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Original article

# Developing the Vulnerability Factor Structure Affecting Injuries and Health Problems Among Migrant Seafood Processing Industry Workers

Itchaya Jiaranai [1,*], Preeda Sansakorn [2], Junjira Mahaboon [2]

[1] Environmental, Safety Technology and Health Program, School of Public Health, Walailak University, Nakhon Si Thammarat, Thailand
[2] Occupational Health and Safety Department, School of Public Health, Walailak University, Nakhon Si Thammarat, Thailand

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ABSTRACT

*Background:* The vulnerability of international migrant workers is on the rise, affecting the frequency of occupational accidents at workplaces worldwide. If migrant workers are managed in the same way as native workers, the consequences on safety assurance and risk management will be significant. This study aimed to develop the vulnerability factor model for migrant workers in seafood processing industries because of significant risk-laden labor of Thailand, which could be a solution to control the risk effectively.

*Methods:* A total of 569 migrant workers were surveyed (432 Burmese and 137 Cambodian), beginning with 40 initial vulnerability factors identified in the questionnaire established from experts. The data were analyzed through descriptive analysis; exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to ascertain the model.

*Results:* The result of content validity >0.67 and the Cronbach's alpha of 0.957 specified the high reliability of 40 factors. The EFA indicated a total variance of 65.49%. The final CFA validated the model and had an empirical fitting; chi-square = 85.34, Adjust Goodness-of-Fit Index = 0.96, and root mean square error of approximation = 0.016. The structure concluded with three dimensions and 18 factors. Dimension 1 of the structure, "multicultural safety operation," contained 12 factors; Dimension 2, "well-being," contained four factors; and Dimension 3, "communication technology," contained two factors.

*Conclusion:* The vulnerability factor structure developed in this study included three dimensions and 18 factors that were significantly empirical. The knowledge enhanced safety management in the context of vulnerability factor structure for migrant workers at the workplace.



## 1. Introduction

The number of vulnerable migrant workers globally is indicative of a blatant proportion facing hazards in the workplace. There were 272 million international migrant workers in 2019, and the number is expected to rise to 405 million by 2050 [1]. The studies conducted worldwide claim that migrant workers are more vulnerable to occupational accidents than local workers. For example, in three European countries, migrant workers, particularly the unregistered ones, working in construction and agricultural fields, were more vulnerable to injuries. Although migrant workers had positive perceptions of management commitment and the safety systems, the language barrier because of gaps in understanding and a lack of accident data are factors that require improvement [2]. In the Republic of Korea, age, education, and proficiency in the Korean language needed for migrant construction workers significantly affected their safety perception level, and there was a need to enhance their abilities to be on a par with the Korean workers [3]. In Spain, a vulnerability index [4] was developed as a measure of occupational health and safety vulnerability for workers. A survey using the measure proved that migrant workers in Spain were at a higher risk (81%) of being exposed to occupational hazards than native workers (54%) [5]. As suggested by the results, occupational health and safety management for migrant workers are imperative. Moreover, 36 studies in 13 countries worldwide indicated that the pooled morbidity rate among 7,260 migrant workers was 47%, with

* Corresponding author. Environmental, Safety Technology and Health Program School of Public Health, Walailak University, Hat Yai, Songkhla, Thailand.
*E-mail address:* itchaya.ja@gmail.com (I. Jiaranai).

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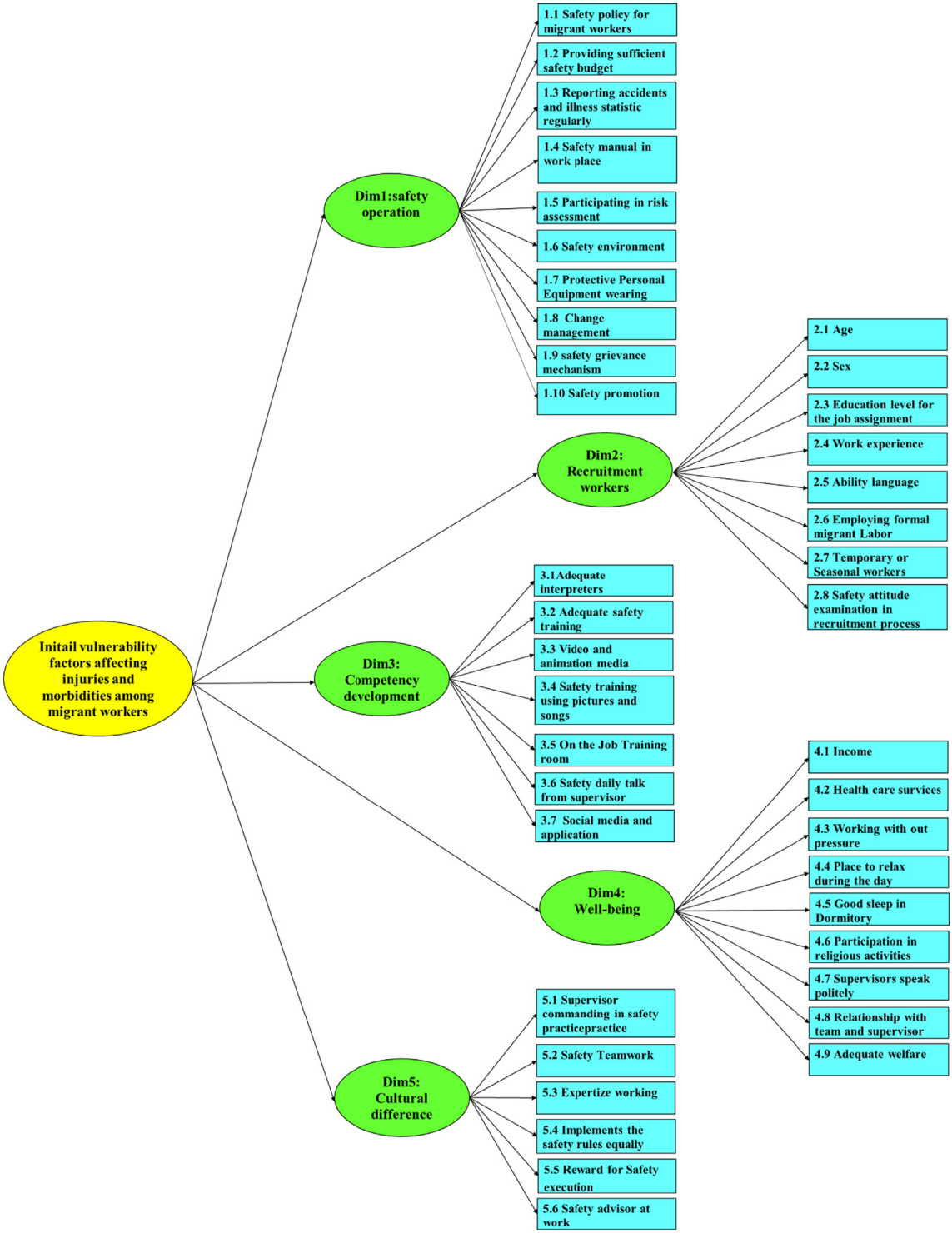


**Fig. 1.** Five dimensions, 40 factors; migrants' vulnerability factors hypothesis model.

22% of 3,890 workers experiencing injuries at the workplace; these studies' findings were representative of undocumented migrant workers with low wages and long working hours [6]. The trend of employed migrant workers in Thailand was similar; there was a significant increase in migrant workers from 0.88 to 1.96 million between 2016 and 2020 [7]. Seafood is Thailand's most commonly exported products. Its seafood processing industries employ over 80,000 workers; two-thirds of whom are migrants. Despite the importance of the seafood industry in Thailand and other Asian countries, there is only a limited number of studies regarding migrants' health. The occupational accidents statistics of seafood factories reported that 25% of migrant workers experienced work accidents and health problems, mostly related to lower back pain and musculoskeletal problems. This is one of the reasons the Royal

Thai Government strongly encouraged industries to adhere to decent work promotion as a commitment in the European Union–funded ILO Ship to Shore Rights Project in 2018 [8–11].

Despite the prevalence of occupational accidents in Thailand, there are no previous studies specifically assessing the components of vulnerability factors among migrant workers from an empirical standpoint. Workplaces must ensure the safety of migrant workers because vulnerability factors can contribute to accidents and morbidities. This study aimed to identify the vulnerability factors and create a vulnerability factor structure affecting injuries and health problems among migrant workers in the workplace. Fig. 1 shows the initial five dimensions and 40 factors summarized into a questionnaire survey using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) techniques to verify the factor structure empirically. The model assessed through our study would be beneficial for controlling risk factors for migrant workers at the workplace.

## 2. Materials and Methods

This study used EFA and CFA techniques to develop the vulnerability factors of migrant workers' structure empirically. These analysis techniques have been previously applied in several fields of health and safety, including occupational health literacy, perception of safety climate, safety preparedness, perceived risk, safety behavior, and safety leadership model [12–15].

A cross-sectional survey with 569 participants working at three seafood processing factories in the Songkhla province, which is the commercial center located on the east coast in southern Thailand, was conducted using the questionnaire of factor structure between January 5 and March 31, 2021. The population comprised of 3,006 international migrant workers, and the minimum sample size for testing the 40 questions based on CFA and EFA needed to be in the ratio of 1:10 [16]; we thus referred to a confidence interval of 96% [17], considering a minimum sample size of 517 and adding 10% to ensure complete data collection. Therefore, our final sample size was 569. A multistage random sampling was performed to collect the data, covering three factories based on region and working area, instead of simple random sampling. Only those migrant workers who had worked in the factories for more than 1 month were surveyed.

The preliminary five dimensions and 40 vulnerable factors were summarized based on their problem statements into the questionnaire, being investigated by three experts in occupational and safety management. The five dimensions consisted of the following: Dimension 1, safety operation, contained 10 questions; Dimension 2, recruitment workers, contained eight questions; Dimension 3, competency development, contained seven questions; Dimension 4, well-being, contained nine questions; and Dimension 5, cultural difference, contained six questions, as shown in Appendix I. The questionnaire assessed general background information, occupation accident statistics, and safety management related to vulnerability factors; it was separated into two sections: section 1 included 14 questions for participants' general information and safety and health statistics, and section 2 comprised the previously mentioned 40 questions in five dimensions; 40 factors (six questions were negative). Participants' scores were rated on a 5-point Likert scale, where 1 = extremely disagree, 2 = disagree, 3 = fair, 4 = agree, and 5 = extremely agree. The content validity of 40 questions was checked by three experts in occupational and safety science and seafood processing, with the result of Index of item Objective Congruence (IOC >0.5) being acceptable [18]. The questionnaire's Likert scale was tested by 30 migrant workers in another seafood factory that was not included in our sample, and its reliability was confirmed through Cronbach's alpha coefficient >0.7, which specified high reliability of our questionnaire [19]. The model has been validated through EFA in SPSS program and CFA method in Lisrel program. Finally, the correlations between factors and accidents and health problems were tested using chi-square (significance level set at $p < 0.05$).

Burmese and Cambodian migrant workers in the large seafood processing industries were surveyed using our questionnaire translated in their languages; the interpreters assisted in conducting the survey with the participants at the factories' dormitories. Descriptive analysis was conducted to examine the demographic details and statistics related to accidents and health problems. The initial 40 factors were analyzed through SPSS program using EFA and varimax rotation method. The Kaiser-Meyer-Olkin (KMO; >0.5) and Bartlett's test of sphericity (<0.05) were conducted [20]. The factors remaining after EFA were renamed and verified through first-order and second-order CFA to fit the model. The vulnerability factor structure was verified by chi-square goodness-of-fit statistics ($p > 0.5$; GFI and AGFI >0.90) and root mean squared error of approximation (RMSEA <0.08), Normed Fit Index (NFI >0.95), Comparative Fit Index (CFI >0.95), Incremental Fit Index (IFI >0.95), root mean square residual (RMR), and standardized RMR (<0.08) [21–23]. Finally, relationships of the factors with occupational accidents were tested using chi-square.

Data were collected after obtaining informed and voluntary consent of the participants.

**Table 1**
Demographic characteristic of the participants

| Demographic characteristics | Respondents | Percentage |
|---|---|---|
| Sex | | |
| Male | 249 | 43.76 |
| Female | 320 | 56.24 |
| Age | | |
| <20 years | 20 | 3.51 |
| 21–30 years | 272 | 47.80 |
| 31–40 years | 252 | 44.29 |
| 41–50 years | 23 | 4.04 |
| 51–60 years | 1 | 0.18 |
| >60 years | 1 | 0.18 |
| Min = 19, Max = 65, $\bar{x}$ = 30.67, SD = 6.373 | | |
| Nationality | | |
| Burmese | 432 | 75.92 |
| Cambodian | 137 | 24.08 |
| Work experience | | |
| 1–5 years | 376 | 66.08 |
| 6–10 years | 166 | 29.17 |
| 11–15 years | 24 | 4.22 |
| 15–20 years | 2 | 0.35 |
| >20 years | 1 | 0.18 |
| Min = 1, Max = 24, $\bar{x}$ = 4.94, SD = 3.195 | | |
| Education level | | |
| Less than primary school | 60 | 10.54 |
| Primary school | 227 | 39.89 |
| Secondary school | 256 | 44.99 |
| Bachelor's degree | 26 | 4.57 |
| Accident experience in last 12 months | | |
| Yes | 125 | 21.96 |
| Day lost >3 days | 55 | 9.66 |
| Day lost 1–3 days | 70 | 12.30 |
| No | 444 | 78.04 |
| Sick leave in last 12 months | | |
| Yes | 340 | 59.75 |
| No | 229 | 40.25 |
| Min = 0, Max = 16, $\bar{x}$ = 0.45, SD = 3.220 | | |
| Using nursing rooms in workplace | | |
| Yes | 406 | 71.35 |
| No | 163 | 28.65 |

Min, minimum; Max, maximum; SD, standard deviation.

**Table 2**
Reliability of the initial factors in the questionnaire

| Dimensions | Items | Cronbach's alpha |
|---|---|---|
| Dim1: Safety operation | 10 | 0.825 |
| Dim2: Recruitment process | 8 | 0.822 |
| Dim3: Competency development | 7 | 0.745 |
| Dim4: Well-being | 9 | 0.750 |
| Dim5: Cultural | 6 | 0.888 |
| | 40 | 0.957 |

## 3. Results

### 3.1. Demographic characteristics

Table 1 shows 569 participants who were surveyed. Almost three-fourth of them were Burmese (n = 432, 75.92%), and the remaining were Cambodian (n = 137, 24.08%); the response rate was 100%; 320 respondents were women (56.24%). Most workers were young, including a proportion of participants aged around 21–30 years (41.80%) and 31–40 years (44.29%). Most participants graduated from secondary school (44.99%); 376 had work experience of fewer than 5 years.

The safety statistics from the survey indicated that 21.96% of the workers had experienced accidents at the workplace, 12.30% had lost 1–3 days, and 9.66% had lost more than 3 days. Meanwhile, 340 participants used sick leave, and 406 used healthcare services in the factory.

The questionnaire was validated using content validity by three occupational and safety specialists. The IOC ranged from 0.67 to 1.00 (>0.5). An overall Cronbach's alpha of 0.957 specified the high reliability of the questionnaire, with alphas in each of the five dimensions falling between 0.750 and 0.888, as indicated in Table 2. These confirmed the questionnaire's validity and reliability.

### 3.2. Exploratory factors analysis

The initial five dimensions and 40 vulnerability factors were verified by EFA. This study used the principal component analysis with varimax rotation method. The results are shown in Table 3.

**Table 3**
KMO and Bartlett's test of ssphericity

| Statistic | Value |
|---|---|
| Kaiser-Meyer-Olkin measure of sampling adequacy | 0.873 |
| Bartlett's test of sphericity | |
| Approx. chi-square | 10937.491 |
| df | 780 |
| Sig. | 0.000 |

The KMO index was 0.873, and the Bartlett's test of sphericity was significant (chi-square = 10,937.491, df = 780, $p < 0.001$), confirming the suitability of the 40 factors for EFA analysis [20]; the result of initial extraction of each variable (initial communalities = 1) complied with principal component analysis (PCA).

We determined the number of factors to retain the proportion of variance. The total variance explained by vulnerability factors is illustrated in Table 4. The cumulative variance of 10 factors was 65.49%.

The result of factor loading by PCA—Varimax with Kaiser Normalization—was done using components with five factors, whereas some factors, such as those with factor loading <0.5 (D1.6, D1.8, D2.2, D3.4, D3.5, D4.8, and D5.3) and with factor component less than two items (D4.7, D1.5, D1.0, D5.5, D5.6, and D2.4), were eliminated. The remaining five dimensions contained 27 factors (factors loading >0.5). The dimension "multicultural safety operation" contained 12 factors, with factor loading of 0.511–0.828; Dimension 2, "well-being," contained seven factors with a loading of 0.534–0.780; Dimension 3, "safety feedback," contained three factors; Dimension 4, "communication technology," contained three factors; and Dimension 5, "individual characteristic," contained two factors, with factor loadings of 0.504–0.816, 0.512–0.818, and 0.653–0.763, respectively.

### 3.3. Confirmatory factor analysis

This study used first- and second-order CFA to validate the migrant vulnerability factor in each item (observed variable) and dimension (latent variable). The result of first-order CFA verified that the structure fitted in terms of the 27 items being significant (chi-square = 127.06, df = 1.07, $p = 0.28979$ [$p > 0.05$], GFI = 0.98, AGFI = 0.95 [GFI and AGFI >0.90], and RMSEA = 0.011 [RMSEA <0.08]), as indicated in Fig. 2.

Consequently, five dimensions were validated by second-order CFA, and the dimensions were unfitted from the model; the values were as follows: chi-square = 2425.88, ($\chi^2$)/df = 7.60 (<2) $p = 0.0000$ ($p > 0.05$), GFI and AGFI = 0.76, 0.72 (>0.90), RMSEA = 0.108 (<0.08), showing that the results needed adjustment. After the first adjustment, five dimensions with 27 factors had chi-square = 147.03, ($\chi^2$)/df = 1.19 (<2), $p$ value = 0.06884 ($p > 0.05$), GFI and AGFI = 0.98, 0.94 (>0.90), and RMSEA = 0.019 (<0.08). The results showed that two variables had a factor loading index of <0.50 (>0.5). Therefore, a second adjustment was conducted to confirm the fitting model; nine factors (D1.9, D2.1, D2.5, D2.7, D3.1, D3.6, D4.3, D4.4, and D4.5) with a factor loading of <0.5 were eliminated, resulting in 18 factors in three dimensions. The loading factor of observed variable was more than 0.5, and latent

**Table 4**
Total variance explained by the vulnerability factors

| Component | Initial eigenvalues | | | Extraction sums of squared loadings | | | Rotation sums of squared loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of variance | Cumulative % | Total | % of variance | Cumulative % | Total | % of variance | Cumulative % |
| 1 | 9.72 | 24.29 | 24.29 | 9.72 | 24.29 | 24.29 | 6.69 | 16.72 | 16.72 |
| 2 | 3.79 | 9.47 | 33.76 | 3.79 | 9.47 | 33.76 | 4.55 | 11.37 | 28.09 |
| 3 | 2.91 | 7.27 | 41.04 | 2.91 | 7.27 | 41.04 | 2.68 | 6.69 | 34.78 |
| 4 | 1.98 | 4.95 | 45.99 | 1.98 | 4.95 | 45.99 | 2.67 | 6.69 | 41.47 |
| 5 | 1.64 | 4.11 | 50.10 | 1.64 | 4.11 | 50.10 | 1.87 | 4.67 | 46.13 |
| 6 | 1.57 | 3.92 | 54.02 | 1.57 | 3.92 | 54.02 | 1.64 | 4.10 | 50.23 |
| 7 | 1.32 | 3.31 | 57.33 | 1.32 | 3.31 | 57.33 | 1.63 | 4.06 | 54.29 |
| 8 | 1.17 | 2.93 | 60.25 | 1.17 | 2.93 | 60.25 | 1.59 | 3.98 | 58.27 |
| 9 | 1.07 | 2.68 | 62.94 | 1.07 | 2.68 | 62.94 | 1.54 | 3.84 | 62.11 |
| 10 | 1.02 | 2.55 | 65.49 | 1.02 | 2.55 | 65.49 | 1.35 | 3.38 | 65.49 |

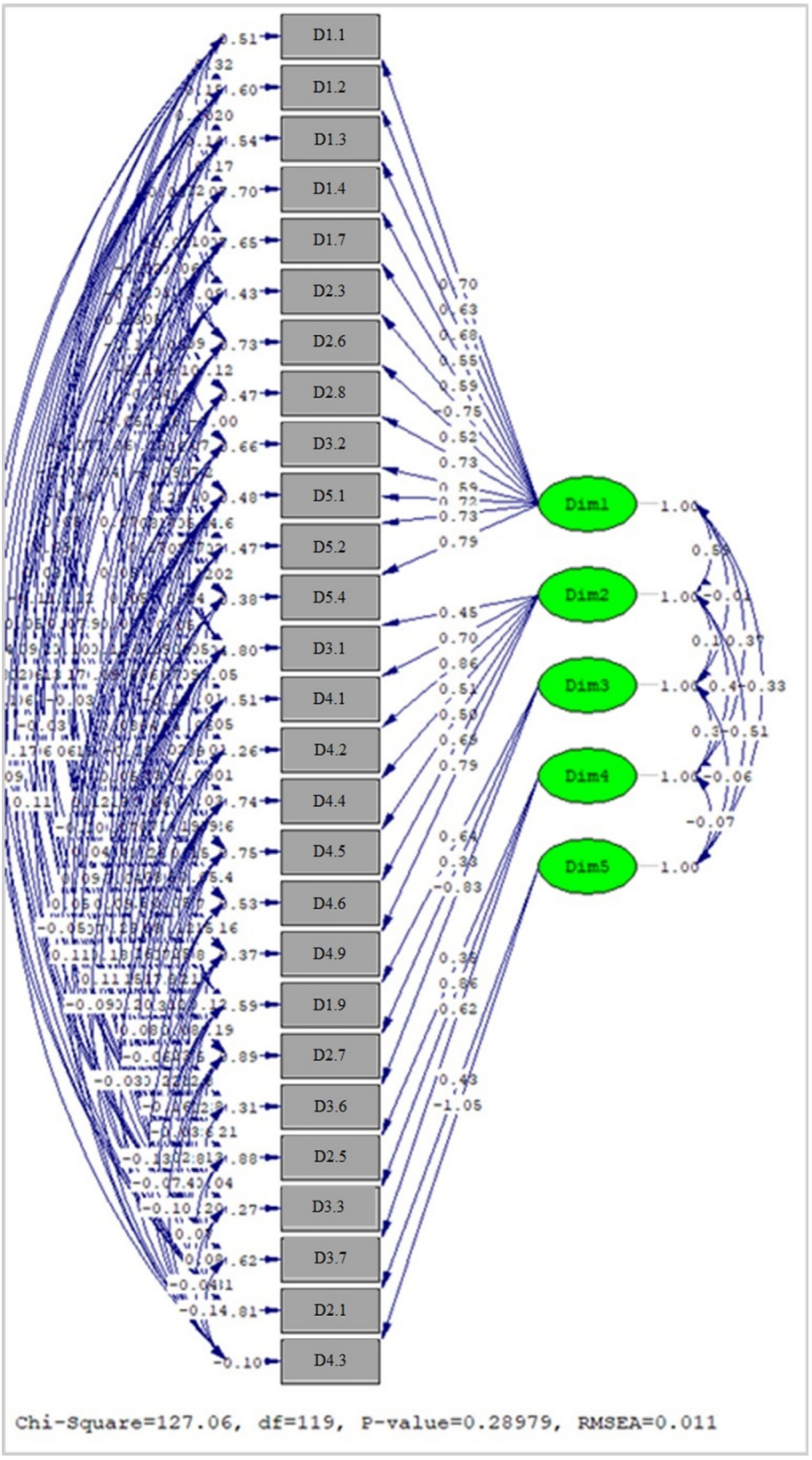


**Fig. 2.** The result of first-order confirmatory factor analysis. $\chi^2 = 127.06$, df = 119, $p = 0.28979$, *GFI = 0.98, AGFI = 0.95, RMSEA = 0.011.*

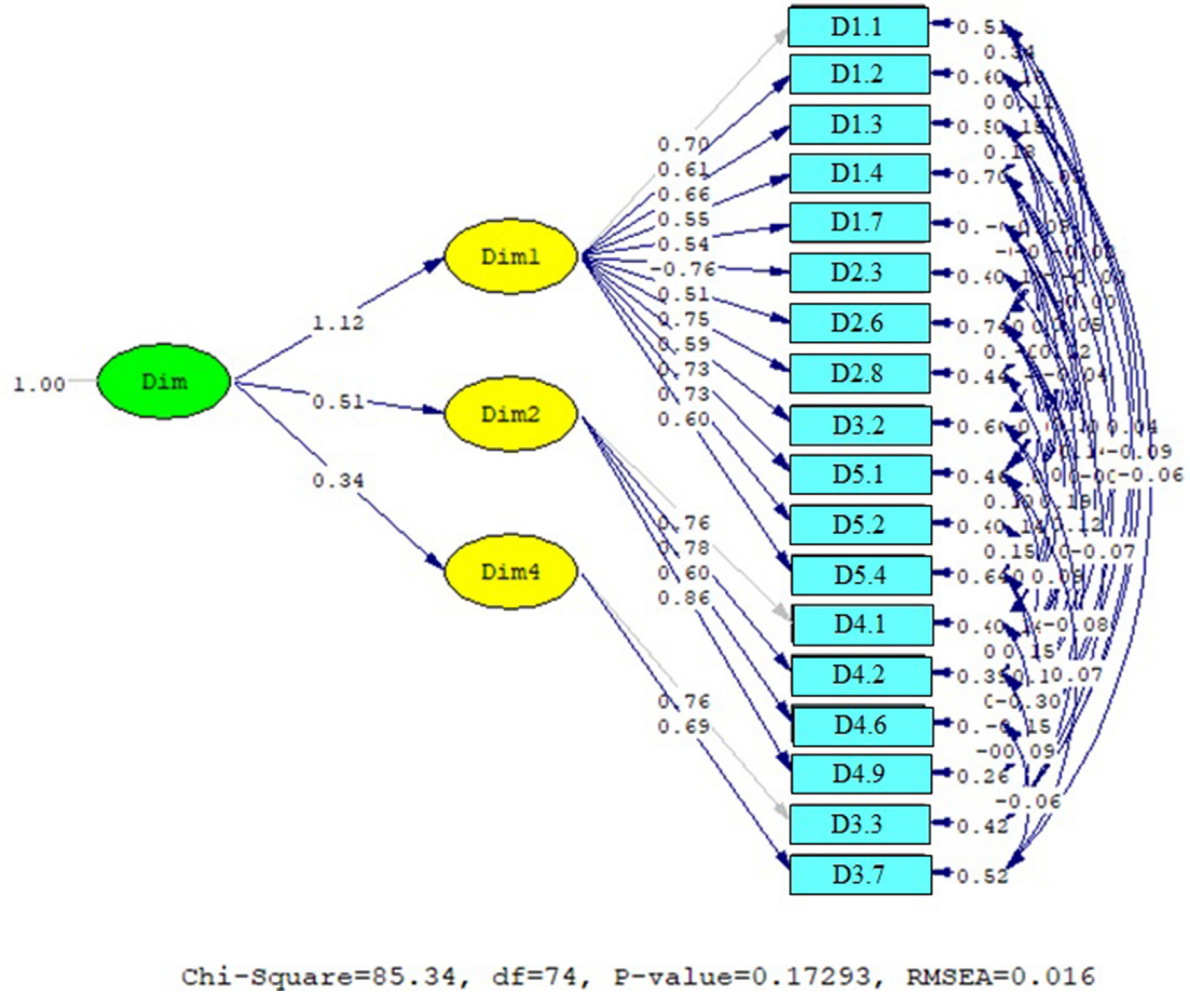


**Fig. 3.** Second-order confirmatory factor analysis after second adjustment.

variables were 1.12, 0.51, and 0.34 in Dimensions 1, 2, and 3, respectively. The validation of goodness of fitted model was as follows: chi-square = 85.34, df = 74, ($\chi^2$)/df = 1.15 (<2), GFI = 0.98, AGFI = 0.96 (>0.90), RMSEA = 0.016 (<0.08) and $p$ = 0.17293 (>0.05), NFI = 0.99 (>0.95), CFI = 1.00 (>0.95), IFI = 1.00 (>0.95), RMR = 0.027, standardized RMR = 0.024 (<0.08). The model was thus empirically consistent, as illustrated in Fig. 3.

Fig. 4 shows the final component analysis of vulnerability factor structure affecting injuries and health problems among migrant workers in the workplace, summarizing the result after EFA and CFA methods.

Finally, the relationships of the 18 factors with accident experience, sick leave, and using healthcare services were tested through chi-square ($\chi^2$; $p$ value <0.05), as illustrated in Table 5.

## 4. Discussion

This study aimed to create the first vulnerability factor structure for migrant workers to create a useful tool to mitigate the safety risk for workers at the workplace. Forty factors were summarized from the problems faced by migrant workers worldwide to validate and develop the structure using EFA and CFA methods.

The accidents and health problems in factories were described through our results. One-fourth of the workers in Thailand's seafood industry had experienced accidents, and 40.25% availed sick leaves due to health problems, similar to the meta-analysis results of injuries and morbidities in 13 countries worldwide [6]. The participants included mainly those aged 21–30 years, having a highest educational level of secondary school, and <5 years of work experience. Furthermore, healthcare services were identified as crucial because of their high rate of usage (71.35%).

The EFA method screened 40 factors, which were reduced to 27 and classified into five dimensions. All factors contribute to a variance cumulative of 65.49%, and the structure was verified through first-order and second-order CFA. The first-order CFA validated 27 observed variables; 12 factors in Dimension 1 showed factor loadings of 0.52–0.79 (>0.5). In contrast, there were four factors with a loading <0.5, which impacted the model fitting; for example, Factor 5.4 in Dimension 2, 2.7 in Dimension 3, 3.6 in Dimension 4, and 2.1 in Dimension 5 had factor loadings of 0.45, 0.33, 0.34, and 0.43, respectively. Thus, the model needed adjustment.

After the second adjustment, there were three dimensions and 18 factors remaining, and the result of first-order CFA for observed variables of 18 factors, and the second-order CFA in three dimensions of latent variables confirmed the fitting of the model. The model was fitted empirically through 18 factors classified into three dimensions: "multicultural safety operation" contained 12 factors, the "well-being" dimension contained four factors, and "communication technology" contained two factors. Eventually, the factors

| Initial structure | | After EFA | | | After CFA | | | |
|---|---|---|---|---|---|---|---|---|
| Dimensions/ Factors | Total items | Factor loading | Dimensions/ Factors | Total items | Factor loading: First order | Factor loading: Second order | Dimensions/ Factors | Total items |
| Dim 1: Safety operation<br>Items numbers: 1.1-1.10 | 10 | 0.51-0.82 | Dim 1: Safety operation<br>Items numbers: 1.1,1.2,1.3,2.8,5.2,2.3, 5.1,1.4,3.21.7,5.4,2.6 | 12 | 0.51-0.76 | 1.12 | Dim 1: Multicultural safety operation<br>Items numbers: 1.1,1.2,1.3,1.4,1.7,2.3,2 .6,2.8,3.2,5.1,5.2, 5.4 | 12 |
| Dim 2: Recruitment process<br>Items numbers: 2.1-2.8 | 8 | 0.53-0.78 | Dim 2: Well-being<br>Items numbers: 4.2,4.6,4.5,4.1 ,4.9,4.4,3.1 | 7 | 0.60-0.86 | 0.51 | Dim 2: Well-being<br>Items numbers: 4.1,4.2,4.6,4.9 | 4 |
| Dim 3: Competency development<br>Items numbers: 3.1-3.7 | 7 | 0.50-0.81 | Dim 3: Safety feedback<br>Items numbers: 1.9,3.6,2.7 | 3 | 0.69-0.76 | 0.34 | Dim 3: Communication technology<br>Items numbers: 3.3,3.7 | 2 |
| Dim 4: Well-being<br>Items numbers: 4.1-4.7 | 9 | 0.51-0.81 | Dim 4: Communication technology<br>Items numbers: 3.3,3.7,2.5 | 3 | | | | |
| Dim 5: Difference cultural<br>Items numbers: 5.1-5.6 | 6 | 0.51-0.81 | Dim 5: Individual characteristic<br>Items numbers: 2.1,4.3 | 2 | | | | |
| Total | 40 | | | 27 | | | | 18 |

**Fig. 4.** The result of remaining factors after EFA and CFA.

were tested for their relation with occupational accidents through chi-square ($p > 0.05$), confirming the significant factors that influenced injuries and morbidities. Our results show that safety management for migrant workers should consider the vulnerability factors by integrating multicultural workers, their well-being, and aspects of technological communication.

"Multicultural safety operation" is the first dimension with a loading factor of 0.51–0.76 that influenced occupational accidents. This dimension combined items D1.1, D1.2, D1.3, D1.4, D1.7, D2.3, D2.6, D2.8, D3.2, D5.1, D5.2, and D5.4 realistically. The name of the dimension was changed from "safety operation" to "multicultural safety operation" to consider safety management for culturally diverse individuals. D1.1, D1.2, D1.3, and D1.4 were items that considered aspects related to safety policies, safety budget, and safety manuals at the workplace. D1.7 was more about personal safety in terms of wearing protective equipment. Similarly, Garcia and De Castro explored working conditions and occupational injuries with Filipino seafood processing workers in Alaska [24]. They discussed the use of personal protective equipment, which is essential to protect workers from cold temperatures, and how the workers had insufficient time to put it on and take it off while using the restroom.

D2.3, D2.6, and D2.8 considered education level to suit the job assignment, employment of formal migrant labor, and safety attitude. D3.2 considered provisions of adequate safety training and design since the recruitment process. D5.1, D5.2, and D5.4 referred to the cultural difference dimension to be reviewed for safety management. Seafood processing industries employ large numbers

**Table 5**
The finalized vulnerability factor structure and relation between injuries and health problems

| Vulnerability factors structure | | Chi-square ($p$ value) | | |
|---|---|---|---|---|
| | | Injury | Sick leave | Health |
| Dim1 | Multicultural safety operation | | | |
| 1.1 | Safety policy for migrant worker | 0.000 | 0.001 | 0.000 |
| 1.2 | Providing safety budget | 0.000 | 0.015 | 0.000 |
| 1.3 | Reporting accidents and illness statistic regularly | 0.000 | 0.000 | 0.000 |
| 1.4 | Safety manual in workplace | 0.000 | 0.475 | 0.000 |
| 1.7 | Protective personal equipment wearing | 0.213 | 0.054 | 0.067 |
| 2.3 | Education level for the job assignment | 0.000 | 0.022 | 0.000 |
| 2.6 | Employing formal migrant labor | 0.016 | 0.040 | 0.278 |
| 2.8 | Safety attitude examination in recruitment process | 0.000 | 0.654 | 0.000 |
| 3.2 | Adequate safety training | 0.000 | 0.003 | 0.001 |
| 5.1 | Supervisor commanding in safety practice | 0.000 | 0.031 | 0.000 |
| 5.2 | Safety teamwork | 0.000 | 0.141 | 0.000 |
| 5.4 | Safety advisor in workplace | 0.000 | 0.031 | 0.006 |
| Dim2 | Well-being | | | |
| 4.1 | Income | 0.165 | 0.202 | 0.068 |
| 4.2 | Healthcare service | 0.256 | 0.020 | 0.490 |
| 4.6 | Participation in religious activities | 0.066 | 0.004 | 0.130 |
| 4.9 | Adequate welfare | 0.598 | 0.007 | 0.110 |
| Dim3 | Communication technology | | | |
| 3.3 | Video and animation media | 0.001 | 0.000 | 0.002 |
| 3.7 | Social media and application | 0.004 | 0.000 | 0.000 |

of Burmese and Cambodian workers, the results confirming that D5.1, supervisor commanding in safety practice; D5.2, safety teamwork; and D5.6, safety advisor in the workplace, were accepted and recognized by the participants who followed the supervisor's orders and were involved in teamwork to achieve safety. These results were consistent with those of Syron et al. who, through manager training and knowledge sharing, indicated that the middle managers are role models for workers, with workers relying on their instructions [25].

The second dimension that influenced accidents was "well-being," with loading factors between 0.60 and 0.86. This showed that fundamental safety at the workplace was not the only aspect involved in preventing hazards; staying well in life was also important. D4.1, income; D4.2, healthcare service; D4.6, religious activity participating; and D4.9, adequate welfare, were all related to injuries and health problems. This conformed to Kesornthong et al.'s (2017) study, in which migrant workers who worked in seafood processing industries in Samut Sakhon Province, Thailand, were interviewed. The study revealed that although workers have access to fundamental healthcare services, it is limited to health promotion and disease prevention [26]. It is also consistent with a study by Centro de Los Derechos del Migrante, Inc., in which Maryland's women migrant workers who pick crabs were interviewed and revealed that their well-being and access to health care is essential [27]. The third dimension, "communication technology," with a factor loading of 0.69–0.76, confirming that recently, Burmese and Cambodians in seafood processing industries fully reached and appreciated the dimensions of video and animation media (D3.3) and social media and application (D3.7). These channels enabled effective communication for them.

## 5. Conclusion

In summary, the results of our study facilitate the development of a new framework for vulnerability factors that employers can implement during multicultural safety operations at their workplace. Safety policy must be specific for migrant workers by employing only formal workers and checking if they are qualified for the jobs. Burmese and Cambodian migrant workers' approach toward safety management consists of following their supervisor's commands, adhering to advisories, and ensuring teamwork safety, which motivates them to efficiently practice safety, which is culturally inherent to them. This study confirmed the efficiency of communication technology channels by using videos, animation media, social media, and applications in the workers' languages, which can be useful in designing the influential training media and safety instructions. The results also imply that workers' well-being is necessary and that their basic wage and adequate welfare should be appropriately determined depending on their work and must comply with the relevant regulations. In addition, nursing rooms at work should be accessible and adequate in number. Furthermore, where applicable, workers should be allowed to engage with religious activities regularly if they wish to.

Researchers and government should consider working with industry managers to control safety risks at workplaces. Developing a database for migrant workers, containing their linkage information, such as work permit, education level, injury, and health background, could be useful for the appropriate recruitment of workers suitable for a job. Moreover, enhancing the well-being of migrant workers by providing them health care, additional education, and safety training will be beneficial. Overall, the vulnerability factor structure for migrant workers portrays the items that are directly beneficial for improving safety and mitigating risk factors for them. The result would depend on the existing safety management contexts and origins of the workers' destination countries. Future studies can modify the model to consider the risk assessment method by establishing its accuracy.

## Ethical approval

The study was approved by the Office of the Human Research Ethics Committee of Walailak University (WU). The project number is WU-EC-PU-1-451-63, and the approval number is WUEC-20-326-01.

## Conflicts of Interest

The authors have no conflict of interest to declare.

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## Appendix

**Appendix**
Forty-question survey for the vulnerability factors

| Item code | Questionnaires |
|---|---|
| Dim1 | Safety operation in workplace |
| D1.1 | The company announces safety policy for migrant workers. |
| D1.2 | The company provides sufficient budgetary support. |
| D1.3 | The company reports accidents and illness statistic regularly. |
| D1.4 | Your department provides a safety manual and explains hazard exposure at the workplace. |
| D1.5 | The company allows you to participate in risk assessment in your working area. |
| D1.6 | The workplace has unsafe working environment. |
| D1.7 | You are provided with adequate necessary personal protective equipment (PPE). |
| D1.8 | You change your job duties normally. |
| D1.9 | The company provides safety grievance mechanism. |
| D1.10 | The company arranges safety activities to reduce accidents and illness. |
| Dim2 | Recruitment process |
| D2.1 | There is no age limit for workers in your department. |
| D2.2 | Your jobs can be done by men and women without affecting the frequency of accidents and illness. |
| D2.3 | There is no education level limit in the job application process. |
| D2.4 | Work experience was specified during recruitment process. |
| D2.5 | The company chooses workers who are proficient in their language. |
| D2.6 | The company employs workers who comply with the regulations. |
| D2.7 | The company provides temporary employment or hires seasonal workers for a short time. |
| D2.8 | The company examines safety attitude in recruitment process. |
| Dim3 | Competency development |
| D3.1 | The company provides adequate interpreters when you need to access safety information. |
| D3.2 | You are trained regularly to prevent accidents at work. |
| D3.3 | The company arranges safety training using Video and animation. |
| D3.4 | The company arranges safety training using pictures and songs. |
| D3.5 | The company has On the Job Training room for real practice. |
| D3.6 | There is no daily safety talk from your supervisor. |
| D3.7 | The company uses social media to communicate and prevent accidents at work. |
| Dim4 | Well-being |
| D4.1 | The company provides good income with enough to save every month. |
| D4.2 | There is a convenient and adequate nursing room service. |
| D4.3 | You work under pressure to reach the effective capacity of production. |
| D4.4 | The company provides place to relax during the day. |
| D4.5 | The company provides dormitory for you to have a good sleep. |
| D4.6 | The company allows and supports you to participate in religious activities. |
| D4.7 | Your supervisors speak impolitely to control safety execution. |
| D4.8 | You have a good relationship with your supervisors and team, including Thai workers. |
| D4.9 | The company provides the necessary welfare items. |
| Dim5 | Different culture |
| D5.1 | The supervisor commands and controls work safely authoritatively. |
| D5.2 | The company manages safety at work depending on individual performance more than teamwork. |
| D5.3 | In the workplace, you work as an expert. |
| D5.4 | The company implements the safety rules for worker of every nationality equally. |
| D5.5 | The company did not provide safety rewards for executing safety rules. |
| D5.6 | Your supervisors take care of you and advise you. |

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