roy, 2003). Correlations have been found between communication quality and safe working, and that the act of sharing information is educational, providing opportunities for workers to learn about potential hazards and methods of protection affecting personal and team safety. Also, in environments marked by open and honest communication, employees feel confident to raise and discuss safety concerns (Parker, Axtell, Turner, 2001; Mullen, 2005). According to Nielsen, Carstensen, and Rasmussen (2006), the establishment of an information pipeline indicates a high level of management commitment to safety, a factor contributing to employee willingness to report even minor mishaps and near misses. This ability to learn from failure is at the heart of the improvement process and the

development of a shared safety culture (Ek et al., 2003). Though it is rare to find experimental research related to safety in the literature, Zohar and Luria (2003) implemented three interventions designed to change communication patterns between shop-floor supervisors and subordinates. The combined effect of supervisor interaction and communication with upper management significantly improved safety practices among workers, decreasing incidences of unsafe work behavior, and improving safety climate.

Within the literature, however, there is lack of emphasis on research relating to data collection strategies, which serve to inform management and workers of changes in the safety system. Furthermore, exploration into the development of analytical tools to help management and workers identify and mitigate problems before serious mishaps occur is likewise lacking. Amendola's (2001) paradigm for shared decision making is one example of a proactive procedure that is participatory in nature, a process which relies heavily on accurate information. This path of investigation offers direction and possibilities for future research.

*Dimension 2. Resources*

According to Gilbert's (2001) model, the attainment of exemplary performance outcomes is facilitated through access to proper resources. Proposed safety culture models have factored 'resources' into several variables: work processes, plans, practices, and procedures; supervisor availability; safety/production balance; personal protective gear; perceived barriers; and working conditions (Seo, 2005). The literature is scattered with studies that focus on the critical nature of the relationship between resources and safety across a number of occupational contexts. Resource provisions are of two types:

availability of proper equipment and effective processes which minimize hazards to humans (Ramsay, Denny, Szirotnyak, Thomas, Corneliuson, & Paxton 2006). Huang, Hwang, Yenn, Yu, Hsu, & Huang (2005) illustrate the interplay between equipment availability and processes. In an evaluation of a newly installed auto-reset alarm in the control room of a nuclear power plant, researchers found that worker controlled processes which override equipment are necessary for safety's sake. Additional studies have suggested that worker empowerment over processes may provide a strategy for improving safety outcomes (Neely & Wilhelmson, 2006; Jensen, Stage, & Noer, 2006), eliminating the tendency of workers to accept faulty or inadequate processes as part of the normal course of events. According to Wolfe (2005), in terms of resources, "richer is more reliable" (p.9). A workplace supported by resource availability is indicative of high management commitment to safety, an essential underpinning of a shared safety culture.

*Dimension 3. Incentives*

Gilbert (1978) contends that the use of incentives has a potential for extreme misuse in the workplace. Rewards involving money, especially, have the power to both motivate and demotivate (Geller, 1996). Under a behavior based safety system, for example, incentives are an integral method of reinforcing behavior; however, external rewards (both positive and negative) can tend to discourage workers from reporting incidents and mishaps (Geller, 1996). Goodrum and Gangwar (2004) quantified the effects of safety incentives on various metrics, including OSHA recordables, lost time workdays, restricted workdays, and the company's experience modification rate. Findings indicate that statistical differences among incentive programs and variables are only significant when use of safety incentives is coupled with a supportive environment and

worker training. Haines, Merrheim and Roy's (2001) research involving employee reactions to monetary safety incentives also explains the tentative nature of rewards in the workplace. In a study of 329 workers employed in a large high-technology aluminum production plant, incentives were most effective when implemented in the presence of positive management-worker relationships and interdependent teams. As research surrounding the topic of incentives is limited and somewhat neglected, additional study into the essential nature and impact of incentives on safety culture/climate is needed.

*Dimension 4. Knowledge*

Although formal training is only one factor of six influencing organizational outcomes, expenditures in this category often outweigh intervention effectiveness (Gilbert, 1978). Nevertheless, the focus on and faith in training to promote quality in the workplace continues. Among models, the acquisition of worker safety knowledge is recognized as a critical factor related to both performance outcomes and culture formation. Within the realm of safety, OSHA standards mandate an array of worker training (OSHA, n.d.). Under compliance regulations, training has become a pivotal method for ensuring workplace safety. In the safety literature, however, formal classroom training has received mixed reviews. On one hand, Harrington and Walker (2004) and Lingard (2002) both found individual training courses to be effective in specific settings, resulting in a reduction in accidents and injuries. To the contrary, Bell and Grushecky (2006) concluded that training in a high hazard industry such as logging has little effect on safety performance. Nevertheless, conspicuously absent in the literature are studies which delve into reasons behind discrepant findings. Wallen and Mulloy (2006) offer one plausible explanation. As OSHA standards establish content requirements, methods of

delivery are left to the discretion of the instructor. The majority of safety training is delivered through lecture, an instructional method which fails to meet the needs of a majority of workers who learn best through other means (i.e. hands-on, visual, etc…). The failure to match instruction style to learner preferences may be one potential cause underlying the ineffectiveness of safety training. Recently, there have been additional research efforts to explore alternate methods of safety instruction that prove more efficacious than traditional lecture strategies. Researchers, in conjunction with the National Institute of Occupational Safety and Health (NIOSH), developed a series of video learning materials based on a strategy of storytelling (Smith, 2005). Designed specifically for underground miners, these innovative learning materials replicate natural methods used by experienced miners to transmit safety rules and cultural values to younger workers.

Wallen and Mulloy's (2006) study of the effects of computer based training (CBT) on both younger and older workers demonstrate the critical role that delivery plays in the learning process. Researchers exposed workers of various ages to safety training delivered via computer. Overall, younger workers learned best through computer based instruction, but learning improved in older workers when instruction consisted of a combined strategy consisting of text, pictures, and audio narration. Nevertheless, Mendonca, Beroggi, vanGent, and Wallace (2006) advised against training workers to be technologically dependent when solving safety problems or making decisions. Under simulated training conditions, it was found that reliance on technology can hinder higher order human cognition. For safety situations involving complex decisions, researchers

advise application of a combined training strategy whereby management and workers are taught to complement technology with creative thinking skills and human logic.

*Dimension 5. Capacity*

As all personnel bring both innate and acquired aptitudes to the job (Gilbert, 1978), the establishment of processes which seek to identify at-risk candidates is a practical hiring strategy. Workers exhibiting negative affectivity, job dissatisfaction, and risk taking behavior pose a major safety problem to management, are more likely to be injured on the job, thereby affecting overall productivity (Clarke, 2006). Clarke and Robertson's (2005) meta-analysis of the empirically derived big five personality dimensions (extraversion, neuroticism, conscientiousness, agreeableness, and openness) found a correlation between low conscientiousness and low agreeableness with accident involvement. Pre-hire screening to identify deep-seated personality traits which hinder the ability to participate in a positive, shared safety culture, appear to be worth the effort and expense involved. Nevertheless, although individual factors significantly contribute to workplace accidents, it is safety climate that also influences whether or not an individual behaves safely on the job (Hetherington, Flin,& Mearns 2006). A major determiner of worker perceptions of safety climate is management's capacity for leadership. The literature suggests that managers who possess transformational leadership qualities have the best potential to positively impact safety culture and worker attitudes (Paul & Maiti, 2007; Barling, Iverson, & Kelloway, 2003). Leaders who inspire through appeals to ideals and values are able to elicit higher levels of thinking among followers (Piccolo & Colquitt, 2006) and gain worker commitments to safety.

*Dimension 6. Motivation*

Strong cultures help organizations perform because they create a strong sense of motivation in workers. (Kotter & Heskett, as cited in Flamholtz, 2001). Gilbert (1978) maintains that when the five dimensions addressed above (information, resources, incentives, knowledge, and capacity) are aligned and operating interdependently, workers are intrinsically motivated to perform. According to Wallace and Chen (2006), a personal capacity for conscientiousness motivates worker safety behavior. Conscientious workers are safety minded either because of a desire to act correctly or due to fear of consequences if a mishap occurs. The selection of highly conscientious employees may be one way to improve safety odds in the workplace. Peterson and Arnn (2005) maintain also that training quality is motivating, as effective training builds worker self-efficacy, a belief in one's own competence to successfully complete a task. Experimental studies have shown that the impact of feedback from a supervisor on intrinsic motivation is mediated by individuals' perceptions of self-efficacy (Guay, Boggiano, & Vallerand, 2001).

## Safety Culture: The Heart of an Effective Safety System

Through qualitative exploration of cultural performance within the context of the railway industry, Farrington-Darby et al., (2005) sought the answer to the following research question: Why does experienced staff (sometimes) work unsafely? Study findings indicate, when benchmarked against Gilbert's (1978) model of behavior engineering, the root cause for unsafe behavior lies primarily within the configuration of the work environment. As Gilbert (1978) maintains, below average performance is not

the fault of the performer. Farrington-Darby et al. (2005) have identified the trend in the safety industry toward 'beyond compliance' with a focus on safety culture.

> The promotion of a positive safety culture is now considered by many to be a viable way of managing risk, creating a culture within an organization where everyone is personally involved in ensuring safety and where the values of safety are evident in every activity, from general company policy and philosophies to the one-off actions of a front line operator." (p.40)

Yet, the creation of a universal model is impeded by site specific factors, which subtly influence safety culture within a particular setting (Cooper, 2000; Sorenson, 2002; Harvey et al, 2002; Iacuone, 2004). Like organizational culture, safety culture is as unique as the human fingerprint. Although patterns of similarities exist across industries, cultural manifestations are rarely identical from one workplace to another (Schein, 1990). However, the simplicity and generality inherent in Gilbert's (1978) model of human performance offers a potentially simple, generic foundation over which site specific factors can be arranged, organized, and manipulated. Gilbert's (1978) model provides possibilities for approaching safety culture systemically and systematically.

As an exploration of past and current research, this literature review attempted to trace the path of study of the concept of safety culture. Additionally, this review sought to introduce Gilbert's (1978) behavioral engineering model to safety researchers and practitioners who may be unfamiliar with tenets within the field of performance improvement. Some new insights relative to the role that learning plays in the formation of safety culture were also highlighted in this review. Certainly, such insights require further and continuous exploration and investigation. However the following model is

proposed, representative of the kind of comprehensive, integrated, performance based safety system, whereby culture is at the heart of the improvement process. This model is reflective of the type of 'beyond compliance' program currently supported by OSHA and other regulatory agencies (OSHA, n.d.).

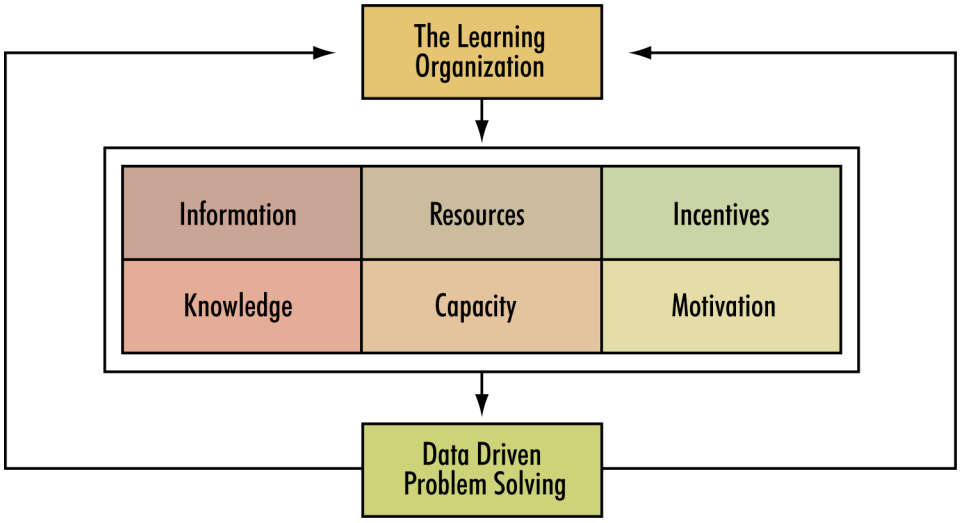


*Figure 2.* Proposed safety system model

*Note: Reprinted with permission, RPT Safety & Health Services, LLC, 2007*

It is through the efforts of the learning organization that mental models, espoused values; linguistic paradigms; shared meanings, and patterns of thinking are developed (Senge, 2006), sustaining and supporting the stimulus-response nature of the cultural system (Gilbert, 1978). Additionally, a process of collaborative problem solving serves to inform and refresh the learning organization (Schein, 1990; Joiner, 2004), keeping the cultural system in balance (Gilbert, 1978), enabling a proactive rather than reactive

approach to safety in the workplace, and resulting in an iterative process of continuous performance improvement.

## Safety Culture and the Economic Bottom Line

Undoubtedly, 'beyond compliance' safety programs require additional upfront funding from senior level management. However, most safety managers find it difficult to articulate the cost and benefit value of 'beyond compliance' efforts to upper management (Behm, Veltri, & Kleinsorge, 2004) in order to obtain increased funding for safety sustainability. Weighing safety in terms of economics seems immoral and unethical, and senior level management have in the past rarely engaged in the process of assessing financial return on safety investments (Smallman & John, 2001), exhibiting instead an optimistic bias regarding program excellence (DeArmond, Huang, Chen, 2007). Overestimation of program success leads to reduced funding and misallocation of monies.

Yet, the safety industry, in recent years, has encouraged professionals and practitioners to approach safety from a business perspective. Behm et al.'s (2004) Cost of Safety (COS) model provides management a method for balancing the costs and benefits associated with safety. From a practical standpoint, effective use of funding enables the attainment of exemplary safety performance, reducing further the potential for injuries and fatalities, and ultimately improving the social lot of workers and the external community at large. Nevertheless, Behm et al's. (2004) COS model begs the question with which management is forced to grapple--what constitutes an acceptable level of risk? As risk is inherent in any human activity, management must determine at what level

investments in safety are fruitless and ineffective. Depending on one's perspective, such judgments reflect either heartless reasoning or stark realism. Rechenthin (2004) views the economics of safety pragmatically: "safety in general is not where a company generates revenue but it is a place that does generate profit by reducing risk and thus the potential for loss" (p. 300). Safety in the workplace is very much a 'what if' proposition, and especially when safety performance is exemplary, management's ironic tendency is to reduce spending.

The potential bottom line impact, however, of a single accident involving injury is staggering. Economic estimates associated with workplace injuries place safety related costs in three separate categories: direct, indirect and social, or quality of life costs (Waehrer, Dong, Miller, Haile, & Men, 2007; NIST, 2004). In the fire service, for example, the industry that the sample of this study was drawn, average costs of one firefighter injury can range from hundreds to over a million dollars, depending on injury severity (NIST, 2004). Recent efforts to quantify the potential costs of worker injuries are designed to prompt a shift in the traditional way of thinking about safety.

### *Organizational Culture and Financial Outcomes*

According to Gilbert (1996), "measures of accomplishment have no real validity until they reflect value to someone, and the dollar currency is one excellent way to express this value" (p.25). Empirical proof of safety's ROI illustrates a clear relationship between safety excellence, productivity, and financial outcomes (Jervis & Collins, 2001). Employer moral and legal duties associated with safety are tantamount and inarguable; economic rationale provides supporting evidence that good safety is good business

(Behm, Veltri, & Kleinsorge, 2004). The pursuit of empirical evidence pertaining to the link between safety culture and the bottom line is preceded by substantive research involving organizational culture and financial outcomes. Although the phenomenon of organizational culture differs from the concept of safety culture, there are similarities and commonalities between these two notions, and a brief review of recent literature related to organizational culture and financial efficacy can provide insights into future explorations of safety culture and the bottom line.

A review of literature conducted by Sanders and Cooke (2005) revealed validation and support for a strong correlation between organizational culture and real financial return. Researchers assessed three cross-sectional studies and two longitudinal cases across several industries, which demonstrate that investments in cultural change programs lead to significant improvements in financial performance. Using a slightly different tact, Flamholtz (2001) explored the effects of organizational culture on financial performance within the context of a single company. Study findings indicate a statistically significant relationship between culture and gross earnings. It is theorized that the link between culture and financial performance is mediated by worker motivation (Kotter & Heskett, cited in Flamholtz, 2001). Mersman (2002) likewise explored organizational culture of seven branches of the same bank and found that sites with customer and/or employee focused cultures exhibit higher financial performance than those whose cultures are geared toward profit-making.

*Safety Culture and Financial Outcomes*

Interest in the economic issues surrounding safety is high among major U.S. safety organizations. In late 2004, the National Safety Council (NSC) sponsored a world-wide symposium to explore technological tools that are designed to assist management in evaluating safety at the company level (Biddle, Ray, Owusu-Edusei, & Camm, 2005; Linhard, 2005; Amador-Rodezno, 2005; Lahiri, Gold, Levenstein (2005); Koningsveld, 2005; Bergstrom, 2005; Oxenburgh & Marlow, 2005.). More recently, OSHA posted a new web link within the context of its website to enhance management understanding of economic factors impacting safety (OSHA, 2006). The ASSE recently formed a safety business committee and held its first symposium in Baltimore, Maryland to help its membership better understand the economic issues associated with safety (ASSE, 2006).

Nevertheless, most evidence pertaining to the relationship between safety and the financial outcomes is anecdotal or derived from opinion (Veltri, Pagell, Behm, & Das, 2007) rather than empirically supported. For example, LaBelle's (2000) methodology for calculating the direct and indirect costs associated with safety mishaps and Mohamed's (2003) safety specific recommendations for application of the Balanced Scorecard (Kaplan & Norton, 2006), though well-presented and convincing, are empirically unsupported. However, limited empirical research linking safety with the bottom line exists. Behm et al. 's (2004) development of a Cost of Safety model offers a possible solution for dealing with the socioeconomic issues management faces when administrating safety within the confines of restricted budgets. Compatibility of safety and production functions were further explored by McLain and Jarrell (2007), and findings indicated that when workers perceive a balance between safety demands and

production expectations, the interference of safety in the execution of production tasks were significantly reduced. Findley et al.'s (2004) investigation of safety's impact on workers' compensation premiums has produced some impressive scientific results. Drawing data from a sample of 350 construction companies, the study found that companies who incorporated key safety program elements earned a below average experience modification (ex-mod) rate and paid below average workers' compensation premiums. Barling, Iverson, and Kelloway (2003) found a relationship between safety mishaps and worker retention, a factor which has indirect impact on the organizational bottom line. Data were collected across eight different occupational groups and findings point to job satisfaction as a mediating factor in the connection between safety and the bottom line. Wrona's (2006) study of quantified costs of work-related traumatic brain injuries over a seven-year period in Washington State also demonstrated a connection between safety and the bottom line. Research findings suggest a potential for overwhelming direct and indirect cost savings if appropriate interventions are aimed toward reducing this particular workplace injury.

A study of the impact of safety climate on the organizational bottom line was conducted by Veltri, Pagell, Behm and Das (2007). A quantitative investigation of 19 manufacturing firms was intended as an initial empirical first step toward exploring the relationship between safety and quality, productivity, and other business metrics. Correlation coefficients indicated that when gaps exist between management and workers' perceptions of safety culture, safety deteriorates and performance suffers both internally and externally. Although the study sample was one of convenience, the findings offer valuable insights for management. Researchers maintain that study results

support what has only been until now been verified anecdotally—"manufacturing firms should recognize occupational safety performance as an economic opportunity, not as an annoying cost or inevitable regulatory threat" (Veltri, Pagell, Behm & Das, 2007, p.4).

Phillips (2003) ROI methodology has application for connecting training and performance improvement programs with the safety bottom line. With a focus on learning, this five framework model is useful for evaluating the direct, indirect, and intangible business impact of change initiatives such as safety culture formation. However, although the methodology provides valid feedback within the context of a safety operation, Phillips (2003) maintains that ROI evaluations of compliance programs are inappropriate.

## Summary

The discussion of safety and financials can be an extremely sensitive topic. Weighing the value of human life against the health of the organizational bottom line can appear compassionless. Loomes (2006) succinctly articulates the socioeconomic dilemma faced by researchers:

> So the question is: how do individuals and societies strike the balance and allocate the appropriate levels of resources to health, safety and the environment as compared with all the other goods and services which are valued (p. 714)

The difficulty in attaching value to safety lies in the conflict between the affective and cognitive domains (Loomes, 2006). In the face of "intense global competitive pressure, shorter product cycle time, high customer expectation on product quality and reliability, and stringent cost constraints" (Ayomoh & Oke, 2006, p. 222), workers are driven by self

interest and employers are often accused of being hard-hearted (McLain & Jarrell, 2007). Yet, much of the value of safety is intangible and indirect, and many employers are unaware and uninformed of the bottom line impact of hidden hazards. The purpose in pursuing a path of research related to safety and the bottom line is to encourage appreciation of human capital and demonstrate to employers how keen attention to safety will serve two ends: protecting workers and maximizing bottom line profits.

In light of recent industry interest in building a business case for safety, it is reasonable that research efforts should be directed toward investigation of the impact of safety culture on the organizational bottom line. In the absence of a definitive model, this study will test the relationship using Gilbert's (1978) model of human competence. Though unproven as a model of safety culture, Gilbert's model has earned legitimacy as a foundational theory in the field of human performance technology, and the literature review has uncovered some striking consistencies between safety culture research and the model. The application of Gilbert's model may provide some interesting insights, which can subsequently be incorporated into future research involving factor analysis, model creation, and ancillary studies surrounding the relationship between safety and organizational financial performance.

# CHAPTER 3. METHODOLOGY

## Problem Statement

Within the last several years, reductions in accidents and injuries have reached a statistical plateau, and it appears that governmental compliance is ineffectual in advancing the cause of safety in the workplace (Rechenthin, 2004). Clearly, further improvements in U.S. safety performance demand a beyond compliance approach (OSHA, n.d.; ASSE, 2002). Safety culture development is an ideal beyond compliance strategy, which is thought to be simultaneously socially responsible and economically advantageous. However, there is neither a consensus definition nor universal model to guide the formation of positive safety culture. Also, in today's competitive business environment, employers are demanding accountability and return-on-investment for expenditures (Barksdale & Lund, 2001; Phillips, 2003). Despite widespread belief in the power of safety culture and the presence of research results suggestive of a relationship between safety culture and safety performance, there is little empirical proof that safety culture related interventions are a sound fiscal business strategy. Without a universal theory or evidence based data of financial efficacy, employers are reluctant to directly invest in culture building beyond compliance strategies, thereby unnecessarily exposing workers to inherent and subtle risks and hazards that fall outside the scope of compliance regulations.

## Type of Study

The design of this study was non-experimental, quantitative, and correlational. It had a predictive purpose--to determine the strength and direction of the effect that related elements of safety culture exert on worker motivation and the financial bottom line. This research was influenced by previous studies, concerning safety culture's impact on worker behavior (Harvey, Erdos, Bolam, Cox, Kennedy, & Gregory, 2005; Mohamed, 2002; Taylor & Thomas, 2003; Mearns, Rundmo, Flin, Gordon & Fleming, 2004; Adie, Cairns, Macdiarmid, Ross, Watt, Taylor, et al. 2005; Havold, 2004; Farrington-Darby, Pickup, & Wilson, 2005; Ayomoh & Oke, 2006; Ek, Akselsson, Arvidsson, & Johansson, 2006) and the effect of safety climate on the bottom line (Veltri, Pagell, Behm, Das, 2007). A quantitative, survey design was used to explore the relationship between study variables. Surveys are used extensively in educational research to obtain information about phenomena that are not directly observable (Gall, Gall, & Borg, 2003). According to Creswell (2005), survey design research is appropriate for identifying beliefs, attitudes, and behaviors of individuals. Guldenmund (2007) maintained that, "in safety culture research a (safety climate) questionnaire has been the predominant measurement instrument" (p. 724).

Nevertheless, despite the widespread use of surveys in safety climate related research, Guldenmund (2007) noted problems surrounding the use of this method of measurement. In the administration of the survey, it is difficult to control "unwanted influences affecting the responses." (p. 724). Methodologically, there are challenges that must be dealt with:

> Basically, in survey research one is caught between the theoretical demands of statistics (heterogeneous normally distributed variables around a single mean obtained from large populations) and the theoretical requirements of culture [strong] convictions shared by groups or categories of people, which are small enough to interact and create a culture about safety or any other related topic). (Guldenmund, 2007, p. 726).

And finally, the complexity of the culture system, which is influenced both from inside and outside the overall organization, can affect data quality.

Yet, according to Guldenmund (2007), questionnaires are valuable tools in social scientific research. Despite the imperfect nature of survey research, a full awareness and understanding of the challenges surrounding this methodology will ensure a sound design and trustworthy results.

## Population

### *Target Population*

According to the National Fire Protection Association (NFPA) estimates, there are approximately 1,136,650 firefighters in the U.S. Of the total number of firefighters, 313,300 (28%) are career firefighters and 823,350 (72%) serve as volunteers. There are an estimated 30,300 fire departments in the U.S. Of the total number of departments, 2,087 departments are all career, 1,766 are mostly career, 4,092 are mostly volunteer, and 21,575 are all volunteer.

The decision to study safety culture within the context of the fire service is based on the desire to deepen understanding of risk management, an issue with which most fire

departments consistently grapple. Firefighting, whether paid or volunteer, is an activity fraught with the potential for danger. In 2005, 87 firefighters were killed in the line of duty (Fahy & LeBlanc, 2006) and over the four year period from 2001-2004, there was an estimated 38,545 firefighter fireground injuries in the U.S. Of these, 28,790 were minor, and 9,755 were moderate or severe (Karter, 2007). The alarming numbers of fatalities and injuries have prompted speculation of possible causes behind mishaps. Traditionally, firefighter culture is generally paramilitary, dominated by managerial coercion and rigid procedures (Thackaberry, 2004).

In 2004, the National Fallen Firefighters Foundation, an organization created and supported by Congress, developed a list of 16 initiatives, the goal of which is to reduce the number of firefighter fatalities by 25% in 5 years and 50% in 10 years. Initiative number one focused on the need for cultural change within the fire service (National Fallen Firefighters Foundation, 2007). This study was an effort to support the work of this Foundation.

*Accessible Population*

For purposes of this study, a sample of volunteer firefighters representing 30 volunteer departments across three counties (County 1 = 10 departments; County 2 = 10 departments; County 3 = 10 departments) located in upstate New York were selected to participate. The three counties, which were the focus of this study, were selected by convenience. Despite the nature of the sample, however, it is important to note that according to National Fire Protection Association (NFPA) statistics, the Northeast region of the U.S. has twice the rate of injury than the rest of the country (Fahy & LeBlanc, 2006).

The decision to study volunteers rather than career firefighters was based upon reasons beyond that of convenience. Whether volunteer or career, most firefighters are expected to achieve and demonstrate the same high level of skill, knowledge, and competency (U.S. Fire Administration, 2007). However, there are significant differences between these two groups in terms of attitudes. As career firefighters are paid to do a job, money is a variable that definitely affects motivation. The choice to study volunteers, who receive no monetary remuneration for services, offers a unique opportunity to study the relationship between safety climate and motivation without the interference of powerful monetary incentives that may distort study findings.

## Description of Sample

From these 30 departments, 20 firefighters per department were selected to complete the survey. Total sample size equaled 600 firefighters. According to Vogt (2007), there is no definitive formula for determining the optimal sample size:

> One formula for the minimum sample size in a multiple regression, for the overall prediction equation (the $R^2$), is 50 plus 8 times the number of variables (Vogt, 2007, p.176)

According to Gall, Gall & Borg (2003), a sample consisting of more than 200 participants and at least 20-30 per sub-group ensures sufficient statistical power for rejection of a false null hypothesis.

Participants were drawn from the lowest ranks of firefighters. Firematic officers and board of commissioner members were excluded from the study. To participate, firefighters must have been classified as active according to membership requirements or

by-laws of each individual department, have undergone basic training as mandated by the New York State Office of Fire Prevention and Control (n.d.), and engage in on-going training provided by the Department. Respondents were 98% male and 2% female. No other demographic data was collected to ensure a high degree of anonymity in the hope of maximizing participation. In total, 24 departments out of 30 participated in the study and 341 firefighters completed surveys. Table 4 shows the distribution of participation by county and department.

Table 4.

*Distribution of Survey Participation by County and Department*

| | County 1 | County 2 | County 3 |
|---|---|---|---|
| Department 1 | 20 | 13 | 11 |
| Department 2 | 20 | 9 | 12 |
| Department 3 | 20 | 20 | 6 |
| Department 4 | 6 | 13 | 19 |
| Department 5 | 10 | 19 | 18 |
| Department 6 | 20 | 17 | 5 |
| Department 7 | 15 | 14 | 8 |
| Department 8 | 7 | 20 | |
| Department 9 | | 19 | |
| Total Participation | 118 | 144 | 79 |

*n* = 341

## Measurement Method

Among researchers, it is believed that measurement of safety culture is virtually impossible because of the abstraction of the concept (Seo, Torabi, Blair, & Ellis, 2004; Lin, Tang, Miao, Wang & Wang, 2008; Fullarton & Stokes, 2007). However, it is thought feasible to measure safety climate, a manifestation of worker or management perceptions. According to researchers, safety climate measurements, when compared to other proactive evaluation methods, is more cost effective (Lutness, as cited in Seo et al., 2004) and is considered to be a leading indicator of safety performance (Flin et al., cited in Seo et al., 2004). Surveys generally consist of various subscales, which measure factors identified through past literature (Mearns, Whitaker, & Flin, 2003). A review of available instruments revealed a lack of consensus over which subscales best represent the primary constructs of the concept of safety climate (Lin et al., 2008). According to Lin et al. (2008), management commitment and worker attitude are two factors common to most safety climate instruments. Nevertheless, safety climate instruments on the whole have been criticized because of poor construct and predictive validity (Fullarton & Stokes, 2007).

### *Survey Instrument Selection*

The Work Safety Scale (WSS) was chosen to measure firefighter perceptions of safety climate (Hayes, Perander, Smecko & Trask, 1998). Minor adaptations in wording were necessary, as the survey was developed for measurement within the context of an industrial environment. This survey instrument is comprised of 50 items and a five-point Likert-type response format, ranging from *strongly disagree* to *strongly agree*. The instrument was constructed and validated by researchers through a series of three

consecutive pilot studies. Reliability of the WSS, established using Cronbach's alpha, is above .87. Coefficient alpha provides good reliability estimates when applied to Likert scale instruments (Ravid, 2005). Intercorrelations among the WSS subscales were relatively low (.33 to .76), suggesting the instrument demonstrates acceptable construct validity among five subscales: job safety, co-worker safety, supervisor safety, management safety practices, and satisfaction with safety program (Hayes et al., 1998) Construct validity was also supported through analysis of additional multiple source data. WSS also demonstrated an acceptable level of predictive validity. According to Hayes et al. (1998), "the best predictor of near accidents was management safety, while the best predictors of CSB [Compliance Safety Behavior] were management safety and co-worker safety" (p. 156).

*Measures*

A survey consisting of 50 items was used to assess perceptions of the workplace environment and motivation for safety. Firefighters responded on a 5 point scale to all items ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Items from the survey correspond to environmental variables derived from Gilbert's (1978) model of behavior engineering (See Table 4). Firefighter perceptions of company safety climate were assessed according to five subscales: job safety, co-worker safety, supervisor safety, management safety practices, and safety program policies.

Table 5.

*Variable-Survey Item Correspondence*

| Study Variable | Measure Item Number |
|---|---|
| Management-Worker Commitment | 23, 25, 26, 27, 28, 31, 39, 40 |
| Process Support | 29, 30, 32, 33, 35, 36, 37, 38, 41 - 50 |
| Incentives | 11-20, 21, 22, 24, 34 |
| Worker Self-Efficacy | 1-10 |

*Independent Variables*

Officer-Firefighter communication (COMM) was assessed by 8 survey items. Inter-level communication is a factor frequently identified in the literature (Guldenmund, 2007) related to quality of safety culture. Firefighters were asked to respond to phrases such as “provides safety information” and “keeps workers informed of hazards,” a rating which indicated officers’ capability to maintain an interference-free pipeline of information between upper and lower ranks.

Resource availability (RES_AV) was assessed by 18 items. In the literature, resource provisions are of two types: availability of proper equipment and effective processes, which minimize hazards to humans (Ramsay, Denny, Szirotnyak, Thomas, Corneliuson, & Paxton 2006). This study’s focus is on the processes that drive safety. Items 41- 50, for example, asked workers to rate the quality and effectiveness of the

organization's safety program, a written document which encompasses departmental safety processes and procedures.

External incentives (INCENT), specifically positive psychological rewards, were assessed by 14 items. Though literature concerning safety incentives is sparse, there have been several investigations in the use and abuse of incentive programs within the safety environment (Geller, 1996; Goodrum & Gangwar, 2004; Haines, Merrheim and Roy, 2001). The 14 items asked firefighters to rate the presence of peer pressure from co-workers and praise from management, factors which serve as either motivators or de-motivators in the workplace.

*Dependent/Independent Variable*

Safety motivation (SELF_EFF) was assessed by 10 items. Firefighters were asked to reflect on basic personal beliefs about the workplace environment relative to safety. Items 1-10 asked workers to rate the work environment according to varying levels of perceived risk.

*Dependent Variable*

Injury related costs (INJ_COST) were operationalized, according to department, by averaging three past years of injuries and multiplying the mean by the average cost of firefighter injury as calculated by the National Institute of Standards and Technology (NIST) (2005).

## Data Collection Procedure

All volunteer fire companies in each of the three counties hold monthly member meetings. Study participants were asked to arrive at the department's monthly meeting

approximately 30 minutes early. Participating firefighters received a packet containing the questionnaire, an informed consent agreement, and a letter of explanation. Prior to completing the questionnaire, firefighters were instructed to read the consent form carefully, direct any questions to the researcher, and sign the form before beginning the survey. Absentees were contacted individually, and if consented to participate, were sent the identical packet by mail. Absentees were asked to provide informed consent, complete the survey and return the questionnaire and informed consent form in the SASE provided. All participants were instructed not to place any personal identifier on the survey or envelope, and were assured that all survey responses were confidential. Completed surveys were collected either by the researcher or by the individual in charge designated by the researcher. The survey required no more than 15 minutes to complete.

# CHAPTER 4. RESULTS

Prior to hypotheses testing, data sets were screened through the EXPLORE function of *The Statistical Package for Social Scientists* (SPSS, version 16.0) to resolve issues that may have a potential to impact accuracy of results. Tabachnick and Fidell (2007) recommend consideration and resolution of the following before analysis is run: data accuracy, missing data, assessment of data against assumptions, transformation of outliers, and identification of perfect or near perfect correlations.

Accuracy of data entry was validated manually and through examination of descriptive values. Analyses of county combined data sets for independent variables officer-firefighter communication (COMM); resource availability (RES_AV); and incentives (INCENT) revealed that the proportion of missing data was approximately 5% or slightly greater for each variable. Missing data was identified as item non-response, in which some respondents failed to answer certain individual items (Schafer & Graham, 2002). Missing not at random values (MNAR) were confined to a single department, in which 50 percent of total responses ($n$ = 10) exhibited a monotone pattern of non-response. The decision was made to delete these 10 cases from the study, reducing the total sample size from 341 to 331 ($n$ = 331). Deletion of cases, which seem to be a random subsample of the whole sample, is an acceptable solution (Tabachnick & Fidell, 2007). However, Schafer and Graham (2002) warn that discarded cases may have the potential to unduly bias study results. Because of the evident pattern of raw non-response data and its potential to result in a violation of the assumption of independence of errors, it was concluded that these cases may bias results if retained, and extrapolating data

based on likelihood was not a satisfactory option. Deletion of these ten cases reduced the average proportion of missing data among variables to less than 5%. According to Tabachnick and Fidell (2007), if less than 5% of data points are “missing in a random pattern from a large data set, the problems are less serious and almost any procedure for handling missing values yields similar results” (p. 63). Replacement of missing completely at random (MCAR) and missing at random (MAR) data on both independent and dependent variables was accomplished using expectation maximization (EM) methods. Although EM is not ideal, as methods fail to factor in error (Tabachnick & Fidell, 2007), generated values were considered suitable in light of the large sample size and low overall percentage of missing values.

All variables were evaluated against assumptions of normality, linearity, and homoscedasticity. Individually, variables appeared slightly non-normal. However, conducting a preliminary regression analysis and screening residuals is an alternative to screening variables individually (Tabachnick & Fidell, 2007). Residuals (predicted vs obtained dependent variable values) were found to be normally distributed. According to Tabachnick & Fidell (2007), “if residual plots look normal, there is no reason to screen the individual variables for normality” (p. 82). The normal probability plot for residuals is displayed in Figure 3 below.

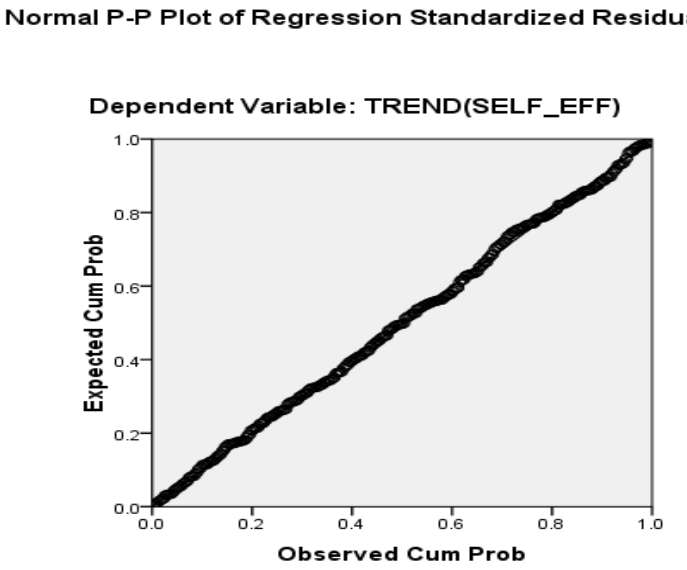


*Figure 3.* Normal probability plot of regression standardized residual

Examination of residuals, however, revealed weak linear patterns of relationships among IV's and the DV, and efforts to transform individual data sets produced little substantive improvements in linearity and homoscedasticity, and simultaneously compromised normality. Regression analysis through ANOVA was decidedly ineffective because rendering the dependent variable discrete would result in a loss of information. Based upon screening runs and examination of residual scatterplots, all of which exhibited a slight curvilinear relationship and acceptable homescedasticity, a determination was made to use untransformed data in the analysis. According to Klein (2005), multiple regression is possible with curvilinear effects. As Tabachnick and Fidell (2007) maintain, "failure of linearity of residuals in regression does not invalidate an analysis so much as weaken it" (p.127).

Evaluation of tolerance and VIF revealed absence of multicollinearity and singularity, as values fell within range of the recommended 'rule of thumb' (tolerance > .10 and VIF < 10) (Tabachnick & Fidell, 2007). However, evidence of potential multicollinearity was suspected in the multiple correlations between COMM and RES_AV (r = .78). Both data sets were transformed, centered around a mean of 0, to test whether an interaction effect existed between the two independent variables (Aiken & West, cited in Tabachnick & Fidell, 2007). An analysis with centered variables revealed no change in Pearson r. The Durbin-Watson value (2.03) indicated that residuals met the assumption for independence of errors. As a rule of thumb, residuals are not correlated if the Durbin-Watson statistic is in the range of 1.50 to 2.50.

Two cases, containing univariate outliers on at least one variable were identified. Outliers were examined and one case was determined to be connected to its data set. The second case, with univariate outliers on all four variables, was assigned a raw score one unit larger than the next most extreme score in the distribution. Because of the large sample size and as measurement is rather inexact, this is a recommended solution to reduce the impact of a univariate outliers on analysis (Tabachnick & Fidell, 2007). Assessment of data against calculations for Mahalanobis $D^2$ and Cook's D value resulted in deletion of fifteen cases containing multivariate outliers. Total sample size was reduced to 316 ($n$ = 316).

## Testing Hypotheses 1, 2, and 3

*Hypothesis 1.*

$H^1$ (0): The level of communication between management and workers has no effect on worker safety motivation.

$H^1$ (A): The level of communication between management and workers has a positive effect on worker safety motivation.

A bivariate correlation was conducted to determine the size, strength, and direction of the relationship between COMM and SELF_EFF. The resulting Pearson product-moment correlation coefficient, r, was not significant, indicating that the level of communication between management and workers has no effect on worker safety motivation.

Table 6.

*Bivariate Correlation for COMM and SELF_EFF*

| Variables | DV | $IV^1$ |
|---|---|---|
| DV | --- | |
| $IV^1$ | .05 | --- |

** p< .05 level (two-tailed); ** p< .01 level (two-tailed)*

*Hypothesis 2.*

$H^2$ (0): Resource availability is unrelated to worker safety motivation.

$H^2$ (A): Resource availability is positively related to worker safety motivation.

The bivariate relationship between RES_AV and SELF_EFF was also tested and found to be non-significant. Results suggest that resource availability is unrelated to worker safety motivation.

Table 7.

*Bivariate Correlation for RES_AV and SELF_EFF*

| Variables | DV | $IV^2$ |
|---|---|---|
| DV | --- | |
| $IV^2$ | .05 | --- |

** p< .05 level (two-tailed); ** p< .01 level (two-tailed)*

*Hypothesis 3.*

$H^3$ (0): External incentives have no effect on worker safety motivation.

$H^3$ (A): External incentives have a positive effect on worker safety motivation.

A bivariate correlation was again performed to explore the relationship between INCENT and SELF_EFF. For combined-county data, external incentives (INCENT) was found to be significantly correlated with the worker safety motivation (SELF-EFF) ($r = .13$, $p < .05$). $R^2 = .02$, a measure of strength of association between the variables,

indicates that the relationship is weak. Analysis supports claim 3 that external incentives have a positive effect on worker safety motivation, and the null hypothesis was rejected based on statistical evidence.

Table 8.

*Bivariate Correlation for INCENT and SELF_EFF*

| Variables | DV | $IV^3$ |
|---|---|---|
| DV | --- | |
| $IV^3$ | .13* | --- |

* *p< .05 level (two-tailed); ** p< .01 level (two-tailed)*

## Testing Hypotheses 4

$H^4$ (0): A safety environment characterized by effective communication between management and workers, process support, and external incentives has no effect on worker safety motivation.

$H^4$ (A): A safety environment characterized by effective communication between management and workers, process support, and external incentives has a positive effect on worker motivation.

*Multiple Regression*

A standard multiple regression analysis was used to test the combined influence and the predictive power of worker-management communication (COMM), resource availability (RES_AV), and external incentives (INCENT) on safety motivation (SELF_EFF). The regression model itself was non-significant; however, INCENT was found to be a statistically significant factor within the model ($t = 2.23$, $p < .05$). Coefficients indicate a positive relationship, and for every one unit increase in incentives, there is a corresponding increase in self-efficacy by .17. A summary of data for coefficients is displayed in Table 9.

Table 9.

*Multiple Regression Coefficient Relationships*

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | | B | Std.Error | Beta | *t* | Sig. |
| 1 | (Constant) | 28.011 | 3.366 | -.022 | 8.322 | .000 |
| | COMM | -.023 | .101 | -.043 | -.229 | .819 |
| | RES_AV | -.030 | .064 | .169 | -.461 | .645 |
| | INCENT | .199 | . 089 | | 2.231 | .026 |

Dependent Variable: SELF_EFF; $p < .05$ (two-tailed)

*Path Analysis*

A path analysis was performed to further explore relationships among study variables and to develop a rudimentary working model for safety culture within the context of the fire service based on Gilbert's (1978) theory of behavior engineering. Data sets COMM, RES_AV, INCENT, and SELF_EFF, used in the multiple regression

analysis, were previously screened for normality, linearity, homoscedasticity, and multicollinearity, and met assumptions reasonably well. The path model was fitted to a covariance matrix constructed from the correlations displayed in Table 10.

Table 10.

*Input Data for Analysis of Path Model of Firefighter Safety Climate*

| Variable | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1. INCENT | 1.00 | | | |
| 2. SELF_EFF | 3.21 | 1.00 | | |
| 3. COMM | 15.50 | 1.50 | 1.00 | |
| 4. RES_AV | 22.97 | 1.94 | 32.57 | 1.00 |
| *SD* | 21.30 | 29.49 | 26.79 | 63.52 |

*n* = 316

As multiple regression provides analysis of observed variables, path analysis offers a method for exploring indirect effects among variables and testing hypotheses in greater abstraction (Kline, 2005). Preliminary development of a model of safety culture was driven first by theory and secondarily by data. According to Klein (2005), when building a path model, it is wise to "learn from your data, but your data should not be your teacher" (p. 149). Model generation began by testing a recursive, just-identified model, as recommended (Klein, 2005). Analysis was conducted using LISREL software (version. 8.80, student ed). As just-identified models always fit data perfectly, model revisions were undertaken to produce a recursive, overidentified model, which according

to several indices, had good fit ($\chi^2$ (1, N = 316) = 0.05, p < .05; RMSEA = 0; RMR = 0.068.) The unstandardized solution is shown in Figure 3.

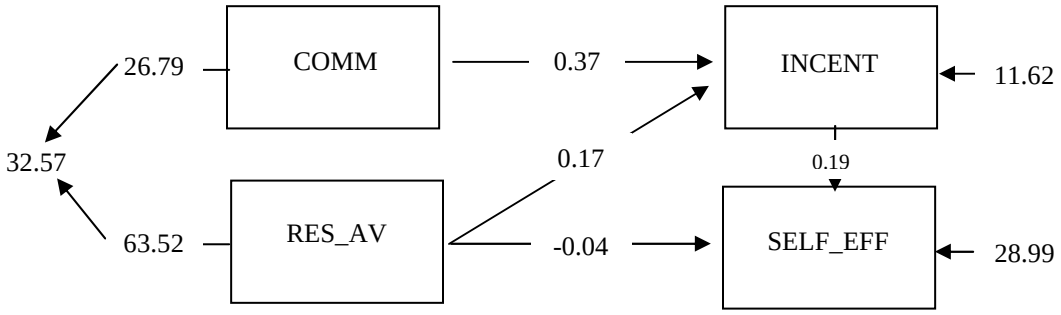


*Figure 4.* Proposed path model of firefighter safety culture

Displayed in Table 11 are the maximum likelihood (ML) estimates of model parameters. There are a number of advantages to using the ML method for estimating parameters. First, estimates are scale free (transformed variables can be algebraically converted back to the original metric) and scale invariant (the value of the fitting function in a particular sample remains the same regardless of the scale of observed variables (Kaplan, 2000). Also, ML estimation is robust against violations of multivariate normality (Klein, 2005).

Table 11.

*Maximum Likelihood Parameter Estimates for Recursive, Overidentified Path Model of Firefighter Safety Climate*

| Parameter | Unstandardized | *SE* | CR | Standardized |
|---|---|---|---|---|
| | Direct Effects | | | |
| M_W_COMM ⟶ INCENT | 0.37** | 0.061 | 6.09 | .0.41 |
| PRO_SUP ⟶ INCENT | 0.17** | 0.039 | 4.38 | 0.30 |
| PRO_SUP ⟶ SELF_EFF | - 0.04 | 0.049 | -0.80 | -0.06 |
| INCENT ⟶ SELF_EFF | 0.19* | 0.084 | 2.28 | 0.16 |
| | Variances and Covariances | | | |
| M_W_COMM | 26.79** | 2.14 | 12.51 | 1.00 |
| PRO_SUP | 63.52** | 5.08 | 12.51 | 1.00 |
| M_W_COMM **U** PRO_SUP | 32.57** | 2.97 | 10.96 | 0.79 |

*p < .05; **p < .01 (two-tailed t-test)

As indicated in Table 11, all path coefficients except RES_AV⟶SELF_EFF are significant, consistent with the prediction proffered in hypothesis 4. Increased levels in communication, resource availability, and incentives result in increased safety self-efficacy.

Evidence is suggestive of a mediating effect of incentives between observed and the dependent variable. A mediator variable carries the influence of an independent variable to a dependent variable (Preacher & Leonardelli (2001). Using the Sobel test, the mediating influence of INCENT between M_W_COMM and PRO_SUP and SELF_EFF was analyzed. For both independent variables, the mediating influence of INCENT on the dependent variable was significant ($p < .05$). Results are displayed in Table 12.

Table 12.

*Sobel Test for Mediating Influence of INCENT*

| Indirect Effect | a | *SE* | b | *SE* | z | *p* |
|---|---|---|---|---|---|---|
| M_W_COMM→INCENT→SELF_EFF | .17 | .039 | .19 | .084 | 2.300 | 0.021 |
| PRO_SUP→INCENT→SELF_EFF | .37 | .061 | .19 | .084 | 2.073 | 0.038 |

*p < .05*

Estimates of the unstandardized variances and covariances of COMM and PRO_SUP, observed exogenous variables are all significant ($p < .05$). According to results, COMM and PRO_SUP explain 45% of the variance in INCENT, and INCENT predicts 2% of the variance in motivation. Because the purpose of this path analysis was primarily exploratory, disturbance errors were not added to the model. Klein (2005) elaborates on this point:

> When there is justification...specification of these types of unanalyzed associations [disturbances] may be appropriate. Otherwise, they can be a way to improve fit simply by making a model more complex…If the model in fact does not adequately explain the observed association among the indicators, adding measurement error correlations without a substantive reason can be a way to mask this fact (p. 316).

Unstandardized path estimates for different variables are difficult to compare (Klein, 2005). However, standardized estimates are analogous. For example, the standardized path coefficient for the direct effects of COMM and RES_AV on INCENT are 6.09 and 4.38, respectively. That is, a level of communication one full standard

deviation above the mean predicts an incentive level more than 6 standard deviations above the mean, controlling for resource availability. A level of resource availability one full standard deviation above the mean predicts an incentive level more than 4 standard deviations above the mean. Relatively speaking the influence of COMM is 20% greater than the impact of RES_AV. In turn, a level of incentives one standard deviation above the mean predicts a self-efficacy level slightly more than 2 standard deviations above the mean. According to results, analysis of data through path analysis supports rejection of the null hypothesis. The pattern of relationships among COMM, RES_AV, INCENT, and SELF_EFF suggests that when the workplace environment is conducive to safety, there is a corresponding positive influence on worker safety behavior.

## Testing Hypotheses 5 and 6

Out of 23 fire departments that successfully participated in the study, 19 provided injury data for years 2004-2006. For each department ($n$ = 19), a three year injury average was calculated, and individual results were multiplied by the average cost of one firefighter injury, as established by NIST (2005) through a national study of economic costs impacting U.S. fire departments. Z-scores for DEPT_INJ_COST were calculated and a logarithmic transformation was also performed to improve distribution normality. The transformed variable was used in the analysis. Individual department scores were assigned, based on group means, for safety motivation (DEPT_SELF_EFF) and the mediating variable incentives (DEPT_INCENT), (which includes the indirect effects of COMM and RES_AV). See Table 13. The square root transformation of

DEPT_SELF_EFF, which improved normality of the distribution, was substituted for original variable values.

Table 13.

*Group Breakdown of Study Sample by Department*

| (*N* = 19) | DEPT_SELF_EFF | DEPT_INCENT | DEPT_INJ_COST (Standardized) |
|---|---|---|---|
| Department 1 | 37.16 | 47.00 | -1.07 |
| Department 2 | 32.80 | 47.55 | -0.73 |
| Department 3 | 32.90 | 46.05 | 2.04 |
| Department 4 | 33.80 | 46.43 | 0.01 |
| Department 5 | 30.04 | 43.69 | -1.46 |
| Department 6 | 36.00 | 44.25 | 0.25 |
| Department 7 | 34.47 | 45.73 | -0.58 |
| Department 8 | 34.32 | 49.53 | 0.35 |
| Department 9 | 34.41 | 46.85 | 0.77 |
| Department 10 | 31.69 | 51.69 | 0.61 |
| Department 11 | 34.85 | 45.92 | -1.07 |
| Department 12 | 35.52 | 50.06 | -0.02 |
| Department 13 | 34,00 | 47.25 | -0.51 |
| Department 14 | 36.72 | 43.10 | 0.25 |
| Department 15 | 38.39 | 43.56 | 1.31 |

Table 13 (Continued).
*Group Breakdown of Study Sample by Department*

| | | | |
|---|---|---|---|
| Department 16 | 35.50 | 41.55 | -0.60 |
| Department 17 | 34.00 | 49.60 | 1.53 |
| Department 18 | 32.47 | 46.75 | -1.57 |
| Department 19 | 37.25 | 46.17 | 0.46 |

*Hypothesis 5*

$H^5$ (0): An organization characterized by high levels of worker-management communication, availability of resources, and external incentives has no effect on injury related costs.

$H^5$ (A): An organization characterized by high levels of worker-management communication, availability of resources, and external incentives has a positive effect on injury related costs.

Departmental injury costs (DEPT_INJ_COST) were correlated with the mediating variable DEPT_INCENT (which includes the indirect effects of COMM and RES_AV) to determine if environmental factors have any influence on the organizational bottom line. No significance was found in the resulting Pearson r value. See Table 14.

Table 14.

*Bivariate Correlation for DEPT_INJ_COST and DEPT_INCENT*

| Variables | DV | IV |
|---|---|---|
| DV | --- | |
| IV | .10 | --- |
| | . | |

*p < .05; **p < .01 (two-tailed t-test)

As INCENT was shown to be mediating variable effected by COMM and RES_AV within this particular work environment, DEPT_INCENT data was grouped according to three categories: (Low = 1; Medium = 2; High = 3), and tested with the dependent variable DEPT_INJ_COST through a one-way ANOVA. The resulting F value was non-significant, leading to the conclusion that this combination of environmental factors has no effect on the organizational bottom line (See Table 15).

Table 15.

*ANOVA Results for DEPT_INCENT Group Comparison*

DEPT_INJ_COST

| | Sum of Squares | *df* | Mean Square | *F* | Sig. |
|---|---|---|---|---|---|
| Between Groups | .046 | 2 | .023 | .542 | .592 |
| Within Groups | .674 | 16 | .042 | | |
| Total | .719 | 18 | | | |

**p < .05; **p < .01 (two-tailed t-test)*

*Hypothesis 6*

$H^6$ (0): Worker self-efficacy has no effect on the organizational bottom line.

$H^6$ (A): Worker self-efficacy has an inverse effect on the organizational bottom line.

Departmental injury costs (DEPT_INJ_COST) were correlated with the mediating variable DEPT_SELF_EFF to determine if any association exists between safety motivation and the organizational bottom line. No significance was found in the resulting Pearson r value. (See Table 16.)

Table 16.

*Bivariate Correlation for DEPT_INJ_COST and DEPT_SELF_EFF*

| Variables | DV | IV |
|---|---|---|
| DV | --- | |
| IV | .24 | --- |
| | . | |

**p < .05; **p < .01 (two-tailed t-test)*

A one-way ANOVA was also performed to determine whether group mean differences on the independent variable DEPT_SELF_EFF influenced the dependent variable DEPT_INJ_COST. Sample cases ($n$ = 19) were grouped relative to self-efficacy according to the following criteria: Low = 1; Medium = 2; High = 3. Analysis revealed no significant differences among group means. See Table 17.

Table 17.

*ANOVA Results for DEPT_SELF_EFF Group Comparison*

DEPT_INJ_COST

| | Sum of Squares | *df* | Mean Square | *F* | Sig. |
|---|---|---|---|---|---|
| Between Groups | .091 | 2 | .046 | 1.16 | .338 |
| Within Groups | .628 | 16 | .039 | | |
| Total | .719 | 18 | | | |

**p < .05; **p < .01 (two-tailed t-test)*

## Summary of Findings

As previously noted, Gilbert's (1978) model emphasized that performance is dependent upon the contextual structure of the workplace, more than individual or collective worker knowledge, skill, or behavior habits. Based on this theoretical assertion, this study tested, first, the effects of three cultural variables previously identified in past literature—management-worker communication, resource availability, and incentives--on safety self-efficacy, a fundamental component of safety motivation. Secondly, the cultural environment and its effect were tested to determine if there existed any suggestion of association or link with the organizational bottom line. To the first point, study findings indicate a direct relationship between incentives and self-efficacy, and the association was both positive and significant. Incentives was determined to have a predictive value of approximately 2% on safety self-efficacy. Findings from the first three hypotheses led to testing of other direct effects and possible indirect effects among cultural variables. An insignificant, negative, direct effect was evidenced between self-

efficacy and resource availability. Both worker-management communication and resource availability wielded influence on self-efficacy, mediated through incentives. Path estimates were found to be in the moderate range, and the two variables together accounted for 45% of the variance in self-efficacy. To the second point, no association was found between the cultural environment and safety motivation and the organizational bottom line.

Of the six hypotheses posed, two resulted in rejection of corresponding null hypotheses. Hypothesis 3, which predicted a significant and positive association between incentives and self-efficacy, was supported by the data. Support was also found for Hypothesis 4, as the influences on self-efficacy were found to be a combination of direct and indirect effects of management-worker communication, resource availability, and incentives. Results are confirmatory of Gilbert's (1978) main contention that system dimensions are interdependent, interoperable, and synergistic.

# CHAPTER 5. RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

## Discussion

This study explored the impact of the occupational cultural environment on safety motivation and the organizational bottom line. Gilbert's (1978) model of behavior engineering provided a primary theoretical underpinning for design and execution of this study. Three contextual factors (communication, resource availability, and incentives) were tested to determine the relationship and extent of impact on both worker self-efficacy and injury related costs. Study findings indicate that within the context of the volunteer firefighter work environment represented in this sample, the combined effects of communication, resource availability, and incentives exert influence on safety motivation. Specifically, incentives play a mediating role, both absorbing the indirect effects of communication and resource availability and directly influencing safety motivation. Findings confirm Gilbert's (1978) contentions that (1) system dimensions are interdependently related; and (2) structuring the environment is a critical management task in improving and maintaining performance. These findings also adequately answer one of the study's main research questions in terms of defining the extent to which the cultural environment is predictive of firefighter safety motivation.

For purposes of this study, two types of incentives were assessed—peer pressure and management praise. An evaluation of incentives of a purely psychological nature provides essential information that may be practically useful when attempting to improve the efficacy of behavior based safety interventions. However, investigation of informal incentives stands in contrast to the focus of recent safety research, which has traditionally

centered on formal incentive programs involving either monetary or non-pay material gifts of thanks. According to Gangwar and Goodrum (2004), the research literature has raised concern about the viability of formal incentive programs and substantive long-term performance improvements. Studies have shown either lack of relationship between incentives and injuries (Lauver, 2007) or that incentive programs are curvilinearly related to injuries (Gangwar & Goodrum, 2005). Especially counterproductive are tangible and material rewards made contingent upon reductions in injuries (Krause, 2005). The exploration of the impact of informal psychological incentives undertaken through this study fills a gap in the research literature on this particular topic. Positive reinforcement, which predominantly involves simple praise, is "the weakest and misunderstood link" (Gangwar & Goodrum, 2004, p.25) among safety professionals. Furthermore, it is believed that "positive reinforcements should be a daily affair" (Geller & Daniels, cited in Gangwar and Goodrum, 2004, p. 26) and "ideally peers are in the best position to deliver positive reinforcement" (Gangwar & Goodrum, 2004, p.26). The significant suggestive link between informal psychological incentives and safety motivation uncovered through this study is also confirmatory of results obtained by Gostick and Elton (2007), who found significant improvements in performance in the presence of informal, ongoing, ad hoc, or on- the-spot recognition efforts. Such incentives were most significant when delivery was frequent, specific, and timely. Researchers point out that day-to-day recognition was also shown to be a low cost/high impact method of reinforcement that exerts influence on bottom line metrics.

Most pointedly, results indicate that investigation into use of positive peer pressure as a method of reinforcement may be a worthwhile endeavor. Within the

literature, group cohesiveness correlates with effects of safety incentives (Haines, Merrheim, & Roy, 2001), and group influence has been found to be a subtle, yet powerful, agent of conformity (Pronin, Molouki, & Berger, 2007). Pool and Schwegler (2007) indicated that conformity to norms is especially likely in situations associated with uncertain outcomes, in which people seek social consensus for actions. The camaraderie typical among volunteer firefighters, if properly leveraged, may prove to be a useful tactic for enhancing safety performance.

As a mediating variable, incentives imposed a statistically significant effect size on safety motivation within this particular population of volunteer firefighters. According to Kline (2005), interpretive guidelines for determining effect size are limited, and researchers are advised to reference past research literature to judge the strength of impact among variables. Tabachnick and Fidell (2007) also provide cautionary recommendations when determining the magnitude of effect size:

> It is important to assess the degree of relationship [between DV and the IV] to avoid publicizing trivial results as though they had practical utility…Effect size reflects the proportion of variance in the DV that is associated with levels of an IV. It assesses the amount of total variance in the DV that is predictable from knowledge of the levels of the IV (p. 54).

The challenge facing the researcher is how best to interpret study results within the context of past research and the framework of existing findings. Mohamed (2002), whose research into safety climate and safe work behavior in the construction industry, found a range of unstandardized path coefficients that fell between -.39 to .52. In comparison, this study's reported path estimate of .19 between incentives and self-efficacy appears to

be within average range. However, is a variance proportion of 2%, which was found statistically significant, large enough to be practically significant? It is essential to remember that the path model was based on perceptions of safety climate, which at best offers a momentary snapshot of workplace reality. Assuming longitudinal consistency of results, a 2% effect size over time can potentially mean a profound influence on firefighter safety beliefs. Mohamed (2004) also conjectured that 'small' effect sizes in safety research may signify the difficulty involved in changing embedded, personal safety beliefs among workers. Johnson (2007) also speculated that the significance and power of correlation coefficients and the predictive validity of safety is depressed because of the spurious effects of mediating variables.

A most interesting finding, however, was the negative (albeit insignificant) effect evidenced between resource availability and firefighter self-efficacy. Intuitively, it is reasonable to assume that a work environment rich in resources should, in and of itself, positively contribute to worker perceptions of safety, and research is supportive of such arguments (Wolfe, 2005). Traditionally, in the safety industry, risks associated with human error are commonly addressed and mitigated through improved design of processes, tools, and devices (Gambetese, 2008). However, a cogent explanation of the indirect influence may be psychological in nature. Despite the presence of state of the art equipment and adequate processes and procedures, workers must have compelling personal reasons for using resources safety. For example, post 911 many U.S. fire departments were able to upgrade personal protective equipment through government grants. Yet, access to modern equipment does not guarantee proper and correct usage of equipment in the absence of either positive or negative reinforcement. .Prior research has

identified the front line supervisor to be a critical resource (Zohar, 2002 2004), who also has the potential to deliver the kind of informal, low cost/high impact incentives examined in this study. A justification of the indirect relationship between communication and self-efficacy follows a similar line of reasoning. Management may be proficient at disseminating information; however, inducements must exist within the system for proper application and internalization of information.

Inasmuch as past studies have found relationships between safety climate perceptions and safety associated costs, the current study failed to uncover any significant correlations between culture related variables and injury costs. One possible reason underlying this lack of significant findings may lie with the small accessible sample size. With only 19 departments participating in this component of the study, low participation may have resulted in insufficient statistical power necessary for analysis. Secondly, this lack of significant findings between culture and the bottom line may be attributed to the nature of measures used in the analysis. Injury data upon which costs were calculated were obtained through self-reporting methods rather than derived directly and observably from archival records. Reliability is a persistent concern when using self-reported data in analysis. On the other hand, Gyekye and Salminen (in press) found self reported measures to be closely related to archival records. The possibility exists that there truly is no relationship between safety motivation and injuries. However, a second point to consider is that injury data and associated costs were based on a single lagging indicator. Although it is common practice in many areas of research to use single-item measures, such measures also raise concerns over data reliability (Barling, Kelloway & Iverson, 2003). On the other hand, collected data of participant perceptions is considered a leading

indicator of unspecified future results (Gyekye & Salminen, in press). Ideally, to effectively capture potential cause and effect relationships, metrics must be designed to accurately reflect the order that such metrics drive improvement (Petersen 2005). In defining the culture-bottom line relationship, the execution of a longitudinal study may well be necessary to effectively represent the essential sequential nature of the variable relationship.

## Limitations

It should be noted that because of the site-specific factors that influence the formation of safety culture within the context of the volunteer fire service, study findings are not highly generalizable to other industries. Caution is also advised in generalizing results to the professional fire service, the salaried counterparts of volunteers, a population of firefighters who are remunerated for employment. Wages and incentives are not synonymous (Gostick & Elton, 2007), and a system that includes a payroll process may produce interactions among dimensions far different than the synergisms generated among volunteers. Replication of this study among other populations will provide a basis for comparison. Moreover, as this study was based on a convenience rather than a random sample, generalizing results beyond the target population is also not advisable. Low generalizability underscores the difficulty in identifying a universal model of safety culture. Although Gilbert's model may provide a general guideline for cultural analysis, the weight and priority attributed to dimensions may be highly dependent upon the peculiarities of each industry.

A second limitation involves the nature of collected data. Evaluated perceptions emanate from the perspectives of firefighters. Officer perceptions, if accounted for, would provide a more complete picture of safety climate and overall indication of what is actually occurring within sampled departments.

## Recommendations for Future Research

One of the purposes of this study was to introduce Gilbert's (1978) theory of behavior engineering to the safety industry, proposing it as a possible universal model of safety culture. Study findings indicate that the model may have potential usefulness in defining common patterns of relationships among safety culture factors across industries. Based on initial results, further testing of Gilbert's model across other high-risk industries, apart from the fire service is warranted. Future testing should also include exploration of the impact of training and capacity (two dimensions purposely excluded from this study), to obtain a complete picture of the dynamics and synergism inherent in the model. Most critical is the study of capacity, as past research has shown that personality is one factor influencing safety attitude (Mullen, 2004) and conforming behavior (Endler, 1966). Moreover, study findings also suggest that hiring practices that account for prior work experience are associated with lower numbers of workplace injuries (Lauver, 2007). The inclusion of capacity may be integral to determining the relationship between safety culture and the bottom line that Gilbert (1978) maintained is an integral part of this model. As the instrument for this study was adapted from an existing survey, it is also suggested that a new instrument be developed to assess more accurately the factors represented in the model.

As incentives was shown through this study to be a pivotal factor affecting the formation of worker safety beliefs, it is recommended that researchers investigate further the implications of leveraging psychological incentives such as verbal praise and positive peer pressure. Verbal praise, especially, has been found to be motivating because it is perceived by workers to be a form of personal, rather than dutiful acknowledgement (James, 2005) Unlike material or monetary rewards that may crowd out intrinsic motivation, verbal praise has a humanizing influence on the workplace and tends to increase intrinsic motivation (Gostick & Elton, 2007). Gostick and Elton's (2007) landmark study found incentives to be a social accelerator of sorts, conveying the positive values, norms, and beliefs that drive the formation of organizational culture. In a culture of recognition, work becomes spiritually fulfilling, "…workers are engaged and willing to give their best efforts to their work, creating mutual benefit for the organization and the individual" (Gostick & Elton, 2007, p.59). This study suggests a similar type of effect on safety culture. Future research may well confirm the contention of Krause (2005), who maintains that social values, norms, and beliefs, which underpin safety, also serve as a primary driver of organizational success. Once considered a business liability, safety may in time, through ongoing research, be redefined as an integral business asset.

The reinforcing power of peer pressure in the workplace is another issue that deserves the attention of researchers. According to Endler (1966), it is possible to manipulate conformity behavior, which is a socially learned response and function of social pressure and reward. Exploration of the positive motivational properties of peer pressure may provide insight into the dynamics of influence, among workers, apart from management. Although considered to be a phenomenon of adolescence, peer pressure is

also a socially motivating force in adulthood. Future research might investigate the link peer pressure and safety culture, leading to the development of interventions that harness the positive reinforcement power of peer pressure for purposes of safety performance improvement.

Presently, the safety industry is seeking strategies to transcend the current injury plateau. If Gilbert's (1978) theory of behavior engineering is ultimately determined through continued research to be useful as universal model of safety culture, it may have simultaneous application as a sustainability process, as sustainability involves the development of safety culture at its highest level and the ability to address latent, embedded, or inherent system gaps.. According to Krause (2005), sustainability processes, when integrated with any 'beyond compliance' program, will result in continuous improvement and attainment of world-class safety performance. The hallmark of a useful sustainability process is the low cost/high impact nature of interventions. In an article geared for the commercial nuclear industry, Coe and Lake (2003) recommended the application of Human Performance Improvement (HPI) principles and practices for "when [safety] quality nears perfection and efficiency efforts have picked all the low hanging fruit" (Coe & Lake, 2003, p. 40). The foundation of HPI rests upon Gilbert's (1978) model, and therefore the theory deserves ongoing research attention to exploit its maximum potential and application to the field of occupational safety.

Further research should also be pursued as to how the industry can better leverage learning for improved safety performance. Currently, much learning involving safety is ad-hoc, occurring after an accident occurs. Gilbert's (1978) model may provide the industry with a template for establishing a comprehensive learning organization that

drives the improvement process a priori, enabling organizations the capacity to identify and eliminate system gaps preemptively,  before crises or disaster occur (Cooke & Rohleder, 2006).

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