Development and Validation of an Integrated Healthy Workplace Management Model in Taiwan

Fu-Li Chen¹, Peter Y. Chen², Chi-Chen Chen³, Tao-Hsin Tung⁴,*

¹Department of Public Health, Fu-Jen Catholic University, New Taipei City, Taiwan
²Department of Psychology, Auburn University, Auburn, USA
³Department of Public Health, Fu-Jen Catholic University, New Taipei City, Taiwan
⁴Taiwan Association of Health Industry Management and Development, Taipei, Taiwan

Abstract

Background: Impacts of exposure are generally monitored and recorded after injuries or illness occur. Yet, absence of conventional after-the-effect impacts (i.e., lagging indicators), tend to focus on physical health and injuries, and fail to inform if workers are not exposed to safety and health hazards. In contrast to lagging indicators, leading indicators are proactive, preventive, and predictive indexes that offer insights how effective safety and health. The present study is to validate an extended Voluntary Protection Programs (VPP) that consists of six leading indicators.

Methods: Questionnaires were distributed to 13 organizations (response rate = 93.1%, 1,439 responses) in Taiwan. Cronbach’s α, multiple linear regression and canonical correlation were used to test the reliability of the extended Voluntary Protection Programs (VPP) which consists of six leading indicators (safe climate, transformational leadership, organizational justice, organizational support, hazard prevention and control, and training). Criteria-related validation strategy was applied to examine relationships of six leading indicators with six criteria (perceived health, burnout, depression, job satisfaction, job performance, and life satisfaction).

Results: The results showed that the Cronbach’s α of six leading indicators ranged from 0.87 to 0.92. The canonical correlation analysis indicated a positive correlation between the six leading indicators and criteria (1st canonical function: correlation = 0.647, square correlation = 0.419, p < 0.001).

Conclusions: The present study validates the extended VPP framework that focuses on promoting safety and physical and mental health. Results further provides applications of the extended VPP framework to promote workers’ safety and health.

© 2022 Occupational Safety and Health Research Institute, Published by Elsevier Korea LLC. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

Exposures to safety and health hazards at work are well documented and researched. Impacts of exposure are generally monitored and recorded after injuries or illness occur. These after-the-effect outcomes (i.e., lagging indicators) focus on exposures that lead to death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness (e.g., US Occupational Safety and Health Administration [OSHA], 2001) [1]. Conventionally, these lagging indicators serve as performance index pertaining to occupational safety and health.

Although these indicators offer useful insights, they fall short of providing a complete picture how well organizations manage workplace safety and health. First, absence of after-the-effect outcomes does not necessarily mean employees are not exposed to safety and health hazards [2]. Second, these indicators tend to emphasize physical health more than mental health, even though mental health outcomes are as important as physical health outcomes, and their relationships are intertwined. For instance, stressful working conditions such as high workload tend to disrupt workers’ immune systems as well as mental health such as anxiety [3].
US OSHA [4], Singapore WSH Council [5], and Japan Industrial Safety & Health Association [6] have all proposed that leading indicators should be integrated with the organization’s safety and health management processes. In contrast to lagging indicators, leading indicators are proactive, preventive, and predictive indexes that offer insights into effective safety and health management.

As yet, there is no official leading indicators endorsed by government agencies such as OSHA. In addition, Walaski (2021) observes little or no consensus about what leading indicators should be included in the safety and health management system [7]. She argued that OSH professionals likely lack of knowledge to create useful leading indicators, and some leading indicators don’t indicate anything in substantive way that is associated with successful prevention.

Although there is no consensus about leading indicators, empirical research and recommendations from professional agencies offer insightful directions. The Voluntary Protection Programs (VPP) of the U.S. OSHA proposed a framework that safety and health management system should focus on hazard prevention and control, worksite analysis, training, worker involvement and management commitment [8]. In the remaining sections, we will expand the VPP framework with empirical findings to guide the present research.

Similar to VPP [8], the Singapore WSH Council [5] and the Japan Industrial Safety & Health Association [6] also suggested the importance of hazard prevention and control, which is referred to the systematic identification, assessment, elimination and control of safety and health hazards. Worksite analysis can be considered part of hazard prevention and control process because worksite analysis identifies and assesses hazards.

Training is an efficient organizational strategy to prevent and control workplace hazards, which can directly and actively improve employees’ safety, reduce injuries and accidents, as well as prevent occupational diseases and illness [9]. A meta-analysis further showed that employees who actively participate in training and acquire relevant knowledge and skills tend to report fewer workplace accidents, injuries and diseases [10].

Both worker involvement and management commitment are core components of safety climate, which contributes to workers’ safety and health. Safety climate is the shared perception held by workers about aspects of their organizational environment pertaining to safety and health [11]. Management in an organization with a strong safety climate often commit to workers’ safety and health policies and practices. Workers also involve in building healthy and safe work environment by providing feedback to and communicate freely with management about how to improve safety and health at work. Safety climate also set up priority of safety and health over other competing goals, such as production speed or sales [12]. Empirical research has consistently shown that successful safety and health management system is a result of a strong safety climate in which leaders and employees engage in safety practices and prioritize safety and health concerns over other competing priorities [5,3].

It has been postulated that leaders create climate [13]. Transformational leaders committing to promote safety and health inspire workers to engage safe and health practices, seek out workers’ input for better ways to building a safe and health workplace. Through observing what leaders do and say, how policies, practices, and procedures are actually implemented and managed, and how resources and efforts are allocated to eliminate safety and health hazards, workers’ shared perceptions about safety and health (i.e., safety climate) are formed [13].

Transformational leaders often go beyond rewarding and monitoring employees. They express a clear and positive vision for employees to achieve their goals, show respect and personal concern for employees as individuals, inspire them to think creatively and innovatively and encourage them to voice their opinions and to think about problems in new ways, promote participation and cooperation between units within organizations, encourage them to strive for something beyond their individual goals to reach their full potential, and coach or mentor them to develop skills and to instill pride in themselves [14]. Empirical studies have provided support for the importance of transformational leadership in particular in establishing the safety climate in an organization, with meta-analyses estimating corrected correlations close to 0.5 to 0.6 [10,15].

The next two leading indicators, organizational justice and organizational support, also play vital roles in building and strengthening safety and health management system, although both indicators have not yet be integrated into the VPP framework. Organizational justice refers to employees’ perception if they are treated fairly, or whether they are treated with respect and dignity. There are three different forms of organizational justice perceived by employees: distributive justice (perceived fairness regarding how rewards are allocated), procedural justice (perceived fairness regarding how the allocation process is developed and implemented), and interactional justice (perceived fairness regarding treatment and communication by management). Based on meta-analysis studies [16,17], employees who perceive fair treatment tend to be more satisfied with their jobs, experience lower levels of negative emotion, and engage in fewer counterproductive and withdrawal behaviors.

Finally, organizational support is considered a multi-faceted concept which includes perceived emotional support from the organization [18], perceived support from colleagues and supervisors [19], or flow of safety information from the organization [20]. Meta-analytic results have shown that supervisor support is positively associated with employees’ well-being [21]. Katz-Navon found that an increased flow of safety information tends to lead to better safety performance [22].

In sum, the extended VPP framework consists of practical and evidence-based leading factors that promote healthy and safe workplaces. These leading indicators include hazard prevention and control (including worksite analysis), training, safety climate (including worker involvement, and management commitment), transformational leadership, organizational justice, and organizational support. The main aim of this study is to use criteria-related validation strategy to examine validity of the extended VPP framework applied in Taiwan. In specific, the present study investigates the relationships of the key leading factors with physical and mental health criteria (i.e., perceived health, burnout, and depression), as well as job related criteria (i.e., job satisfaction, and job performance). According to the literature reviewed previously [9–11,16,17,21,22], the leading indicators within the extended framework are expected to be positively related to perceive health, job satisfaction, and job performance, and negatively related to burnout and depression.

2. Materials and methods

2.1. Participants

Employees from 13 organizations (6 small or medium enterprises and 7 large enterprises) across service, construction, and manufacturing industries in Taiwan were recruited to participate in this study through purposive sampling. After acquiring the consent of the enterprises, each participating employee received a package that consisted of a questionnaire, a consent form, and a return envelope. Written informed consent was obtained from all participants, and all responses were anonymous. A total of 1,439
completed questionnaires were received between October to December 2016, with a response rate of 93.1%.

This study’s protocols were reviewed and approved by the Institutional Review Board at Taiwan Fu-Jen Catholic University (FJU-IRB No: C104116) before the process began.

2.2. Measures

The questionnaire consisted of participant background information, measures of leading indicators, and criteria measures, which are described below.

2.2.1. Background information

Background questions asked about gender (male/female), age (20–29, 30–39, 40–49, 50–59, 60 and above), education level (high school or below, college/university, postgraduate), marital status (single, married, or separated/divorce), industry type (manufacturing, construction, or service), job position (department manager, general staff), seniority (within 1 year, 1–5 years, 5–10 years, 10–15 years, 15–20 years, over 20 years), working days per week (below 5 days, 5 days, 5 and half days, over 6 days), working hours (7 hours or below, 8 hours, 9 hours, over 10 hours), and whether they did shiftwork (yes vs. no).

2.2.2. Leading indicators

Measures of the leading indicators included hazard prevention and control, training, safety climate, transformational leadership, organizational justice, organizational support.

2.2.3. Hazard prevention and control

Hazard prevention and control was measured with four items modified from the Voluntary Protection Programs (VPP): Policies and Procedures Manual [9]. The scale assessed routine monitoring of causes of health and safety hazards, sources of exposure to such hazards, control of physical and psychological health and safety hazards (e.g., source elimination or quarantine, work procedure improvement, and the provision of personal protective equipment).

2.2.4. Training

Four items were developed to assess training availability. These items were developed based on the Voluntary Protection Programs (VPP): Policies and Procedures Manual [9]. Respondents were asked whether a company provided sufficient, skill-based training programs to enhance employees’ health competence and workplace safety prevention skills.

2.2.5. Safety climate

The measure, modified from Zohar and Luria [23], consisted of 8 items regarding the commitment of the enterprise to employees’ physical and psychological health and safety, enterprise prioritization of employees’ physical and psychological health and safety, and listening carefully to employees’ suggestions about improving workplace safety and health.

2.2.6. Transformational leadership

Modified from Carless, Wearing, and Mann’s [24] scale, the transformational leadership scale consisted of 3 items regarding staff development, innovative thinking, and charismatic leadership.

2.3. Organizational justice

Modified from Colquitt [25] and Moorman [26], the 4-item organizational justice measure assessed fairness of procedure in implementing health and safety welfare, and fairness of rewarding for effort.

2.3.1. Organizational support

Based on McMillan [19] and Ladd & Henry [20], a 4-item scale was developed in the present study. It assessed to what extent a company provided sufficient health and safety information, and how a company encouraged teamwork and support for promoting safety and health.

2.3.2. Criteria measures

Criteria measures consisted of physical and psychological health outcomes (perceived health, burnout, and depression), job satisfaction, life satisfaction and job performance. Among health outcome measures, one item each regarding perceived health, burnout, and depression was adapted from Fisher, Matthews, and Gibbons [27]. Job satisfaction and life satisfaction were restructured by one item, also developed by Fisher, Matthews, and Gibbons [27]. Finally, employees were asked to report on their job performance over the last six months, on a scale developed by Kessler et al. [28] ranging from 0 to 10.

Table 1
Baseline characteristics among research population (n = 1,439)

| Variables               | Number | %    |
|------------------------|--------|------|
| Gender                 |        |      |
| Male                   | 987    | 68.6 |
| Female                 | 433    | 30.1 |
| Missing                | 19     | 1.3  |
| Age                    |        |      |
| 20–29                  | 261    | 18.1 |
| 30–39                  | 523    | 36.3 |
| 40–49                  | 425    | 29.5 |
| 50–59                  | 152    | 10.6 |
| 60 and above           | 63     | 4.3  |
| Missing                | 15     | 1.0  |
| Education level        |        |      |
| High school or below   | 302    | 21.0 |
| Colleges/university    | 829    | 57.7 |
| Post-graduate          | 296    | 20.6 |
| Missing                | 12     | 0.8  |
| Marriage               |        |      |
| Single                 | 489    | 34.0 |
| Married                | 870    | 60.5 |
| Separated/divorce      | 44     | 3.0  |
| Missing                | 36     | 2.5  |
| Industry               |        |      |
| Manufacturing          | 783    | 54.4 |
| Construction           | 200    | 13.9 |
| Service                | 456    | 31.7 |
| Job seniority          |        |      |
| Within 1 y             | 139    | 9.7  |
| 1–5 y                  | 377    | 26.2 |
| 5–10 y                 | 235    | 16.3 |
| 10–15 y                | 274    | 19.0 |
| 15–20 y                | 224    | 15.6 |
| Over 20 y              | 178    | 12.4 |
| Missing                | 12     | 0.8  |
| Position               |        |      |
| Department manager     | 195    | 13.6 |
| General staff          | 1229   | 85.4 |
| Missing                | 15     | 1.0  |
| Shifts                 |        |      |
| Yes                    | 209    | 14.5 |
| No                     | 1203   | 83.6 |
| Missing                | 27     | 1.9  |
| Work days per week     |        |      |
| Below 5 d              | 37     | 2.6  |
| 5 d                    | 1014   | 70.5 |
| 5 and half days        | 140    | 9.7  |
| Over 6 d               | 157    | 10.9 |
| Missing                | 91     | 6.3  |
| Average working hour   |        |      |
| 7 h or below           | 40     | 2.8  |
| 8 h                    | 892    | 62.0 |
| 9 h                    | 287    | 19.9 |
| Over 10 h              | 208    | 14.4 |
| Missing                | 12     | 0.8  |
2.4. Data analysis

Statistical analysis was performed using SAS Version 9.4 (SAS Inc., Cary, NC). The underlying characteristics of the overall sample distribution and the distribution in each individual industry were analyzed. Firstly, categorical or continuous variables were described through absolute frequency (%) or mean (SD) respectively. Secondly, Cronbach’s $\alpha$ was used to assess the internal
Table 3
Correlations between healthy workplace management dimensions and criteria

| Criterion               | Indicators                          | β-value | p-value | 95% CI Lower | 95% CI Upper |
|-------------------------|-------------------------------------|---------|---------|--------------|--------------|
| Perceived health        | A. Hazard prevention and control    | 0.04    | 0.001   | 0.02         | 0.06         |
|                         | B. Training                         | 0.02    | 0.09    | -0.03        | 0.05         |
|                         | C. Safety climate                   | 0.02    | <0.001  | 0.01         | 0.04         |
|                         | D. Transformational leadership      | 0.02    | 0.51    | -0.02        | 0.04         |
|                         | E. Organizational justice           | 0.01    | 0.38    | -0.01        | 0.03         |
|                         | F. Organizational support           | -0.003  | 0.86    | -0.03        | 0.03         |
|                         | R                                    | 0.41    |         |              |              |
|                         | R²                                   | 0.17    |         |              |              |
| Burnout                 | A. Hazard prevention and control    | -0.05   | 0.001   | -0.08        | -0.02        |
|                         | B. Training                         | -0.004  | 0.78    | -0.03        | 0.03         |
|                         | C. Safety climate                   | -0.05   | <0.001  | -0.06        | -0.03        |
|                         | D. Transformational leadership      | -0.06   | 0.002   | -0.09        | -0.02        |
|                         | E. Organizational justice           | -0.02   | 0.13    | -0.05        | 0.01         |
|                         | F. Organizational support           | 0.05    | 0.01    | 0.02         | 0.09         |
|                         | R                                    | 0.45    |         |              |              |
|                         | R²                                   | 0.21    |         |              |              |
| Depression              | A. Hazard prevention and control    | -0.05   | 0.002   | -0.08        | -0.02        |
|                         | B. Training                         | 0.01    | 0.50    | -0.02        | 0.04         |
|                         | C. Safety climate                   | -0.05   | 0.01    | -0.08        | -0.02        |
|                         | D. Transformational leadership      | -0.05   | 0.01    | -0.08        | -0.02        |
|                         | E. Organizational justice           | -0.004  | 0.81    | -0.03        | 0.03         |
|                         | F. Organizational support           | 0.03    | 0.06    | -0.01        | 0.07         |
|                         | R                                    | 0.42    |         |              |              |
|                         | R²                                   | 0.18    |         |              |              |
| Job satisfaction        | A. Hazard prevention and control    | 0.07    | <0.001  | 0.05         | 0.09         |
|                         | B. Training                         | 0.03    | 0.01    | 0.01         | 0.05         |
|                         | C. Safety climate                   | 0.02    | 0.003   | 0.01         | 0.03         |
|                         | D. Transformational leadership      | 0.06    | <0.001  | 0.04         | 0.09         |
|                         | E. Organizational justice           | 0.01    | 0.27    | -0.01        | 0.03         |
|                         | F. Organizational support           | -0.01   | 0.52    | -0.03        | 0.02         |
|                         | R                                    | 0.63    |         |              |              |
|                         | R²                                   | 0.39    |         |              |              |
| Job performance         | A. Hazard prevention and control    | 0.07    | 0.002   | 0.03         | 0.11         |
|                         | B. Training                         | 0.01    | 0.53    | -0.02        | 0.04         |
|                         | C. Safety climate                   | 0.03    | 0.01    | 0.01         | 0.05         |
|                         | D. Transformational leadership      | 0.03    | 0.26    | -0.02        | 0.08         |
|                         | E. Organizational justice           | -0.04   | 0.04    | -0.08        | -0.001       |
|                         | F. Organizational support           | 0.04    | 0.12    | -0.01        | 0.09         |
|                         | R                                    | 0.35    |         |              |              |
|                         | R²                                   | 0.12    |         |              |              |
| Life satisfaction       | A. Hazard prevention and control    | 0.04    | <0.001  | 0.02         | 0.06         |
|                         | B. Training                         | 0.02    | 0.10    | -0.003       | 0.04         |
|                         | C. Safety climate                   | 0.02    | <0.001  | 0.01         | 0.04         |
|                         | D. Transformational leadership      | 0.04    | 0.004   | 0.01         | 0.07         |
|                         | E. Organizational justice           | 0.01    | 0.38    | -0.01        | 0.03         |
|                         | F. Organizational support           | 0.01    | 0.36    | -0.01        | 0.04         |
|                         | R                                    | 0.56    |         |              |              |
|                         | R²                                   | 0.31    |         |              |              |

Note: Adjusted for gender, age, education level, marriage, industry, job seniority, position, shifts, work days per week, and average working hour.

Table 4
The results of canonical correlation analysis

| Criterion                  | Structural coefficients | Leading indicators     | Structural coefficients |
|----------------------------|-------------------------|------------------------|-------------------------|
| Perceived health           | -0.613                  | Hazard prevention and control | -0.935                  |
| Burnout                    | 0.662                   | Training               | -0.874                  |
| Depression                 | 0.610                   | Safe climate           | -0.868                  |
| Job satisfaction           | -0.947                  | Transformational leadership | -0.862                  |
| Job performance            | -0.501                  | Organizational justice | -0.847                  |
| Life satisfaction          | -0.825                  | Organizational support | -0.866                  |
| Variance explained         | 0.503                   | Variance explained     | 0.767                   |

p = 0.647, $r^2 = 0.419, p < 0.001.$

3. Results

Of the 1,439 participants enrolled in this study, 68.6% ($n = 987$) were male, and 54.4% ($n = 784$) were younger than 40 years. 57.7% ($n = 829$) had a college or university education, and 60.5% ($n = 870$) were married. In addition, 52.2% ($n = 751$) participants had a total service time less than 10 years, 85.4% ($n = 1229$) were general staff, 14.5% ($n = 209$) did shift work, 70.5% ($n = 1014$) worked 5 days per week, 62.0% ($n = 892$) worked 8 hours a day on average, and 54.4% ($n = 783$) were in the manufacturing industry (see Table 1).

Reliability is gauged by the Cronbach’s α as shown in Table 2. The Cronbach’s α of hazard prevention and control, training, safe climate, transformational leadership, organizational justice and organizational support are 0.89, 0.82, 0.81, 0.87, respectively. The ranges of item total correlation of hazard prevention and control, training, safe climate, transformational leadership, organizational justice and organizational support are 0.81–0.91, 0.87–0.92, 0.68–0.81, 0.89–0.92, 0.86–0.90 and 0.83–0.88, respectively.

Table 3 provides the linear regression analysis results of the relationship between six leading indicators and six criteria after adjustment for confounding factors. $R^2$ of six leading indicators to perceived health, burnout, depression, job satisfaction, job performance, and life satisfaction were estimated at 0.17, 0.21, 0.18, 0.39, 0.12, and 0.31, respectively. Both safety climate and hazard prevention and control are positively associated with perceived health ($β = 0.02, 95% CI: 0.01–0.04; β = 0.04, 95% CI: 0.02–0.06$), job satisfaction ($β = 0.02, 95% CI: 0.01–0.03; β = 0.07, 95% CI: 0.05–0.09$), job performance ($β = 0.03, 95% CI: 0.01–0.05; β = 0.07, 95% CI: 0.03–0.11$) and life satisfaction ($β = 0.02, 95% CI: 0.01–0.04; β = 0.04, 95% CI: 0.02–0.06$), but negatively associated with burnout ($β = 0.05, 95% CI: 0.06–0.09; β = 0.05, 95% CI: 0.08–0.12$) and depression ($β = 0.05, 95% CI: 0.08–0.10$).

Table 4 and Fig. 1 present the results of canonical correlation analysis. The first criterion canonical variate is characterized by perceived health ($r = -0.613$), burnout ($r = 0.662$), depression...
4. Discussion

Results of the present study show positive relationships between the six leading indicators and six outcome criteria. These findings suggest that the six leading factors proposed in the extended VPP framework be integrated with the organization’s safety and health management system to reduce psychosocial risks at work.

Among these indicators, hazard prevention and control explains the most variance in perceived health, burnout, depression, job satisfaction, and job performance, and life satisfaction that the evidence clearly suggests the benefit for employers to conduct worksite analysis to mitigate or control work hazards inherent in each particular environment.

Safety climate is the shared perceptions of organizational members regarding how safety policies, procedures and practices are implemented [29]. Evidence-based studies have also indicated that there are relationships between perceived workplace safety climate and worker health behaviors, worker outcomes, and employer outcomes [30]. Integrated strategies to improve an organization’s overall safety climate may positively influence employee physical and mental health, as well as job satisfaction, job performance, and life satisfaction.

We also found transformational leadership was significantly related to burnout, depression, and job satisfaction. This result echoed the important role of transformational leadership in establishing safe and health work environments [31]. Transformational leadership is frequently related to higher levels of employee satisfaction, job performance, work engagement, and employees’ willingness to put in extra effort to reach a targeted goal [32]. By establishing transformational relationships with subordinates, transformational leaders obtain the trust of their employees and meet their needs by providing the necessary information, support, and resources required to carry out their work in a meaningful way [31].

The present study showed the association between organizational justice and job performance. Organizational justice is defined as “the rules and social norms governing how outcomes (e.g., rewards and punishments) should be distributed, the procedures used for making such distribution decisions (as well as other types of decisions), and how people are treated interpersonally [33].” There is a mutually beneficial relationship between an organization and its employees when employees feel that they are not being treated fairly by the organization. If the relationship is imbalanced, employees may reduce or withdraw their participation in this relationship [34].

Burnout has become one of the major concerns in organizations, especially when employees frequently interact with the public [35]. Previous studies have shown that lack of adequate resources likely contribute to stress and burnout [36]. Efforts to improve personal, interpersonal, and organizational resources such as worker involvement, management commitment, fair treatment, or organizational support may increase work engagement and buffer the impact of employees’ stress and burnout [37].

Past research has shown a positive relationship between positive training experiences and job satisfaction. Specifically, initial training, ongoing supervision, and continuing education accounted for 24% of the variance in job satisfaction [38]. This result in conjunction with the present result point out that organizations could benefit from improving training programs delivery and implementations.

A surprising finding from this study was a positive relationship between burnout and organizational support ($\beta = 0.05, p = 0.01$) and a negative relationship between job performance and organizational justice ($\beta = -0.04, p = 0.03$). In the univariate analysis, the Pearson’s correlation coefficients between burnout and organizational support and between job performance and organizational justice were 0.314 ($p < 0.01$) and 0.241 ($p < 0.01$), respectively. This disparity indicates the appearance of suppressor effects. There are two possible reasons why the suppressor effects occurred. First, intercorrelation among the leading indicators may have confounded the results. Second, the suppressor effects may reveal that those with lower scores of leading indicators may have a higher risk of developing burnout and depression. This possible explanation implicated the need to design interventions by tailoring to the special staff subgroups.

4.1. Limitations

Three limitations should be considered when interpreting results of this study. First, cross-sectional design utilized in this study could not provide definitive conclusion about the causal

\[ r = 0.610, \text{ job satisfaction } (r = -0.947), \text{ job performance } (r = -0.50), \text{ and life satisfaction } (r = -0.825). \text{ High levels of hazard prevention and control, training, safety climate, transformational leadership, organizational justice, and organizational support seem to be good predictors for the criteria, as all have expected correlations with the first criterion canonical variate. In addition, the canonical correlation analysis indicated a positive correlation between the six leading indicators and criteria (1st canonical function: correlation } r = 0.647, \text{ square correlation } r^2 = 0.419, \text{ } p < 0.001). \]
relationships between the leading indicators and the criteria. Future studies with longitudinal design are needed to assess long-term effects (e.g., prevalence of accidents or occupational diseases) of the leading indicators within the extended VPP framework. Second, the present study was conducted in the service, construction, and manufacturing industries. Results may not be generalizable because other industries may not have similar characteristics. Results of the present study should be replicated in other industries. Finally, participants of the present studies are invited from selected organizations. Therefore, the present findings should not be extrapolated to other organizations or industries in Taiwan.

5. Conclusion

The present study provides an initial investigation of the extended VPP framework, which consists of six leading indicators focusing on physical and mental health, in addition to safety. As shown in Table 4, strong magnitude of structured coefficients of the leading indicators (ranging from 0.77 to 0.94 in absolute values) not only provide validity evidence of six leading indicators, but also support future applications of the extended VPP framework to manage and improve workers safety and health.

Authorship

Conception and design, and acquisition of data: Fu-Li Chen, Peter Y. Chen. Statistical analysis and interpretation of data: Chi-Chen Chen, Tao-Hsin Tung.

Drafting of the article: Fu-Li Chen, Tao-Hsin Tung. Revised the manuscript critically for important intellectual content: Peter Y. Chen.

Declaration of competing interest

All authors declare that there are no conflicts of interest.

Acknowledgments

This research was supported by a grant (#IOSH99-H999) from the Institute of Labor, Occupational Safety and Health, Ministry of Labor, Taiwan (R.O.C).

References

[1] US Occupational Safety and Health Administration. Recording and reporting occupational injuries and illness; 2001. Available from: https://www.osha.gov/laws-regs/regulations/standardnumber/1904/1904.7.
[2] Chen PY, Li Y, Tuckey M, Cigularov KP. Progress and challenges in occupational health and safety research. In: Leka S, Sinclair RR, editors. Contemporary occupational health psychology: global perspectives on research and practice. Vol. 3. Chichester: Wiley-Blackwell; 2014, p. 131–48.
[3] Chen PY, Li Y, Wu H. Impacts of stress and well-being on organizations and societies: a global perspective. In: Lapierre LM, Cooper C, editors. Cambridge companion to organisational stress and well-being. Cambridge University Press; 2022.
[4] US Occupational Safety and Health Administration. Using leading indicators to improve safety and health outcomes; 2019. Available from: https://www.osha.gov/leading-indicators.
[5] Singapore Workplace Safety and Health Council. Guide to total workplace safety and health; 2010. Available from: http://docplayer.net/7791035-Guide-to-total-workplace-safety-and-health.html.
[6] Japan Industrial Safety & Health Association. Ministry of Labor, health and welfare OSHMS guideline; 1999 [cited 2006 March 10]. Available from: https://jishams.jska.or.jp/english/index.html.
[7] Walski, P. Lagging indicators, leading indicators…let’s start over. Saf Manag. [cited 202 May 21]. Available from:https://incident-prevention.com/blog/lagging-indicators-leading-indicators-let-s-start-over/.
[8] US Occupational Safety and Health Administration. Voluntary protection programs (VPP): policies and procedures manual. Washington DC: U.S. Department of Labor; 2007. Available from: https://www.osha.gov/enforcement/directives/csp-03-01-002.
[9] Lingard H. The effect of first aid training on Australian construction workers’ occupational health and safety motivation and risk control behavior. J Saf Res 2011:1–10.
[10] Christian MS, Bradley JC, Wallace JC, Burke MJ. Workplace safety: a meta-analysis of the roles of person and situation factors. J Appl Psychol 2009:94:103–27.
[11] Zohar D. Safety climate in industrial organizations: theoretical and applied implications. J Appl Psychol 1980:65:96–102.
[12] Zohar D. Thirty years of safety climate research: reflections and future directions. Accid Anal Prev 2010:42:1517–22.
[13] Levin K, Lipptit R, White R. Patterns of aggressive behavior in experimentally created “social climates”. J Soc Psychol 1939:10:269–99.
[14] Bass BM. Leadership and performance beyond expectation. New York: Free Press; 1985.
[15] Njuguna JD, Morgeson FP, Hofmann DA. Safety at work: a meta-analytic investigation of the link between job demands, job resources, burnout, engagement, and safety outcomes. J Appl Psychol 2011:96:71–94.
[16] Cohen-Charash Y, Spector PE. The role of justice in organizations: a meta-analysis. Org Behav Hum Decis Process 2001:86:278–321.
[17] Colquitt JA, Conlon DE, Wesson MJ, Porter C, Ng KY. Justice at the millenium: a meta-analytic review of 25 years of organizational justice research. J Appl Psychol 2001:86:425–45.
[18] Eisenberger R, Huntington R, Hutchison S, Sowa D. Perceived organizational support. J Appl Psychol 1986:71:500–7.
[19] Ladd D, Henry RA. Helping coworkers and helping the organization: the role of support perceptions, exchange ideology, and conscientiousness. J Appl Psychol 2000:90:2028–49.
[20] McMillan R. Customer satisfaction and organizational support for service providers. Gainesville: University of Florida; 1997.
[21] Mathieu M, Eschleman KJ, Cheng D. Meta-analytic and multiwave comparison of emotional support and instrumental support in the workplace. J Occup Health Psychol 2019:24:387–409.
[22] Katz-Navon T, Naveh E, Stern Z. Safety climate in health care organizations: a multidimensional approach. AMJ 2005:48:1075–89.
[23] Zohar D, Luria G. A multilevel model of safety climate: cross-level relationships between organization and group-level climates. J Appl Psychol 2005:90:516–28.
[24] Carless SA, Wearing AJ, Mann L. A short measure of transformational leadership. J Bus Psychol 2000:14:389–405.
[25] Colquitt JA. On the dimensionality of organizational justice: a construct validation of a measure. J Appl Psychol 2001:86:386–400.
[26] Moorman RH. Relationship between organizational justice and organizational citizenship behaviors: do fairness perceptions influence employee citizenship? J Appl Psychol 1991:76:845–55.
[27] Fisher GC, Matthews RA, Gibbons AM. Developing and investigating the use of single-item measures in organizational research. J Occup Health Psychol 2016:21:3–23.
[28] Kessler RC, Barber C, Beck A, Berglund P, Cleary PD, McKenas D. The world health organization health and work performance questionnaire (HQW). J Occup Environ Med 2001:45:156–74.
[29] Wallace JC, Popp E, Mondore S. Safety climate as a mediator between foundation climates and occupational accidents: a group-level investigation. J Appl Psychol 2006:91:881–8.
[30] Katz AS, Priskin NP, McCellan D. Perceived workplace health and safety climates: associations with worker outcomes and productivity. Am J Prev Med 2019:57:487–94.
[31] Boannah SA, Spence Lachinger HK, Wong C, Clarke S. Effect of transformational leadership on job satisfaction and patient safety outcomes. Nurs Outlook 2018:66:180–9.
[32] Zhu W, Avolio BJ, Walumbwa FO. Moderating role of follower characteristics with transformational leadership and follower work engagement. Group Org Mgmt 2009:34:590–619.
[33] Sora B, Höge T, Caballer A, Peiró JM, Boada J. Job insecurity and performance: associations with job demands, resources, and effective classroom practices. J Sch Psychol 2019:77:36–51.
[34] Cross W, Wyman PA. Training and motivational factors as predictors of job satisfaction and anticipated job retention among implementers of a school-based prevention program. J Prim Prev 2006:27:195–215.