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The effects of a safety climate on safety decision-making

Troy Ricardo Mills
Iowa State University

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Troy Ricardo Mills

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Nir Keren, Major Professor
Steven A. Freeman
Paula Morrow

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ABSTRACT

This study examines the relationship between the strength of safety climate and the orientation towards safety in a decision-making process (*Safety Decision-Making*). The study attempted to answer the following question: *Can the strength of a safety climate predict safer decision-making process and choice?*

Two web-based instruments have been utilized to address the question above: a safety climate survey followed by decision-making simulation (Decision Mind ™).

The study was conducted in a manufacturing facility in Iowa. It included 111 of the 186 employees in the facility. The results indicated that an aggregated measure of the strength of safety climate was a significant predictor of the choice of a safer alternative. However, the correlation between the strength of safety climate and a safety-oriented decision process was not found to be significant.

Keywords: safety climate; safety decision-making.

CHAPTER 1. INTRODUCTION

1.1 Background

The effects of safety climate on safety performance (behavioral safety) remain a paradox to both, practitioners and researchers alike. Although there is a significant correlation between safety climate and safety behaviors, careless behaviors still prevail during work functions (DeJoy, 1994, & 2005; Glendon & Litherland, 2001; Zohar & Erev, 2007; Zohar & Luria, 2003). These unsafe behaviors present an immense managerial challenge (Cooper & Phillips, 2004; Prussia, Brown, & Willis, 2003; Smith, Huang, Ho, & Chen, 2006). This challenge is evident in the fact that forty percent of work accidents and occupational diseases are the result of employees' failure to use mandatory personal protective gear (National Safety Council [NSC], 1999). Statistically, this forty percent (NSC, 1999) has not changed in more than twenty years, despite the fact that the correlation between safety climate and safety behaviors was established five and a half decades ago (Fleishman, 1953; Guldenmund, 2000). Even in an environment where safety behavior should be paramount, such as the National Aeronautical and Space Administration (NASA), this paradox is evident (Columbia Accident Investigation Board [CAIB], 2003). Following the loss of the Columbia Space Shuttle, a report by the CAIB (2003) showed that NASA failed to support its stated commitment to put safety first. This report explained that NASA was committed to the concepts of safety but not to the actual practices. The failure to practice commitment to safety is not limited to NASA; it is a widespread concern and occurs in various industries daily.

Zohar and Luria (2005) conducted a study to illustrate this failure to practice commitment to safety. In the study, workers' behaviors were observed by line managers and safety professional in 423 workgroups across general industrial sectors. The study indicated that each company had an incident rate over thirty three percent for unsafe behaviors.

Behavioral safety uses the Antecedents-Behavior-Consequences (ABC) framework (Luthans & Kreitner, 1985; Stajkovic & Luthans, 1997). ABC framework focuses on two antecedents, training and goal setting associated with target safety behaviors (i.e., housekeeping, earplugs), and two types of consequences (i.e., feedback and incentive). The notion of consequences refers to reinforcement (Skinner, 1974). Reinforcement refers to any behavior-contingent outcome that influences the frequency of preceding behaviors (Geller, 1996). In most cases, intervention is based on publicly displayed feedback charts, based on observations by external observers or co-workers (Krispin & Hantula, 1996). While these intervention methods provide some of the necessary incentives for change (Lingard & Rowlinson, 1997), workers are still engaging in unsafe behaviors. Safety climate researchers (Amabile, Schatzel, Moneta & Kramer, 2004; Fleishman, 1953; Zohar, 1980; Zohar & Luria, 2003) believe that some of these unsafe behaviors are influenced by specific organizational factors.

1.2 Safety Climate

According to the existing literature on safety climate, there have been several progressive definitions for safety climate. However, the core definition that solidified the fundamental meaning of safety climate states that, “safety climate is employees’ perceptions of the priority given to safety over productivity (Zohar, 1980, p. 97).” As early as the 1950s, this perception of the priority given to safety over productivity has been correlated to employees’ safety behaviors (Fleishman, 1953). Despite this significant finding, little has been done to establish the best managerial practices to reduce employees’ unsafe behaviors (Zohar & Erev, 2007). In order to understand decision behaviors, research efforts need to focus on decision-making processes (e.g., perceptual, cognitive, information acquisition) that cause human behaviors to deviate from that predicted by normative models (Hertwig & Ortmann, 2001; Jensen & Meckling, 1976; Mellers, Schwartz, & Cooke, 1998; Payne, Bettman, & Johnson, 1992; Rothman & Salovey, 1997; Shafir, Simonson, & Tversky, 1993; Simon, 1955 & 1979). Unfortunately, decision-making processes have only been studied implicitly, rather than directly. Implicit studies of decision-making address theoretical frameworks and expectations. For example, current efforts to understand these processes are typically devoted to designing psychometric measuring instruments and determining their underlying factor structures (Brown & Homles, 1986; Coyle, Sleeman, & Adams, 1995; Dedobbeleer & Beland, 1991; Garavan & O'Brien, 2001). While this is an important aspect of understanding the concepts of decision-making, it does not provide a complete picture. Therefore, this study argues that the missing link between safety climate and safety behaviors lies with understanding actual decision-making processes.

1.3 Decision-Making

Buchanan and O'Connell (2006) claimed that decision-making has been an area of interest to humankind since the fourth century, since Aristotle argued that in order to understand choice, useful knowledge gained through sensing and deductive reasoning should be important. This interest lies in the fact that human beings are continuously engaged in decision-making processes that are made up of a variety of facets. Decision-making, a process that is guided by a set of rules, involves acquiring and weighing accessible information in order to select the "best" alternatives (Simon, 1955 & 1979; Mintz, 1993; Mintz & Geva 1997; Mintz, Geva, Redd, & Carnes, 1997). Decision rules, theories, and models have been developed to predict, quantify, and measure people's decision-making processes.

Based on the fundamental concepts of the models and theories of decision-making processes, a new concept is defined in this study: ***safety decision-making***. This new concept is defined as the process of selecting a safe alternative through information acquisition based on safety training, personal beliefs, values, previous experience, and accessible safety information. This study is innovative in its approach to finding one of the relationships between safety climate and safety decision-making.

1.4 Problem

The purpose of safety climate research is to provide safety professionals with effective solution to ongoing careless behaviors in industry (NSC, 1999). However safety climate has yet to gain industry wide acceptance (Cooper & Phillips, 2004). Researchers have yet to combine the body of knowledge on safety climate and safety behaviors into a recommendation for best managerial practices to reduce unsafe behaviors in the workplace (Cooper & Phillips, 2004; Ostrom, Wilhelmsen, & Kaplan, Prussia et al., 2003; 1993; Schneider, 2000; Smith et al., 2006; Zohar & Erev, 2007). Thus, this study suggests that this lack of insight might have a causal relationship to managers' inability to solve persistent unsafe behaviors in the workplace. As a result, despite the time and effort spent on safety and safety training, the work environment is still plagued by employees who make poor and unsafe decisions (Payne, Bergman, Henning, & Stufft, 2006; Zohar & Luria, 2003; Zohar & Erev, 2007). Employees who make poor and unsafe decisions are apparent in the manufacturing environment (Zohar & Luria, 2003; Zohar & Erev, 2007). This is due to the fact that the manufacturing industry is a leading work environment, where incidents and injuries occurs daily (Bureau of Labor Statistics [BLS], U.S. Department of Labor [DOL] 2005, http://www.bls.gov). Because of the problems concerning safety in the manufacturing industry, this study seeks to examine a possible additional missing link (safety decision-making) between safety climate and safety behaviors within a manufacturing environment.

1.5 Structure of this Study

The purpose of this study is to examine the effect of safety climate on safety decision-making processes and choice in a manufacturing environment. The study starts with a literature review. The literature on safety climate will discuss several problematic issues associated with safety climate research. The literature on decision-making will be selective in nature (relevant to the study), because of the extensive research conducted on decision-making. A new concept of safety decision-making is discussed later in this study, and a variety of indices will be reviewed during the course of the research. Safety oriented information acquisition processes will be among these indices. This information will be used to address possible correlation between safety climate factors and safety decision-making. Lastly, this study includes research methodology, two null hypothesis, analysis, and results sections. These sections are followed by discussion, recommendations, and conclusions.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

Initially, this section reviews literature on safety climate, which is followed by a review of decision-making scholar efforts.

One of the purposes of measuring safety climate is to inform practitioners on improving safety performance (Carroll, 1998). This effort has been on-going for the past five and a half decades (Guldenmund, 2000). For these five and a half decades industrial organizations have had a major interest in safety climate efforts since they are major stakeholders (Wallace, Popp, & Mondore, 2006). This is due to on-going concerns with work accidents and occupational diseases within industrial environments.

Despite these concerns, safety climate researchers have not reached a consensus on an assessment methodology that addresses the relationship between safety climate and safety behaviors (Flin, Mearns, O'Connor, & Bryden, 2000). Since human actions require that a decision be made, there is a need to understanding decision-making process, as well, with respect to organizational factors such as safety climate.

2.2 Inconsistencies in Defining Safety Climates

Early efforts in safety climate research can be traced backed to the 1950s (Fleishman, 1953). Fleishman (1953) conducted a study on the relationship between safety climate and safety performance, which revealed that the strength of safety climate was highly correlated with the behaviors and attitudes of foremen in industrial settings. By the early 1970s, attempts were made to categorized safety climate criteria and dimensions (Campbell, Dunnette, Lawler, & Weick, 1970). Campbell et al. (1970) posited four major dimensions of safety climate, which are:

- Individual autonomy,
- Degrees of structure imposed on the job functions,
- Reward orientation, and
- Consideration, warmth, and support.

These safety climate dimensions were later solidified by Zohar (1980), who suggested that safety climate is a coherent set of perceptions and expectations that employees have regarding the company's priority of safety over productivity. Byrom and Corbridge (1997) built upon Zohar's (1980) definition of safety climate as the employees' shared perceptions of how safety management is being operated in the workplace, at a particular moment in time. Zohar (2002) further suggest that safety climate evolves. This evolution is characterized by the individuals who occupy the environment, and this evolution can change on the basis of certain inputs (i.e., organizational climate, leadership). Neal, Griffin, and Hart (2000) generalized Byrom and Corbridge's (1997) definition to be a specific form of organizational climate that describes individual perceptions of the value of safety in the workplace. Wallace et al. (2006) further suggest that safety climate is the shared perceptions of emphasis of safety-related policies, procedures, and practices. Based on the review of these definitions this study argues that there have been inconsistencies in defining safety climate. Although researchers have made significant progress in defining safety climate, these inconsistencies have deterred them from reaching a consensus on an assessment methodology.

2.3 Safety Climate Assessment Approach

A Meta analysis of safety climate assessment methods, over the past twenty five years, has grouped safety climate assessment methods into four categories (Cooper & Phillips, 2004):

- Designing psychometric (design, administration, and interpretation of quantitative tests for the measurement of psychological variables such as intelligence, aptitude, and personality traits) measurements and determining their underlying factors (Brown & Holmes, 1986; Coyle et al., 1995; Dedobbeleer & Beland, 1991; Garavan & O'Brien, 2001; Zohar, 1980),
- Developing and testing theoretical models of safety climate to determine factors of safety behaviors and accidents (Cheyne, Cox, Oliver, & Tomas, 1998; Neal et al., 2000; Prussia et al., 2003),
- Safety performance-oriented climate (Glendon & Litherland, 2001; Zohar, 2000), and
- Linking safety climate and organizational climate (Neal et al., 2000; Silva, Lima, & Baptista, 2004; Wallace et al., 2006; Zohar, 2000; 2002).

Psychometric [safety climate] instruments are deliberately designed to discriminate between people on various demographic dimensions (Cook, Hepworth, Wall, & Warr, 1993). Thus, differences between sub-groups only inform about the degree to which the measure has reached its initial design goals. They do not assess or predict actual ongoing safety performance. Moreover, correlating demographic data to safety climate questionnaire responses is neither concurrent validation (e.g., safety performance at the time of distribution of survey) nor predictive validity (e.g., forecast future safety performance) (Bausell, 1986).

Some researchers have tried to assess concurrent or predictive validity by correlating the factor scores against accident rates, human error analysis, expert rating, rating of behavioral compliance, and safety behavior (Arboleda, Morrow, Crum, & Shelley, 2003; Diaz & Cabrera, 1997; Garavan & O'Brien, 2001; Glendon & Stanton, 2000; Lee & Harrison, 2000; Mearns, Whitaker, & Flin, 2001; Niskanen, 1994; O'Toole, 2002; Silva et al., 2004; Varonen & Mattila, 2000; Vredenburgh, 2002; Zohar, 2000). The only evidence of a predictive relationship between a safety climate instrument and safety behaviors was found by Zohar (2000), whose findings showed a strong predictive relationship between safety climate and "micro-accident" (i.e., behavior dependent on-the-job, minor injuries needing medical attention). However, all other research efforts have had unsuccessful outcomes in contributing to Zohar's (2000) findings. Other methods of finding a predictive relationship between safety climate and safety performance are the developing and testing of theoretical models of safety climate. The purpose of this method is to determine factors relating to safety behaviors accidents (Cooper & Phillips, 2004).

Some theoretical models of safety climate attempt to understand the relationship between construct of safety climate models and self-reported indices such as: appraisals of work environment, work hazards, managerial assessments of employees' safety compliance, safety hazards, and self-reported compliance (Brown & Homles, 1986; Cheyne et al., 1998; Neal et al., 2000; Thompson, Hilton, & Witt 1998). The correlation between safety climate models and self-reported safety activities has only a moderate association at best (Cooper & Phillips, 2004). This moderate association is a result of the inflation of the correlation between two perceptual constructs (Miller & Monge, 1986). For this reason, it is difficult to rely on the validity of theoretical models in finding a relationship between safety climate and safety performance. Overwhelmingly, this body of research suggests that there is no direct link between perceptual safety climate constructs and actual safety behaviors (Cooper & Phillips, 2004). Another reason for the difficulty in finding a relationship between safety climate and safety behaviors is the problem of accurately measuring safety performance.

Measurement of safety performance is made up of such factors as accident and injury rates, and compensation cost. It is a challenge to measure these factors because they are reactive (e.g., after the event) and they are infrequent (Cooper & Phillips, 2004). The focus on safety results means that the success of safety is measured by lower levels of system failure (Cohen, 2002). Thus, safety climate research is intended to be a more proactive measure of safety performance (Strickoff, 2000). Unfortunately, there are limited publications that have established a clear link between safety climate and safety behavior. The relationship between safety climate and safety behavior has mostly been inferred from structural equation models based on a variety of self-reported instruments. This is a reflection of two things: there may be no predictive links between safety climate and safety behavior, or the relationship between safety climate and safety behaviors can be found if behavioral measurements are measured over a longer period of time (Cooper & Phillips, 2004). The struggle to link safety climate and safety behavior using these other assessment methods has caused safety climate researchers to consider broader factors of safety climate such as organizational climate (Wallace et al., 2006).

Recently, safety climate researchers have begun examining organizational based processes and perceptions, which are thought to impact the tendency to be involved in accidents (Hofmann & Stetzer, 1996; Zohar, 2000; 2002). Climate refers to the shared perceptions among members of an organization with regard to policies, procedures, and practices (Ostroff, Kinicki, & Tamkins, 2003). In other words, climate is an experientially based description of what people see and report happening to them in an organizational setting. Therefore, an understanding of climate is important in assessing organizational effects on employee behaviors. This is because employees do not directly respond to the work environment; they first perceive and interpret the work environment and then act according to their interpretations (Campbell et al., 1970; Carr, Schmidt, Ford, & DeShon, 2003).

Schneider and Bowen (1993), and Schneider, Bowen, Ehrhart, and Holcombe, (2000) have expanded the climate construct to represent two types: foundation and specific. Foundation climate refers to shared perceptions of a larger or more encompassing environment. Specific climate refers to those shared perceptions that are specific to a given area of interest (i.e., safety climate). They further suggest that while foundation climate does not correlate strongly with specific measures of outcomes, specific climate is more strongly related to a specific outcome (i.e., safety climate correlation with safety performance). For example, foundation climate (i.e., management-employee relations and organizational support) may predict safety climate. However, safety climate will have a stronger relationship with safety performance than will foundation climate (Wallace et al., 2006). Wallace et al., (2006) suggest that it is important to include both foundation and specific climates in capturing criteria of interest in climate research. This is due to the possible indirect effects of a foundation climate effect on outcomes (i.e., safety performance) by way of a specific climate. Unfortunately, limited research has examined both foundation and safety climates as a predictor of safety performance (Neal et al., 2000; Silva et al., 2004; Wallace et al., 2006; Zohar, 2002; Zohar & Luria, 2004). Therefore, the significance of this theory has yet to be validated (Wallace et al., 2006).

These current studies on safety climate assessment methodologies have struggled or have yet to strengthen the predictive relationship between safety climate and safety behaviors. The struggle to find a predictive relationship between safety climate and safety behaviors may account for the slow reception of safety climate findings among practitioners. The lack of acceptance or application of these studies can be traced to two reasons. First, researchers have not reached any agreement on safety climate assessment methods (Cox & Flin, 1998; Ostrom et al., 1993; Schneider, 2000; Zohar, 2000; Zohar & Erev, 2007). Second, researchers have not provided practitioners with appropriate solutions to reduce unsafe behaviors (Prussia et al., 2003; NSC, 1999; Zohar & Luria, 2005; Zohar & Erev, 2007). The present study seeks to further understand the relationship between safety climate and safety decision-making, a facet of safety behaviors, and perhaps advance the understanding of unsafe practices in industry.

2.4 Challenges to the Assessment Approaches to Safety Climate

Earlier studies of safety climate assessment focused primarily on environmental factors while later studies focused on the cognitive and psychological factors that affected safety performance in the workplace (Cooper, 1995; Cooper & Phillips, 1994 & 2004; Guldenmund, 2000; Schneider, 2000). Cooper (1995), Cooper and Phillips (1994 & 2004), and Prussia et al. (2003) argue that researchers have been slow to reach a consensus on which of these factors, environmental or cognitive/psychological, are more influential. Furthermore, the separation of these factors has led to a proliferation of criteria and dimensions used to assess safety climate (Cox & Flin, 1998). This proliferation has made it difficult to develop a universal safety climate assessment methodology (Guldenmund, 2000; Williamson, Feyer, Cairns, & Biancotti, 1997).

Cox and Flin (1998) demonstrated the negative effect that this wide range of dimensions has had on safety climate research. In their study, Cox and Flin (1998) showed how particular safety climate assessment methods were effectively used in one sector of an industry but failed to be effective in other industries. Further evidence of the failure to develop a universal safety climate assessment methodology was demonstrated in a study conducted by Coyle et al. (1995). The study (Coyle et al., 1995) used a previously identified assessment methodology in a similar kind of industry but failed to yield the same results. From these examples, it could be argued that the lack of a universal assessment methodology is a sign that this research area could still be at its beginning stage (Guldenmund, 2000; Williamson et al., 1997). Since this research area is viewed as new, practitioners have yet to see the practicality of the research (Ostrom et al., 1993; Schneider, 2000; Zohar & Erev, 2007).

From the review of these current struggles in safety climate research, it is apparent that there is a need for a recognized and accepted set of criteria and dimensions to measure and assess safety climate. This study argues that a systematic approach for selecting dimensions for safety climate should be based on commonly acceptable criteria (e.g., type of industry, type of organization). This approach could lay the foundation for developing a universal safety climate assessment methodology.

2.5 Universal Criteria and Dimensions for Safety Climate Assessment Methodology

Flin et al., (2000) and Guldenmund (2000) identified that the following themes have been emphasized consistently in the majority of studies over the past four and a half decades:

- Management commitment,
- Functionality of organizational safety system,
- Work pressure,
- Employees' competencies, and
- Policy and procedures.

Flin et al. (2000) suggest that these five principal themes are vital when measuring employees' perceptions on management attitudes and behaviors with respect to the relationship between the priorities of safety and productivity. The present study agrees with Flin et al. (2000) and believes that these themes are relevant to finding a systematic approach for selecting dimensions based on commonly accepted criteria. For this reason, this study examines the themes (management commitment, approach to safety systems, work pressure, employees' competencies, policy and procedures) in further detail below.

2.5.1 Management Commitment

Flin et al. (2000) argue that management commitment is a prime theme worthy of measurement. This theme relates to the worksite safety climate and other issues such as selection, discipline, and planning. Management commitment appears explicitly (e.g., with a dimension label) in more than 13 reviewed studies and implicitly (from inspecting the items) in over 18 reviewed studies (Flin et al., 2000). However, Clarke (1999) argues that using the label implicitly makes it difficult to discern the level of management being assessed (e.g., supervisors, senior managers/plant managers). This is not a trivial point because these levels of management have distinct roles and are perceived differently by the workforce (Clarke, 1999; Zohar, 2002; Zohar & Luria, 2003; Zohar & Erev, 2007).

The role of the supervisor in safety management has long been recognized (Heinrich, 1959, p. 22):

> "The supervisor or foreman is the key man in industrial accident prevention. His application of the art of supervision to control of worker performance is the factor of greatest influence in successful accident prevention."

Studies on supervisor behaviors and leadership styles have correlated with critical safety behaviors (Fleishman, 1953; Mearns, Flin, Fleming, & Gordon, 1997; Simard & Marchand, 1995; Zohar & Luria, 2003), which have led to increase assessment of this aspect of management. Likewise, the examination of upper management behaviors and leadership styles can increase overall assessment of management's influence on safety behaviors (Flin et al., 2000).

2.5.2 Functionality of Organizational Safety System

Senior management's influence on workforce perceptions and safety performances was of greater interest 20 years ago, when leadership research was more popular (Guldenmund, 2000). For example, there were several studies that investigated the relationship between managers' beliefs and leadership styles and accident rates on their sites (Andriessen, 1978; Eyssen, Hoffmann, & Spengler, 1980). Unfortunately, these studies did not identify the processes relating to upper management behaviors and the resulting impact on safety behaviors (Flin et al., 2000). Thompson et al. (1998) stated that while senior managers affect the overall safety system of their organization (e.g., set the tone for the organizational atmosphere, establish priorities, and allocate resources) there is very little evidence that shows how this affects workforce safety performance.

Functionality of organizational safety system is the second most identified theme in almost every survey (Flin et al., 2000). The perception of the functionality of the organizational safety system encompasses many different aspects of the organization's safety management system. This perception includes safety officials and safety committees' level of authority, permit to work systems, adequate safety equipment, safety policies/procedures, reward/recognition program, and the balance between production and safety (Flin et al., 2000). The functionality of the organizational safety system is measured based on three criteria of safety climate (Zohar, 2002; Zohar & Luria, 2003):

- The effects of supervisory style on the level of concern for safety among subordinates,

- Supervisory attitudes and practices toward safety that lead to safety climate within the organization, and
- Safety priority dictated by upper management and its effects on supervisory safety practices and leadership styles.

According to these three assessment criteria the key component of the functionality of the organizational safety system is based on the role of supervisors. As stated by Zohar and Luria (2003, p. 4),

> "If supervisors repeatedly make safety procedures contingent on production pressure, workers will infer low safety priority even if management's overt policy is that safety has top priority…If merit bonuses are awarded to workers who are not known for their safety, other workers will infer low safety priority despite formal declarations to the contrary."

Supervisors' effects on workers' perceptions of the functionality of the organizational safety system are further evident in a study conducted by Zohar and Erev (2007); their study demonstrated that safety behaviors depend largely on external supervisory contingencies (e.g., rewards and work pressures) rather than internal self-preservation considerations.

2.5.3 Work Pressure

Work pressure is job demands and stress in the work environment that exceeds the skills and abilities of an employee (Guldenmund, 2000). When the skill and abilities of a worker is exceeded this contributes to work overload, role ambiguity, and conflicting role demands. For this reason, work pressure is recognized as a vital element of a safety climate (Advisory Committee on Safety of Nuclear Installations [ACSNI], 1993; Falbruch & Wilpert, 1999). Work pressure related to safety has been thought to be primarily a function of management (e.g., line supervisors, plant managers, etc.) attitudes and practices of maintaining balance between productivity and safety (Flin et al., 2000).

However, recent studies have also identified that peer-pressure (i.e., team pressure to meet production goals) along with pressure from upper management, is a determining factor in establishing perceived work pressure (Havold, 2005; Michael, Evans, Jansen, & Haight, 2005). The combination of these two determinant factors creates the overall workforce perception of the balance maintained between productivity and safety. This notion is evident in a study conducted by Dedobbeleer and Beland (1998), which demonstrated that the tendency of workers to take risks or ignore procedures was highly correlated to their perception of working in a high stress environment. Another factor associated with the tendency to take risks is the competency of the workforce. A worker with low competency (e.g., qualifications, skills and knowledge) for the job function is more likely to take risks because of peer pressure (Helmreich & Merritt, 1998; Flin et al., 2000; Flin & O'Connor, 2000).

2.5.4 Competence

Competence is workers' perceptions of the level of qualifications, skills and knowledge possessed by both co-workers and management (Guldenmund, 2000). This perception is highly correlated to management practices such as selection, training, and assessment of competence standards (Flin et al., 2000). These management practices are likely influenced by broader economic conditions, such as the labor market and training budgets (Flin et al., 2000; Flin & O'Connor, 2000; Helmreich & Merritt, 1998). In turn, these economic conditions affect the adoption of specific maintenance policies and procedures (e.g., educational requirements, assessment of competence standards) within an organization (Bax, Steijn, & De Witte, 1998;

Guldenmund, 2000; Hudson, Van der Graaf, & Verschuur, 1998; McDonald, 1998; Reason, Parker, & Lawton, 1998).

2.5.5 Policies and Procedures

Policies and procedures are the most frequently recurring theme in safety climate assessment methodology studies (Guldenmund, 2000). The concept of policies and procedures deals with communications concerning accessible safety information, attitudes toward safety rules, and compliance with and enforcement of the policies and procedures. The defiance of these communications has been correlated with risk-taking behaviors (Bax et al., 1998; Hudson et al., 1998; Lee, 1998; McDonald, 1998; Reason et al., 1998). Lee (1998) conducted a study that showed that failure to enforce policies and procedures correlates with risk-taking behaviors, and is highly connected with accident involvement in the workplace. These studies suggest that policies and procedures need to be included in safety climate factors.

Although these five themes (e.g., management commitment, functionality of organizational safety system, work pressure, competencies, policy and procedures) are identified as consistent dimensions in safety climate assessment methodology, there is still a need to develop a universal safety assessment methodology (Flin et al., 2000; Guldenmund, 2000).

2.6 Assessment Methodology

Currently, the only universally accepted approach to safety climate assessment is through an analysis of self-administered questionnaires (Flin et al., 2000; Guldenmund, 2000). The development of a self-administered questionnaire utilizes the following process (Guldenmund, 2000):

1) Set up bounds for the particular area of interest,

2) Identify aspects relevant to the area of interest with a major focus on beliefs, perceptions, and attitudes,
3) Formulate a questionnaire,
4) Pre-test the questionnaire in a pilot study on a relevant population, and
5) Analyze the data.

Once a questionnaire has been developed, following these five processes, the data is collected and analyzed, based on the expected relationships between the independent and dependent variables (i.e., linearity); several typical methods of analysis are (Guldenmund, 2000):

- Factor Analysis (FA),
- Principle Component Analysis (PCA),
- Homogeneity Analysis (HOMALS),
- Non-linear principal components analysis (PRINCALS),
- Smallest Space Analysis (SSA), and
- Singular Value Decomposition (SVD)

Unfortunately, despite the logic of using an assessment methodology for safety climate, the literature review reveals that these methods are rarely utilized in industry (Cox & Flin, 1998; Coyle el al., 1995; Guldenmund, 2000; Williamson et al., 1997; Zohar, 2000).

The review of existing literature shows the struggles and attempts that safety climate researchers had both defining and reaching universal assessment methodology. Although careless behaviors still remain in industry (NSC, 1999), a methodology to assess safety climate and its usefulness has yet to gain industry wide acceptance. Researchers have yet to tie together the knowledge about safety climate and safety behaviors into best managerial practices to reduce unsafe behaviors in the workplace (Cooper & Phillips, 2004; DeJoy, 1994 & 2005; Prussia et al., 2003; Ostrom et al., 1993; Smith et al. 2006; Zohar & Erev, 2007). This study argues that safety climate researchers have yet to solidify the decision-making processes (cognitive and psychological implications) that cause human decision behaviors to deviate from that predicted by normative models.

2.7 Decision-making

Buchanan and O'Connell (2006) claimed that decision-making has been an area of interest to humankind since the fourth century, since Aristotle argued that in order to understand choice, useful knowledge gained through sensing and deductive reasoning should be important. This interest in choice lies in the fact that human beings are continuously engaged in decision-making processes that are made up of a variety of facets. Decision-making, a process that is guided by a set of rules, involves acquiring and weighing accessible information in order to select the "best" alternative (Mintz, 1993; Mintz & Geva, 1997; Mintz et al., 1997; Simon, 1955). Decision rules, theories, and models have been developed to predict, quantify, and measure people's decision-making processes.

Decision-making theories and models that address the cognitive and behavioral processes study the way people process and organize information and arrive at judgments or conclusions based on their observations of situations (Steers, 1988). Cognitive style reflects "how," rather than "how well" people perceive and judge information (Hough & Ogilvie, 2005).

2.7.1 Behavioral Decision-Making

Four decades ago, Edwards (1954) provided a major review for psychologists concerning research by economists, statisticians, and philosophers on decision behaviors. He argued that normative and predictive decision models should be important to psychologists who are interested in judgment and choice. Simon (1955) further argued that in order to understand judgment and choice (e.g., decision behaviors), research should focus on perceptual, cognitive, and learning factors. These factors explain why human decision behaviors deviate from those predicted by normative models. He also stated that the limited computational capabilities of decision-makers, influenced by the complexity of task environments, create bounded rationality (e.g., decision behaviors that may suggest or reflect limited information processing). Later, Simon (1978) stated that actual decision behaviors might not estimate the behaviors predicted by normative models of decision tasks.

Four decades later, a clear and separate area of inquiry emerged, which is referred to as Behavioral Decision Research (BDR). BDR, an interdisciplinary area of study, employs concepts and models from economics, social and cognitive psychology and statistics (Payne et al., 1992). It is unique among sub-disciplines in psychology, because it tests the descriptive adequacy of normative theories of judgment and choice. By doing so, it makes substantial use of psychological concepts in general and cognitive method in particular.

There is a growing focus on the problem structuring and learning elements of decision behavior, although the amount of such research is still small (Payne et al., 1992). Examples include research on alternative generation (Gettys, Pliske, Manning, & Casey, 1987; Keller & Ho, 1988) and studies of how cues for inference are learned from outcome feedback (Klayman, 1988). The richness of methods and problem descriptions used in decision research continues to increase. For example, process-tracing techniques, case methods, computer-game simulations, and even the presentation of data via radar screens are being used (Brehmer, 1990; Eisenhardt, 1989; Ford, Schmitt, Schechtman, Hults, & Doherty, 1989; Lusk & Hammond, 1991).

Because this review is selective rather than exhaustive, there will only be a review of the major trends (constructive nature of judgment and choice, and decision processing theories and models) and applications of recent BDR. For a more in-depth review on BDR that covers a longer time span and alternative perspectives please see the following literature: Abelson & Levi, 1985; Slovic, Lichtenstein, & Fischhoff, 1988; Stevenson, Busemeyer, & Naylor, 1990.

2.7.1.1 The Constructive Nature of Preferences and Beliefs

An underlying theme of BDR is preferences "for" and beliefs "about" the complexity of an event, that are constructed by people and not revealed in response to a judgment or choice (Slovic, Griffin, & Tversky, 1990). The idea of constructive preferences is more than observed preferences which result from reference to a master list in the memory. Constructive preferences also mean that preferences are not necessarily generated by some consistent and invariant algorithm such as expected value calculation (Tversky, Sattath, & Solvic, 1988).

March (1978) attributes constructive preferences to the same limits on information processing capacity that is emphasized by Simon (1955). In his words, "Human beings have unstable, inconsistent, incompletely evoked, and imprecise goals at least in part because human abilities limit preference orderliness" (March, 1978, p. 598). March's argument about preferences applies to belief judgments as well, and the constructive view as a major organizing theme. It appears that decision-makers have a range of strategies for identifying their preferences and developing their beliefs. These strategies result from both experience and training (Fong, Krantz, & Nisbett, 1986; Kruglanski, 1989; Larrick, Morgan, & Nisbett, 1990).

Descriptive research on decision-making has shown that information acquisition and strategies used to construct preferences or beliefs are contingent upon a variety of task, context, and individual-difference factors (Payne et al., 1992). Task factors are general characteristics of a decision problem, such as response mode (e.g., judgment or choice), which is not dependent upon the values (e.g., context factors) of the alternatives (Payne et al., 1992). Context factors, such as similarity of alternatives, are associated with the particular values of the alternatives. Task and context factors cause different aspects of the problem to be significant and to evoke different processes for combining information. Thus, characteristics of the decision problem, such as the response mode or similarity, can evoke different strategies that determine preferences and beliefs. Further, the characteristics to which people are sensitive often come from a normative perspective, although this is not always relevant (Tversky & Kahneman, 1986; Tversky et al., 1988). Consequently, people sometimes ignore normatively relevant information. Hence, an important component of current decision research is the identification of task conditions that can determine whether normative information will be used (Gigerenzer, Hell, & Blank, 1988; Ginossar & Trope, 1987).

Also, related to the constructive nature of decision behaviors are the conflicting meta-goals adopted for the decision sequence (i.e., maximize accuracy or justifiability, minimize effort, regret, or conflict) (Einhorn & Hogarth, 1981; Tetlock, 1985). Meta-goals are functions of individual difference-factors such as processing capacities and prior knowledge or expertise (Bettman, Johnson, & Payne, 1990; Shanteau, 1988). Another important ongoing issue is the extent to which individual differences in values and beliefs are related across task and context changes (MacCrimmon & Wehrung, 1990; Schoemaker, 1990). Thus, many current issues in BDR can be related to the notion of the constructive nature of human preferences and beliefs and the use of multiple approaches for solving decision problems. These themes show the fundamental elements of BDR (e.g., preferences and beliefs) and multiple strategies aimed at improving decision-making processes (e.g., cognitive and psychological aspects) (Russo, 1977; Simon, 1955; Viscusi, Magat, & Huber, 1986).

2.7.1.2 Application of Behavioral Decision Research (BDR)

BDR is often motivated by the desire to improve decision-making processes (Russo, 1977; Simon, 1955; Viscusi et al., 1986); several approaches to improving decision processes have been identified in the literature (Clemen, 1996; Keeney, 1982; Kirkwood, 1997; Payne et al., 1992; Pratt, Raiffa, & Schlaifer, 1964;). Some researchers emphasize the need for changes in the task environment facing the decision-maker (Payne et al., 1992). For example, because BDR is descriptively variant (e.g., information presentation), it suggests that decisions might be improved through straightforward and imperceptible changes to the information with which individuals make judgments and choices.

Other approaches (e.g., decision analysis) emphasize improving the information-processing abilities of decision-makers for dealing with decision tasks (Clemen, 1996; Keeney, 1982; Kirkwood, 1997; Pratt, Raiffa, & Schlaifer, 1964). Improving the information-processing abilities requires task reconstruction to make judgments and choices easier for the decision-maker (Henrion, Fischer, & Mullin, 1993; MacGregor, Lichtenstein, & Slovic, 1988; Ravinder, Kleinmuntz, & Dyer, 1988). However, decision analysts also try to improve the abilities of decision-makers to cope with complex tasks. This is accomplished through the provision of decision aids (e.g., computer-based decision support systems) and training in statistical and decision-theoretical reasoning (Payne et al., 1992). The combination of task reconstruction, decision aids, and training can possibly improve information processing abilities. The combination of these decision aids can be thought of as methods for improving the match between the task and the person's strategic decision-making abilities. Thus, to further advance the field of BDR, there needs to be more studies on strategic decision-making (e.g., perception, communication, cognitive and environmental factors) (Payne et al., 1992). However, people are more complex than manifested by their observable decisions and behaviors. Therefore, BDR does not provide a reliable portrayal of an individual's complete makeup (Hambrick & Mason, 1984).

Furthermore, both practitioners (managers) and researchers are interested in the process of strategic decision-making and improving the quality of those decisions (Hough & Ogilvie, 2005). As Stubbart (1989) states, most strategy researchers do not accept the "think alike" notion of economic man; instead, they believe that strategy is intentional. There are individual differences in how individuals perceive, acquire, interpret, and use information (Walsh, 1995). Hough and Ogilvie (2005) conducted a resource-based review of strategy, which revealed that these differences are important. Their review showed that how individuals perceive, acquire, interpret, and use information lead to differences in organizational capabilities and performance inconsistencies. Sadler-Smith (1998) states that since cognitive style can affect workers' choice and behaviors, it is essential that researchers examine this further.

2.7.2 Cognitive Style

Messick (1976) defined cognitive style as individual differences in preferred ways of organizing and processing information and experience. Witkin, Moore, Goodenough, and Cox (1977) state that cognitive style is an individual difference in how people perceive, think, solve problems, learn, and relate to each other. They further explain that the way in which people process, organize information, and arrive at judgments or conclusions based on their observations of situations. Hough & Ogilvie, (2005) stated that, cognitive style reflects "how," rather than "how well," people perceive and judge information. Thus, cognitive styles are processes that emphasize individual traits rather than cognitive ability; it focuses on preferred styles rather than which is better. Thus, another area of cognitive research that is relevant to this study in understanding rules, theories, and models of decision-making processes.

2.7.3 Process Characteristics of Decision-Making

A decision task typically consists of the selection of an alternative from a set of options. Rational decision-making is a process by which a set of options is identified, as well as a set of dimensions (efficiency, reputation, safety, etc.) employed to evaluate the alternatives. Weights are then assigned to each dimension; and subsequently, the alternatives are ranked based on the evaluation along all dimensions. Finally, the alternative with the highest weight is expected to be selected.

There are five fundamental processing characteristics of decision-making (Billings & Sherer, 1988; Ford et al., 1989; Keren, Freeman, & Schwab, 2006; Mintz & Geva, 1997; Mintz et al., 1997; Schoemaker, 1980; Sage, 1990), which are relevant to this study: holistic vs. nonholistic decision-making, alternative-based vs. dimension-based decision-making, satisfying vs. optimizing decision principles, risk oriented information acquisition vs. non-risk oriented information acquisition, and choice.

Holistic vs. nonholistic decision-making (Schoemaker, 1980): holistic decision-making is a thorough examination of all available alternatives. This is followed by an exhaustive comparison of the alternatives (and their implications) against each other across the decision dimensions. Nonholistic decision-making is a simplified process whereby the decision maker sequentially disregards or selects alternatives (Sage, 1990) “by comparing them to each other, or against a standard, either across dimensions or across alternatives (p. 233).” The cognitive load in holistic decision-making is demanding, while cognitive load in nonholistic decision-making are streamlined by heuristics (simple, efficient rules by evolutionary processes or learned, which explain how people make decisions) that introduce cognitive shortcuts (Sage, 1990).

Alternative-based vs. dimension-based decision-making (Ford et al., 1989): Alternative-based decision-making processing involves the sequential consideration of alternatives. In an alternative-based process, decision makers consider all the implications of an alternative before considering a second alternative. In contrast, in a dimension-based process, decision makers compare several alternatives against one dimension before considering a second dimension. Decision-making oriented around alternatives is a process whereby all alternatives and dimensions are considered with a pattern oriented toward alternative-based decision-making; In contrast, decision-making oriented around dimension-based is a process whereby alternatives and dimensions are considered with a pattern oriented towards dimension-based decision-making (Mintz et al., 1997).

Safety oriented vs. non-safety oriented information acquisition: In a safety-oriented information acquisition process, safety is a significant dimension. Thus, it is expected that during a safety-oriented information acquisition process, decision makers will intensively review all the implications of safety against a set of alternatives. In contrast, in a non-safety-oriented information acquisition process, safety is not a significant dimension. Thus, it is expected that during a non-safety-oriented information acquisition process, decision makers will not intensively review all the implications of safety against a set of alternatives

2.7.4 Strategy Selection

Beach and Mitchell, (1978) explain that strategy selection is contingent upon characteristics of both the decision task and the individual decision-maker. There are some characteristics which are inherent in the decision problem, which affects strategy selection. For instance, the uncertainty of the task, the amount of relevant information, and the influence of future decisions, will affect strategy selection (Billings & Scherer, 1988). Ford et al. (1989) suggest time and pressure also influence strategy selection since imposed time constraints may affect the format of the information (e.g., exclude some strategies from consideration).

Moreover, strategy selection is also influenced by changes in the format in which the information is presented to decision-makers. Hey and Paradiso (2006) showed how people's evaluation of the same problems differs in respect to their temporal format. Rahn, Aldrich, and Borgida (1994) gave further evidence to the influence of formatting. They examined the importance of individual and contextual variations in information-processing strategies for candidate evaluation. The results of their study showed that differences in presentation format play a critical role in candidate appraisal.

Other influential factors in strategy selection were illustrated by Stone and Schkade (1991). They noted that decision-makers resort to an alternative-based information search and less to compensatory processing, when the values (utilities) associated with alternatives are given in words rather than in numbers. Furthermore, Gilliland, Wood, and Schmitt (1994) conducted another study that found strategy selection was affected by the labeling or non-labeling of alternatives. Their study showed that the labeling of alternatives may facilitate the recollection of information relevant to the decision. This may also cause decision-makers to avoid unfamiliar information. Also, when provided with labels, decision-makers may also employ simplified decision models, because it may appear to them that not all alternatives may need to be accessed or searched.

When information search patterns are compared among scenarios containing familiar and unfamiliar alternatives, a dimension-based pattern is characteristic of the unfamiliar (and therefore more cognitively demanding) scenarios, whereas an alternative-based search is more common in familiar choice sets (Mintz et al., 1997). Mintz et al. (1997) and Tetlock (1992) also show that accountability affects strategy and choice. Decision-makers who must justify their decisions invest more effort in acquiring and retaining information than those who do not have to be stressed over such situations.

Maoz (1997) found a significant relationship between levels of stress and the selection of three particular decision strategies (e.g., analytic, cybernetic, or cognitive). The analytic approach characterizes decision-making at moderate stress levels. The cybernetic approach tends to be associated with low stress; the cognitive approach is often found at high levels of stress. Lastly, Suedfeld, Wallace, and Thachuk (1993) argue that leaders, as “cognitive managers,” ultimately need to weigh the potential advantages and disadvantages of differing levels of complexity in choosing the kind of strategy that they adapt. This will be obvious in the reflection of their choices.

2.7.4.1 Effect of Strategy Selection on Choice

Payne, Bettman, and Johnson (1988) stated that the selection of a particular strategy affects the ultimate choice. Thus, it is expected that judgment and choice outcomes will differ based on the type of strategy used. For instance, Hinson, Jameson, and Whitney (2003) conducted a study on decision-making where decision-makers favored short-term over long-term consequences of actions. Short-term consequences of action were defined as impulsive or temporally intolerant. This relates to individual differences in the decision-making functions of working memory, which affected preference (alternative or attribute) and choice outcomes.

Ford et al. (1989) stated that choices by alternative and dimensions are different. Similarly, choices based on a compensatory strategy are very different from those made under non-compensatory rules. Often the strategy selection and choice are based on accessibility to vital information.

Sharps and Martin (2002) conducted research where they demonstrated that people often make decisions without reference to vital information, even when such information is readily available. This tendency originates from a failure to have pertinent information immediately available in the decision context. Thus, the presentation of pertinent information in immediate decision contexts, even information available in long-term memory, can improve understanding of decision situations and reduce “mindless” decision processes. Another area of research that is vital to referencing important information is the state of mind or mood of individuals (Jonas, Graupmann, & Frey, 2006; Nabi, 2003).

Jonas et al. (2006) conducted a study on the interplay between dissonance theory and mood regulation approach. They examined how individuals search for information after making a decision while under the influence of positive versus negative mood. Dissonance theory (Festinger, 1957) is based on two factors:

1) Cost incurrence will increase the decision maker’s perceived value of choice or outcomes, and
2) Individuals are motivated to reduce a negative state and engage in dissonance-reducing strategies to accomplish cognitive consonance (harmony).

Jonas et al. (2006) suggested that negative moods increase the preference for consonant (consistent) over dissonant (variance) information during decision-making. They showed that a positive mood leads to a more balanced information search by decision-makers. Thus, people’s emotional state will determine their preference, value, strategy selection, and choice whether the problem is consonant or dissonant (Jonas et al. 2006; Simonson, 1989).

The selective nature of this literature review on decision-making illustrates the extensive research studies on decision rule theories and models, some of which are not covered by this study. The relevant literature on decision-making offers a framework from which to correlate safety climate with safety decision-making. Thus, several of these fundamental models and theories will be incorporated into this study.

CHAPTER 3. METHODOLOGY

3.1 Introduction

In order to examine the relationship between the strength of a safety climate and the orientation towards safety in a decision-making processes and choices, questionnaire and decision scenarios were used in this study. Through these methods, this study hopes to answer the following questions: *Can the strength of a safety climate predict safer decision-making process and choice?*

Both the questionnaire and decision scenarios methods were administered through the web. The study was conducted in a manufacturing facility in Iowa. It included 111 of the 186 employees in the facility.

3.2 Instruments

The intended research study proposes to investigate the relationship between safety climate and safety decision-making through the utilization of two instruments:

- Safety climate survey, were developed and distributed to employees in a manufacturing environment. Variety of indices was used to quantitatively correlate between strength of safety climate and safety decision-making.
- Decision Mind software, a web based decision-making simulation program was utilized to capture decision-making processes and choices among participants. Participants were asked to work on the simulation following completion of the safety climate survey.

3.2.1 Safety Climate Survey

A survey was constructed to measure key areas of safety climate. The first step in developing this survey was to identify primary areas of interest in this research. These areas were determined from a meta-analytic review of consistent themes in prior safety climates studies (Guldenmund, 2000; Flin et al., 2000). These themes are:

- Management commitment to safety,
- Functionality of organizational safety system,
- Peer pressure/work pressure,
- Employees' competencies, and
- Communication/ Policy and procedures

Flin et al. (2000) suggest that these themes are vital when measuring employees' perceptions of management attitudes and behaviors with respect to safety and productivity. Thus, these five themes were used as a foundational point in developing the areas of interest of this study.

The safety climate survey was developed to measure employees' beliefs, perceptions, training, previous experience, and attitudes. Through a review of 29 safety climate surveys, over 400 statements/questions were generated (Berends, 1996; Brown & Homles, 1986; Cabrera, Isla, & Vilela, 1997; Carr et al., 2003; Cooper, 1995; Cooper & Phillips, 1994; Coyle et al., 1995; Cox & Cox,1991; Dedobbeleer & Beland, 1991; DeJoy, Schafferb, Wilson, Vandenberg, & Butts, 2004; Flin et al., 2000; Geller, 1994; Glennon,1982a, & 1982b; Lee, 1996; Havold, 2005; Michael et al. 2005; Niskanen, 1994; Olive, O'Connor, & Mannan, 2006; Ostrom et al., 1993; Safety Research Unit, 1993; Seo Torabi, Blair, & Ellis, 2004; Sheron, Shotkin, & Baratta, 1993; Williamson et al., 1997; Zohar, 1980; Zohar & Luria, 2003). These statements/questions were reduced by half, by first controlling for recurring and parallel statements/questions (i.e., those conveying the same meaning). These statements/questions were further reduced by controlling for personal identifiers (e.g., gender, age, and other demographics). This step was taken in order to maintain anonymity among the participants. Maintaining anonymity is a key component to evoking honest responses from participants. Jordan and Lundin's (2002) study on workplace conflict revealed that participants view anonymity as a great advantage when expressing their true and personal feelings. Once all personal identifiers were eliminated, the goal was to select statements that measured areas of interest within this research. These statements were then categorized into seven areas of interest.

A questionnaire of 33 statements was created. It was organized by the following areas of interest of this study:

- ***Management commitment to safety:*** Seven statements addressing management's commitment to safety as reflected in the balance of safety over productivity,
- ***Communication of safety expectations/goals:*** Four statements addressing communication about safety expectations, goals, and performance of employees,
- ***The Functionality of organizational safety:*** Eight statements addressing safety personnel's authority and availability, accident investigation, safety performance feedback and evaluation, and enforcement issues,
- ***Physical Working Environment:*** Four statements addressing the physical condition of the work environment,
- ***Compliance with Procedures:*** Five statements addressing the relationships among co-workers, and
- ***Competence:*** Five statements addressing transfer of learning from safety training, and management/supervisors' familiarity with safety requirements.

A seventh dimension was created following the factorial analysis of the survey data (see Appendix A). This was done because the analysis of the survey data showed that two statements did not correlate with dimension three, *functionality of organizational safety*. This new dimension was presented as follows:

- ***Safety Performance:*** Two statements addressing safety performance feedback and its effects on promotion.

In order to measure the perception of these dimensions, a variation of the 5-point Likert scale was used (Latham, 2006). A Likert scale is a psychometric response scale widely used in survey research. When responding to a Likert questionnaire item, participants specify their level of agreement with a statement/question. Thus, the statements in this study were arranged on a 5-point Likert scale. Responses range from *strongly disagree* (a value of one) to *strongly agree* (a value of five). All the statements were constructed with positive valence (i.e., the higher the rating the more favorable the response). The statements are listed below in Table 3.1.

Table 3.1 *Safety Climate Dimensions and Statements*

Management Commitment
Managers are committed to safety.
Safety is given priority over productivity.
Managers are always examples of appropriate safety procedures.
Work will not begin until we are properly staffed to perform work safely.
Exemplary safety performance is recognized/awarded.
Employees are authorized to stop work process if hazards arise.
Reports of safety concerns are addressed appropriately.
Communication of safety expectations/goals
Company safety performance is widely communicated.
Management clearly defines/emphasize safety performance expectations/goals.
Top management is receptive when middle management expresses their concerns with maintaining appropriate safety level.
Supervisors are always receptive to reports of safety concerns.

Table 3.1 *Safety Climate Dimensions and Statements* (Contd).

The Functionality of organizational safety
Safety personnel are authorized to stop production in case of a safety concern.
Safety personnel are available in a timely manner to address safety concerns.
Accidents are thoroughly investigated
Accident investigation recommendations are implemented in a timely manner.
Safety staff enforces safe working practices on employees.
Safety staff enforces safe working practices on managers.

Safety Performance
I receive safety performance feedback during my employee evaluation.
Personnel safety record play role in evaluation for promotion process.

Physical Working Environment
Working conditions (noise, temperature, lighting, required work posture, etc.) are comfortable.
Safety concerns (electrical faults, broken ladder, spills etc.) are repaired in a timely manner.
Tools/equipments are adequate to perform my job safely.
We are required to keep our work areas clean and in order.

Compliance with procedures
We do not take safety shortcuts at work (not following safety procedures).
Supervisors encourage us to report co-workers who take safety shortcuts.
My co-workers will not ask me to take shortcuts.
My relationship with my co-workers will NOT be affected if I refuse to take safety shortcuts
My co-workers will report my behavior if I take a safety shortcut.

Competence
The knowledge I gained from safety training helps me to perform my work safely.
Policies and procedures strongly emphasize safe working practices.
Supervisors are familiar with safety requirements specified in the policies/procedures.
I can easily understand safety documents and their meaning.
My co-workers are familiar with safety requirements specified in the policies/procedures.

This questionnaire was reviewed and approved by the Iowa State University's Institutional Review Board (see Appendix B). The questionnaire was administered to the participants through the use of a web-base program, Survey Monkey (www.surveymonkey.com).

The questionnaire provided the background upon which inferences can be made about participants' decision-making processes and choices.

3.2.2 Decision-Making Simulation

Process tracing is a methodology designed to identify the information accessed and the order in which the information is viewed during a decision-making process. The data gathered from process tracing can be used to make inferences about which decision strategies were employed en route to a choice (Payne, Bettman & Johnson, 1993). In this study, the Decision Mind™, software used to simulate decision-making, was utilized to facilitate decision process tracing.

The Decision Mind™ simulator facilitates decision process tracing. The computerized Decision Mind ™ software records key features of a decision-making process, such as: the sequence in which participants acquire information, the number of items that participants viewed for every alternative along each dimension, the time period from the start of the decision task until the participants make a choice, and the participants' final choice. The Decision Mind™ simulator then displays the "decision portraits" of each participant. In addition, the Decision Mind™ simulator calculates indices about the information search for each of the key features of a decision-making process described above (Mintz, 2004, 2005). Information search indices are new features that use information collected by Decision Mind™ simulator. The categorization of these search indices are complied by the Decision Mind™, without numerical interpretations. Therefore, calculations for Dimension Search Indices are made separately.

The core structure of the Decision Mind™ simulator is a matrix of decision alternatives (A_i) and decision dimensions (D_j), as presented in Figure 3.1. The participants are introduced to the decision matrix electronically (web-based computer program). Participants are expected to choose an alternative from a set of alternatives based on the information they acquire from the scenario in the Decision Mind™ simulator. This information is acquired by "clicking" on information buttons V_{ij}. The information available in V_{ij} represents the evaluation of a given alternative (A_i) on a given dimension (D_j). V_{ij} consists of a descriptive statement (e.g., implication of alternatives against each dimension and vice versa) and a numeric rating value (on a scale from -10 to +10). A lower numeric rating (less than zero) refers to a negative evaluation, and a high numeric rating (greater than zero) refers to a positive evaluation. The numeric values are intended to create a sense of scaled impact that an alternative will have on each dimension.

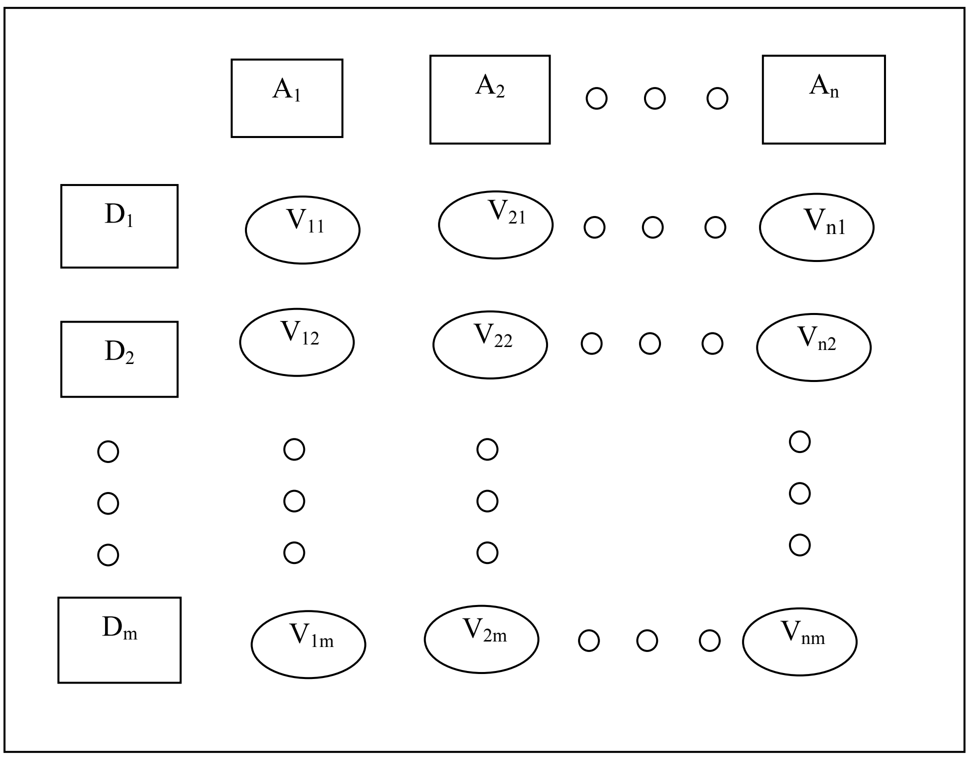

Figure 3.1. Decision Mind^{MT} Simulator

The Decision Mind simulator records key features from the decision-making process of each participant:

- The sequence in which participants acquire information,
- The number of items viewed by participants, for every alternative along each dimension,
- The time period from the start of the decision task until the participants make a choice, and
- The final choice of each participant.

3.2.2.1 Decision Scenario

The majority of industrial operations are documented in Standard Operating Procedures (SOP). SOPs provide detailed guidelines for most industrial operations. Failure to follow SOPs (taking a “short cut”) has been linked to injuries and accidents in the workplace (NSC, 1999). For this reason the focus of the decision scenario is on complying with SOPs. The text of the scenario was stated as follows:

> *You are employed by a steel manufacturing plant. During day to day routine activities one co-worker suggests taking a short cut in implementation for one of the standard operating procedures. Your decision will have implications in the following dimensions:*

- *Peer Pressure*,
- *Safety*,
- *Productivity*, and
- *Promotion*.

You have the following four alternatives:

- *Ignore: Just ignore the suggestion and continue with work*;
- *Report without details: Disagree with the suggestion and report the event without mentioning names in the situation*;
- *Agree: Agree with the suggested short cut*; *and*

- *Report with details: Disagree with the suggestion and report the event including names and situation.*

When you are ready, follow the steps below in order to initiate and complete the simulation:

After reviewing the scenario, the participants engaged in an information acquisition process in order to make a choice. This process involved reviewing the descriptive statements and numeric ratings based on the scenario, as presented in Appendix C.

A key feature of the Decision Mind™ Simulator is the descriptive statements and numeric ratings of the safety dimension. The descriptive statements are the evaluation of the alternatives across the dimensions. The text and numeric ratings in the information bins (V_{ij}) were developed by a panel of safety experts. This was accomplished by following the Delphi guidelines (Armstrong, 2006). The Delphi method is a way of structuring a group communication process. This process is effective in allowing groups to deal with a complex problem (Linstone, Turoff, & Helmer, 2002). To accomplish this "structured communication" the following steps must occur:

- Feedback on the information (knowledge) contributed by individuals,
- Evaluation of the group's judgment,
- Opportunities for individual revision, and
- A degree of anonymity for the individual responses.

Through this process a consensus was reached on the appropriate numeric ratings and text.

Based on the interest of this study, the safety dimension was used as a reference for the rankings and evaluations of the alternatives. The best choice, according to normative decision models, is the alternative with the highest numeric rating. In this study the "best" alternative is the one with the most favorable rating on safety. The safety ratings for each alternative are presented in Table 3.2.

Table 3.2 *Evaluations of Alternatives on the Safety Dimension*

Alternatives	Score on Safety
Agree	-8
Just Ignore	-6
Report without details	4
Report with details	10

3.2.2.2 Search Indices

The search indices measure the number of times information bins are reviewed on a certain dimension, with respect to the average number of times information bins are reviewed along all other dimensions (Keren et al., 2006). In this study, the following four dimensions accounts for the search indices: Peer Pressure (*Pres_SI*), Safety (S_SI), Productivity (Prod_SI), and Promotion (*Prom_SI*). These indices are calculated as follows:

$$Pres\_SI = \frac{N_{Pressure}}{\frac{1}{n-1}\sum_{i=1}^{n-1} N_{i\_Pres}} \tag{3-1}$$

where

$N_{Pressure}$ represents the number of times Pressure information bins were visited.

N_{i_Pres} represents the number of times information bins in other dimensions *i* (besides Pressure) were visited.

n represents the number of dimensions in the decision matrix.

$$S\_SI = \frac{N_{Safety}}{\frac{1}{n-1}\sum_{i=1}^{n-1} N_{i\_Safety}} \tag{3-2}$$

where

N_{Safety} represents the number of times Safety information bins were visited.

N_{i_Safety} represents the number of times information bins in other dimensions *i* (besides Safety) were visited.

$$Prom\_SI = \frac{N_{Production}}{\frac{1}{n-1}\sum_{i=1}^{n-1} N_{i\_Prod}} \qquad (3\text{-}3)$$

where

$N_{Productivity}$ represents the number of times Productivity information bins were visited.

N_{i_Prod} represents the number of times information bins in other dimensions *i* (besides Productivity) were visited.

$$Prom\_SI = \frac{N_{Produmotion}}{\frac{1}{n-1}\sum_{i=1}^{n-1} N_{i\_Prom}} \qquad (3\text{-}4)$$

where

$N_{Promotion}$ represents the number of times Promotion information bins were visited.

N_{i_Prom} represents the number of times information bins in other dimensions *i* (besides Promotion) were visited.

3.3 Hypotheses.

To address the relationship between the strength of safety climate and safety decision-making, the following four hypotheses have been introduced:

- Hypothesis A: The seven safety climate categories cannot predict safety oriented decision-making process.
- Hypothesis B: The composite safety climate score cannot predict safety oriented decision-making process.
- Hypothesis C: The seven safety climate categories cannot predict selection of a safer choice.

- Hypothesis D: The composite safety climate score cannot predict selection of a safer choice.

Multiple regression analysis was used as a predictive model to test hypothesis A. Simple regression analysis was used as a predictive model to test hypothesis B. Multinomial regression analysis was used a predictive model to test hypothesis C and D. The predictive models for hypotheses A and C will use the same independent variables, and the predictive models for hypotheses B and D will use the same independent variable.

3.4 Analysis

Statistically, the test for the hypotheses will have the following forms:

Hypothesis A:

H_o: $Y = \beta_0 + \varepsilon$ (3-5)

H_A: $Y = \beta_0 + \beta_1 X_1 +,...,+ \beta_k X_k + \varepsilon$ (3-6)

Where *Y* is the dependent variable, (*S_SI)*, *k* is the number of predictors, $X_1 ... X_k$ are the set of predictors, $\beta_0, \beta_1,..., \beta_k$ are the regression coefficients, and ε is the error term.

Hypothesis B:

H_o: $Y = \beta_0 + \varepsilon$ (3-7)

H_A: $Y = \beta_0 + \beta_1 X_1 + \varepsilon$ (3-8)

Where *Y* is the dependent variable, *S_SI*, *k* is the number of predictors, X_1 is the predictor, β_0, β_1 are the regression coefficients, and ε is the error term.

Hypothesis C:

H_o: $Log\left(\frac{\Pr(Y = i \mid \mathbf{X})}{\Pr(Y = 4 \mid \mathbf{X})}\right) = \beta_0 + \varepsilon$ (3-9)

H$_A$: $$Log\left(\frac{\Pr(Y=i\,|\,\mathbf{X})}{\Pr(Y=4\,|\,\mathbf{X})}\right)=\beta_0+\beta_1X_1,...,\beta_kX_k+\varepsilon \quad (3\text{-}10)$$

Where $\Pr(Y=i\,|\,\mathbf{X})$ are the odds of selecting choice i given the set of predictors, and k is the number of predictors, $X_1 ... X_k$ is the predictor, β_0, β_1 are the regression coefficients and ε is the error term

Hypothesis D:

H$_o$: $$Log\left(\frac{\Pr(Y=i\,|\,\mathbf{X})}{\Pr(Y=4\,|\,\mathbf{X})}\right)=\beta_0+\varepsilon \quad (3\text{-}11)$$

H$_A$: $$Log\left(\frac{\Pr(Y=i\,|\,\mathbf{X})}{\Pr(Y=4\,|\,\mathbf{X})}\right)=\beta_0+\beta_1X_1+\varepsilon \quad (3\text{-}12)$$

Where $\Pr(Y=i\,|\,\mathbf{X})$ are the odds of selecting choice i given the predictor, and k is the number of predictors, $X_1 ... X_k$ is the predictor, β_0, β_1 are the regression coefficients and ε is the error term

For all four hypotheses, $\alpha < 0.05$ will be used as an acceptance/rejection criterion.

3.4.1 Independent Variables

Based on the hypotheses of the study there are two sets of continuous independent variables for both the regression and multinomial models:

- The average scores for all the participants for each of the seven categories in the safety climate questionnaire.
- The composite score of the seven categories of the safety climate questionnaire.

3.4.2 Dependent Variables

For hypotheses A and B, the continuous variable *S_SI* is the dependent variable. It is calculated using equation 3-2:

For hypotheses C and D, the categorical (e.g., nominal) variable, *choice* is the dependent variable. The categories for this variable are *agree*, *just ignore*, *report without details*, and *report with details*, which were established in the decision scenario.

3.4.3 Predictive Models

Multiple regression analysis uses a set of predictors to predict a continuous response (i.e., a dependant variable that is continuous). The simple regression analysis is the same as multiple regression analysis except it only has one predictor. Multinomial regression analysis is similar to multiple and simple regression analysis in that it uses a set or one predictors (i.e., independent variables that are continuous or categorical), but it tries to predict a categorical response (i.e., a dependant variable that is categorical). Therefore, multiple regression analysis will be used to address hypothesis A. Simple regression analysis will be used to address hypothesis B. Multinomial regression analysis will be utilized to find a predictive model for hypotheses C and D. The software Statistical Package for the Social Sciences (SPSS, version 15.0) will be used to run the analysis on both of these predictive models.

In the multiple and simple regression analysis, it is expected that an increase in safety climate scores (the averages of seven predictors or the composite of seven predictors) will lead to a higher *S_SI*, which reflects safer oriented decision-making. The mathematical representation of these models is as follows:

Multiple Regression Analysis:

$$Y = \beta_0 + \beta_1 X_1 + ... + \beta_k X_k + \varepsilon \tag{3-13}$$

Simple Regression Analysis:

$$Y = \beta_0 + \beta_1 X_1 + \varepsilon \tag{3-14}$$

where

Y = Dependent variable (e.g., *S_SI*)

$X_1,\ldots,X_k$ = Independent variables (the averages for seven predictors or the composite of seven predictors)

$\beta_1,\ldots,\beta_k$ = Regression coefficients corresponding to each predictor

β_0 = y-intercept, the value of y when all predictors are zero

k = the number of predictors for hypothesis A, $k = 7$ or 1

ε = is the error term (i.e., potential noise in the data).

For the purpose of this study, *S_SI* was the primary interest in the information acquisition process. The model simultaneously describes the effects of the set of predictors on *S_SI*. An F-test was used to test whether all the regression coefficients (β) equal zero at the same time (α = 0.05). If this is rejected, it suggests that at least some of the predictors have an effect on *S_SI*.

Each estimated regression coefficient (e.g., $\hat{\beta}$) reflects the effect of a particular predictor on the *S_SI* when all the other predictors remain unchanged. The estimated coefficients are interpreted as follow:

For example, if $\hat{\beta}$ for commitment is 0.5, it is expected that for every unit increase in commitment scores, the participants *S_SI* will increases by 0.5 when all other scores remain the same.

If $\beta > 0$, then *S_SI* will increase as the predictive variable increase.

If $\alpha > 0.05$ then there is no significant evidence that β is different from zero. In other words, the corresponding predictor for that beta will not be useful in predicting *S_SI*.

In the multinomial regression analysis, it is expected that an increase in safety climate scores (the averages of seven predictors or the composite of seven predictors) will lead to higher odds of choosing choice 4, *report with details* (e.g. use as the reference, because it is considered to be the safest choice). The mathematical representation of these models is as follows:

$$Log\left(\frac{\Pr(Y=i\,|\,\mathbf{X})}{\Pr(Y=4\,|\,\mathbf{X})}\right)=\beta_0+\beta_1X_1,...,+\beta_kX_k+\varepsilon\text{ , } i=1,\ 2,\ 3. \qquad (3\text{-}15)$$

$$Log\left(\frac{\Pr(Y=i\,|\,\mathbf{X})}{\Pr(Y=4\,|\,\mathbf{X})}\right)=\beta_0+\beta_1X_1+\varepsilon\text{ , } i=1,\ 2,\ 3. \qquad (3\text{-}16)$$

where

Y = Dependent variable (i.e., choice 1 - 4)

i = 1(*agree*), 2(*just ignore*), 3(*report without details*)

$X_1,...,X_k$ = Independent variables (the average scores for seven predictors or the composite score of seven predictors)

$\beta_1,...,\beta_k$ = Regression coefficients corresponding to each predictor.

β_0 = y-intercept is the value of the logit when all predictors are zero.

k = Is the number of predictors, for hypothesis B, k = 7 or 1

$\Pr(Y=i\,|\,\mathbf{X})$ = is the probability that the dependent variable Y (i.e., choice) equals choice i, given the set of predictors $\mathbf{X}=(X_1,...,X_k)$

$\Pr(Y=4\,|\,\mathbf{X})$ = is the probability that choice 4 (*report with details*) is chosen given the set of predictors.

$\frac{\Pr(Y=i\,|\,\mathbf{X})}{\Pr(Y=4\,|\,\mathbf{X})}$ = The odds of selecting choice i instead of choice 4

$Log\left(\frac{\Pr(Y=i\mid \mathbf{X})}{\Pr(Y=4\mid \mathbf{X})}\right)$ = The logit (i.e., log of the odds), i = 1, 2, and 3

In this predictive model, choice 4 (*report with details*) was chosen as a baseline/reference category because it was ranked the most important in terms of safety. The model simultaneously describes the effects of the set of predictors on the three logits (equation 3 - 15). The exponent of the estimated regression coefficients ($\exp(\beta)$) reflects multiplicative effects of the predictors on the odds that participants will select one of the other three choices instead of *report with details.* $\exp(\beta)$ is the odds ratio calculated as the odds at an additional unit for the predictor (e.g., X = x + 1) divided by the odds at the initial value of the predictor (e.g., X = x). This is denoted as:

The estimated coefficients odds ratios are interpreted as follows:

$$\frac{odds(\mathrm{X}+1)}{odds(\mathrm{X})}=\left(\frac{\frac{\Pr(Y=i\mid \mathbf{X}=x+1)}{\mathrm{PR}(\mathrm{Y}=4\mid \mathbf{X}=x+1)}}{\frac{\Pr(Y=i\mid \mathbf{X}=x)}{\Pr(Y=4\mid \mathbf{X}=x)}}\right)=e^{\hat{\beta}_1}$$

(3-17)

For example, in the equation (3-15) for the first logit (when i = 1); assumes $\exp(\beta)$ for commitment is 0.5, then, for every unit increase in commitment score, the odds that participants select *ignore* (choice 1) instead of *report with details* (choice 4) increases multiplicatively by 0.5. Equivalently, the odds that a participant select *report with details* (choice 4) instead of *ignore* (choice 1) increases multiplicatively by 2 (e.g., 1/0.5). The estimated probability plots are also used to illustrate the effect of the predictor in the result section.

If exp (β) < 1, then choice 4 is preferred

If α > 0.05 then there is no significant difference in the odds of choosing i or choice 4 as the predictor increases by one unit.

3.5 Participants

Participants were employees of a manufacturing facility in the state of Iowa. The facility employs 186 workers. From this group, 111 front line employees participated in the research. Participants were comprised primarily of production and maintenance workers from all three shifts (i.e., 24-hour period). To maintain the anonymity of each participant, an ID number was given to each participant. This ID number was randomly assigned for completion of both the questionnaire and Decision-Mind scenario.

On average, participants completed both the questionnaire and Decision-Mind scenario in 15 minutes. The data was collected over a three-day period, during February 21 - 23, 2007.

The purpose and aim of the study were introduced to each participant, with a consent letter. The participants voluntarily agreed to participate in the study (e.g., questionnaire and scenario). Participants were allowed to ask clarifying questions during their interaction with both programs. In addition, participants were provided with technical assistance if any technical difficulty arose with the web-based programs.

CHAPTER 4. RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results of the analysis. First, a summary of the data collected will be presented. Then, the results from the predictive models will be discussed.

4.2 Safety Climate Survey

The statements in the questionnaire were constructed to address one of the seven areas of interest in this study (*management commitment*, *communication*, *functionality of organizational safety*, *role of safety performance in promotion*, *physical work environment*, *compliance with procedures*, and *competence*). Therefore, the average rating of each statement indicates the participants' perceptions of how these seven areas are being operationalized within their organization. The composite of the seven categories was constructed to represent the level of safety climate within the participants' place of employment.

The dimension for *management commitment* had an average rating of 3.4 with a standard deviation of 0.75 (Figure 4.2). The distribution of the ratings for *management commitment* indicate that in average participants *neither agree nor disagree* than *agree* on the general strength of commitment management. Seven items addressed the dimension of *management commitment* (Figure 4.3). Two items in this category scored an average below three, which presents a major concern:

- "Work will not begin until we are properly staffed to perform work safely," average of 2.5.
- "Exemplary safety performance is recognized/awarded," average of 2.9.

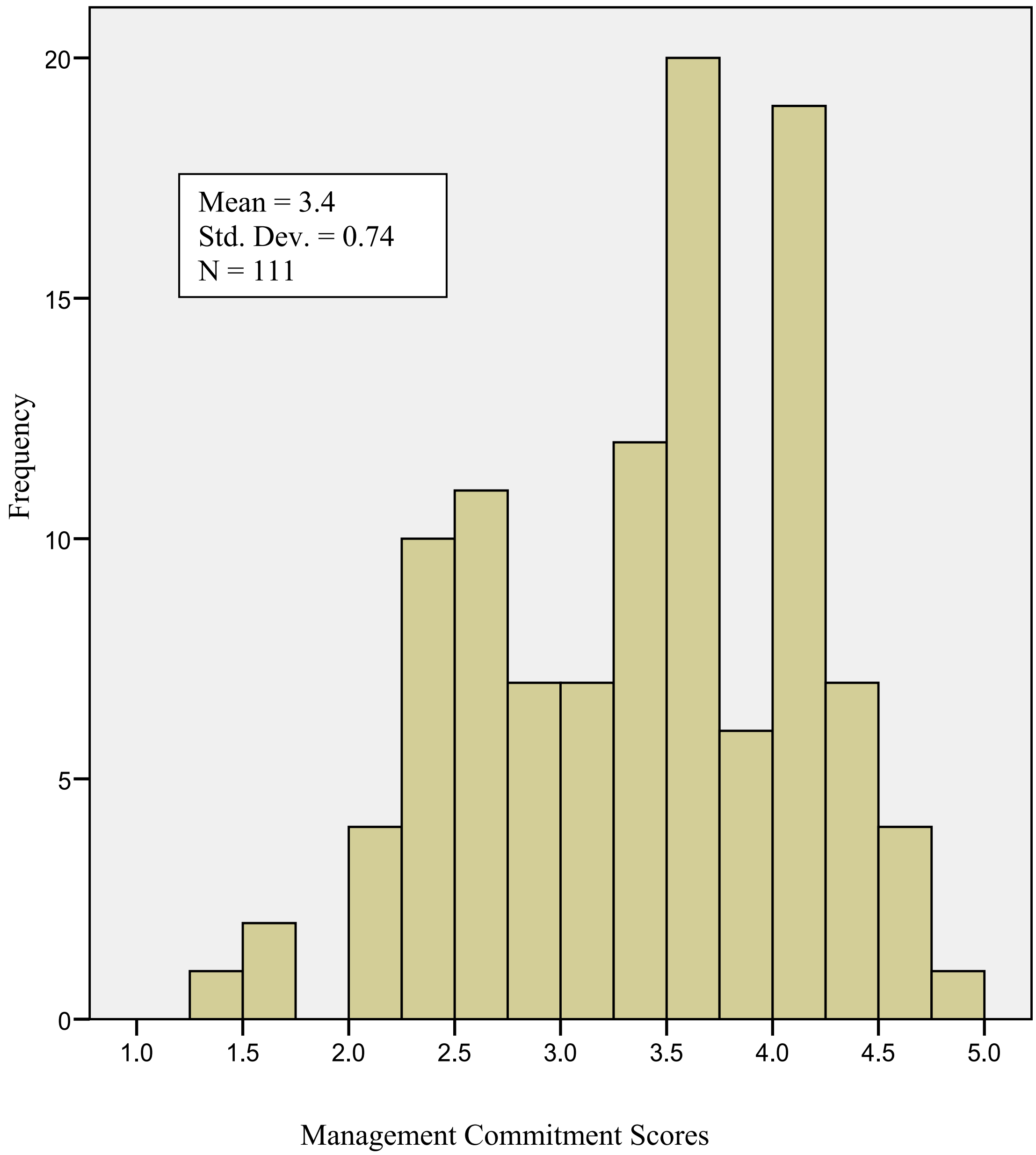

Figure 4.2. Distribution of scores in Management Commitment

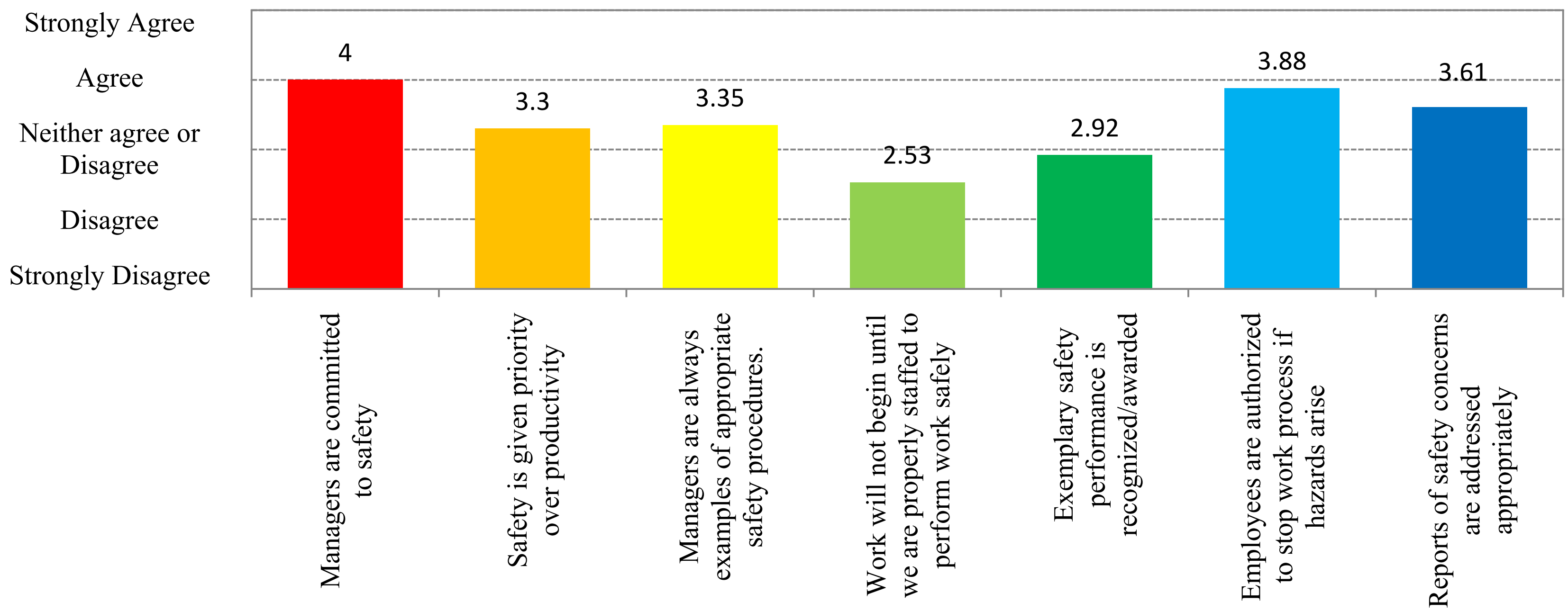

Figure 4.3. Average for statements in Management Commitment

These are alarming values. Zohar (2002), Zohar and Luria (2003), and Zohar and Erev (2007) suggest that these two items are critical to participants' safety performance. They indicate that management, who makes safety contingent upon productivity, cause employees to infer that safety has low priority. Their studies demonstrate that safety behaviors depend largely on external supervisory contingencies (i.e., rewards and work pressures) rather than internal self-preservation considerations.

The dimension *communication* of safety goals and expectations had an average rating of 3.9 and a standard deviation of 0.63 (Figure 4.4). The data indicates that on average participants agreed that the company communicated safety goals and expectations well. Four items addressed the dimension of *communication* (Figure 4.5). The general perception is that management communicates safety goals and expectations very well ($\mu = 4.1$). However, upper management receptivity to middle management (i.e. line supervisor) concerns for safety improvement was rated the lowest ($\mu = 3.5$).

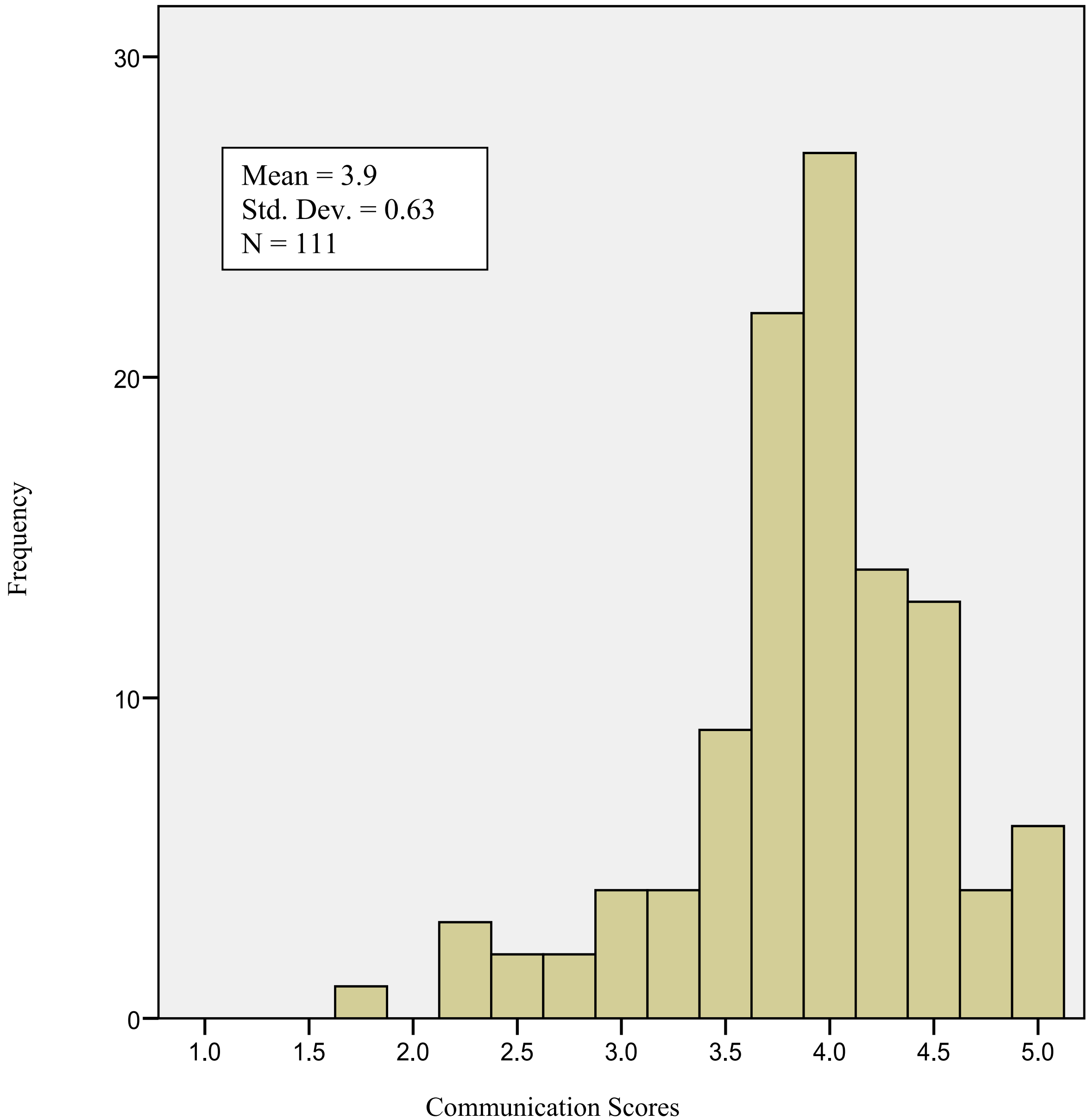

Figure 4.4. Distribution of scores in Communication

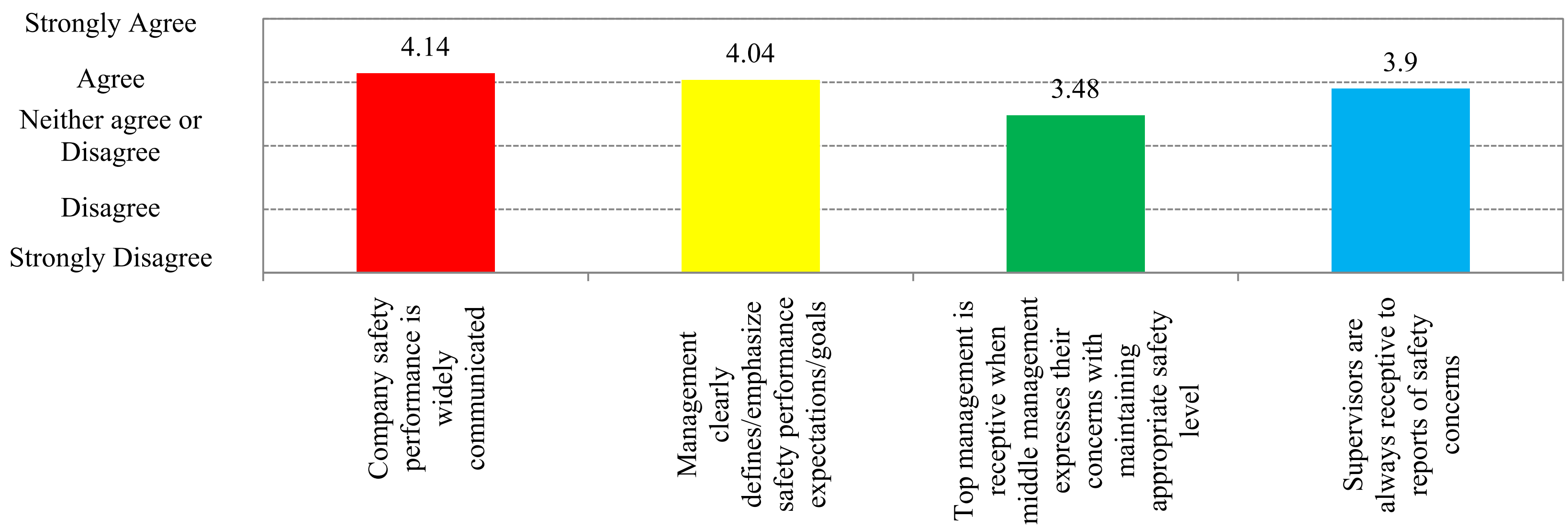

Figure 4.5. Average for statements in Communication

Zohar (2002) and Zohar & Luria (2003) suggest that the level of safety communication between upper management and middle management is a main criterion of how participants view the functionality of safety within the organization. The authors argue that safety priority dictated by upper management influences supervisors' safety practices and leadership styles.

The dimension *functionality of organizational safety* had an average rating of 3.7 and a standard deviation of 0.64 (Figure 4.6). The data indicate that there is some agreement with regards to the strength of *functionality of organizational safety*. Six items addressed the dimension of *functionality of organizational safety* (Figure 4.7). The general perception is that management insists on investigating accidents (μ = 4.0). However, management and safety staff seems to struggle with enforcing SOPs (policies and procedures) (μ = 3.3).

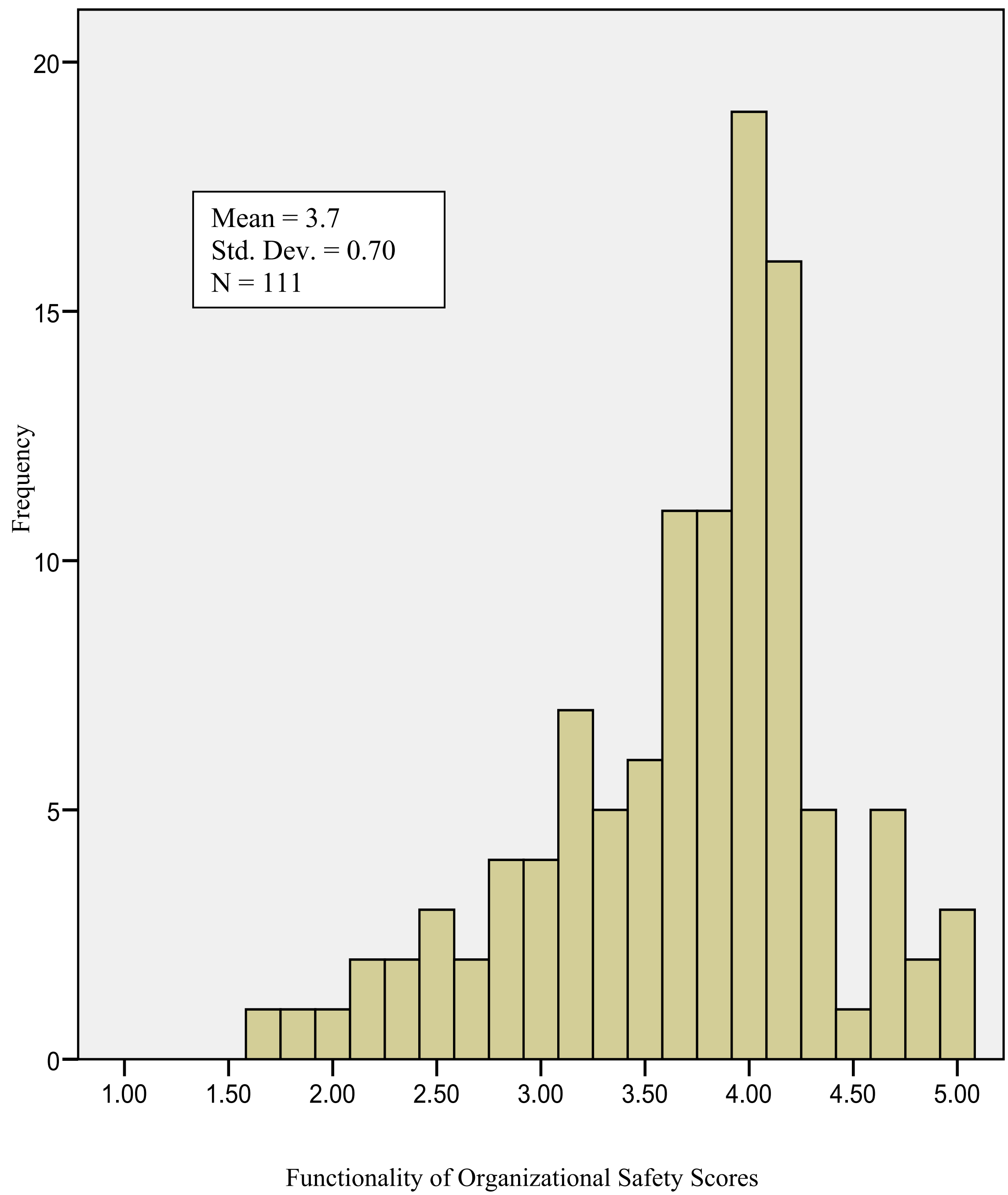

Figure 4.6. Distribution of scores in Functionality of Organizational Safety

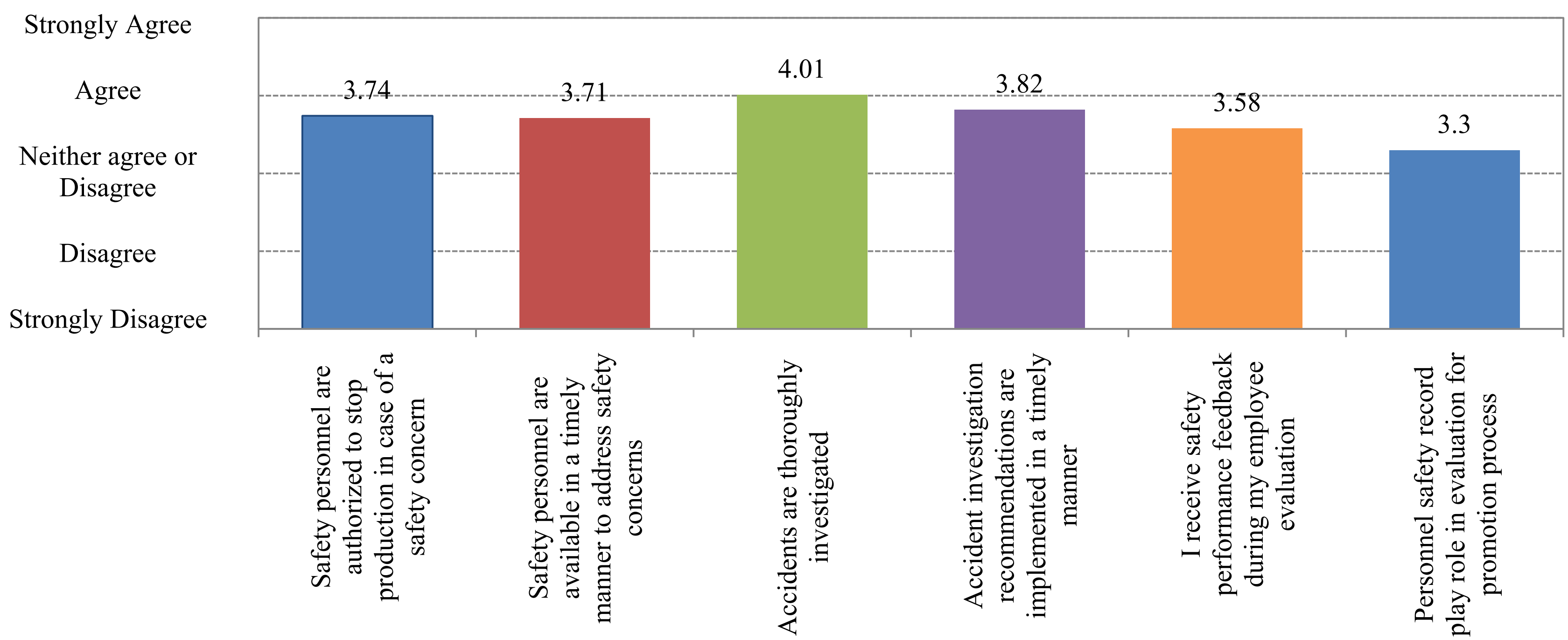

Figure 4.7. Average for statements in Functionality of Organizational Safety

The defiance of SOPs has been correlated with risk-taking behaviors (Bax et al., 1998; Hudson et al., 1998; Lee, 1996; McDonald, 1998; Reason et al., 1998). Lee (1996) showed that failure to enforce safety policies and procedures correlates with risk-taking behaviors, and is highly connected with accident involvement in the workplace.

The dimension *safety performance* had an average rating of 3.3 and a standard deviation of 0.16. Some participants agreed that the company communicates, measures, and reports the safety performance of the organization. Two items addressed the dimension of *safety performance* (Figure 4.8). The general perception is that management provides performance feedback to participants ($\mu = 3.5$). However, participants seemed to be uncertain if their safety performance played any role for potential promotion ($\mu = 3.2$).

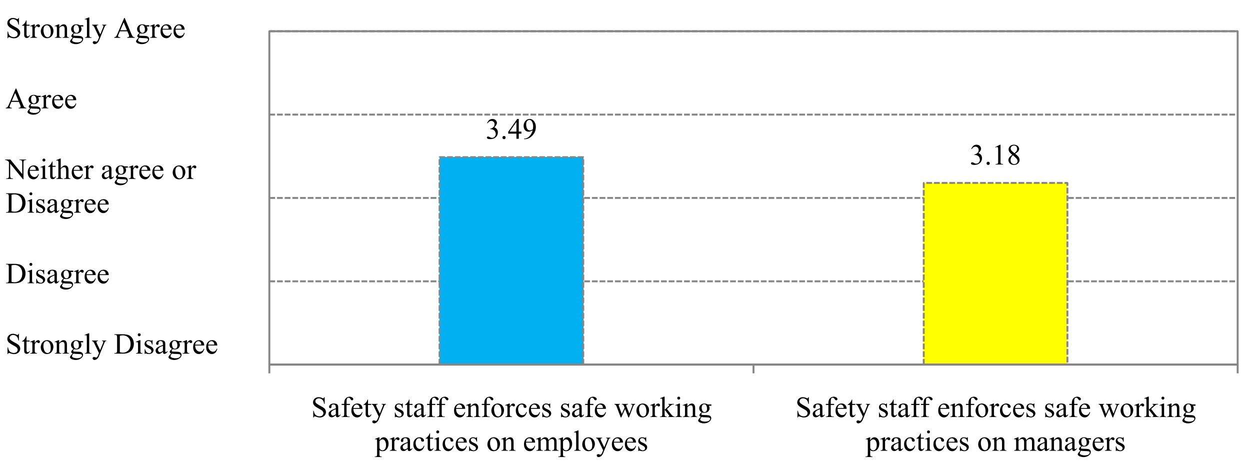

Figure 4.8. Average for statements in Safety Performance

This is an area of interest that has not been studied extensively in any of the literature reviewed in this study. However, safety performance and its role in participant promotion were assumed to be a key criterion of how participants perceive the value of safety in their organization.

The dimension *physical environment* had an average rating of 3.5 and a standard deviation of 0.65 (Figure 4.9). There is some agreement that the physical work environment was comfortable and safe. Four items addressed the dimension of *physical environment* (Figure 4.10). There is strong agreement that management requires a clean and orderly work environment (μ = e 4.5). However, participants did not find their work environment comfortable (μ = 3.1).

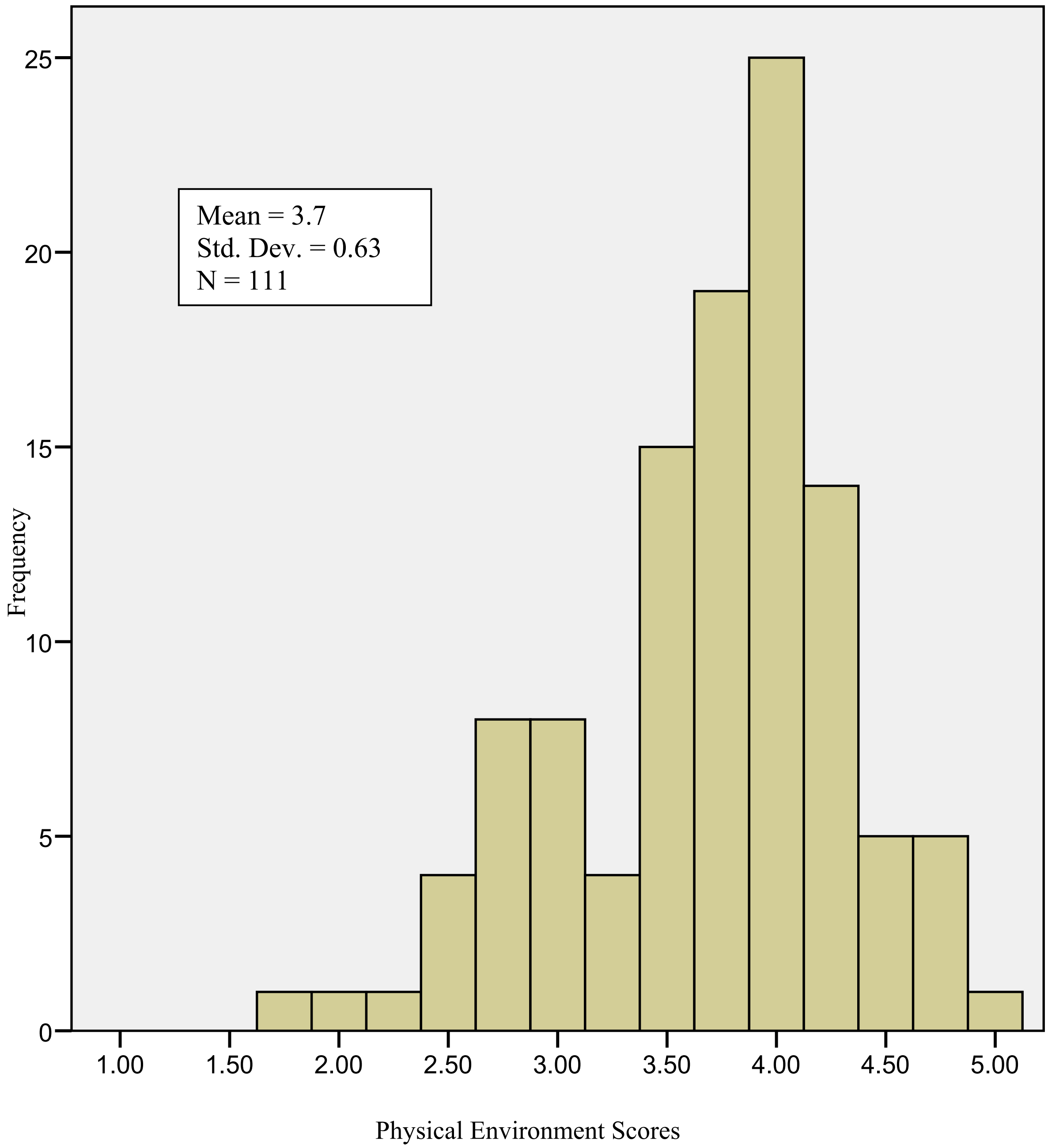

Figure 4.9. Distribution of scores in Physical Environment

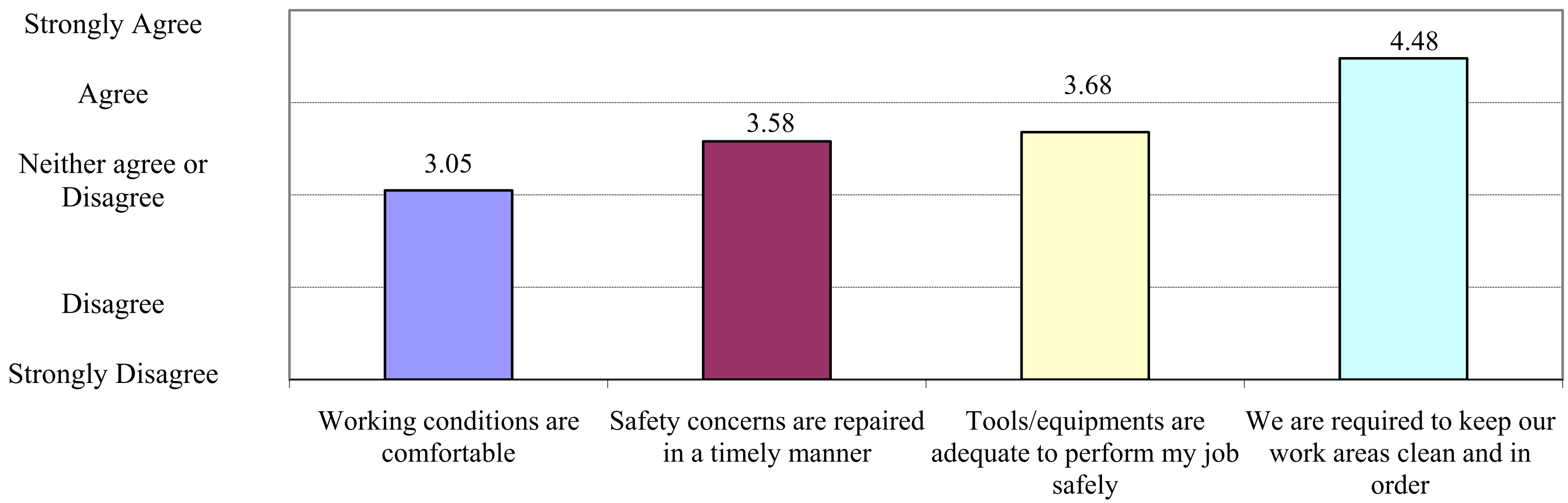

Figure 4.10. Average for statements in Physical Environment

The dimension *compliance with procedures* had an average rating of 3.5 and a standard deviation of 0.65 (Figure 4.11). The data indicate that more participants agreed that co-worker and supervisors were supportive of safety in the work environment. Six items addressed the dimension of *compliance with procedures* (Figure 4.12). In general, participants feel comfortable with each other to say “no” to taking short-cuts ($\mu = 3.8$). However, the participants are less likely to report each other for taking short-cuts ($\mu = 3.1$).

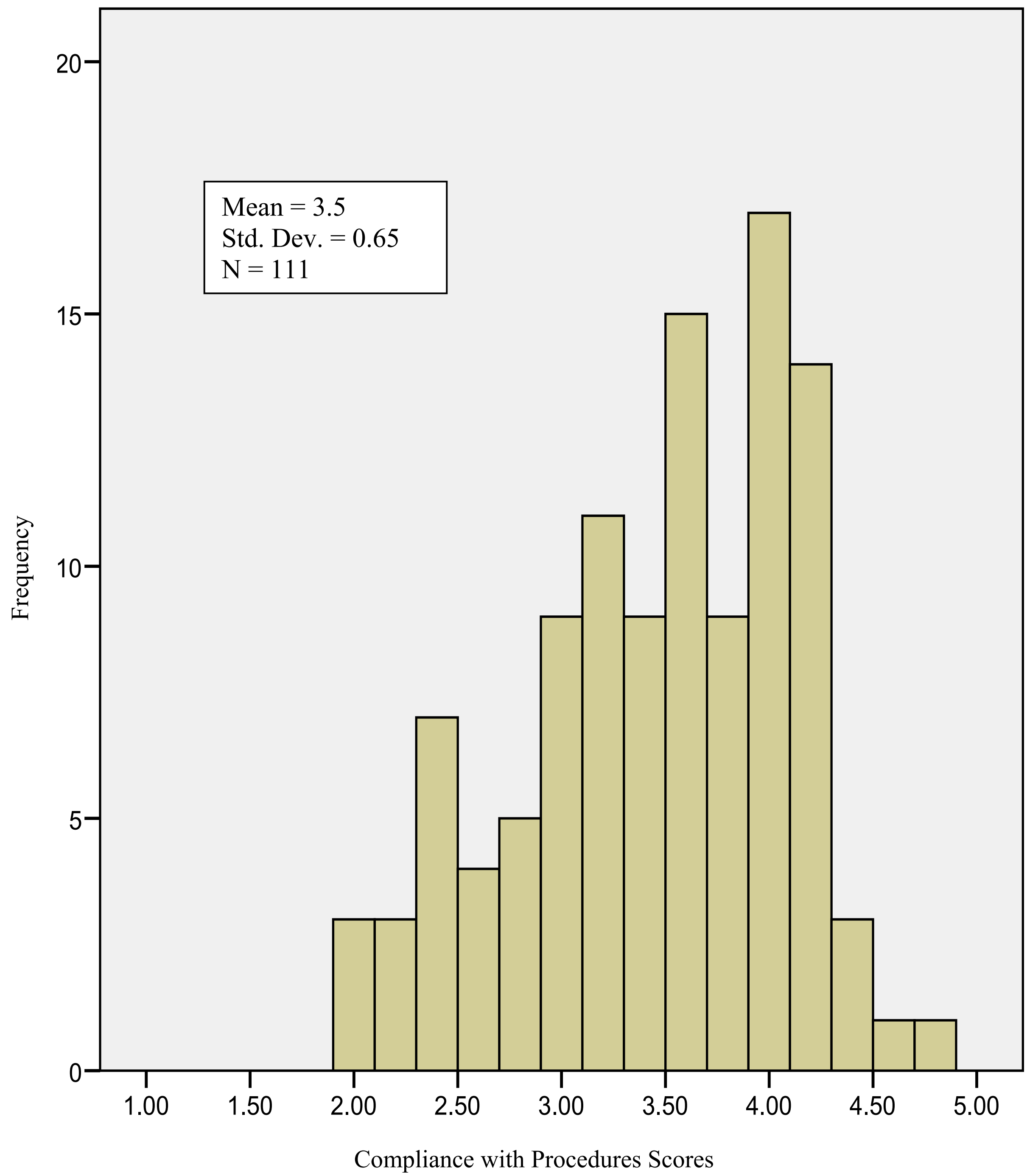

Figure 4.11. Distribution of scores in Compliance with Procedures

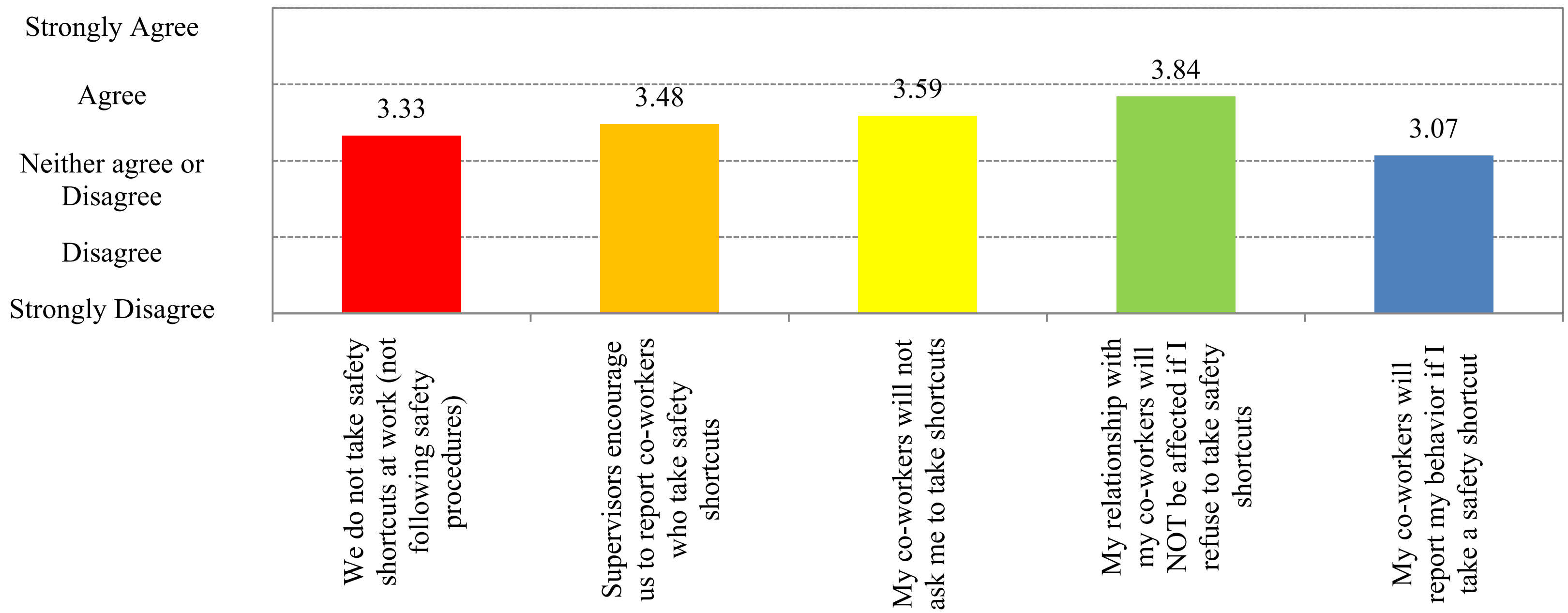

Figure 4.12. Average for statements in Compliance with Procedures

These finding are supported by the results of the analysis of the decision-making simulator, which will be discussed later. Recent studies have identified that peer-pressure (i.e., team pressure to meet production goals) along with pressure from upper management, is a determining factor in establishing perceived work pressure (Havold, 2005; Michael et al., 2005). The combination of these two determinant factors creates the overall workforce perception of the balance maintained between productivity and safety. This notion is evident in a study conducted by Dedobbeleer and Beland (1998). Their study demonstrated that the tendency of workers to take risks or ignore procedures was highly correlated to their perception of working in a high stress environment.

The dimension *competence* had an average rating of 3.7 and a standard deviation of 0.64 (Figure 4.13). The data indicate that more participants agreed that the workforce had a good working knowledge of safety procedures. Six items addressed the dimension of *competence* (Figure 4.14). In general, participants indicated that management is familiar with safety policies and procedures ($\mu = 4.0$). However, participants do not fully agree that the knowledge gained from safety training helps improve safety performance ($\mu = 3.7$). However, despite the fact that this is the lowest score in this dimension, it is high relative to the highest scored item.

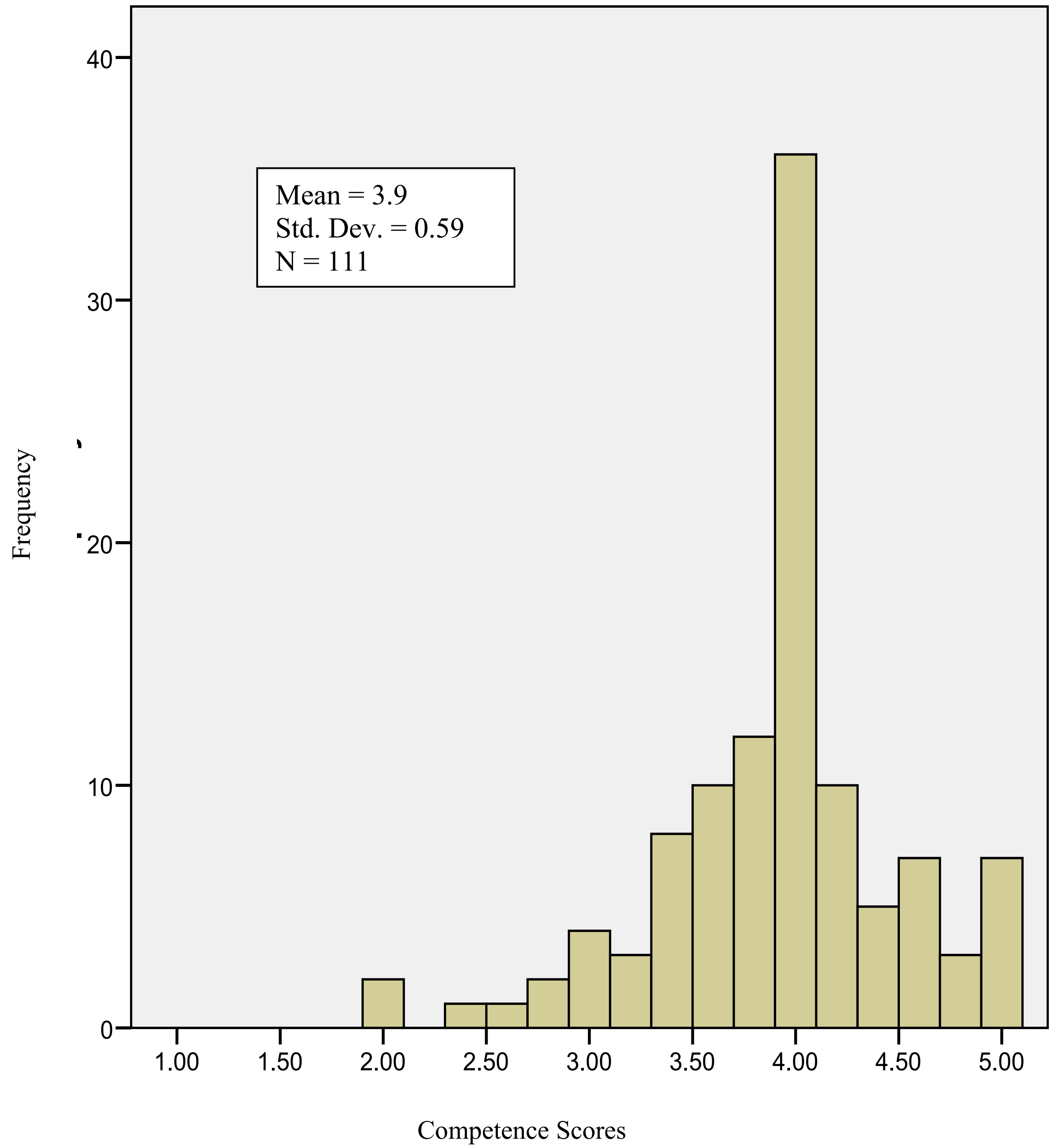

Figure 4.13. Distribution of scores in Competence

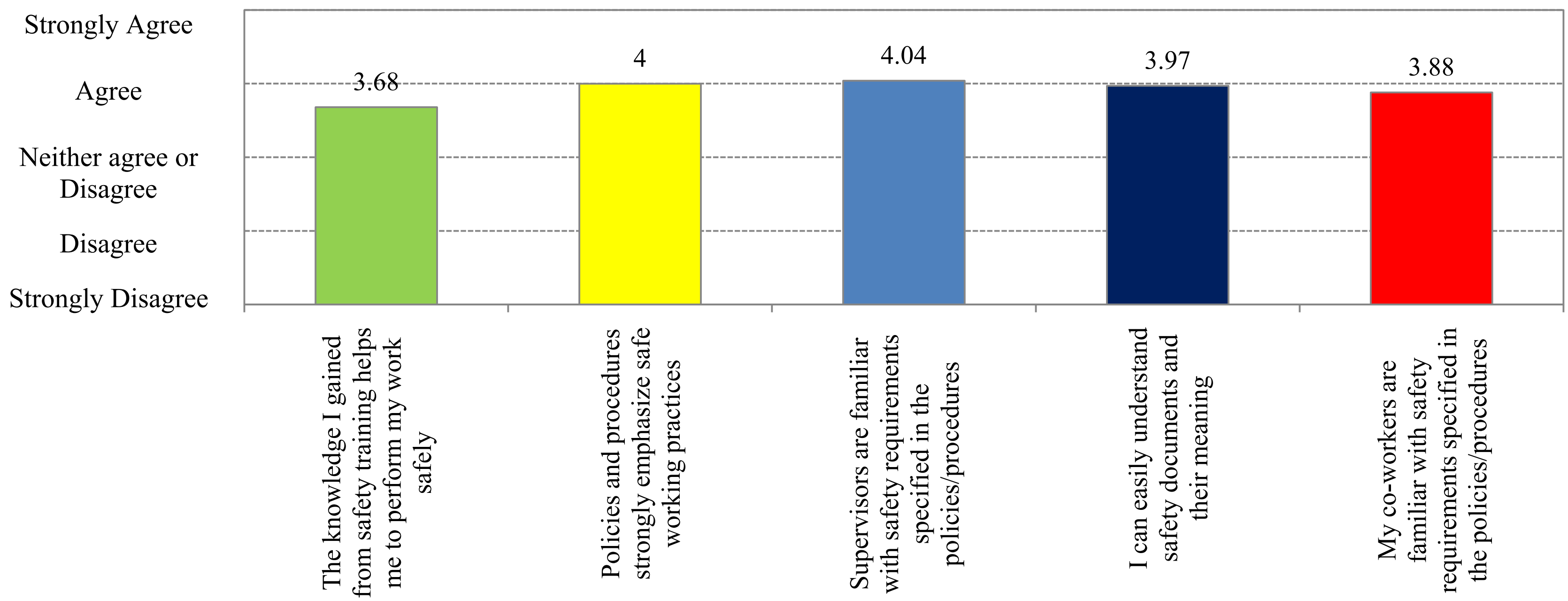

Figure 4.14. Average for statements in Competence

Competence presents workers' perceptions of the level of qualifications, skills and knowledge possessed by both co-workers and management. This perception is highly correlated to management practices such as selection, training, and assessment of competence standards (Flin et al., 2000). These management practices are likely influenced by broader economic conditions, such as the labor market and training budgets (Helmreich et al., 1998; Flin et al., 2000; Flin & O'Connor, 2000). In turn, these economic conditions affect the adoption of specific maintenance policies and procedures (e.g., educational requirements, assessment of competence standards) within an organization (Baxet al., 1998; Guldenmund, 2000; Hudson et al., 1998; McDonald, 1998; Reason et al., 1998).

The composite score had an average rating of 3.7 and a standard deviation of 0.64 (Figure 4.15). All categories' average values were higher than 3 (*neither agree nor disagree*). The categories that scored highest are *competencies* (μ = 3.9) and *communication* (μ = 3.9) (Figure 4.16). The data indicate that more participants agreed that the strength of the safety climate was above average within their organization. The combination of the averages of all seven factors accounted for the composite score. In general, participants perceive that management is meeting the minimum requirement of balancing the need for productivity and the need for safety within the organization.

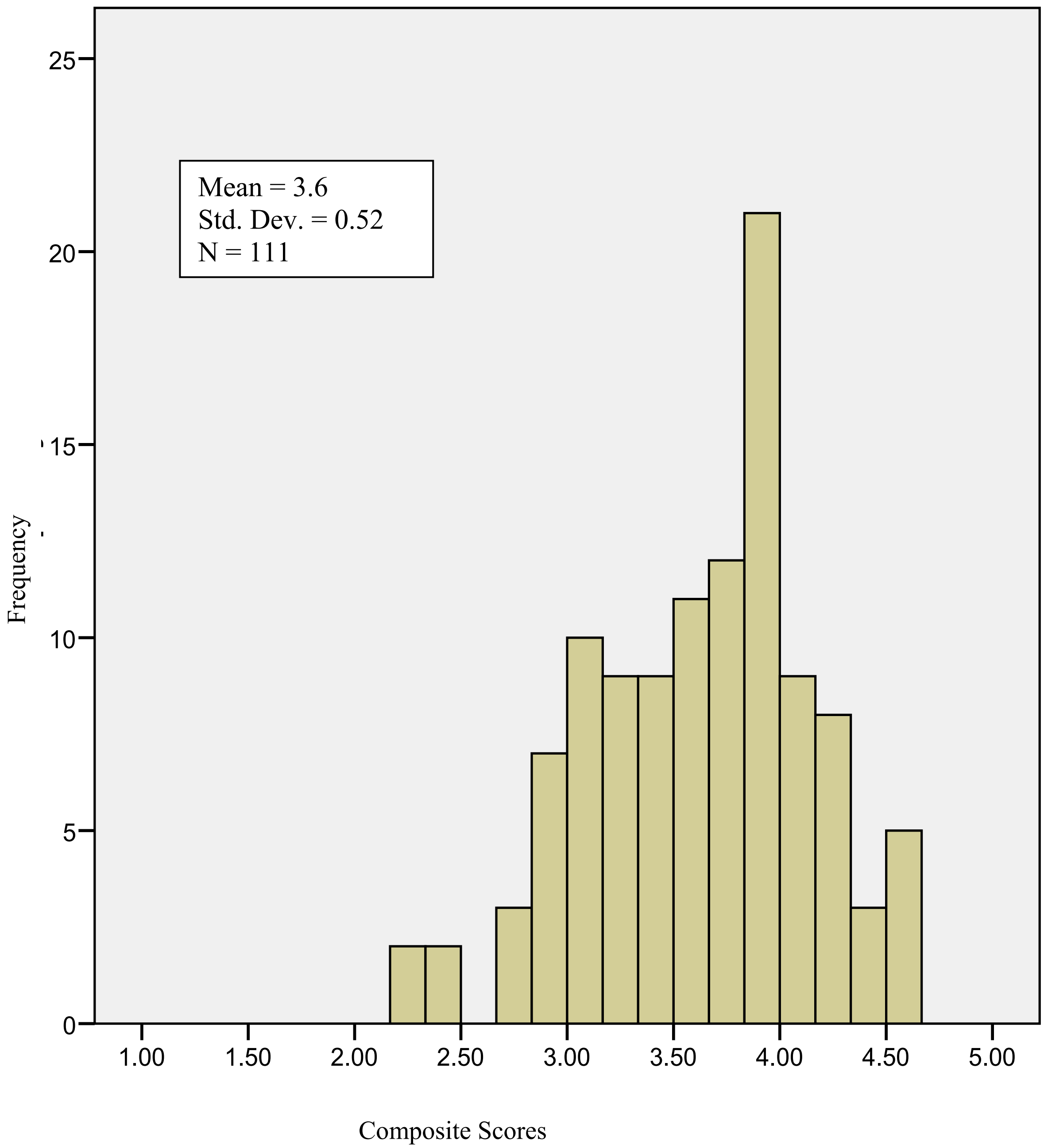

Figure 4.15. Distribution of All 33 Statements in the Questionnaire

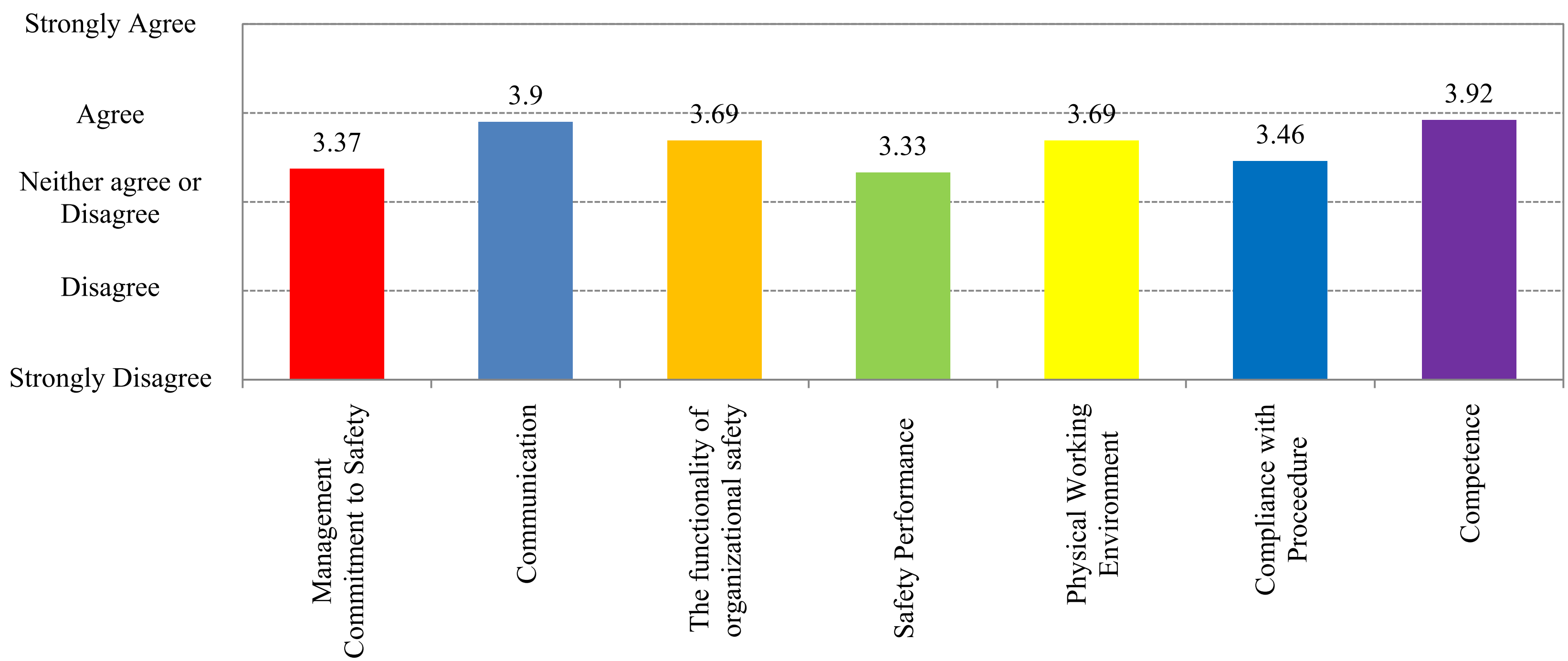

Figure 4.16. Category averages for Safety Climate Survey

4.3 Decision-Making Search Indices (SI) and Choice

4.3.1 Search Indices (SI)

Hypotheses A and B address the correlation between the strength of safety climate and safety-oriented decision-making process. The search indices were calculated as described in the methodology section. As previously mentioned in the methodology section, the search indices reflect the level of attention paid to a particular evaluation of an alternative against a dimension; in comparison to the average attention paid to the other evaluations of the other alternatives against the other dimensions. A value of one indicates that the attention paid to a specific dimension is similar to the average interest of the other dimensions. Thus, a T-test was used to benchmark the data on the indices against a mean value of one. The results are available in table 4.3, include the p-value for the benchmark (against one). The distribution of the safety search index (*S_SI)*, productivity search index (*Prod_SI)*, peer pressure search index (*Pres_SI)*, and promotion search index (*Prom_SI)* are presented in figure 4.17, 4.18, 4.19, and 4.20, respectively. As Table 4.3 indicate *Pres_SI* was the most searched dimension during the participants' decision-making process ($\mu = 1.675$). It was the only index that was found to be significantly different than one ($\rho < 0.0001$)

Table 4.3 *The Number of Times Dimensions were Reviewed*

Search Index	Mean	Standard Deviation	p-value
Safety Search Index	1.051	0.823	0.651
Productivity Search Index	0.844	0.665	0.015
Peer Pressure Search Index	1.675	1.184	<0.0001
Promotion Search Index	1.003	0.957	0.972

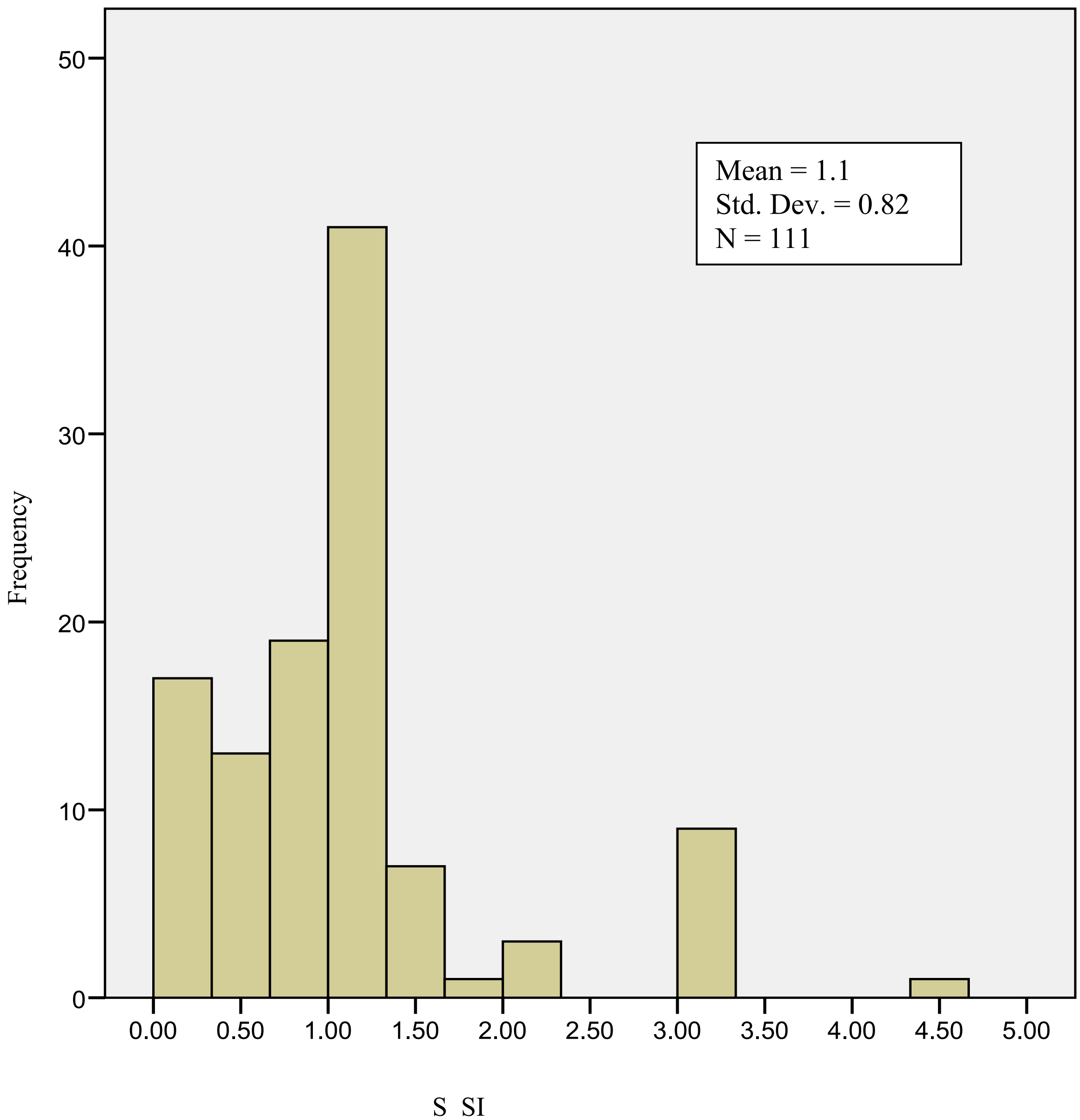

Figure 4.17. Distribution of S_SI Values

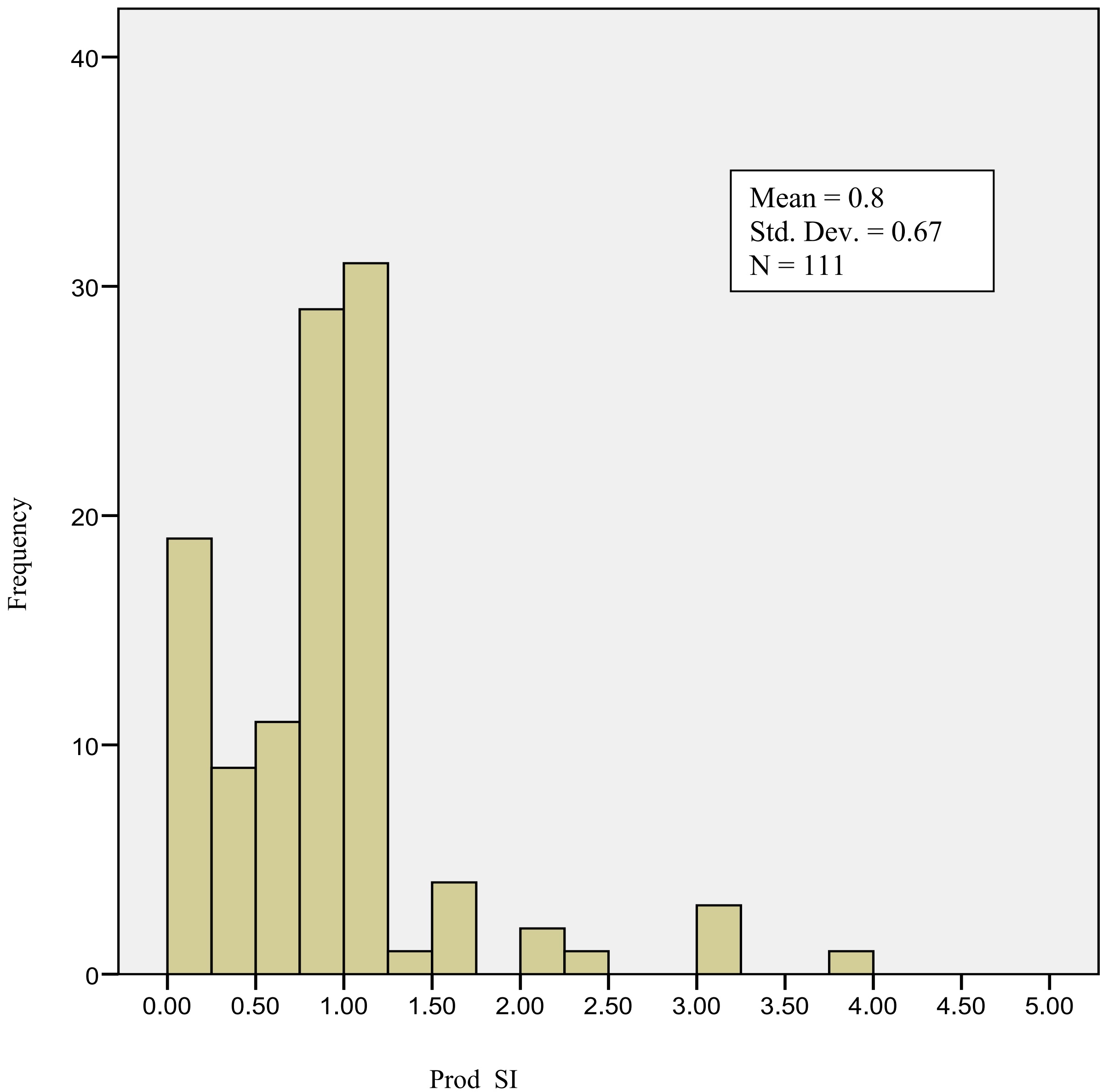

Figure 4.18. Distribution Prod_SI Values

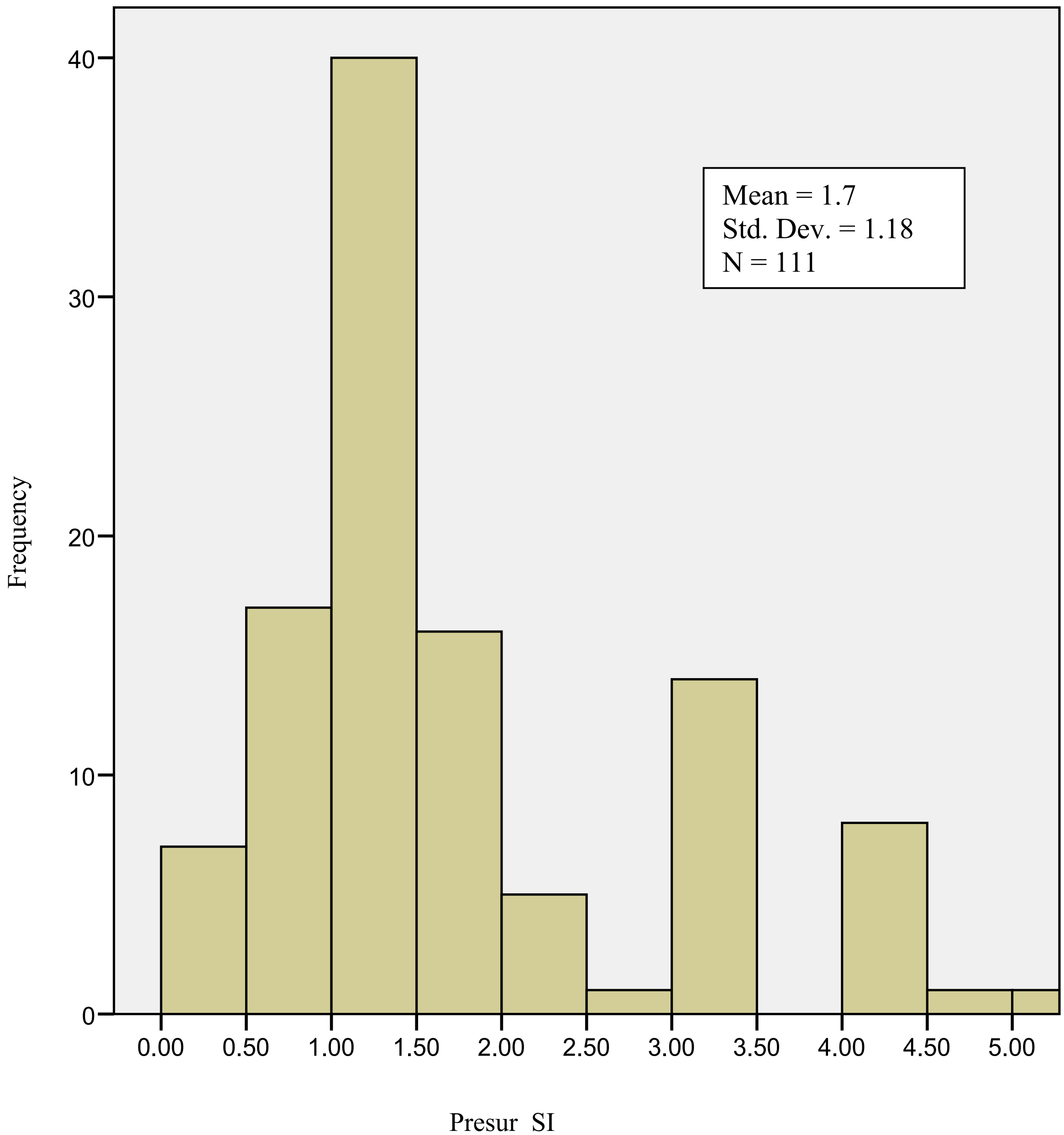

Figure 4.19. Distribution of Pres_SI Values

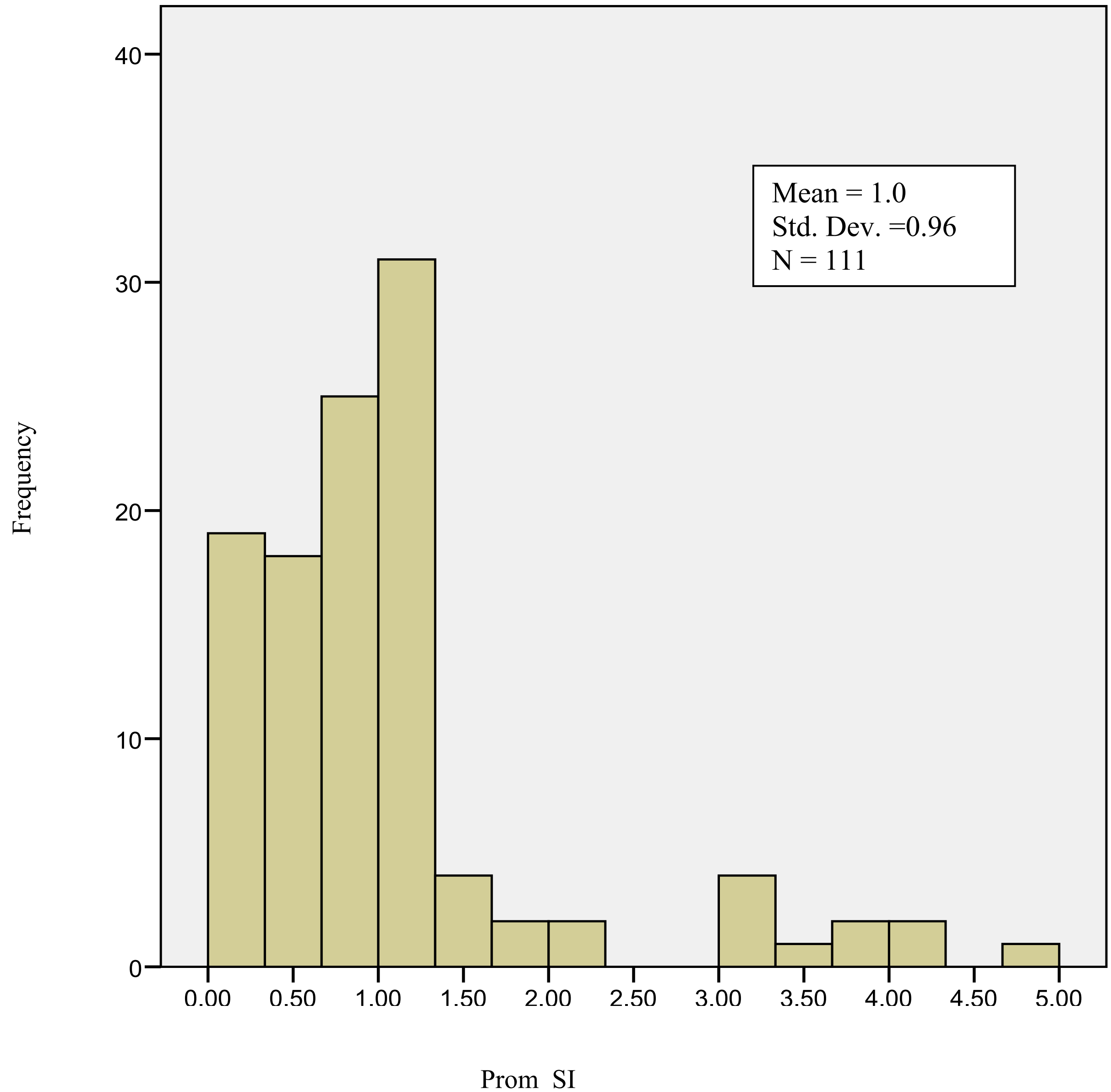

Figure 4.20. Distribution of Prom_SI Values

In the decision-making simulator, participants' non-safety oriented information acquisition (μ = 1.1, α = 0.65) was earlier indicated by their responses to a statement on the safety climate questionnaire. Participants disregarded safety policies and procedures pertaining to being adequately staffed for work *at all times* (μ = 2.5). Clearly, the decision simulator illustrated that the participants showed no interest in the dimension promotion (μ = 1.0, α = 0.97). This lack of interest may have been affected by their uncertainty if their safety performance played any role for potentially being promoted (μ = 3.2).

4.3.2 Choice

Hypotheses C and D address the correlation between the strength of safety climate and the selection of a safer alternative. The distribution of the selection of the alternatives is presented in Table 4.4. *Report without details* was selected by 43.2 % of the participants.

Participants' unwillingness to report each other was earlier indicated in the questionnaire. From the ratings on the dimension *compliance with procedures*, participants *neither agreed nor disagreed* that unsafe behaviors are reported (μ = 3.1). However, it appears that "when" and "if" they had to make a choice, the tendency of most participants would be to report the incident but not the co-worker. Additionally, the intense interest on the decision dimension Peer Pressure indicated the concern the participants had with potential conflict with co-workers. In order to test the hypotheses of this study multiple, simple, and multinomial regression analysis were used.

Table 4.4 *Distribution of Selection of Final Choice*

Choices	#	%
Agree	11	9.3
Just Ignore	20	17.0
Report without Details	51	43.2
Report with details	29	26.13
None response	6	5.1

4.4 Multiple Regression Analysis to Test Hypothesis A

To test hypothesis A, a multiple regression analysis was conducted. This regression analysis tested whether the average scores of the seven dimensions are significant predictors of a safety-oriented information search. The results of the multiple regression analysis are available in Table 4.5. A p-value of 0.461 indicates that the strength of safety climate is not a significant predictor of *S_SI*.

Table 4.5 *Summaries of the Results of the Multiple Regression Analysis: Average of the Seven Predictors*

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	4.587	7	0.655	0.964	0.461
Residual	69.998	103	0.680		
Total	74.585	110			

Further evidence of the lack of significance was noted in the value of R-square (R^2). The value for R^2 with the average scores of the seven predictors is 0.062. This value indicates that only 6.2% of the variability in the dependant variable can be explained by the independent variables.

However, to ensure the reliability of the regression results, the data was tested for multicollinearity (e.g., high correlation among the independent variables). A data set with multicollinearity indicates that the independent variables are affected by each other. Thus, inflating the standard errors of the regression coefficients and leading to inaccurate result for the F-test. In order to check for multicollinearity among the variables Variance Inflation Factor (VIF) value was given for each dimension.

A VIF value greater than 4 is an indication that there may be problems with the variable (e.g., multicollinearity) (Kutner, Nachtsheim, Neter, & Li, 2005). However, serious concerns or actions (i.e., removing or reconstructing the item) are usually taken only if VIF values are greater than 10. The dimension *functionality of organizational safety* had the highest VIF value of 4.102. And the dimension *safety performance* had the lowest VIF value of 1.292, suggesting that this variable has low correlation with other predictors. But overall, the VIF values for the independent variables did not present serious concerns of multicollinearity.

In summary, the analysis failed to reject the null hypothesis for hypothesis A: *The seven safety climate categories cannot predict safety oriented decision-making process*.

4.5 Simple Linear Regression Analysis to Test Hypothesis B

A simple linear regression analysis was conducted to determine the significance of the correlation between the composite score of safety climate questionnaire and *SS_I*. The results are presented in Table 4.6. A p-value of 0.138 indicates that the composite score of safety climate is not a significant predictor of *S_SI*.

Table 4.6 *Summary of the Results of the Simple Linear Regression Analysis: Composite Score*

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.497	7	1.497	2.232	0.138
Residual	73.088	109	0.671		
Total	74.585	110			

Further evidence of the lack of significance was noted in by R^2. R^2 for the simple linear regression analysis with the composite score of the safety climate questionnaire was 0.020. This value indicates that only 2.0% of the variability in the dependent variable (*S_SI*) can be explained by the independent variable (the composite of seven predictors). There were no concerns with multicollineary, because only one independent variable is involved in this simple linear regression model. Thus, VIF is not relevant.

In summary, the analysis failed to reject the null hypothesis for hypothesis B: *The composite safety climate score cannot predict safety oriented decision-making process*.

4.6 Multinomial Regression Analysis to Test Hypothesis C

A multinomial regression analysis was conducted to test whether the averages of the seven safety climate dimensions predicts choice of a safer alternative. The results of the multinomial regression analysis is presented in Table 4.7. The results indicate that the averages of the seven safety climate dimensions were not a significant predictor of choosing a safer alternative, p-value is 0.512.

Table 4.7 *Results of Multinomial regression Analysis: Average of the Seven Predictors*

Effects	Chi-Square	df	p-value
Commitment	1.979	3	0.577
Communication	1.254	3	0.740
Functionality of Organizational Safety	1.952	3	0.582
Safety Performance	0.517	3	0.915
Compliance with procedures	0.874	3	0.832
Physical Working Environment	1.477	3	0.687
Competence	2.922	3	0.404

Thus, the analysis failed to reject the null hypothesis for hypothesis C: *The seven safety climate categories cannot predict selection of a safer choice*.

4.7 Multinomial Regression Analysis to Test Hypothesis D

A multinomial regression analysis was conducted to test whether the composite of the seven safety climate dimensions predicted choice of a safer alternative. The results of the multinomial regression analysis is presented in Table 4.8. The results indicate that the composite of the seven safety climate dimensions was a significant predictor of choosing a safer alternative (p-value is 0.019). Thus, hypothesis D is rejected.

Table 4.8 *Results of Multinomial regression Analysis: Composite Score as a Predictor*

Effects	Chi-Square	df	p-value
Composite	9.989	3	0.019

4.8 Likelihood of Selecting a Choice as a Function of Composite Score

The exponent coefficient estimates indicate that there were differences among the choices (Table 4.9). The reciprocal of the exponent coefficient estimate between choices 1 and 4 indicate that for every unit of increase in the composite score of seven predictors, participants was 5.21 (e.g., 1/0.192, α = 0.025) times more likely to choose choice 4 over choice 1. The exponent coefficient estimate between choices 2 and 4 indicates that for every unit of increase in the composite score of seven predictors, participant was 5.61 times more likely to choose choice 4 over choice 2. The exponent coefficient estimate between choices 3 and 4 indicates that for every unit of increase in the composite score of seven predictors, participants was 3.04 times more likely to choose choice 4 over choice 3.

Table 4.9 *Results of Multinomial regression Analysis*

Choice recorded	β	Std. Error	Sig.	Exp (β)
1 Intercept	5.082	2.681	0.058	
1 Composite	-1.650	0.736	0.025	0.192
2 Intercept	5.938	2.327	0.011	
2 Composite	-1.725	0.632	0.006	0.178
3 Intercept	4.709	1.995	0.018	
3 Composite	-1.111	0.525	0.034	0.329

A visual illustration of these estimated probabilities for choosing choices 1to 4 against the independent variable (the composite of seven predictors) is shown in Figure 4.21. These estimated probabilities were derived from the estimated logit equations with *composite score* as the predictor; as follows:

For i = 1, $\frac{\Pr(Y = 1 \mid \mathbf{X})}{\Pr(Y = 4 \mid \mathbf{X})} = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 X\right) = \exp(5.082 - 1.650 * X) \equiv a_1$ (4 - 1)

For i = 2, $\frac{\Pr(Y = 2 \mid \mathbf{X})}{\Pr(Y = 4 \mid \mathbf{X})} = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 X\right) = \exp(5.938 - 1.725 * X) \equiv a_2$ (4 - 2)

For *i* = 3, $\frac{\Pr(Y = 3 \mid \mathbf{X})}{\Pr(Y = 4 \mid \mathbf{X})} = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 X\right) = \exp(4.709 - 1.111 * X) \equiv a_3$ (4 - 3)

From the logit equations (4 – 1 to 4 - 3) above,

$\Pr(Y = 1 \mid \mathbf{X}) = a_1 * \Pr(Y = 4 \mid \mathbf{X})$ (4 - 4)

$\Pr(Y = 2 \mid \mathbf{X}) = a_2 * \Pr(Y = 4 \mid \mathbf{X})$ (4 - 4)

$\Pr(Y = 3 \mid \mathbf{X}) = a_3 * \Pr(Y = 4 \mid \mathbf{X})$ (4 - 5)

Also,

$$\Pr(Y = 1 \mid \mathbf{X}) + \Pr(Y = 2 \mid \mathbf{X}) + \Pr(Y = 3 \mid \mathbf{X}) + \Pr(Y = 4 \mid \mathbf{X}) = 1$$

$$\Leftrightarrow \Pr(Y = 1 \mid \mathbf{X}) + \Pr(Y = 2 \mid \mathbf{X}) + \Pr(Y = 3 \mid \mathbf{X}) = 1 - \Pr(Y = 4 \mid \mathbf{X})$$ (4 - 6)

Summing Eq. 4 – 7 to 4 - 6, yield

$$\Pr(Y = 1 \mid \mathbf{X}) + \Pr(Y = 2 \mid \mathbf{X}) + \Pr(Y = 3 \mid \mathbf{X}) = \Pr(Y = 4 \mid \mathbf{X}) * (a_1 + a_2 + a_3 + 1)$$ (4 - 7)

Following substituting Eq. 4 - 7 into Eq. 4 - 8, equation 4 - 8 have the following form:

$$1 - \Pr(Y = 4 \mid \mathbf{X}) = 1 - \Pr(Y = 4 \mid \mathbf{X}) * (a_1 + a_2 + a_3 + 1)$$ (4 - 9)

Hence, the estimated probabilities for a selection of the choices as a function of the composite score are derived to be:

$$\Pr(Y = 4 \mid \mathbf{X}) = \frac{1}{(a_1 + a_2 + a_3 + 1)} \tag{4 - 10}$$

$$\Pr(Y = 1 \mid \mathbf{X}) = a_1 * \Pr(Y = 4 \mid \mathbf{X}) \tag{4 - 11}$$

$$\Pr(Y = 2 \mid \mathbf{X}) = a_2 * \Pr(Y = 4 \mid \mathbf{X}) \tag{4 - 12}$$

$$\Pr(Y = 3 \mid \mathbf{X}) = a_3 * \Pr(Y = 4 \mid \mathbf{X}) \tag{4 - 13}$$

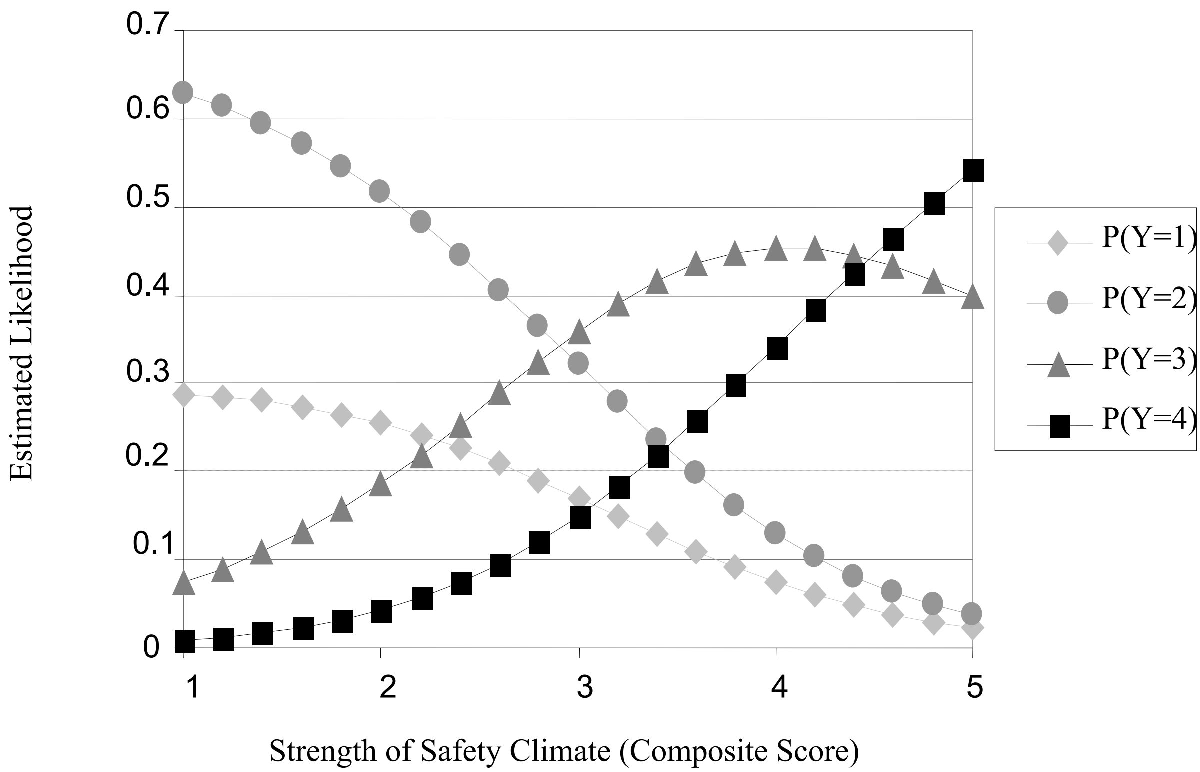

Figure 4.21. Likelihood of Selection of a Safer Alternative as a Function of Composite Score

As figure 4.21 reveals, the likelihood of selecting alternatives with negative evaluation on the safety dimension (Safety) decreases with an increase of strength of safety climate(Strength – represented by the composite score). Moreover, the likelihood for the alternative with the lower evaluation on “Safety” is lower than the likelihood for the one with the higher (still negative) evaluation.

As for the alternatives with positive evaluation on Safety: the alternative “Report without Details” had likelihood higher than the alternative “Report with Details” (which had higher evaluation on Safety) for a range of Strength of less than 4. When Strength is greater than four, the alternative with the higher evaluation on Safety has the highest likelihood for being selected.

The fact that for the range of Strength that is less than 4, the alternative “Report without Details” was more likely to be selected than the safer alternative, might be explained by the extensive interest in “Peer-Pressure” during the decision task. It is possible that this interest reflects a concern with the response of employees to reporting their colleagues, should they decide to provide details on the case. Eventually though, the likelihood of selecting the alternative that included reporting details on their colleagues was the highest when safety climate strength was very high (four or higher).

The change in trend in the likelihood of selecting alternative 3 as a function of Strength around composite score value of 3 - 3.5 could not be explained, and is require further study.

Of the four hypotheses, a hypothesis D is the only one that presents significant relationship between strength of safety climate and safety decision-making. The results suggested that the strength of safety climate (composite score)is a significant predictor of selecting a safer alternative.

CHAPTER 5. SUMMARY, CONCLUSIONS, RECOMMENDATION

5.1 Summary

The purpose of this study was to examine the relationship between the strength of safety climate and the orientation toward safety in decision-making processes and choice (*Safety Decision-Making*). In order to study this relationship an experiment was designed and conducted. The study was conducted in a manufacturing facility in Iowa. The study included 111 of the 186 employees in the facility, over the web. Two web-based instruments were used, a safety climate questionnaire followed by a decision-making simulation.

The following four hypotheses have been employed to analyze this relationship:

Hypothesis A: The seven safety climate categories cannot predict safety oriented decision-making process

Hypothesis B: The composite safety climate score cannot predict safety oriented decision-making process

Hypothesis C: The seven safety climate categories cannot predict selection of safer choice

Hypothesis D: The composite safety climate score cannot predict selection of safer choice

A multiple regression analysis model was used to test hypothesis A, a simple linear regression analysis to test hypothesis B, and multinomial regression analyses for hypotheses C and D.

The analysis failed to reject hypothesis A ($\rho > 0.05$ for all seven categories); the seven categories of the safety climate questionnaire was not a significant predictor of safety oriented information acquisition (denoted by *S_SI*). Likewise, the composite score of the seven categories of the safety climate questionnaire were not found to be a significant predictor of safety oriented information acquisition ($\rho > 0.05$ for composite score); thus, the analysis failed to reject hypothesis B

As for predicting a selection of a safer choice: the analysis failed to reject hypothesis C. The seven categories were not a significant predictor of the selection of a safer choice ($\rho > 0.05$ for all seven categories); however, the composite score of safety climate was a significant predictor of a safer choice ($\rho = 0.019$).e.g. hypothesis D was rejected.

Safety climate questionnaire was developed and validated by Factorial Analyses. The 33 questions in the questionnaires were grouped into seven categories, as follows:

- Management Commitment to safety,
- Communication,
- The functionality of organizational Safety,
- Role of Safety Performance,
- Physical working environment,
- Compliance with procedures, and
- competencies

Participants were asked to rank their level of agreement on the 33 statements, on a scale of one through five, where one represents *strongly disagreed*, three represents *neither agree nor disagree*, and five represents *strongly agree*.

All seven categories had an average value greater than three (*neither agree nor disagree*). The categories that scored highest are *competence* ($\mu = 3.9$) and *communication* ($\mu = 3.9$).

The statements addressing the *competence* category surveyed the perception that participants had towards the adequacy of safety training, familiarity of key personnel with safety procedures, and ease of interpreting safety documents. This perception is highly correlated to management practices such as selection, training, and assessment of competence standards (Flin et al., 2000).

The statements addressing the *communication* category surveyed participants' perception of their organization communication of safety goals/ expectations and performance, and supervisors' openness towards participants' safety concerns. These categories received the lowest scores among the seven categories, where, *safety performance* had an average of 3.3 and *management commitment* had an average of 3.4.

It is important to note that literature documented patterns of improvement in attitude toward safety performance when these are perceived benefits to working safely (Zohar & Luria, 2003; Zohar & Erev, 2007).

The statements addressing *management commitment* surveyed participants' perception of the level of commitment that management had towards safety. Despite the low average of the *management commitment* category, the statement that specifically addressed management commitment to safety had an average of four. However, two items in this category scored an average of below three, and are a source of major concern:

- *Work will not begin until we are properly staffed to perform work safely*, which received an average of 2.5; and
- *Exemplary safety performance is recognized/awarded*, which received an average of 2.9

The low perception on these two statements requires immediate attention by management. Defiance of safety policies and procedures has been correlated with risk-taking behaviors (Bax et al., 1998; Hudson et al., 1998; Lee, 1998; McDonald, 1998; Reason et al., 1998).

The Decision Mind^{TM} simulator recorded key features of the decision-making process from each participant:

- The number of items viewed by participants,
- The sequence of the review of information, and
- The final choice selected by each participant.

The value of the four search indices (*Pres_SI*), Safety (S_SI), Productivity (Prod_SI), and Promotion (*Prom_SI*) have been calculated. These values have been statistically compared to "one," utilizing T-test (One represents an average interest in a dimension in comparison to the interest in other dimensions). Information on the implications of peer pressure on the alternative gained the highest attention (average $Pres\_SI = 1.7, \rho < 0.0001$). The values of the other indices were not found to be significantly different than "one" (with respect to $\alpha = 0.05$).

The decision scenario addressed a situation where the participants are being offered to take a short-cut from the standard operation procedures. The four alternatives are to:

1) *Agree* to take the short-cut,

2) *Ignore* the suggestion to take the short-cut,

3) *Report* the incident to supervisors *without details* of the employees involved, and

4) *Report* the incident to supervisors *with details* of the employees involved.

Alternative 3, *report without details* was the most frequently selected alternative (selected by 43.2 % of the participants). Based on the scenario, the selection of alternative three indicates safety consciousness among the participants. The score on the safety climate questionnaire foreshadowed the fact that reporting ***with*** details (selected by 26.1% of the participants) would not be the most favorite choice. This is supported by the level of interest in Peer Pressure during the process of evaluating the alternatives. Further evidence of this choice was earlier indicated in the safety climate questionnaire, where participants rated that they will not necessarily report each other for taking short-cuts (μ = 3.1). Despite, the significant attention to peer pressure, the high perception of management commitment (μ = 4.0) to safety may have significantly influenced the high response rate for the second safest choice *report without detail*.

Calculation of estimated probability (likelihood) of selecting alternative indicated that alternative with negative evaluation on the dimension of safety have a negative likelihood trend, and when strength of safety climate increases. The trend for alternatives with positive evaluation was positive, other than a change in trend for alternative 3 (*report without details*) in higher strength levels.

5.2 Conclusion

This study established an empirical link between the aggregated measures of the strength of safety climate and choosing a safer alternative; however, it failed to demonstrate relationship with the process. This study showed the significant impact that peer pressure has on the level of safety performance within an organization. The complex relationship between safety climate and safety decision-making requires further attention from researchers. Additional efforts in studying the underlying factors that create the relationship between safety climate and decision-making may establish the link between strength of safety climate and decision-making process.

5.3 Recommendations

Carroll (1998) suggests that, safety climate factors may highlight where system and physical changes are required within an organization, as well as changes of safety related behaviors at all hierarchical levels. It is important that further efforts should review the relationship between safety climate and safety decision-making at all hierarchical levels (CEOs, managers, supervisors, and key safety personnel) of the organizations. The findings should be analyzed for the difference among levels in the hierarchy.

Despite the four and a half decades of studying safety climate, this present study recognizes that significant advancement is needed in this field. Further studies that incorporate behavioral observations may bridge the gap in understanding the relationship between safety climate and safety decision-making with bricks of knowledge.

APPENDIX A: FACTOR ANALYSIS

1.1 Factor Analysis

Factor Analysis was used to validate the safety climate questionnaire. The purpose of factor analysis is to discover simple patterns among the variables. In particular, it seeks to determine if the observed variables can be explained by a smaller number of underlying factors. More than one factor may exist for a given set of items. This may result from items that fit better with another factor. In all but one case, all the items fit comfortably on a single factor. These factors included six preplanned dimensions contained within the questionnaire (*management commitment*, *communication*, *functionality of safety*, *compliance with procedures*, *physical work environment*, and *competence*).

The principal component extraction method indicated that each dimension had one factor with the exception of *functionality of safety* (An earlier effort at factor analysis attempted to use maximum likelihood extraction methods. The maximum likelihood results were not appropriate for the analytical purposes of this paper. This appendix presents the correlation, the Kaiser-Meyer-Olkin (KMO) statistics, total variations explained by the factor, communalities, and component factor loadings of the statements in each dimension. The *Cronbach's Alpha values* will later be presented in this section.

1.1.2 Correlations

Tables A.10 to A.23 display the correlations among the items contained in the dimensions. The correlation is the measurement of the linear relationship of the items (i.e., "strength" and "direction").

Table A.10 *Correlation Matrix: Management Commitment to Safety*

	Committed	Climate	Examples	Properly staff	Awarded	Stop work	Concerns addressed
Committed	1.000	0.709	0.417	0.483	0.365	0.342	0.543
Climate	0.709	1.000	0.490	0.524	0.300	0.391	0.544
Examples	0.417	0.490	1.000	0.519	0.345	0.342	0.444
Properly staff	0.483	0.524	0.519	1.000	0.420	0.375	0.578
Awarded	0.365	0.300	0.345	0.420	1.000	0.406	0.485
Stop work	0.342	0.391	0.342	0.375	0.406	1.000	0.471
Concerns addressed	0.543	0.544	0.444	0.578	0.485	0.471	1.000

All results $p \leq .001$

Table A.11 *Correlation Matrix: Communication of Safety Expectations/Goals*

	Communicated	Define goals	Receptive	Report
Communicated	1.000	0.760	0.451	0.492
Define goals	0.760	1.000	0.380	0.485
Receptive	0.451	0.380	1.000	0.329
Report	0.492	0.485	0.329	1.000

All results $p < .001$

Table A.12 *Correlation Matrix: Functionality of Organizational Safety*

	Stop work 2	Safety available	Investigated	Timely investigation	Performance feedback	Role in promotion	Enforcement	Enforcement 2
Stop work 2	1.000	0.533	0.296	0.374	0.236	0.100	0.338	0.480
Safety available	0.533	1.000	0.594	0.553	0.090	0.241	0.512	0.522
Investigated	0.296	0.594	1.000	0.694	0.122	0.288	0.446	0.447
Timely investigation	0.374	0.553	0.694	1.000	0.070	0.235	0.438	0.499
Performance feedback	0.236	0.090	0.122	0.070	1.000	0.226	0.261	0.212
Role in Promotion	0.100	0.241	0.288	0.235	0.226	1.000	0.388	0.367
Enforcement	0.338	0.512	0.446	0.438	0.261	0.388	1.000	0.714
Enforcement 2	0.480	0.522	0.447	0.499	0.212	0.367	0.714	1.000

All results $p \leq .232$

Table A.13 *Correlation Matrix: Physical Working Environment*

	Conditions	Concerns repaired	Tools/equipments are adequate to perform my job safely	Clean
Conditions	1.000	0.492	0.294	0.214
Concerns repaired	0.492	1.000	0.331	0.269
Tools/equipments are adequate to perform my job safely	0.294	0.331	1.000	0.149
Clean	0.214	0.269	0.149	1.000

All results $p \leq .060$

Table A.14 *Correlation Matrix: Compliance with Procedures*

	No shortcuts	Report co-workers	No shortcuts 2	Not affected	Report me
No shortcuts	1.000	0.327	0.455	0.384	0.368
Report co-workers	0.327	1.000	0.134	0.082	0.234
No shortcuts 2	0.455	0.134	1.000	0.470	0.473
not affected	0.384	0.082	0.470	1.000	0.234
Report me	0.368	0.234	0.473	0.234	1.000

All results $P \leq .081$

Table A.15 *Correlation Matrix: Competence*

	Knowledge gained	Procedure emphasize	Familiar	Easily understand	Co-worker familiar
Knowledge gained	1.000	.445	0.292	0.386	0.422
Procedure emphasize	0.445	1.000	0.576	0.469	0.500
Familiar	0.292	0.576	1.000	0.640	0.606
Easily understand	0.386	0.469	0.640	1.000	0.599
Coworker familiar	0.422	0.500	0.606	0.599	1.000

All results $p \leq .001$

1.1.3 Kaiser-Meyer-Olkin (KMO)

The overall KMO statistic predicts whether the data is likely to factor well. This prediction is based on the correlation and partial correlation of the items. Moreover, the KMO indicates whether or not the survey can be duplicated in other studies (Table A.16). For example, the KMO values can make inference to the following question:

Will the items pertaining to a factor produce the same grouping if administered to another demographic?

KMO values of 0.6 or greater can predict successful replication of a survey instrument in other studies. *Management commitment* had the highest KMO value (0.857). And *physical work environment* had the lowest KMO value (0.673). Thus, the questionnaire's generality is valid.

Table A.16 *KMO Values for Pre-planned Dimensions 1- 6*

Pre-planned Dimension	KMO Values
Management commitment to safety	0.875
Communication of safety expectations/goals	0.725
Functionality of organizational safety	0.791
Physical Working Environment	0.673
Compliance with procedures	0.710
Competence	0.802

1.1.4 Total Variance

Tables A.17 presents the total variance for each of the seven extracted factors. The total variance explained is the percent of variation in the responses to all the items pertaining to that factor. For example, the factor *management commitment* explained a percent variance of 53.4% among the set of items. This means that the factor of *management commitment* contains 53.4 % of the overall meaning of all the items combined. The factor of *communication of safety goals and expectation*s had the highest value (61.9%). And the factor *safety performance* had the lowest value (20.66%). This means that the survey contained between 20 – 70% of the main areas of interest in this study. The low value of 20.66% may be a concern, but this extracted factor is only the combination of two items. These items did not fit well under the factor of *functionality of organizational safety*. Therefore, these two items were extracted to form a separate factor, *safety performance*. *Safety performance* addressed safety performance feedback and its role in promotion.

Table A.17 *Total % Variance for Extracted Factors 1 to 7*

Factors	Total Variance Explained (%)
Management commitment to safety	53.403
Communication of safety expectations/goals	61.903
Functionality	**60.8**
Functionality of Organizational Safety	40.197
Safety Performance	20.663
Physical Working Environment	59.899
Compliance with procedures	47.601
Competence	46.331

1.1.5 Communalities and Component Loadings

Table A.18 presents the communalities and component loadings for each factor. Communality is the sum of the squared factor component loadings (for each item). It is also the variance in a single item accounted for by the factors. Communality is equivalent to the R^2, a statistical parameter used in regression analysis to measure variation in an outcome variable.

For example, the item *concerns addressed,* had a communality of 64.8%. This indicates that 64.8% of the meaning of *concerns addressed* is explained by the factor, *management commitment*. The item *awarded* had a communality of 39.8%. This indicates that only 39.8% of the item *awarded* is represented by the factor *management commitment*. This implies that award and recognition are least represented by this factor. Communalities should have a value of .1 or greater. However, the value of .1 is relative to the rest of the values.

The factor component loadings are the correlation coefficients between the variables and factors. Similar to Pearson's r, the squared factor loading is the percent of variance in that variable explained by the factor. The square of the factor component loadings (Table A.18) are the communalities. The factor component loadings convey the reverse meaning of the communalities. The component loadings indicate the level of fit ("load") in a factor. Component loadings of .4 or greater are considered a well structured factor, relative to the highest value. For example, the highest factor component loading for *management commitment* was *concerns addressed* = 0.805. The lowest component loading value for *management commitment* was *award* = 0.631. Both of these values were greater than 0.4. This means that all of these items addressing *management commitment* fit well together.

Table A.18 *Communalities/Loading Values: Management Commitment to Safety*

	Communalities	Loadings
Concerns addressed	0.648	0.805
Climate	0.624	0.790
Properly staff	0.595	0.771
Committed	0.591	0.769
Examples	0.481	0.694
Stop work	0.401	0.633
Awarded	0.398	0.631

Table A.19 presents the communalities and component loadings for factor *communication of safety expectations/goals*. The item *communicated* had the highest communality value of 78.3% for this factor. *Receptive* had the lowest communality value for this factor, 42.7%. This indicates that management's receptiveness to employees' concerns is least represented by the factor of *communication of safety expectations/goals*. The component loadings column in Table A.19 shows that *communicated* has the strongest loading of 0.885 on this factor. The item with the weakest loading had a value of 0.654, suggesting that all the items fit well together.

Table A.19 *Communalities/Loading Values: Communication of Safety Expectations/Goals*

	Communalities	Loadings
Communicated	0.783	0.885
Define goals	0.742	0.861
Report	0.524	0.724
Receptive	0.427	0.654

Table A.20 presents the communalities and component factor loadings for the pre-planned dimension, *functionality of organizational safety.* The item *timely investigation* had the highest communality value of 70% for this dimension. *Role in promotion* had the lowest communality value of 45.9%. This indicates that safety performance role in promotion was least represented by these factors. However, from the initial analysis of the data, there were two factors contained within this pre-planned dimension. Therefore, the statements within this dimension had to be separated into two factors: *functionality of organizational safety*, and *personnel safety performance feedback and evaluation.* When there are two factors, the sum of the squared values of each "factor component loading" yields the "communality" value.

A varimax rotation was completed on the component loadings to eliminate discrepancies (noise) among the items. Discrepancies within the set of items (factor components loadings) are harder to distinguish (i.e., which item fits the best or the worst with the factor). Therefore, by performing a varimax rotation, the data can be viewed on a larger scale. Conceptually, this is like looking through a cylindrical pipe as opposed to looking at the pipe from the side. By so doing, interpretation of the data is easier, because factor component loadings can be clearly distinguished (i.e., highest or lowest). Therefore, after the varimax rotation, the component loadings indicated that safety performance feedback and its role in promotion address a different factor. The item *performance feedback* had a value of 0.801. And the item *role in promotion* had a factor component loading value of 0.642. This indicates that these items fit well together on the factor of *safety performance feedback*. For the factor *functionality of organizational safety,* the item *timely investigation* had the highest factor component loading, and item *enforcemen*t had the lowest factor component loading of 0.596. This indicates that all the items fit well together in this single factor.

Table A.20 *Communalities/Loading Values: Functionality of Organizational Safety*

	Communalities	Loadings Component 1 & 2 (After Varimax Rotation)	
Timely investigation	0.700	0.836	0.019
Safety available	0.696	0.827	0.112
Investigated	0.655	0.806	0.074
Enforcement 2	0.675	0.668	0.478
Enforcement	0.653	0.596	0.545
Stop work 2	0.388	0.576	0.237
Performance feedback	0.644	-0.055	0.801
Role in promotion	0.459	0.217	0.642

Table A.21 presents the communalities and factor component loadings for the factor *physical working environment*. The item *concerns repaired* had the highest communality value of 64.6% for this factor. The item *clean* had the lowest communality value of 27.4% for this factor. This indicates that keeping the work environment clean and orderly is least represented by the factor *physical working environment*. The item *concern repaired* had the highest factor component loading value for this factor, 0.804. The item with the weakest factor component loading had a value of 0.524, suggesting that all the items fit well together.

Table A.21 *Communalities/Loading Values: Physical Working Environment*

	Communalities	Loadings
Concerns repaired	0.646	0.804
Conditions	0.587	0.766
Tools/equipments are adequate to perform my job safely	0.397	0.630
Clean	0.274	0.524

Table A.22 presents the communalities and factor component loadings for the factor *compliance with procedures.* The item *No shortcut 2 (my co-worker will not ask me to take shortcuts*) had the highest communality value of 62.8% for this factor. The item *report co-worker* had the lowest communality value of 18.8% for this factor. This implies that co-workers reporting each other's unsafe behaviors were represented least by the factor *compliance with procedures.* The item *no shortcut 2* had the highest factor component loading value of 0.793 for this factor. The item with the weakest factor component loading had a value of 0.435, suggesting that all the items fit well together.

Table A.22 *Communalities/Loading Values: Compliance with Procedures*

	Communalities	Loadings
No shortcuts 2	0.628	0.793
No shortcuts	0.588	0.767
Report me	0.480	0.693
Not affected	0.431	0.657
Report co-workers	0.189	0.435

Table A.23 presents the communalities and factor component loadings for the factor *competence.* The item *familiar* had the highest communality value of 67.8% for this factor. The item *knowledge gained* had the lowest communality value of 39.8% for this factor. This implies that knowledge gained through training is least represented by the factor *competence.* The item *familiar* had the highest factor component loading value of 0.823 for this factor. The item with the weakest factor component loading had a value of 0.624, suggesting that all the items fit well together.

Table A.23 *Communalities/Loading Values: Competencies*

	Communalities	Loadings
Familiar	0.678	0.823
Coworker familiar	0.671	0.819
Easily understand	0.659	0.812
Procedure emphasize	0.598	0.773
Knowledge gained	0.389	0.624

1.1.6 Eigenvalues

The scree plots in Figures A.22, A.23, A.24, A.25, A.26, and A.27 plots the “eigenvalues” or “extraction sum of squared loadings,” which measure the units of variance (where the total number of units of variance is equal to the number of items) that are accounted for by each component. There are as many components as there are items, but only components with eigenvalues greater than 1 (using the Kaiser-Guttman criterion) are extracted as factors. When a factor is well-defined by strong correlations among the items, the result is a scree plot that has a sharp “elbow,” or bend, immediately following the first eigenvalue; this indicates that all the important information about the set of items is summarized in that single factor. A.22, A.23, A.24, A.25, A.26, and A.27 show well-defined single factors, as also shown by the communalities and factor loadings, for each dimension; however, Figure A.24 denotes the presence of two factors, as the “elbow” is less sharply defined. The principal component extraction method (PCE) reveals that the last two statements in this dimension do not reside in the dimension. Table A-3 presents the results of PCE following a rotation. The values predict that the two statements do fit a new separate dimension. Hence, a seventh category *safety performance* was established.

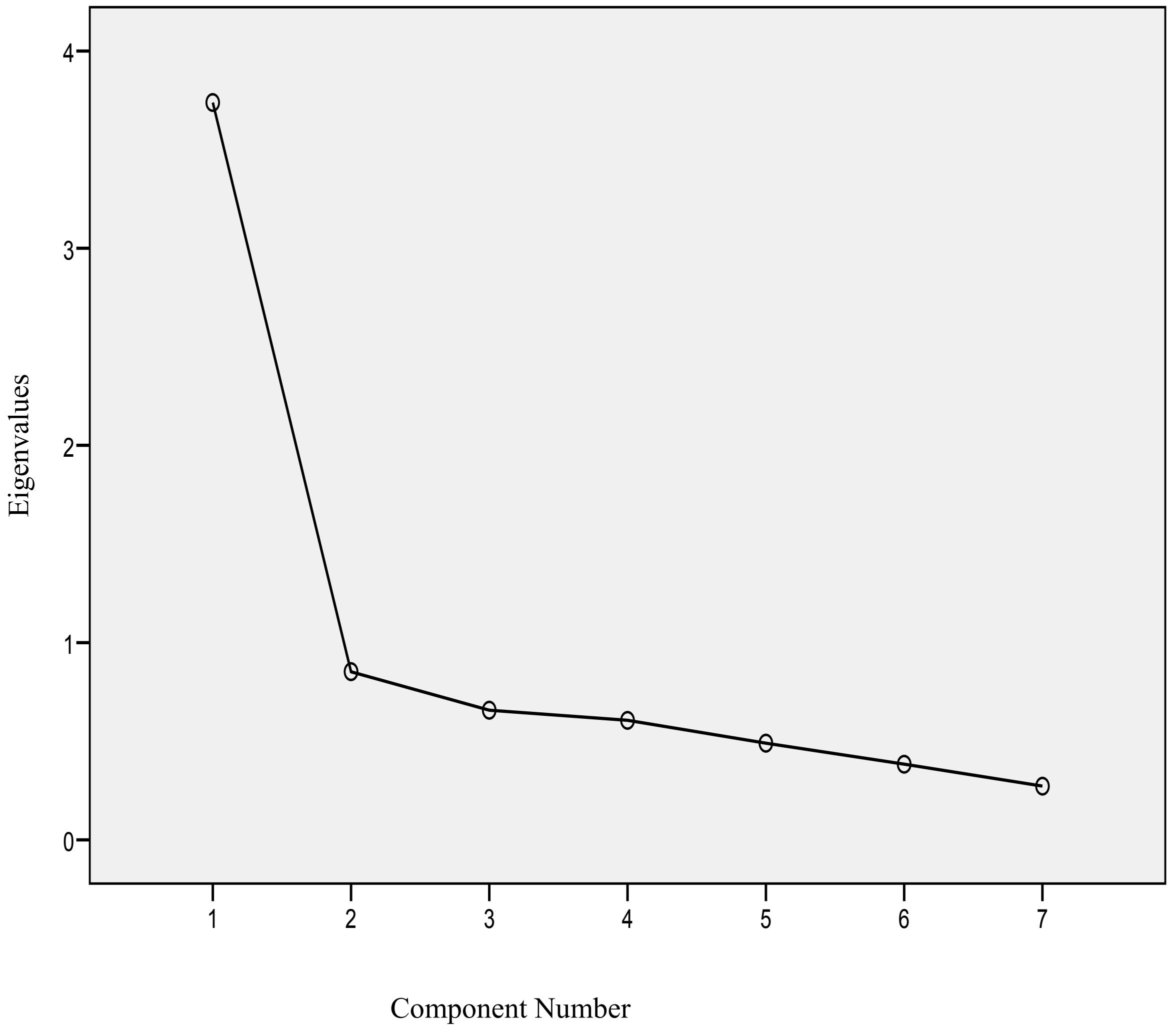

Figure A.22. Scree Plots: Management Commitment to Safety

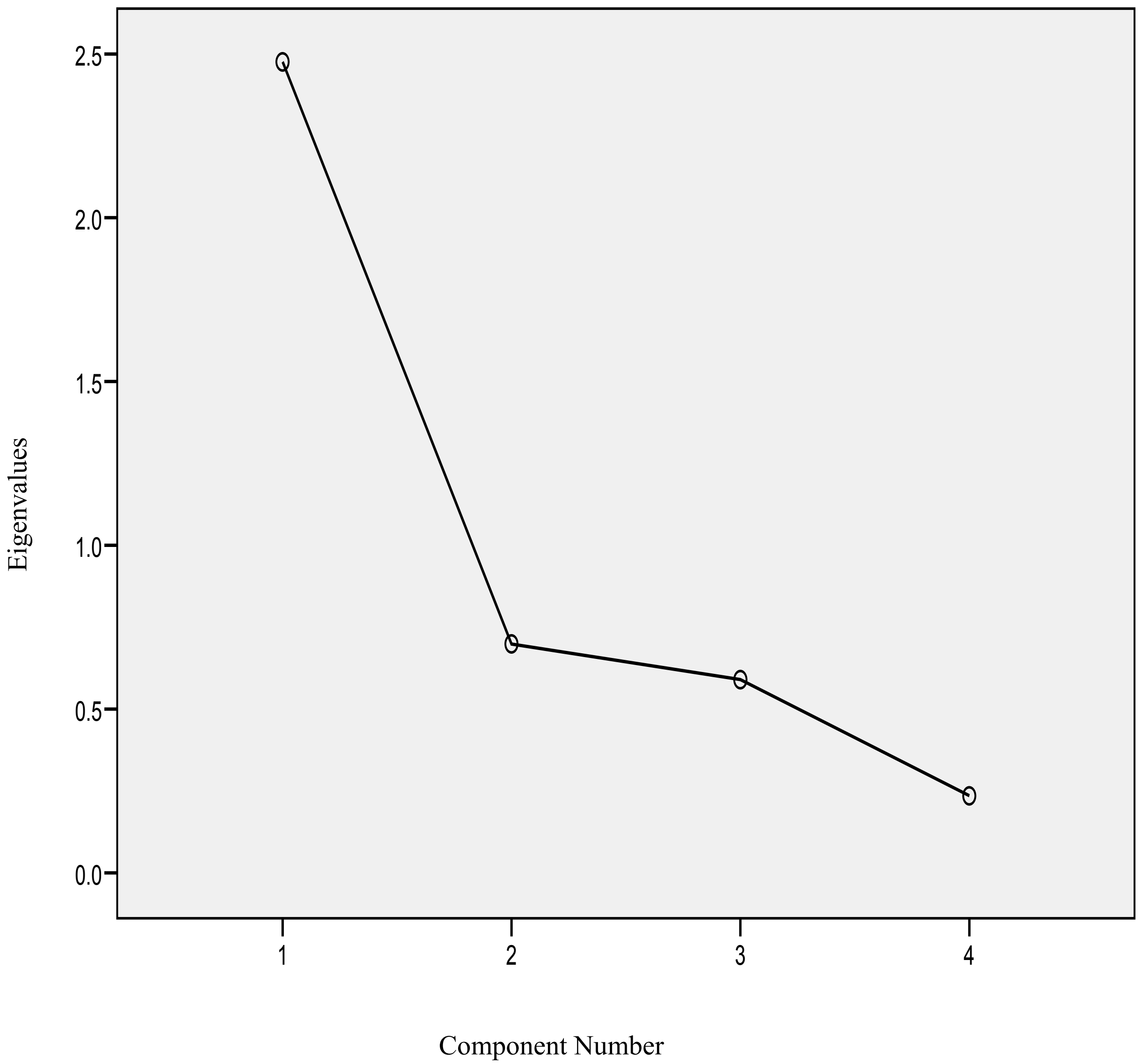

Figure A.23. Scree Plots: Communication of Safety Expectations/Goals

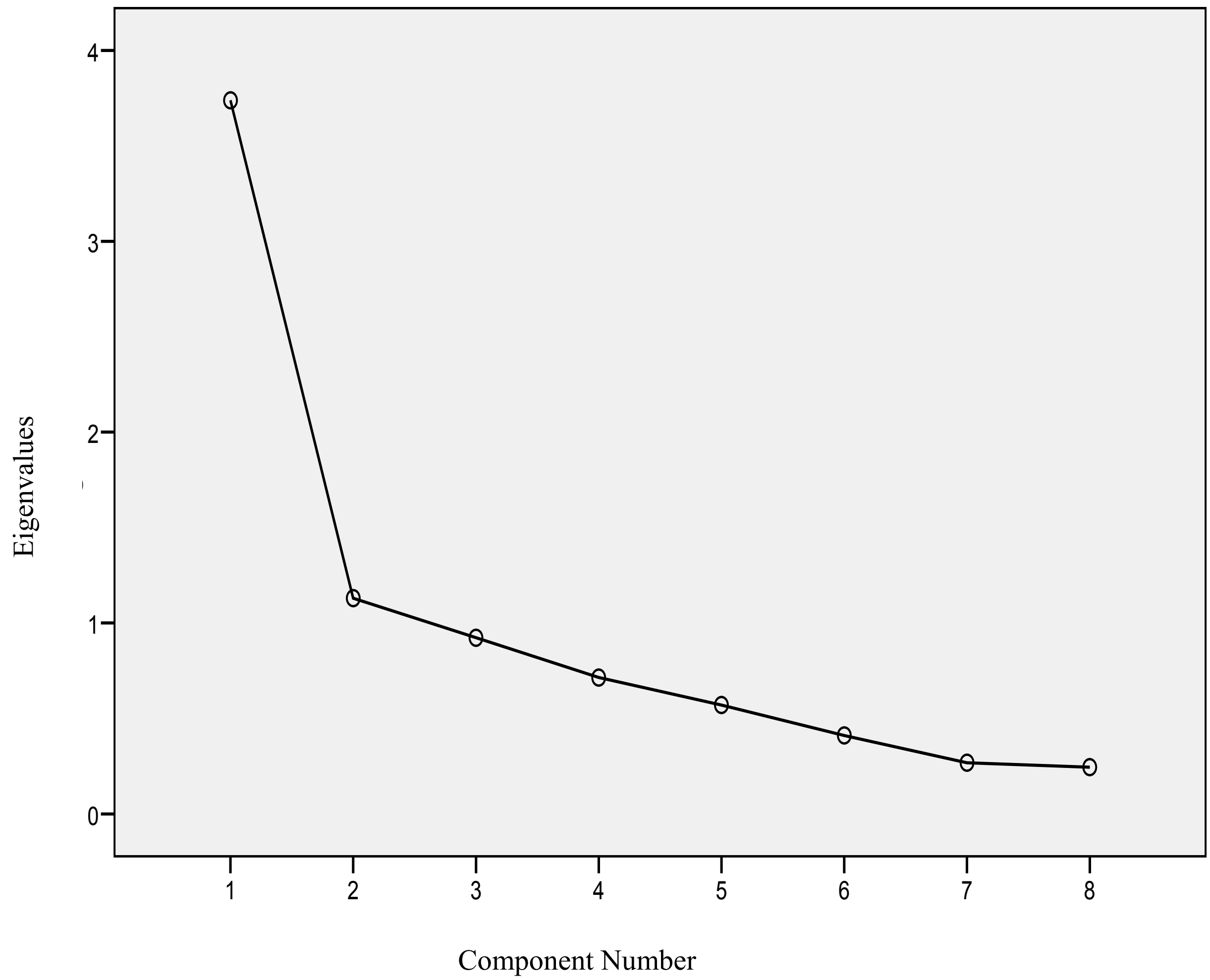

Figure A.24. Scree Plots: Functionality of Organizational Safety

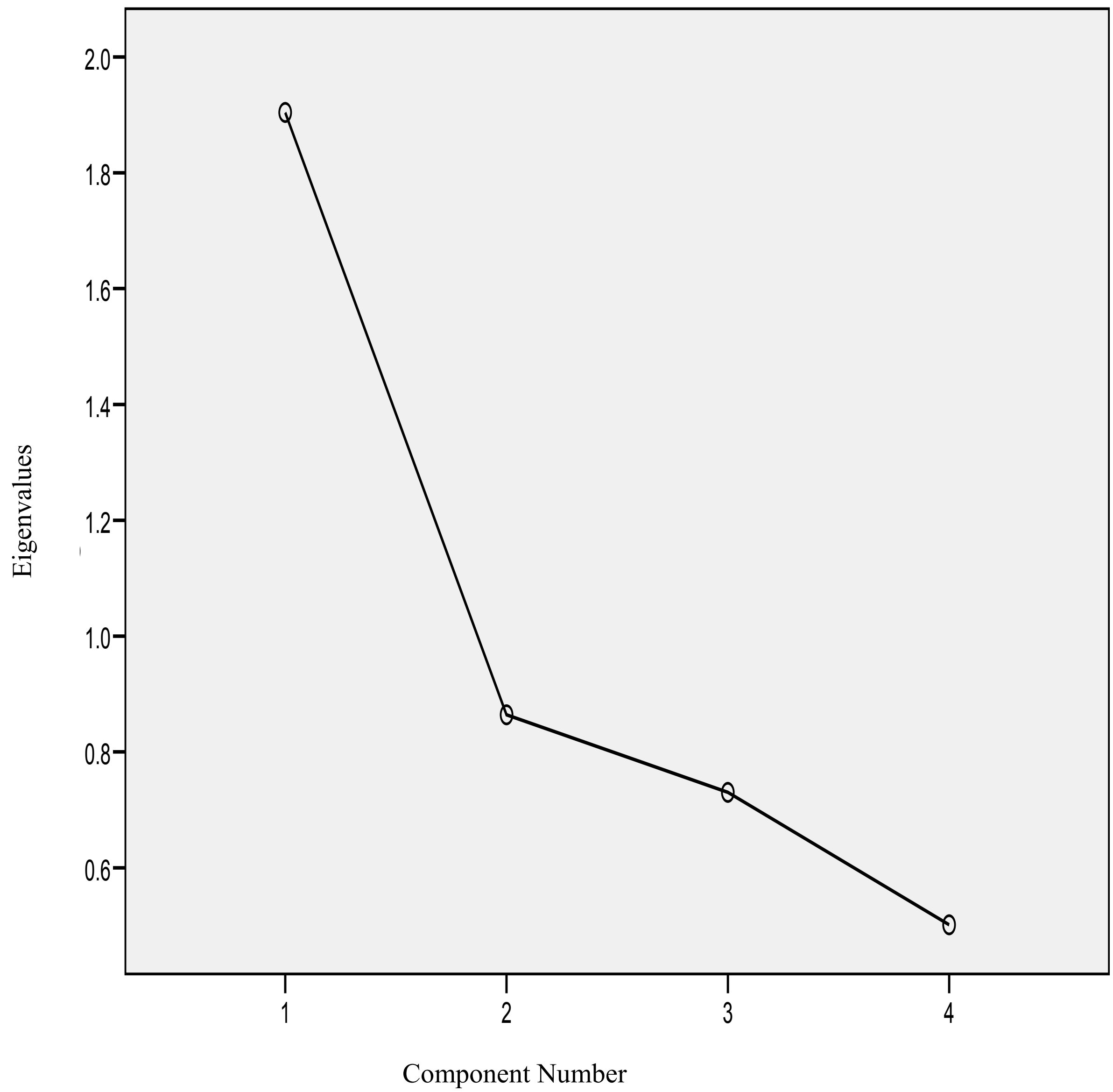

Figure A.25. Scree Plots: Physical Working Environment

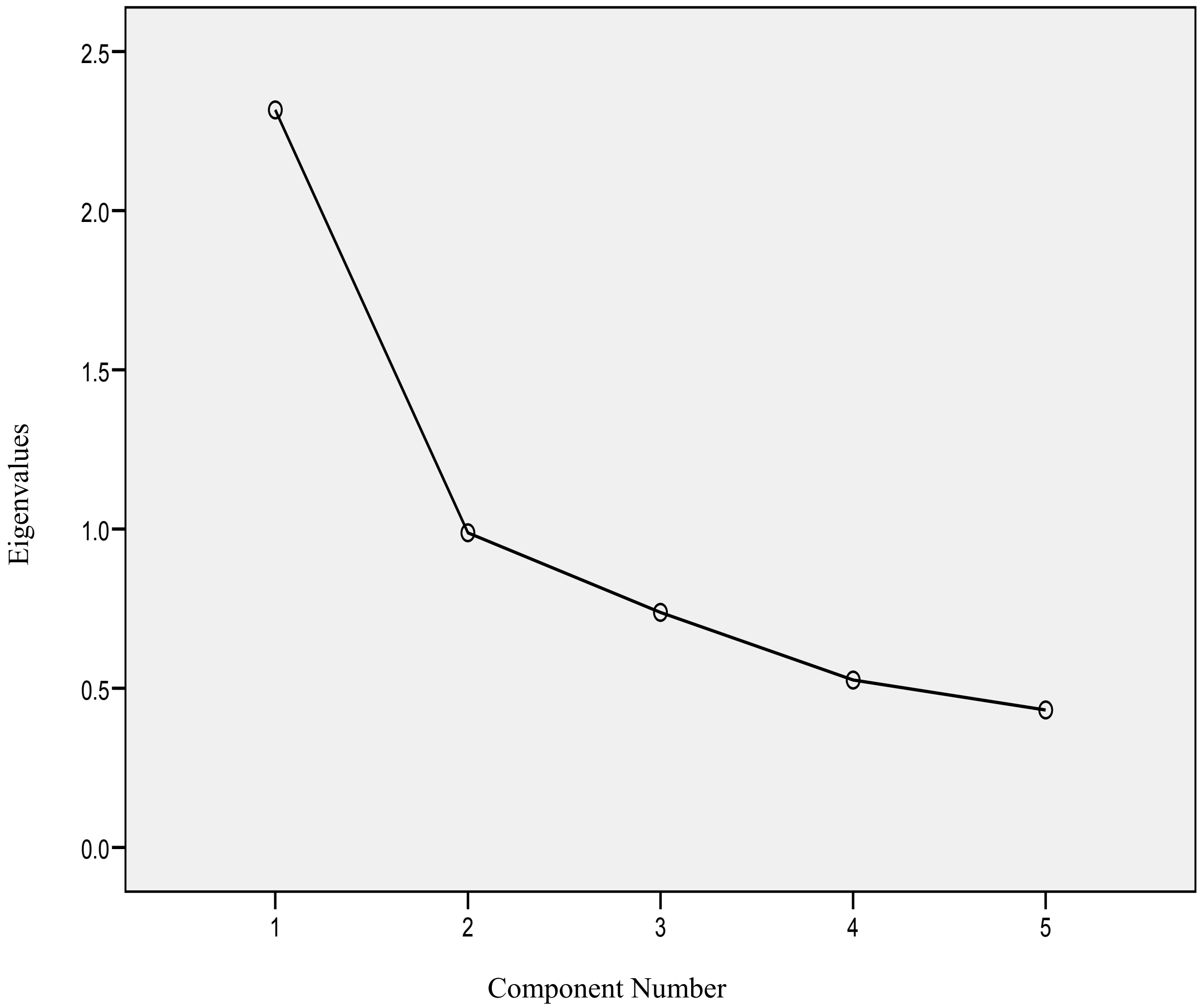

Figure A.26. Scree Plots for Factor 5: Compliance with Procedures

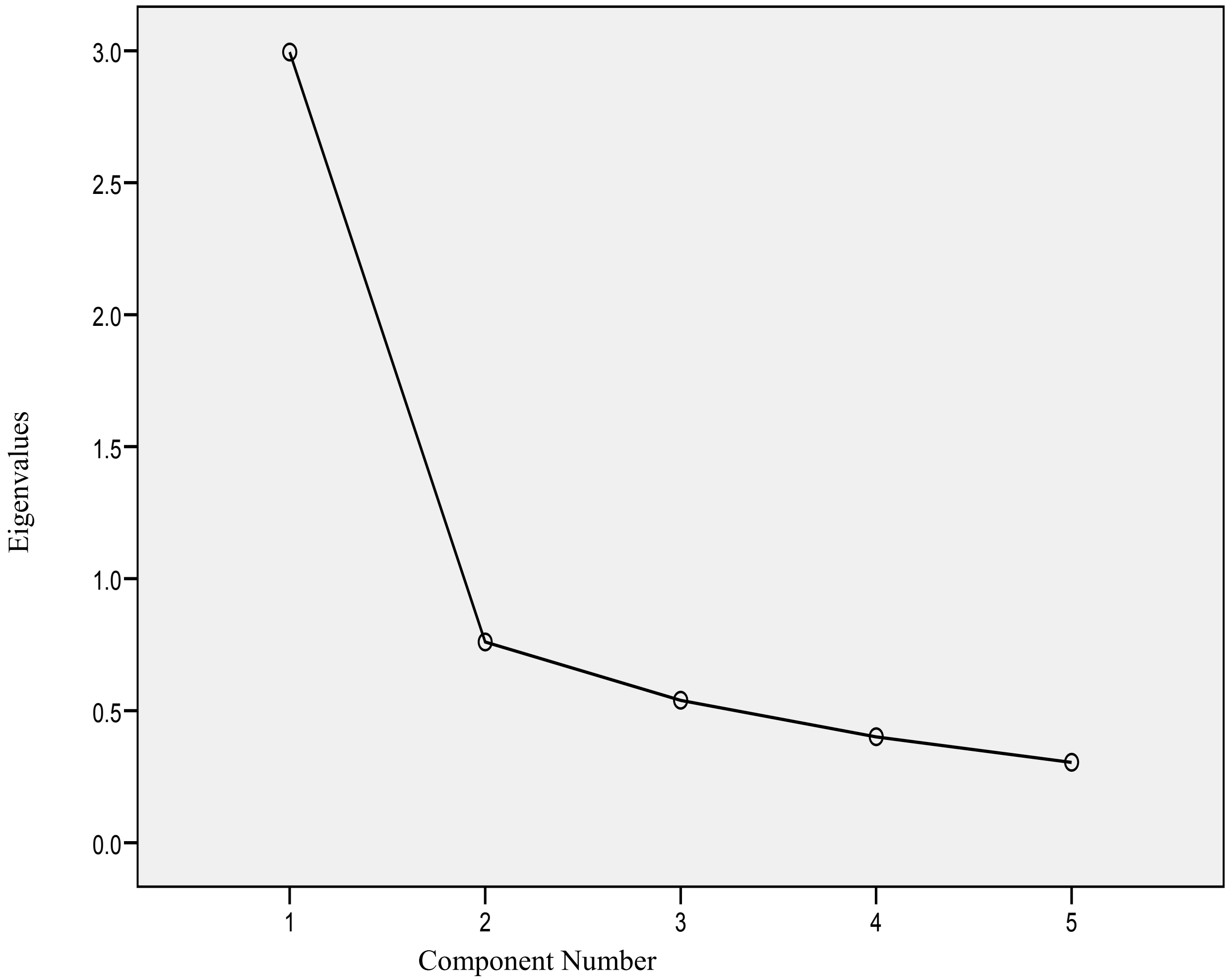

Figure A.27. Scree Plots: Competencies

1.2 Cronbach's Alpha

Once the factor analysis was completed, a Cronbach's Alpha was used to ensure internal consistency of the items in a particular factor. Prior to calculating the average rating for each dimension, it was necessary to ensure that the items in a group had consistent responses from each participant. For example, if a participant responded favorably to the first item in a dimension, then it is assumed that the response rate for that dimension will be high. Similarly, if a participant responds negatively to the first item in a dimension, it is assumed that the response rate for that dimension will be low. Internal consistency for a group of items is important because the average score of the items is a good representation of the individual responses only if each item is responded to similarly. To check for internal consistency of the seven dimensions the statistic Cronbach's Alpha was used. A Cronbach's Alpha value of 0.7 or greater is considered appropriate. The value of 0.7 is relative to the number of questions contained in the dimension (Garson, 2007). For example, 0.6 is considered high if a category only contains five or less questions. However, a category that contains ten or more questions is only considered internally consistent with a value of 0.8 or greater. The Cronbach's Alpha values for the seven dimensions are listed in Table 4-15. Values indicated that all seven dimensions had internal consistency.

Table A.24 *Cronbach's Alpha*

	Cronbach's Alpha	Number of Items
Management Commitment	0.851	7
Communication	0.780	4
Functionality of Safety Systems	0.853	6
Safety performance	0.369	2
Physical Environment	0.628	4
Interpersonal Relationship	0.702	5
Competence	0.814	5

APPENDIX B: SAFETY CLIMATE QUESTIONNAIRE

QUESTIONNAIRE FOR EMPLOYEES

Please rate the following statements about your organization. Your rating should reflect your opinions and beliefs. Use the following five-point scale in your rating:

1 - Strongly Disagree; 2 – Disagree; 3 - Neither Agree nor Disagree; 4 – Agree; 5 - Strongly Agree

1 **Management commitment to safety**	**Strongly Disagree**			**Strongly Agree**
Managers are committed to safety.	1	2	3	4	5
Safety is given priority over productivity.	1	2	3	4	5
Managers are always examples of appropriate safety procedures.	1	2	3	4	5
Work will not begin until we are properly staffed to perform work safely.	1	2	3	4	5
Exemplary safety performance is recognized/awarded.	1	2	3	4	5
Employees are authorized to stop work process if hazards arise.	1	2	3	4	5
Reports of safety concerns are addressed appropriately.	1	2	3	4	5
2 **Communication of safety expectations/goals**	**Strongly Disagree**				**Strongly Agree**
Company safety performance is widely communicated.	1	2	3	4	5
Management clearly defines/emphasize safety performance expectations/goals.	1	2	3	4	5
Top management is receptive when middle management expresses their concerns with maintaining appropriate safety level.	1	2	3	4	5
Supervisors are always receptive to reports of safety concerns.	1	2	3	4	5
3 **The functionality of organizational safety**	**Strongly Disagree**				**Strongly Agree**
Safety personnel are authorized to stop production in case of a safety concern.	1	2	3	4	5
Safety personnel are available in a timely manner to address safety concerns.	1	2	3	4	5
Accidents are thoroughly investigated	1	2	3	4	5
Accident investigation recommendations are implemented in a timely manner.	1	2	3	4	5
I receive safety performance feedback	1	2	3	4	5

during my employee evaluation.					
Personnel safety record play role in evaluation for promotion process.	1	2	3	4	5
Safety staff enforces safe working practices on employees.	1	2	3	4	5
Safety staff enforces safe working practices on managers.	1	2	3	4	5
4 **Physical Working Environment**	**Strongly Disagree**				**Strongly Agree**
Working conditions (noise, temperature, lighting, required work posture, etc.) are comfortable.	1	2	3	4	5
Safety concerns (electrical faults, broken ladder, spills etc.) are repaired in a timely manner.	1	2	3	4	5
Tools/equipments are adequate to perform my job safely.	1	2	3	4	5
We are required to keep our work areas clean and in order.	1	2	3	4	5
5 **Compliance with Procedures**	**Strongly Disagree**				**Strongly Agree**
We do not take safety shortcuts at work (not following safety procedures).	1	2	3	4	5
Supervisors encourage us to report co-workers who take safety shortcuts.	1	2	3	4	5
My co-workers will not ask me to take shortcuts.	1	2	3	4	5
My relationship with my co-workers will NOT be affected if I refuse to take safety shortcuts	1	2	3	4	5
My co-workers will report my behavior if I take a safety shortcut	1	2	3	4	5
6 **Competence**	**Strongly Disagree**				**Strongly Agree**
The knowledge I gained from safety training helps me to perform my work safely.	1	2	3	4	5
Policies and procedures strongly emphasize safe working practices.	1	2	3	4	5
Supervisors are familiar with safety requirements specified in the policies/procedures.	1	2	3	4	5
I can easily understand safety documents and their meaning.	1	2	3	4	5
My co-workers are familiar with safety requirements specified in the policies/procedures.	1	2	3	4	5

APPENDIX C: DECISION SCENARIO

DECISION SCENARIO - STANDARD OPERATING PROCEDURE

You are employed by a steel manufacturing plant. During day to day routine activities one Co-workers suggest taking a short cut in implementation for one of the standard operating procedures. Your decision will have implications in the following dimensions:

1. Peer Pressure from the person making the suggestion;
2. Safety;
3. Productivity; and
4. Promotion

You have the following four alternatives:

1. Ignore: Just ignore the suggestion and continue with work.
2. Report without details: Disagree with the suggestion and report the event without mentioning names in the situation.
3. Agree: Agree with the suggested short cut.
4. Report with details: Disagree with the suggestion and report the event including names and situation.

When you are ready, follow the steps below in order to initiate and complete the simulation:

STEP 1: Assign weight to each one of the decision factors on the far right column on a scale of 0 – 10, 0 being not important and 10 being very important.

STEP 2: Click SELECT to view information that relates a decision factor to an alternative (Decision factors are located on the left column and alternatives on the upper row). The values at the bottom of the cells are given on a 21-point scale, where -10 implies that an alternative is evaluated very unfavorably, 0 implies a neutral position, and 10 implies a very favorable evaluation of the alternative with respect to the specific decision factor.

STEP 3: Based on the features you've selected, choose the best alternative by clicking on the Final Choice button, at the lowest rubric in this alternative's column.

STEP 4: Confirm your choice by clicking Final Decision

Please remember to select at least one implication and one decision.

	Alternative 1 Just ignore	**Alternative 2** Report without Details	**Alternative 3** Agree	**Alternative 4** Report with details
Dimension 1 Peer Pressure	This alternative will not establish peer pressure since the event was not reported. Rating 10	Reporting without details may establish slight peer pressure due to the broadcasting of the event. Rating -5	Agreeing to take short cut will make you look friendly and a person that can be trusted. Rating 10	Reporting with details will establish significant peer pressure and my result in social isolation. Rating -10
Dimension 2 Safety	Not reporting might lead taking short cuts a norm and may lead to severe safety events. Rating -7	Report without details may establish a prevention program that will reduce the likelihood of re-occurrences. Rating 6	Agreeing to take short cut not only may lead to a safety event but may cause harm to you. Rating -7	Report with details will have major impact on reducing the likelihood of re-occurrences since employees will corrective actions against them. Rating 10
Dimension 3 Productivity	Taking short cuts will prevent slow down of work process and will maintain productivity at high level. However, should safety occur productivity will completely stop. Rating 7	Reporting without details will potentially slow down productivity due to the need to adequately follow the standard operation procedure. Rating -3	Taking short cuts will prevent slow down of work process and will maintain productivity at high level. However, should safety occur productivity will completely stop. Rating 7	Reporting with details will potentially slow down productivity due to the need to adequately follow the standard operation procedure. Rating -5
Dimension 4 Promotion	Not reporting will have no impact on promotion. Rating 0	Reporting without details will put you in a positive light in the eyes of your supervisor; Thus the likelihood of getting promoted increases. Rating 6	Agreeing to take short cut will have no impact on promotion. Rating 0	Reporting with details will put you in a strong positive light in the eyes of your supervisor; The likelihood of getting promoted is higher than in any other case. Rating 10

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