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# The Mediating Role of Workers' Climate and Behavioral Perceptions on Safety Management System Performance

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## Abstract

**Based on survey results from over fifty groups of workers and their employees, it has been determined that worker perceptions related to safety climate, interactional justice, and task and team safety proficiency behaviors act as mediators between a system of safety management practices and reductions in recordable injuries and, to a lesser extent, lost time injuries. It appears that in those instances where workers view or believe that their management has placed a strong priority on safety, that they are being treated with dignity and respect through the system of safety management practices, that they are carrying out their own work safely, and that they are cooperating with others to work safely as a group, the system of safety management practices is more effective in producing measurable performance results. Certain human performance constructs (informational and procedural justice climates) do not appear to act as strong mediators. Thus, there appears to be some discrimination as to which human performance constructs actually act as mediators versus a situation where all worker climate and behavioral perceptions have the same or non-distinguishing effects. These results support previous conclusions that safety management practices should be designed and implemented to promote and enhance positive worker perceptions, thereby putting workers at the center of safety management systems which is a fundamental concept behind the human performance approach to safety management.**

## Keywords

**Accident Rates, Human Performance, Justice Climate, Safety Climate, Safety Management System, Task Safety Proficiency, Team Safety Proficiency, Worker Perceptions**

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## 1. Introduction

Safety management systems, such as those described by OHSAS 18001 and ANSI Z10 consensus standards, are designed to develop and institutionalize processes that continually identify, evaluate, prioritize, and reduce or eliminate health and safety (H & S) risk. The success of these systems is often assessed through lagging safety performance measures, such as the number or rate of worker injuries. These safety management systems as described in these consensus standards are limited in terms of defining the role of workers in these systems, including workers' perceptions and human performance attributes.

### 1.1. The Mediating Role of Worker Engagement

In our previous research, the mediating role of worker perceptions on safety performance was investigated—in particular, worker cognitive and emotional engagement [1]. That research was based in part on O'Toole's research results which suggested that the injury reduction experienced at various company locations was strongly impacted by the positive employee perceptions on several key factors, with the most important one being management commitment [2].

In our previous mediation study, a phased approach was used to investigate how safety managers' and workers' safety engagement perceptions mediated the effects of safety management practices (constituting a safety management system) on safety performance. Mediators represent the mechanism that explains the relationship between two variables, or "how" one variable (e.g., safety management practices) relates to another variable (*i.e.*, safety performance as assessed through injury statistics). A mediator is simultaneously a predicting variable (e.g., perceived level of safety engagement negatively predicting injury statistics) and an outcome (e.g., perceived level of safety engagement being determined by the presence of safety management practices).

The results of the first phase of this mediation investigation showed that ten safety management practices (and the unitary system of these practices) impacted both the perceived level of safety engagement and the outcome of safety performance. The ten formalized practices investigated were: employee involvement; pre- and post-task safety reviews; safe work procedures; hiring for safety; cooperation facilitation; safety training; information sharing; accident investigation; detection and monitoring of deviation; and safe task assignment. These ten practices as well as how these were selected to represent a safety management system have been described in detail [1].

In the second phase of this previous study, the results indicated that worker engagement perceptions mediated the relationship between the unitary system of safety management practices and safety performance. The identification of the presence of this mediation role supports the work of Fernández-Muñiz *et al.* [3]. In their model, manager commitment was linked to safety performance through the construct of employee involvement.

This mediating role of worker engagement on performance was initially explored by Rich *et al.* [4]. Their research explicitly positioned engagement as a motivational concept which can lead to desired behavioral consequences. As indicated by Rich *et al.*, this emphasis is consistent with Ashforth and Humphrey's [5] argument that because engagement accounts for the simultaneous expression of both strong motivation and psychological involvement, it is an important motivational concept with great potential to improve understanding of the mechanism through which contextual perceptions and behavioral tendencies ultimately influence behavior and human performance.

### 1.2. The Human Performance System Approach

The previous research mediation results could be explained by a human performance system approach to understanding how accidents occur in the workplace. The presence of a system of safety management practices in organizations may be a necessary foundation for achieving a safe working environment, but it offers no guarantee. Thus, the requirements and resulting practices and processes implemented through safety management system consensus standards, such as OHSAS 18001, ANSI Z10 and OSHA Voluntary Protection Program (VPP), may only provide the necessary "first steps" in arriving at safety excellence. The results indicated the need to expand the idea of a "safety management system" to more emphatically include the role of workers and their impact beyond that normally identified in a safety management system. Workers, who come into daily contact with risk and who are at the sharp-edge where accidents occur, appear to play an equally important role as does the specific system of safety management practices in preventing accidents from occurring. The results in the study in-

dicated that workers' cognitive and emotional engagement may be viewed as a result of safety management practices being in place, but may also act as a necessary implementation component for maintaining an effective system of safety management practices and in preventing accidents from occurring. Thus, a system of safety management practices "work" not only through the written policies, plans, procedures, and processes in place to identify, evaluate and reduce physical hazards and risk (traditional safety management system approach), but through the behaviors of and consequential actions by workers themselves who interact necessarily with the safety management system and its practices (human performance approach). This is consistent with theories that state that management practices operate by reducing barriers that impede desired behaviors [6]; by motivating employees to behave in line with organizational goals [7]-[9], and through enhanced social relationships within organizations [10]. Thus, when organizations invest in a safety management system approach to preventing accidents from occurring and to improving safety performance, they should also be concerned about winning over the minds and hearts and resulting perceptions of their workers through its system of safe work practices.

### 1.3. Research Goal

Based on these previous research results that illuminated the mediating role of worker engagement on a system of safety management practices and its overall performance, the authors posit that aspects of additional human performance constructs can also influence how safety management systems "work" to improve safety performance. In this current study, the authors define human safety performance broadly as any employee safety response which has a desirable influence on their safe-decision-making process and their subsequent safe behavior. The authors consider a number of distinct human safety performance constructs in this study that were chosen collaboratively via an iterative approach using an expert group of human safety performance theorists and practitioners: safety climate, justice climates, and task (individually directed) and team (socially directed) safety behaviors. Although this list is not meant to be comprehensive, it represents some very important theoretical human performance constructs which can be used to facilitate a more complete understanding of how a system of safety management practices work through human performance to impact safety performance.

Consistent with the human resource practice literature, it is suspected that the relative impact of each of the ten individual safety management practices on human safety performance will vary, but the collective system works synergistically to ultimately influence employee safe-decision-making. It is this system of mutually reinforcing practices that is thought to provide the greatest impact on employee perceptions and behaviors and, in turn, organizational safety performance [7] [10] [11]. Therefore, in this study, the impact of the unitary system of safety management practices on human performance perceptions will be investigated.

Thus, the goal of this study is to theoretically and empirically investigate how the system of safety management practices works to improve organizational safety performance through the distinct human performance safety constructs listed above. In order to do so the authors present the results of statistical models in which each of the human performance safety constructs is individually hypothesized to mediate the relationship between the unitary system of safety management practices and occupational injuries and illnesses. The authors first present the necessary theory behind each of the human performance safety constructs and how they work to govern safe-decision-making and safe work behaviors. The authors follow this with a discussion of the research methods and results undertaken to examine these relationships.

## 2. Theoretical Development of Climate (Safety and Justice) and Behavioral (Task and Team) Constructs

### 2.1. Safety Climate

Zohar and Luria [12] argue that safety climate perceptions refer to the established consensus of the relative priority of safety in the workplace versus other competing goals (e.g. efficiency and productivity). At the collective level, safety climate refers to socially construed indications of desired role behavior originating from organizational policies and procedures [13].

A system of safety management practices impacts the level of safety climate directly from the practices themselves and through the changes in the organizational social structure. By facilitating relationships within the organization, generalized norms of reciprocity are fostered which can improve teamwork and safety cooperation [10] [14]. Systems of safety practices also emphasize the priority of safety and these practices inform employees

of expectations in terms of the task performance and thus influence safe decision-making and behavior.

When the level of safety climate is low, other competing goals can take precedence which can lead to poor safety performance. For example, Hofman and Stetzer [15] note that perceptions of performance pressure can lead workers to perceive that "engaging in short cut behavior is an expected, or required, part of the job" (p. 309). Further "in the presence of significant time constraints, individuals can begin to perceive that taking risks is simply part of the job" (p. 310).

Through safety climate, systems of safety management practices act to influence employee perceptions regarding the allowable level of personal and social risk allowable within the organization. These risk perceptions govern an employee's decision-making in routine and uncertain tasks, enhance safety behaviors and ultimately can reduce workplace injuries and illnesses.

**Hypothesis 1: Group-level safety climate will mediate the relationship between the system of safety management practices and occupational injuries and illnesses.**

## 2.2. Justice Climate Focused on Safety Practices (Procedural, Interactional, and Informational)

Justice perceptions are "related to humanitarian and ethical standards that describe how we should act and treat others" [16] (p. 158). Employee safety inherently addresses a moral concern that all workers have in common. Therefore, legitimate organizational safety activities have the capacity to satisfy employee perceptions of justice. The authors hypothesize that the design of organizational safety programs as implemented through safety management practices is critical to facilitating perceptions of justice focused on the programs and reaping the benefits therein. Through a proactive system of the safety management practices outlined in this text, organizations can actively facilitate and enhance perceptions of justice among the workforce.

In the management and industrial psychology literatures, justice has a long history of theoretical and empirical exploration. Workplace justice has been conceptualized as a multi-dimensional employee perceptual construct which lends itself well to multi-level theory and empirical exploration [17]. Three distinct justice climate constructs (procedural, interactional, and informational) were considered as being a potentially important mechanisms in the safety management-organizational safety performance relationship.

Procedural justice is designed to reflect the employee's perception that practices are developed from accurate information, are unbiased and impartial, conform to an ethical standard, and the opportunity has been extended to employees to influence these practices [18]. Interactional justice captures an employee's perception that they are treated with dignity and respect through the implementation of the organization's management system [19]. Informational justice is designed to capture an employee's perception that information regarding practices is communicated by the organization in a timely, candid, and honest way [20].

These theories can be extended to the current discussion where the focus is centered on safety management practices and its unitary system. All of the individual practices within the safety management system are designed to impact and influence these justice perceptions. For example, communication and information sharing, employee involvement, and safe work procedures can influence an employee's perception that the organization's safety program is "just". Collectively these practices provide a mechanism for employees to express their needs and concerns concerning the safety aspects of their work. Through these collective practices, mechanisms are provided such that the organization's respect for employees is visually displayed and felt by employees allowing for the preservation of and enhancement of dignity. Through open and free flowing safety communication and employee influence, employees are able to feel a sense of pride, ownership, and identification with the organization's safety program [21].

There are numerous positive benefits as a result of justice perceptions that can have positive impacts on safety performance. Job satisfaction, organizational commitment, trust in management, compliance, and organizational and group identification, as well as team-work behaviors, are outcomes that have been theorized and researched in the management literature [16] [18] [21]. All of these outcomes are relevant to the outcome of safety performance. Thus, the authors choose to explore whether or not justice climate perceptions can be a potential mediating construct between a system of safety management practices and safety performance.

**Hypothesis 2: Group-level procedural justice climate will mediate the relationship between a system of safety management practices and occupational injuries and illnesses.**

**Hypothesis 3: Group-level interactional justice climate will mediate the relationship between a system**

**of safety management practices and occupational injuries and illnesses.**

**Hypothesis 4: Group-level informational justice climate will mediate the relationship between a system of safety management practices and occupational injuries and illnesses.**

## 2.3. Task and Team Safe Work Behaviors

Safe work behaviors are logically hypothesized to be negatively related to individual accidents and injuries, the aggregate of which leads to varying levels of organizational safety performance. Numerous models of safe work behavior have been conceptualized. For example, Griffin and Neal [22] distinguish between two forms of safe work behaviors: safety compliance and safety participation. Safety compliance refers to adherence to mandated safety rules and regulations and safety participation refers to behaviors that are voluntary in nature. These behaviors, in turn, are hypothesized to be negatively related to safety outcomes (individual accidents and injuries). Griffin and Neal's [22] conceptualization of safe work behaviors has provided a particularly useful framework to categorize and research the different forms safe behavior.

New developments in the concept of job and task performance, however, seem to capture the essence of safe work behavior more accurately especially in light of increasing work interdependency and team-based work structures. Specifically, Griffin *et al.*'s [23] model of work role performance can be applied to safe work behavior to provide new insight into the nature of how employee safe work behavior can improve safety performance. Griffin *et al.* [23] argue that the changing nature of work and organizations have challenged traditional work views of individual work performance. One major change is the increasing interdependence of work systems. Griffin *et al.* further propose that this interdependent work context must be actively managed by organizations.

Interdependence determines the extent to which work roles are embedded in a broader social system. Interdependence "determines whether an individual can be effective by simply managing the responsibilities of his or her role as an individual within an organization or also needs to act to support the broader social context of the organization" [23] (p. 330). Interdependence exists when individuals in a work group need to cooperate to achieve shared goals. In interdependent work systems, the behavior of the worker has an impact on individual, work group, and organizational performance.

The authors propose that safe work behaviors exist in an interdependent context somewhat independent from the structure of work utilized in an organization. The safe or unsafe decisions made by employees have both a personal (individual) and social safety outcome. In the context of human safety performance, all employees share the responsibility of creating a safe work environment. Each individual in an interdependent context must do his/her part in order to minimize the risk for other individuals in the collective. Further, cooperation among co-workers is often important to ensure safety performance goals are met for both the individual and the collective.

Many government regulations incorporate communication and cooperation elements to ensure continuity of safety, for example, during routine shift changes. Often, without the physical and planning assistance of co-workers, manual tasks cannot be completed safely and communication between co-workers is essential for individuals to understand the risk potential in current states of safety sensitive processes. In many workplaces, workers must rely on a co-worker to ensure that machinery and equipment necessary for task execution is constructed and maintained in a safe manner. Finally, each individual accident or injury impacts the group safety performance and organizational safety performance as a whole.

Grounded in the theoretical work by Griffin *et al.* [23], the authors identify two forms of safe work behavior that are relevant to safety performance in organizations, namely task and team safety proficiency. Proficiency is a term designed to reflect the extent to which an individual perceives that they are meeting formalized role requirements. Similar to "compliance" behaviors, individual safety proficiency captures the degree to which an employee carries out his or her own work (e.g., tasks) safely. It reflects the consistent and proper execution of the safe work behaviors required of the individual. Social safety proficiency captures the interdependent nature of employee safety performance behaviors and is conceptualized to represent the minimum cooperative behavioral elements needed to ensure the safety of the collective. Through each of the safety management practices, such as cooperation facilitation for example, a system of safe work practices is expected to influence both individually directed and socially directed safety behaviors necessary to improve safety performance.

**Hypothesis 5: Group-level task (individually directed) safety proficiency will mediate the relationship between a system of safety management practices and occupational injuries and illnesses.**

**Hypothesis 6: Group-level team (socially directed) safety proficiency will mediate the relationship between a system of safety management practices and occupational injuries and illnesses.**

# 3. Methods

## 3.1. Sample

Between 2011 and 2013, data were collected using surveys designed to understand the degree of effectiveness of safety management systems on occupational injuries and illnesses and how they worked to achieve these results. Multiple large scale studies were conducted during this time period. This study reports the results of a group-level study conducted to explore the relationships among the system of safety management practices, employee H & S perceptions and responses, and self-reported injuries and illnesses within establishment units (e.g., work-groups). Supervisors responsible for safety management system implementation and their workers provided the data used in the current study.

Through established professional networks (e.g., the American Society of Safety Engineers, the Society for Human Resource Management, and the Board of Certified Safety Professionals) as well as through open invitation, the current research study was made known to organizations. Approximately forty-four establishments accepted the invitation to participate in this part of the study. Of those, thirty-one were characterized as high hazard industries. Light and heavy manufacturing, nuclear power research and production, and mining were industries represented in the sample. These thirty-one establishments were asked to choose two interdependent departments (groups) within their establishment to participate in the study. The authors worked with the participating organizations to select groups that shared similar tasks, the same production goals, and with members who routinely needed to work interdependently to achieve production goals.

Each of the sixty-two groups completed two different surveys. The first survey measured the characteristics of the safety management system practices. The survey was administered to multiple group managers and supervisors independently in order to counteract potential bias in rating of the safety management practices [24]. A total of 205 department managers completed the survey (average number of managers per group 3.3, range 2 to 5). Another survey was completed by employees within each group which collected information regarding their perceptions associated with the human performance constructs, such as level of task and team safety proficiency behaviors. A total of 1515 employees completed surveys (average per group 24.4, range 13 to 34).

Seven workgroups were eliminated due to incomplete supervisory or worker responses. Thus, the current analysis results are derived from a sample of fifty-five workgroups for which the authors received complete supervisory responses regarding the implemented safety management system and a complete set of responses from the workers within the corresponding workgroup.

## 3.2. Measures

### 3.2.1. Safety Management System Practices

The total number of survey items designed to reflect the safety management system practices was 51. Within the participating organization, managers were asked to evaluate the degree to which each item was relied upon as a key safety management tool. Each item on the safety management practice survey was measured using a 7 point (from strongly disagree to strongly agree) Likert scale. The procedures used to develop the survey along with a complete list of survey items used to assess each practice are presented in Wachter and Yorio [1].

For each practice, the mean was used to summarize the managers' ratings of safety management practices within each group. Within the management practice literature, when high performance work practices are researched as a unitary system, an additive approach is utilized [7] [9] [11] and consistent with this approach, the system of safety management practices was calculated by summing each of the practice composites. The unitary system of safety management practices had a good level of internal consistency (Cronbach's $\alpha = 0.92$). For a complete discussion related to the qualitative process used to develop this measurement device see Yorio and Wachter [25] and Wachter and Yorio [1].

### 3.2.2. Occupational Injuries and Illness

The total number of OSHA recordable and lost-time injuries and illnesses that each group experienced over the previous six month time period was obtained from the organizations. The mean number of recordable and lost

time injuries and illnesses that each employee experienced in each department (group) was used as the outcome of interest (calculated by the total number of injuries in each category divided by the number of employees in that group). The mean was used to offset potential variation in injuries due to different group sizes.

### 3.2.3. Measurement of Human Performance Constructs

Safety climate, justice climates, and the behavioral dimensions of human safety performance were adapted from previously developed measurement devices. Each of the items in the employee survey was measured using a five point scale ranging from strongly disagree to strongly agree. Safety climate was measured using items from Neal and Griffin [26]. Numerous measures of justice have been used in the literature [18] [27]-[30]. The authors chose to measure each of the three related dimensions of justice perceptions (*i.e.* procedural, interactional, and informational) using items adapted from Colquitt [18]. In order to adapt the questions to a focus on the safety aspects of the management system, each question was slightly altered with the addition of safety relevant perceptions. Both task and team safety proficiency items were adapted from the items used by Griffin *et al.* [23] designed to measure the dimensions and elements of work role performance. Griffin *et al.*'s [23] items were also altered slightly in order to place each behavior in a safety relevant context. **Table 1** reports the relevant citations and the items used to measure each of these constructs. Safety climate, justice climates, and safety behaviors all displayed a high level of internal consistency (*i.e.* Cronbach's $\alpha > 0.85$).

For the purpose of this research each of the human safety performance constructs was aggregated (based on the mean) to the group level. Kozlowski and Klein [32] suggest that the mean is an appropriate summarization of individually measured psychological and behavioral constructs when supported theoretically and combined with traditional agreement and inter-rater reliability statistics. Consistent with previous theory and research, in an interdependent context the authors expect consistent safety climate perceptions, justice climate perceptions, and safety behaviors to emerge through theoretical processes such as social exchange, social influence, and so-

**Table 1.** Employee survey constructs and measurement items.

| Climate and behavioral constructs | Statements evaluated/questions used to create climate and behavioral constructs |
|---|---|
| Safety climate (Neal and Griffin, [26]) | • Management places a strong emphasis on workplace safety and health.<br>• Safety is given a high priority by management.<br>• Sometimes, in order to get work done, one must ignore safe work procedures.<br>• It does not matter how work is done as long as there are no accidents. |
| Procedural justice climate (adapted from Colquitt [31]) | • I am able to express my views and feelings during the development of the organization's safety program.<br>• I have influence over the development of my organization's safety program.<br>• Decisions which impact my organization's safety program are made free of bias.<br>• I have been able to question or appear decisions which influence the organization's safety program. |
| Interactional justice climate (adapted from Colquitt [31]) | • When safety practices are developed, implemented and administered, those in charge treat me in a polite manner.<br>• When safety practices are developed, implemented and administered, those with authority treat me with respect.<br>• When safety practices are developed, implemented and administered, those in charge treat me with dignity. |
| Informational justice climate (adapted from Colquitt [31]) | • Management is candid in communications with me about safety practice decisions.<br>• Management explains the rationale for safety practices thoroughly.<br>• Management communicates details about decisions and safety issues in a timely manner. |
| Task safety proficiency (adapted from Griffin, Neal, and Parker [23]) | • I carry out the core safety aspects of my job well.<br>• I always adhere to the core safety responsibilities of my job.<br>• I ensure that my tasks are completed safely. |
| Team safety proficiency (adapted from Griffin, Neal, and Parker [23]) | • I coordinate my work with coworkers to ensure that it is being done in the safest way possible for the benefit of everyone in my work group.<br>• I communicate effectively with my coworkers about the safety aspects of our work.<br>• I help coworkers when asked or needed for the benefit of everyone's safety. |

cialization [32]-[34]. Bliese [35] argued that empirical justification for aggregation of psychological and behavioral constructs measured at the individual level be supported by a significant F statistic and an acceptable level of intra-class correlation coefficient (ICC). Each of the constructs displayed sufficient between group variability and within group homogeneity reflected by the significant F statistic as well acceptable levels of the ICC (Safety climate: F Statistic = 6.95, $p < 0.01$, ICC(1) = 0.17; Procedural justice climate: F Statistic = 3.53, $p < 0.01$, ICC(1) = 0.11; Interactional justice climate: F Statistic = 3.38, $p < 0.01$, ICC(1) = 0.10; Informational justice climate: F Statistic = 3.80, $p < 0.01$, ICC(1) = 0.14; Task safety proficiency: F Statistic = 3.80, $p < 0.01$, ICC(1) = 0.09; Team safety proficiency: F Statistic = 2.95, $p < 0.01$, ICC(1) = 0.07). These results suggest that aggregation of each of the constructs is statistically justified.

### 3.3. Tests for Mediation

In order to test the hypotheses that systems of safety management practices reduce occupational injuries and illnesses through human safety performance, statistical tests were executed for mediation. By modeling the human safety performance constructs outlined above as mediators, the authors are able to directly test hypotheses 1 through 6. Baron and Kenny [36] have developed the statistical test for mediation used most prominently in current empirical research. The procedure can be generically presented as follows. First, the predictor (*i.e.* the safety management system) must be statistically related to the outcome (*i.e.* recordable and lost time injuries and illnesses). Second, the predictor (*i.e.* the safety management system) should be significantly related to the mediator (*i.e.* safety climate, justice climates, and the safety-related behaviors). Third, when both the predictor and the mediator are entered into a multiple regression model simultaneously predicting the outcome, the previously established relationship between predictor (*i.e.* safety management system) and outcome (*i.e.* recordable and lost time injuries and illnesses) should disappear while the mediator's prediction of the outcome is significant. These steps are necessary to statistically support the claim that safety climate, for example, explains how a safety management system decreases organizational injuries.

## 4. Results and Discussion

### 4.1. Descriptive Statistics and Analysis

**Table 2** provides descriptive statistics and correlations among the variables investigated. The correlations show that the system of safety management practices is significantly and negatively correlated with both recordable and lost time injuries ($r = -0.35$ and $-0.31$ respectively). The correlations also show a consistent correlation pattern between the system of safety management practices and each of the climate and safety behavior measures. All of the correlations are strong and positive ($\bar{r} = 0.55$). The system of safety management practices is specifically, significantly and positively associated with group-level worker evaluations of safety climate (r =

**Table 2.** Desciptive statistics and correlations[a].

| Factor | | Mean | SD | 1) | 2) | 3) | 4) | 5) | 6) | 7) | 8) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1) | System of SMPs[b] | 46.99 | 5.31 | | | | | | | | |
| 2) | Task safety proficiency | 4.04 | 0.22 | 0.45 | | | | | | | |
| 3) | Team safety proficiency | 3.99 | 0.23 | 0.42 | 0.70 | | | | | | |
| 4) | Safety climate | 4.01 | 0.49 | 0.66 | 0.63 | 0.56 | | | | | |
| 5) | Procedural justice | 3.54 | 0.37 | 0.60 | 0.49 | 0.30 | 0.65 | | | | |
| 6) | Interactional justice | 4.00 | 0.39 | 0.61 | 0.56 | 0.52 | 0.74 | 0.70 | | | |
| 7) | Informational justice | 3.84 | 0.43 | 0.59 | 0.48 | 0.37 | 0.81 | 0.73 | 0.74 | | |
| 8) | Recordable injuries | 1.09 | 0.17 | −0.35 | −0.40 | −0.45 | −0.47 | −0.15 | −0.48 | −0.39 | |
| 9) | Lost time injuries | 1.00 | 0.12 | −0.31 | −0.39 | −0.47 | −0.41 | −0.10 | −0.42 | −0.29 | 0.83 |

[a]All correlations above or below 0.27 are significant at the 0.05 level. All correlations above or below 0.35 are significant at the 0.01 level. [b]SMPs = safety management practices.

0.66), procedural justice climate (r = 0.60), interactional justice climate (r = 0.61), informational justice climate (r = 0.59), task safety proficiency (r = 0.45), and team safety proficiency (r = 0.42). Each of constructs involving group-level worker perceptions of the human safety performance constructs (safety and justice climates; team and task proficiency) are also negatively related to self-reported measures of injuries ($\bar{r} = -0.38$ for recordable injuries; $\bar{r} = -0.34$ for lost time injuries).

## 4.2. Mediation and Statistics

In order to test the mediating properties of each of the human safety performance construct, each hypothesized mediator was modeled independently of the others. In all the models tested, the same predictor and outcome variable are used while the mediator varies. The common predictor is the system of safety management practices and the common outcome is the number of recordable and lost time injuries per work group. In order to establish a relationship between the system of safety management practices (predictor) and occupational injuries and illnesses (outcome) as well as between the system of safety management practices (predictor) with the each of the human performance constructs (mediators), the authors rely in part on the significant correlations shown in **Table 2** (thereby supporting the first two requirements of the Baron and Kenny test for mediation).

To establish statistical mediation according to the authors' hypotheses, both the safety management system and the individual mediators must be significantly related to recordable and lost time injuries experienced in the group. Although the information presented in **Table 2** statistically verified the relationship between safety management practices and organizational injuries and illnesses, it is prudent to re-establish this relationship for the purpose of completing the mediation tests. The summed measure of the system of safety management practices significantly predicted both the number of recordable injuries ($\beta = -0.411$, $p < 0.001$) and lost work injuries (*i.e.*, injuries that resulted in missed work days) ($\beta = -0.392$, $p < 0.001$). This result revalidates that a condition for conducting statistical mediation exists, namely that the system of safety management practices negatively and significantly predicts injuries.

Consistent with the correlation information in **Table 2**, it was found that the system of safety management practices significantly predicted all of the employee safety perceptual and behavioral constructs (*i.e.* safety climate, safety-specific justice climates, and task (individually directed) and team (socially directed) safety behaviors) (see second column in **Tables 3-8**). All of the regression coefficients were significant at $p < 0.01$. Coefficients of determination (adjusted $R^2$) ranged from 0.217 to 0.446 ($\bar{R}^2 = 0.293$).

**Tables 3-8** provide the remaining statistical tests using multiple regression models for mediation in which each of the mediators is entered individually with the system of safety management practices in multiple regression models predicting recordable injuries and illnesses as well as lost time injuries and illnesses. For statistical mediation to be supported, the established relationship between the system of safety management practices and recordable and lost time injuries and illnesses should diminish as the mediator significantly predicts the outcome in the multiple regression equation. Zero-order correlation coefficients between two variables (those reported to establish the relationship between the system of safety management practices and recordable or lost time injuries) shown in **Tables 3-8** are equivalent to the standardized regression coefficients in a simple linear regression (shown in **Table 2**). Thus, the reduction in the standardized regression coefficient in which the system of safety management practices predicts injuries shown in **Tables 3-8** is directly comparable to the previously reported correlation coefficients in **Table 2** (as stated previously the system of safety management practices had an r = −0.35 and r = −0.31 for recordable and lost time injuries, respectively).

**Table 3.** Safety climate as mediator[a].

| Predictors | Mediator | Outcomes | |
|---|---|---|---|
| | Safety climate | Recordable injuries | Lost time injuries |
| System of safety management practices | 0.555** | −0.154 | −0.175 |
| Safety climate | NA | −0.357* | −0.316* |
| Adjusted $R^2$ | 0.308 | 0.212 | 0.192 |

[a]Standardized regression coefficients reported. †p < 0.07, *p < 0.05, **p < 0.01.

**Table 4.** Procedural justice climate as mediator[a].

| Predictors | Mediator | Outcomes | |
|---|---|---|---|
| | Procedural justice climate | Recordable injuries | Lost time injuries |
| System of safety management practices | 0.474** | −0.408* | −0.384* |
| Procedural justice climate | NA | 0.040 | 0.070 |
| Adjusted $R^2$ | 0.225 | 0.135 | 0.127 |

[a]Standardized regression coefficients reported. †p < 0.07, *p < 0.05, **p < 0.01.

**Table 5.** Interactional justice climate as mediator[a].

| Predictors | Mediator | Outcomes | |
|---|---|---|---|
| | Interactional justice climate | Recordable injuries | Lost time injuries |
| System of safety management practices | 0.581** | −0.094 | −0.180 |
| Interactional justice climate | NA | −0.445** | −0.294† |
| Adjusted $R^2$ | 0.337 | 0.255 | 0.180 |

[a]Standardized regression coefficients reported. †p < 0.07, *p < 0.05, **p < 0.01.

**Table 6.** Informational justice climate as mediator[a].

| Predictors | Mediator | Outcomes | |
|---|---|---|---|
| | Informational justice climate | Recordable injuries | Lost time injuries |
| System of safety management practices | 0.466** | −0.221 | −0.257 |
| Informational justice climate | NA | −0.281† | −0.202 |
| Adjusted $R^2$ | 0.217 | 0.186 | 0.155 |

[a]Standardized regression coefficients reported. †p < 0.07, *p < 0.05, **p < 0.01.

**Table 7.** Task (individually directed) safety proficiency as mediator[a].

| Predictors | Mediator | Outcomes | |
|---|---|---|---|
| | Individual safety proficiency | Recordable injuries | Lost time injuries |
| System of safety management practices | 0.668** | −0.185 | −0.175 |
| Individual safety proficiency | NA | −0.325* | −0.320* |
| Adjusted $R^2$ | 0.446 | 0.196 | 0.160 |

[a]Standardized regression coefficients reported. †p < 0.07, *p < 0.05, **p < 0.01.

**Table 8.** Team (socially directed) safety proficiency as mediator[a].

| Predictors | Mediator | Outcomes | |
|---|---|---|---|
| | Social safety proficiency | Recordable injuries | Lost time injuries |
| System of safety management practices | 0.477** | −0.114 | −0.190 |
| Social safety proficiency | NA | −0.396* | −0.325* |
| Adjusted $R^2$ | 0.227 | 0.141 | 0.131 |

[a]Standardized regression coefficients reported. †p < 0.07, *p < 0.05, **p < 0.01.

Information presented in **Tables 3-8** suggests that the all of the proposed mediators (except for procedural justice) mediate (to varying degrees) the relationship between the system of safety management practices and recordable injuries. The proposed mediators (except for procedural and informational justice) mediate the relationship between the system of safety management practices and lost time injuries, however to a lesser extent. The presence of mediation is reflected by the regression coefficients for the system of safety management practices to its outcomes decreasing to insignificance (especially when compared with the linear regression coefficients presented in **Table 3**), while those associated with the mediators to its outcomes showing significance. Based on the results shown in **Tables 3-8**, the following hypotheses have been supported:

**Hypothesis 1: Group-level safety climate will mediate the relationship between the system of safety management practices and occupational injuries and illnesses.**

**Hypothesis 3: Group-level interactional justice climate will mediate the relationship between a system of safety management practices and occupational injuries and illnesses.**

**Hypothesis 5: Group-level task (individual directed) safety proficiency will mediate the relationship between a system of safety management practices and occupational injuries and illnesses.**

**Hypothesis 6: Group-level team (socially directed) safety proficiency will mediate the relationship between a system of safety management practices and occupational injuries and illnesses.**

To a lesser extent, the following **hypothesis** has been supported by the statistical analyses:

**Hypothesis 4: Group-level informational justice climate will mediate the relationship between a system of safety management practices and occupational injuries and illnesses.**

The following hypothesis has not been supported:

**Hypothesis 2: Group-level procedural justice climate will mediate the relationship between a system of safety management practices and occupational injuries and illnesses.**

The strongest mediators of the **relationship** between the system of safety management practices and injuries are: interactional justice; safety climate; and task (individually directed) and team (socially directed) safety behaviors. It is no surprise that interactional justice perceptions would have the strongest mediation function since there is a wealth of information that suggests that workers who perceive the workplace as unfair and unjust become dissatisfied and unmotivated workers and by extrapolation would not be motivated to make the safety management practices work effectively or efficiently. Gyeke [37] provides information to support this line of thought. Gyeke found that workers who expressed more job satisfaction had positive perceptions of safety climate and were more committed to implementing safety management policies and consequently had a lower rate of accidents [37]. The mediating role of task (individually directed) and team (socially directed) behaviors is discussed more in depth by Yorio and Wachter [25] who, like Evans and Davis [10], support their mediation results through the theoretical argument that high performance work practices can influence organizational performance through changes in an organization's internal social structure.

These findings do indeed suggest that safety management practices are effective at reducing occupational injuries through their effects on both employee perceptions on climate and their behaviors.

## 5. Conclusions

The results of this study extend previous findings that showed that employee engagement acted as a mediator between a system of safety management practices and injuries. In this current study, it has been determined that worker perceptions related to safety climate, interactional justice, task safety proficiency (individual) behaviors and team safety proficiency (group) behaviors can also act as mediators between a system of safety management practices and how it works to reduce recordable injuries and to a lesser extent lost time injuries. It appears that in those instances where workers view/believe that their management has placed a strong priority of safety, that they are being treated with dignity and respect through the system of safety management practices, that they are carrying out their own work safely, and that they are cooperating with others to work safely as a group, the system of safety management practices appears to be more effective in producing measurable results—the reduction in recordable and lost-time injuries. It is also noted that certain human performance constructs (informational and procedural justice climates) do not seem to act as strong mediators between the presence of a system of safety management practices and its performance outcomes. Thus there appears to be some discrimination as to which human performance constructs actually act as mediators versus a situation where all worker perceptions on climate and behaviors have the same (or non-distinguishing) effect.

These results support previous conclusions that the "either-or" schism between safety management system and behavioral approaches common in many organizations when choosing how to manage their safety function should be bridged. Safety management practices should be designed and implemented to promote and enhance positive worker perceptions, thereby putting "workers" at the center of safety management systems. These mediation results suggest just that workers' behaviors and perceptions are at the center of the system linking (mediating) safety management practices with safety performance (injury reduction). This is the fundamental concept behind the human performance approach to safety management [38].

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## References

[1] Wachter, J.K. and Yorio, P.L. (2013) A System of Safety Management Practices and Worker Engagement for Reducing and Preventing Accidents: An Empirical and Theoretical Investigation. *Accident Analysis & Prevention*, **68**, 117-130. http://dx.doi.org/10.1016/j.aap.2013.07.029

[2] O'Toole, M. (2002) The Relationship between Employees' Perceptions of Safety and Organizational Culture. *Journal of Safety Research*, **33**, 231-243. http://dx.doi.org/10.1016/S0022-4375(02)00014-2

[3] Fernández-Muñiz, B., Montes-Peón, J.M. and Vázquez-Ordás, C. (2007) Safety Culture: Analysis of the Causal Relationships between Its Key Dimensions. *Journal of Safety Research*, **38**, 627-641. http://dx.doi.org/10.1016/j.jsr.2007.09.001

[4] Rich, B.L., Lepine, J.A. and Crawford, E.R. (2010) Job Engagement: Antecedents and Effects on Job Performance. *Academy of Management Journal*, **53**, 617-635. http://dx.doi.org/10.5465/AMJ.2010.51468988

[5] Ashforth, B.E. and Humphrey, R.H. (1995) Emotion in the Workplace: A Reappraisal. *Human Relations*, **48**, 97-124. http://dx.doi.org/10.1177/001872679504800201

[6] Pfeffer, J. (1998) The Human Equation: Building Profits by Putting People First. Harvard Business School Press, Boston.

[7] Becker, B. and Huselid, M.A. (1998) High Performance Work Systems and Firm Performance: A Synthesis of Research and Managerial Implications. *Research in Personnel and Human Resource Management*, **16**, 53-101.

[8] Delery, J. E. and Shaw, J. D. (2001) The Strategic Management of People in Work Organizations: Review, Synthesis, and Extension. In: Ferris, G.R., Ed., *Research in Personnel and Human Resources Management*, **20**, JAI, Greenwich, 165-197.

[9] Huselid, M.A. (1995) The Impact of Human Resource Practices on Turnover, Productivity, and Corporate Financial Performance. *Academy of Management Journal*, **38**, 645-672. http://dx.doi.org/10.2307/256741

[10] Evans, W.R. and Davis, W.D. (2005) High-Performance Work Systems and Organizational Performance: The Mediating Role of Internal Social Structure. *Journal of Management*, **31**, 758-775. http://dx.doi.org/10.1177/0149206305279370

[11] Zacharatos, A., Barling, J. and Iverson, R.D. (2005) High-Performance Work Systems and Occupational Safety. *Journal of Applied Psychology*, **90**, 77-93. http://dx.doi.org/10.1037/0021-9010.90.1.77

[12] Zohar, D. and Luria, G. (2005) A Multi-level Model of Safety Climate: Cross-level Relationships between Organization and Group-level Climates. *Journal of Applied Psychology*, **90**, 616-628. http://dx.doi.org/10.1037/0021-9010.90.4.616

[13] Zohar, D. and Erev, I. (2007) On the Difficulty of Promoting Workers' Safety Behavior: Overcoming the Underweighting of Routine Risks. *International Journal of Risk Assessment and Management*, **7**, 122-136. http://dx.doi.org/10.1504/ijram.2007.011726

[14] Zohar, D. and Tenne-Gazit, O. (2008) Transformation Leadership and Group Interaction as Climate Antecedents: A Social Network Analysis. *Journal of Applied Psychology*, **93**, 744-757. http://dx.doi.org/10.1037/0021-9010.93.4.744

[15] Hofman, D.A. and Stetzer, A. (2006) A Cross-level Investigation of Factors Influencing Unsafe Behaviors and Incidents. *Personnel Psychology*, **49**, 307-339. http://dx.doi.org/10.1111/j.1744-6570.1996.tb01802.x

[16] De Cremer, D. and Tyler, T. R. (2005) Managing Group Behavior: The Interplay between Procedural Justice, Sense of Self, and Cooperation. In: Zanna, M., Ed., *Advances in Experimental Social Psychology*, **37**, Academic Press, New

York, 151-218.

[17] Simons, T. and Roberson, Q. (2003) Why Managers Should Care about Fairness: The Effects of Aggregate Justice Perceptions on Organizational Outcomes. *Journal of Applied Psychology*, **88**, 432-443. http://dx.doi.org/10.1037/0021-9010.88.3.432

[18] Colquitt, J.A., Conlon, D.E., Wesson, M.J., Porter, C.O. and Ng, K.Y. (2001) Justice at the Millennium: A Meta-Analytic Review of 25 Years of Organizational Justice Research. *Journal of Applied Psychology*, **86**, 425-445. http://dx.doi.org/10.1037/0021-9010.86.3.425

[19] Bies, R.J. and Moag, J.F. (1986) Interactional Justice: Communication Criteria of Fairness. In: Lewicki, R.J., Sheppard, B.H. and Bazerman, M.H., Eds., *Research on Negotiations in Organizations*, **1**, JAI Press, Greenwich, 43-55.

[20] Greenberg, J. (1993) Stealing in the Name of Justice: Informational and Interpersonal Moderators of Theft Reactions to Underpayment Inequity. *Organizational Behavior and Human Decision Processes*, **54**, 81-103. http://dx.doi.org/10.1006/obhd.1993.1004

[21] Tyler, T.R. and Blader, S.L. (2003) Can Businesses Effectively Regulate Employee Conduct? The Antecedents of Rule Following in Work Settings. *Academy of Management Journal*, **48**, 1143-1158. http://dx.doi.org/10.5465/AMJ.2005.19573114

[22] Griffin, M. A. and Neal, A. (2000) Perceptions of Safety at Work: A Framework for Linking Safety Climate to Safety Performance, Knowledge, and Motivation. *Journal of Occupational Health Psychology*, **3**, 347-358. http://dx.doi.org/10.1037/1076-8998.5.3.347

[23] Griffin, M.A., Neal, A. and Parker, S.K. (2007) A New Model of Work Role Performance: Positive Behavior in Uncertain and Interdependent Contexts. *Academy of Management Journal*, **50**, 327-347. http://dx.doi.org/10.5465/AMJ.2007.24634438

[24] Wright, P.M., Gardner, T.M., Moynihan, L.M. and Park, H.J. (2001) Measurement Error in Research on Human resources and Firm Performance: Additional Data and Suggestions for Future Research. *Personnel Psychology*, **54**, 875-901. http://dx.doi.org/10.1111/j.1744-6570.2001.tb00235.x

[25] Yorio, P.L. and Wachter, J.K. (2014) Safety and Health Specific High Performance Work Practices and Occupational Injury and Illness Prevention: The Mediating Role of Task and Team Safety Proficiency Behaviors. *Journal of Safety, Health, and Environmental Research*, **10**, 123-133.

[26] Neal, A. and Griffin, M.A. (2006) A Study of the Lagged Relationships among Safety Climate, Safety Motivation, Safety Behavior, and Accidents at the Individual and Group Levels. *Journal of Applied Psychology*, **91**, 946-953. http://dx.doi.org/10.1037/0021-9010.91.4.946

[27] Folger, R. and Konovsky, M.A. (1989) Procedural Justice: Effects of Procedural and Distributive Justice on Reactions to Pay Raise Decisions. *Academy of Management Journal*, **32**, 115-130. http://dx.doi.org/10.2307/256422

[28] Moorman, R.H. (1991) Relationship between Organizational Justice and Organizational Citizenship Behaviors: Do Fairness Perceptions Influence Employee Citizenship? *Journal of Applied Psychology*, **76**, 845-855. http://dx.doi.org/10.1037/0021-9010.76.6.845

[29] Tyler. T.R. and Lind, E.A. (1992) A Relational Model of Authority in Groups. In: Zanna, M., Ed., *Advances in Experimental Social Psychology*, **25**, Academic Press, New York, 192.

[30] Niehoff, B.P. and Moorman, R.H. (1993) Justice as a Mediator between Methods of Monitoring and Organizational Citizenship Behavior. *Academy of Management Journal*, **36**, 527-556. http://dx.doi.org/10.2307/256591

[31] Colquitt, J.A. (2001) On the Dimensionality of Organizational Justice: A Construct Validation of a Measure. *Journal of Applied Psychology*, **86**, 425-445. http://dx.doi.org/10.1037/0021-9010.86.3.425

[32] Kozlowski, S.W.J. and Klein, K.J. (2000) A Multilevel Approach to Theory and Research in Organizations: Contextual, Temporal and Emergent Processes. In: Klein, K.J. and Kozlowski, S.W.J., Eds., *Multilevel Theory and Methods in Organizations*, Jossey-Bass, San Francisco, 3-91.

[33] Moreland, R.L and Levine, J.M. (1982) Socialization in Small Groups: Temporal Changes in Individual-Group Relations. *Advances in Experimental Social Psychology*, **15**, 137-183.

[34] Festinger, L.A. (1957) A Theory of Cognitive Dissonance. Row Peterson, Evanston.

[35] Bliese, P.N. (2000) Within-group Agreement, Non-Independence, and Reliability: Implications for Data Aggregation and Analysis. In: Klein, K.J. and Kozlowski, S.W.J., Eds., *Multilevel Theory and Methods in Organizations*, Jossey-Bass, San Francisco, 43-55.

[36] Baron, R.M. and Kenny, D.A. (1986) The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Consideration. *Journal of Personality and Social Psychology*, **51**, 1173-1182. http://dx.doi.org/10.1037/0022-3514.51.6.1173

[37] Gyeke, S.A. (2005) Workers' Perceptions of Workplace Safety and Job Satisfaction. *International Journal of Occupa-*

*tional Safety and Ergonomics*, **11**, 291-302.

[38] Wachter, J.K. and Yorio, P.L. (2013) Human Performance Tools: Engaging Workers as the Best Defense against Errors & Error Precursors. *Professional Safety*, **58**, 54-64.