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# Preliminary Validation of a Safety Culture Maturity Model for Occupational Health and Safety in the Garment Industry

**Irwan Iftadi[1], Bambang Suhardi[2*], Eko Pujianto[3], Retno Wulan Damayanti[4]**

[1]Department of Industrial Engineering, Faculty of Engineering, Sebelas Maret University, Surakarta, Indonesia
[2]Department of Industrial Engineering, Faculty of Engineering, Sebelas Maret University, Surakarta, Indonesia
[3]Department of Industrial Engineering, Faculty of Engineering, Sebelas Maret University, Surakarta, Indonesia
[4]Department of Industrial Engineering, Faculty of Engineering, Sebelas Maret University, Surakarta, Indonesia

**Correspondence:** Bambang Suhardi. Email: bambangsuhardi@staff.uns.ac.id

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## ABSTRACT

**Introduction:** This study aimed to provide preliminary validation of a second-order Safety Culture Maturity (SCM) measurement model and to propose a conceptual roadmap for future organisation-level maturity assessment in the Indonesian garment industry. The model comprised communication, organisational learning, management commitment, and employee involvement.

**Methods:** A quantitative cross-sectional survey was conducted using an online questionnaire. The initial 20-item instrument underwent expert-based content validation before confirmatory factor analysis (CFA). A total of 178 complete responses were obtained from workers at 10 garment companies belonging to two industry groups in the Surakarta region. A second-order CFA was estimated using maximum likelihood with robust Huber–White standard errors and the Yuan–Bentler scaled test. The questionnaire assessed workers' perceptions at one point in time; company-level maturity classification was outside the scope of the design.

**Results:** Seventeen items met the content-validity retention threshold. The final 13-item second-order CFA model showed good fit: Yuan–Bentler $\chi^2$ (60) = 74.8, p = 0.094; SRMR = 0.029; robust RMSEA = 0.046, 95% CI [0.000, 0.076]; robust CFI = 0.989; and robust TLI = 0.986. Standardised first-order loadings ranged from 0.768 to 0.908, and standardised second-order loadings ranged from 0.930 to 0.997. Cronbach's α ranged from 0.836 to 0.920, and AVE ranged from 0.641 to 0.747. One within-construct residual covariance between safety planning and safety budgeting was retained. Six salient indicators, interpreted alongside prior maturity-model literature, informed a four-stage conceptual roadmap for developing future organisation-level maturity criteria.

**Conclusion:** The findings provide preliminary empirical support for a four-dimensional, perception-based SCM measurement model in the present sample. The model offers an empirical foundation for developing stage-specific organisation-level maturity criteria, and the conceptual roadmap defines the next phase of cross-company, longitudinal, and predictive validation.

**Keywords:** Safety Culture Maturity; Confirmatory Factor Analysis; Garment Industry; Employee Involvement; Occupational Safety and Health

## INTRODUCTION

The garment industry, an integral part of the textile and clothing sector, plays a strategic role in the global economy, particularly in developing countries. More than 60 million workers are employed globally in this sector, making it one of the world's largest labour-intensive subsectors (1). In addition to its major contribution to employment, the garment industry is a key driver of apparel exports. In 2022, global textile exports were valued at USD 339 billion, while apparel exports—dominated by garment products—were valued at USD 576 billion (2). In Indonesia, the garment subsector represents an important part of the textile and textile products (TPT) industry, which in 2023 accounted for 5.84% of manufacturing GDP and employed nearly 3.9 million workers as of 2024. However, employment in this subsector declined by 7.5% from the previous year (3,4).

As a labour-intensive and export-oriented industry, the garment sector faces major challenges in maintaining competitiveness while protecting occupational safety and health. Workers in this sector are exposed to hazardous chemicals, machine-related injuries, ergonomic disorders, and respiratory risks caused by dust and fibres (1). In Indonesia, the garment workforce is predominantly female—accounting for more than 70% of total employment—many of whom are engaged in short-term or informal contracts that limit access to social protection and workplace safety programmes (5). The limited representation of workers in occupational safety committees has further weakened participatory mechanisms in identifying and reporting hazards (5). Global supply-chain pressures have also intensified production targets and reduced tolerance for downtime, often leading to extended working hours and ergonomic strain among operators, while compromising workplace safety and well-being (5).

The textile sector continues to face serious challenges regarding occupational safety and health (OSH), particularly in small and medium-sized enterprises, which often face constraints in implementing OSH standards. According to the Fair Wear Foundation (FWF), the most common violations include improper storage of hazardous chemicals (46% of factories), absence of OSH committees (44%), non-compliant fire-detection systems (43%), and inadequate emergency exits (42%). Working conditions further exacerbate risks, with indoor temperatures in some factories reaching up to 42 °C and common complaints of poor air quality, dehydration, and physical exhaustion. Gender-based violence has also been reported, with 56.5% of female workers experiencing harassment and 85.2% expressing concern about workplace violence. Although OSH has been identified as a national development priority, enforcement capacity remains limited—one labour inspector oversees more than 11,000 companies—reflecting systemic weaknesses in regulation, monitoring, and safety culture awareness (5,6). Despite the sector's significant economic contribution, worker protection remains an urgent priority, particularly in developing countries such as Indonesia. These socio-structural and policy-related conditions indicate that improving safety outcomes in the garment sector requires not only compliance with regulations but also the cultivation of a mature safety culture that actively engages workers and management at all levels (5).

The concept of safety culture was first introduced after the Chernobyl nuclear accident in 1986 (7). In the INSAG-4 report, safety culture was defined by the International Atomic Energy Agency (IAEA) as the characteristics and attitudes of individuals and organisations that determine how safety is managed (8). This definition reflected a shift from a technical and procedural approach towards recognition of the importance of values, attitudes, and shared behaviours in developing a safe working system. Safety culture has also been understood as a collective commitment to risk awareness, developed through conscious leadership, emotional involvement, and the integration of safety values into everyday decision-making. Safety culture is not merely a matter of compliance; it also involves shaping the entire organisation's mindset so that safety is prioritised as a core value (9).

Although safety culture, safety climate, safety culture dimensions, and safety culture maturity are related, they are not interchangeable. Safety culture broadly concerns the values, assumptions, practices, and behaviours through which safety is understood and managed. Safety climate more specifically reflects employees' shared perceptions of current safety policies, practices, and priorities and can be understood as a time-specific perceptual manifestation—a "snapshot"—of the broader safety culture. Safety culture dimensions are particular domains through which safety-related perceptions and practices can be assessed, whereas safety culture maturity refers to organisational development across qualitatively different stages (8,10–12). In the present cross-sectional study, workers' responses provide a time-specific perceptual view of four safety culture dimensions. These perceptions are not treated as direct maturity classifications; instead, they are evaluated as indicators of a higher-order SCM measurement model intended to inform the subsequent development of organisation-level maturity assessment criteria.

In response to the complexity of modern organisations, particularly in high-risk industries, systematic approaches for gradually measuring and improving safety culture began to be developed by researchers. In this context, the concept of Safety Culture Maturity (SCM) emerged in the early 2000s (13). Fleming introduced a five-level model—Emerging, Managing, Involving, Cooperating, and Continually Improving—to describe the evolution of safety culture from a basic stage towards an ideal maturity level (14). Hudson subsequently developed a five-stage evolutionary model—Pathological, Reactive, Calculative, Proactive, and Generative—which has been widely cited across various industries (10). The model emphasises that a mature safety culture is characterised by proactive learning, continuous improvement, and the embedding of safety as a core value within the organisation (15,16).

Core dimensions of Safety Culture Maturity (SCM) models have been identified in several studies, although considerable variation has been reported across authors. In one study, management commitment to safety, communication, employee involvement, reporting and learning from incidents, safety leadership, and compliance with safety procedures were recognised as recurring dimensions (11). A subsequent review emphasised communication, organisational learning, management commitment, training, and employee involvement as dominant dimensions, further extending the previous synthesis (17).

More recently, a bibliometric analysis reported similar patterns, showing the prominence of these dimensions in contemporary SCM research (18). Previous reviews have also raised concerns about the lack of empirical validation in SCM research, emphasising that many models remain conceptual and require confirmatory testing in diverse industrial contexts (14). This highlights the need for more evidence-based assessments that can substantiate the structural validity and contextual adaptability of existing SCM frameworks.

The four dimensions examined in this study were selected as parsimonious and integrative domains rather than as an exhaustive list of safety culture attributes. Communication represents the circulation and accessibility of safety information; organisational learning represents the conversion of incidents, reports, and experience into organisational knowledge; management commitment represents managerial direction, resource allocation, training, and formal safety systems; and employee involvement represents workers' participation in identifying, reporting, and resolving safety problems. Other frequently reported elements, including safety leadership, reporting justice, competence, and learning from near misses, were not dismissed; some were incorporated within the four broader domains, whereas others were reserved for explicit examination in future research (11,17–21).

Nevertheless, important contextual and measurement gaps remain. Safety culture maturity models have predominantly been developed in high-risk sectors, whereas labour-intensive garment manufacturing remains underrepresented (22–24). Many maturity frameworks are also conceptual and have received limited confirmatory evaluation in developing-country manufacturing contexts (14). The present study addresses these gaps by examining whether four commonly identified safety culture dimensions can be represented within a higher-order measurement structure in a sample of Indonesian garment workers. This contextual examination contributes preliminary measurement evidence while leaving developmental progression and the exhaustiveness of the four-domain model for subsequent research.

Therefore, this study aimed to provide preliminary validation of a second-order SCM measurement model in which workers' perceptions of communication, organisational learning, management commitment, and employee involvement were represented as four interrelated first-order dimensions of a higher-order construct. Based on the preliminary measurement evidence and relevant safety culture maturity literature, the study also proposed a four-stage conceptual roadmap to guide the subsequent development of stage-specific, organisation-level maturity assessment criteria (10,11,17,25,26). The roadmap was intended as the next phase of instrument development rather than as a classification of the participating companies.

## METHODS

### Study Design

A quantitative cross-sectional survey design was used to provide a preliminary evaluation of a second-order measurement structure based on workers' perceptions of Communication, Organizational Learning, Management Commitment, and Employee Involvement. Confirmatory factor analysis was used to examine the relationships between the observed indicators, the four first-order dimensions, and the higher-order SCM construct. The analysis evaluated the measurement model only; no directional or causal paths among the first-order dimensions were tested, and companies were not classified into maturity stages (27,28).

### Dimension and Indicator Identification

Drawing on prior reviews (11,17,18), four broad and mutually related domains were selected for evaluation: communication, organisational learning, management commitment, and employee involvement. Communication captures the accessibility and regularity of safety information; organisational learning captures structured investigation, case analysis, and knowledge management; management commitment captures planning, training, resources, procedures, and the safety management system; and employee involvement captures hazard reporting, case analysis, and participation in safety activities (11,17–21). The model was intended to be parsimonious rather than exhaustive. Training was represented within management commitment; incident learning within organisational learning; reporting practices across communication, organisational learning, and employee involvement; and leadership-related practices partly within management commitment. Reporting justice, competence, and near-miss learning were not modelled as separate latent constructs.

### Instrument Development and Content Validation

The initial questionnaire comprised 20 items developed from the operational definitions of Communication, Organizational Learning, Management Commitment, and Employee Involvement, as presented in Table 1. Responses were recorded on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. Content validity was evaluated by six experts representing academia and manufacturing practice, including the garment and textile sectors. Each item was assessed using a five-point relevance scale, and Aiken's V was calculated for each item. A value of 0.70 was applied as the practical item-retention threshold rather than as a statistical critical value; items below this threshold were excluded before CFA (29–31).

**Table 1.** Dimensions and Indicators

| Dimension | Code | Indicator | Key words |
|---|---|---|---|
| **Communication** | C1 | All safety issues are communicated completely to all employees. | Comprehensive safety issues |
| | C2 | Evaluation of safety communication is carried out regularly to improve employees' understanding of safety. | Regular safety communication evaluation |
| | C3 | Various communication channels are available so safety information is easily accessible to all employees. | Accessible safety communication |
| | C4 | Safety communication is conducted routinely, increasing compliance with safety procedures. | Routine safety communication |
| | C5 | Employees feel comfortable reporting safety issues without fear or pressure. | Comfortable reporting |
| **Organizational Learning** | OL1 | An incident reporting system is available to detect and prevent recurrence. | Incident reporting system |
| | OL2 | A structured investigation system is applied to identify root causes of safety incidents. | Structured investigation |
| | OL3 | Each safety case is analyzed systematically to understand patterns and contributing factors. | Systematic case analysis |
| | OL4 | A safety knowledge management system supports continuous learning for safety improvement. | Safety knowledge management |
| **Management Commitment** | MC1 | Safety planning strategies are clearly formulated to minimize risks. | Clear safety planning |
| | MC2 | Structured safety training is routinely provided to enhance employee readiness. | Structured safety training |
| | MC3 | Adequate budget is allocated to support safety policies and programs. | Adequate safety budget |
| | MC4 | Safety procedures are consistently implemented and serve as guidelines for all employees. | Consistent safety procedures |
| | MC5 | Reward programs are provided for employees who comply with safety procedures. | Safety reward program |
| | MC6 | A dedicated team is responsible for managing and monitoring safety. | Dedicated safety team |
| | MC7 | An integrated safety management system has been implemented to ensure work safety and environmental protection. | Integrated safety management system |
| **Employee Involvement** | EI1 | Employees are willing to report potential hazards and accidents to prevent greater risks. | Willingness to report hazards |
| | EI2 | Employees are involved in analyzing safety cases to identify root causes and prevent recurrence. | Involvement in case analysis |
| | EI3 | Employees are involved in reviewing safety procedures to ensure alignment with real working conditions. | Involvement in procedure review |
| | EI4 | Employees actively participate in various safety activities to build a safety culture. | Involvement in safety activities |

### Population and Data Collection

The study population comprised workers in the garment manufacturing subsector in the Surakarta residency area, Central Java, Indonesia. This area was selected because it is an important garment production zone in Central Java and provided a relevant setting for examining workers' perceptions of safety practices in a labour-intensive manufacturing context (5).

Eligible participants were active workers aged at least 18 years who had completed senior high school or a higher level of education, were currently employed by one of the participating companies, and were willing to participate voluntarily and provide informed consent. Workers who did not meet these criteria or did not provide informed consent were excluded from the study.

Two garment industry groups operating within the target population and geographic area agreed to participate, together comprising 10 companies. Organisational participation was voluntary, and not all eligible companies that were approached agreed to participate. Because the numbers of companies approached and declining were not retained, an organisational participation rate could not be calculated. All 10 participating companies were included in questionnaire distribution. Workers were recruited through an open, voluntary invitation, resulting in a non-probability sample. Company-specific respondent counts and the number of workers who received or accessed the invitation were not retained, so company-specific and overall worker response rates could not be calculated.

The initial target sample size was approximately 200 respondents, based on the commonly used rule of thumb of 10 respondents per indicator for the 20-item instrument. Ultimately, 178 complete and eligible responses were obtained and included in the analysis. No a priori model-based sample-size or power analysis was conducted.

Data were collected in December 2025 using an online questionnaire distributed through the headquarters of the two participating garment industry groups. Before accessing the questionnaire, participants received information on the study purpose, confidentiality, voluntary participation, and the right to discontinue, and provided written informed consent through the online form.

### Data Screening and Estimation

Data were screened for completeness, coding accuracy, and univariate distributional characteristics. Multivariate normality was assessed using Mardia's multivariate skewness and kurtosis tests. After the final indicator solution was obtained, potential multivariate outliers were examined as a diagnostic check using Mahalanobis distance with a conservative chi-square criterion at $p < 0.001$. Flagged observations were reviewed for data-entry errors, missing responses, and implausible response patterns and were not removed solely because they exceeded the cutoff. The CFA analyses were conducted using Jamovi version 2.6.44. Maximum likelihood estimation was used with robust Huber–White standard errors and the Yuan–Bentler T2* scaled test to reduce sensitivity to multivariate non-normality; robust fit indices were the primary basis for interpretation (27,32–34).

**Model Specification and Evaluation**

A second-order CFA was specified in which Communication, Organizational Learning, Management Commitment, and Employee Involvement were modelled as first-order latent factors represented by their observed indicators and subsequently as dimensions of a higher-order SCM construct. The analysis evaluated a measurement structure only; no directional or causal paths among the dimensions were specified.

Each first-order factor was scaled using marker-variable identification, with the unstandardised loading of its first indicator fixed at 1.00. Because Communication was represented by only two indicators, it was identified within the second-order model by fixing the unstandardised loading of C3 at 1.00. The loading of C4, the residual variances of C3 and C4, and the disturbance variance of the Communication factor were freely estimated. The higher-order SCM factor was scaled by fixing its unstandardised loading on Communication at 1.00 (27,33,35).

Model fit was evaluated using the Yuan–Bentler scaled chi-square test, SRMR, robust RMSEA with its 95% confidence interval, robust CFI, and robust TLI (28,32). Values below 0.08 for SRMR and RMSEA and values approaching or exceeding 0.95 for CFI and TLI were used as general interpretive guidelines rather than rigid decision rules (27,28,32,36). Internal consistency was assessed using Cronbach's α, and convergent validity was evaluated using AVE (27,33). Model-implied correlations and second-order factor loadings were examined to characterise shared variance and the empirical distinctiveness of the four first-order dimensions. Because these dimensions were specified as related components of a common higher-order construct, conventional discriminant-validity criteria were interpreted cautiously rather than as rigid pass–fail rules (28).

Model refinement was conducted sequentially by considering factor-loading performance, modification indices, changes in overall fit, content overlap, and preservation of conceptual coverage. Item removal was not determined by a single loading cutoff, and model modifications were retained only when they were statistically supported and substantively interpretable (28,37).

**Exploratory Demographic Analyses**

Dimension scores were calculated as the mean of the retained items within each dimension. Mann–Whitney U tests were used for gender, income, operational versus management/OSH position, and secondary versus higher education comparisons. Spearman's rank correlation was used for age, and Kruskal–Wallis tests were used for the five length-of-service categories. Rank-biserial correlations and epsilon-squared values were used as effect-size measures. Holm adjustment was applied across 24 comparisons, with two-sided $p < 0.05$ as the significance criterion. These analyses were exploratory and were not treated as tests of measurement invariance (38).

**Ethical Approval**

The study was reviewed and approved at the program level by the Doctoral Program in Industrial Engineering, Faculty of Engineering, Universitas Sebelas Maret. A formal research permit was granted under Letter No. 55/UN27.08.4.3/TU.00/2025. Ethical clearance was also obtained from the Ethics Committee of the Faculty of Psychology, Universitas Muhammadiyah Malang, under Approval No. E.6.m/434/KE-FPsi-UMM/XI/2025. Participation was voluntary. Before completing the questionnaire, participants received information on the study purpose, confidentiality, voluntary participation, and the right to discontinue. Written informed consent was obtained from every participant through the online questionnaire.

## RESULTS

**Respondent Characteristics and Exploratory Demographic Findings**

The demographic profile of the 178 participants was as follows. Most respondents were female (72.5%), while male respondents accounted for 27.5%. In terms of age, the largest proportion of respondents was in the 25–34 years age group (48.9%), followed by those aged below 25 years (22.5%), 35–44 years (20.8%), 45–54 years (5.6%), and 55 years or older (2.2%). Based on job position, most respondents were production employees (56.2%), followed by other employees (28.1%), middle management personnel (11.2%), safety officers or safety managers (3.4%), and top management personnel (1.1%). Regarding length of service, respondents with more than 10 years of service represented the largest group (30.9%), followed by those with 5–10 years (28.7%), 3–5 years (18.0%), 1–3 years (12.4%), and less than 1 year of service (10.1%). In terms of educational background, the majority of respondents had completed senior high school or vocational high school (79.2%), followed by bachelor's degree holders (11.2%), diploma 3 graduates (5.1%), diploma 1 graduates (2.2%), diploma 4 graduates (1.7%), and diploma 2 graduates (0.6%). Regarding income level, most respondents reported earning the local minimum wage (71.9%), while 28.1% reported earning above the local minimum wage. Finally, based on employment status, most respondents were permanent employees (97.8%), while contract employees and probationary employees accounted for 1.7% and 0.6%, respectively.

No demographic comparison remained statistically significant after Holm adjustment. Before adjustment, income-group comparisons were nominally significant for Communication ($p = 0.022$), Management Commitment ($p = 0.009$), and Employee Involvement ($p = 0.042$), but the corresponding adjusted p-values were 0.501, 0.216, and 0.922. No nominally significant patterns were observed for gender, job position, education, age, or length of service. Employment status was not compared because 97.8% of respondents were permanent employees.

### Content Validity and Item Selection

The instrument-development process began with 20 items. Expert content validation produced item-level Aiken's V coefficients ranging from 0.667 to 0.958. Seventeen items met the practical retention threshold of 0.70. MC5, MC6, and EI3 each obtained an Aiken's V coefficient of 0.667 and were therefore excluded before CFA. The item-level content-validity results are presented in Table 2.

**Table 2**. Item-level content-validity results

| Dimension | Code | Aiken's V | Decision |
|---|---|---|---|
| **Communication** | C1 | 0.917 | Retained |
| | C2 | 0.875 | Retained |
| | C3 | 0.875 | Retained |
| | C4 | 0.833 | Retained |
| | C5 | 0.875 | Retained |
| **Organizational Learning** | OL1 | 0.958 | Retained |
| | OL2 | 0.958 | Retained |
| | OL3 | 0.958 | Retained |
| | OL4 | 0.875 | Retained |
| **Management Commitment** | MC1 | 0.958 | Retained |
| | MC2 | 0.958 | Retained |
| | MC3 | 0.917 | Retained |
| | MC4 | 0.917 | Retained |
| | MC5 | 0.667 | Removed |
| | MC6 | 0.667 | Removed |
| | MC7 | 0.750 | Retained |
| **Employee Involvement** | EI1 | 0.792 | Retained |
| | EI2 | 0.750 | Retained |
| | EI3 | 0.667 | Removed |
| | EI4 | 0.750 | Retained |

During sequential CFA refinement, C1, C2, C5, and OL1 were removed. The intermediate CFA outputs from each item-removal step were not preserved; therefore, the exact removal sequence and item-specific loading, modification-index, and model-fit change statistics cannot be reconstructed retrospectively. The retained analysis records indicate that the refinement process considered factor-loading performance, modification indices, overall model fit, content overlap, and preservation of conceptual coverage rather than a single numerical cutoff. Because the step-specific statistical evidence is unavailable, the following item-level observations are presented only as retrospective content-based interpretations and should not be interpreted as reconstructed statistical reasons for deletion. C1 (comprehensive communication) showed conceptual overlap with the retained Communication indicators, particularly C3 (accessible communication) and C4 (routine safety communication). C2 (evaluation of safety communication) likewise addressed communication-process content represented by the retained Communication indicators, although its specific statistical contribution at the removal step cannot be determined from the retained records. C5 (fear-free reporting) overlapped with reporting-related content represented elsewhere in the model, particularly EI1. OL1 (incident reporting system) overlapped conceptually with retained incident-learning and reporting content, particularly OL2 and EI1. These substantive observations are not substitutes for the unavailable step-specific loading, modification-index, or model-fit statistics. The final second-order CFA comprised 13 observed indicators—C3–C4, OL2–OL4, MC1–MC4 and MC7, and EI1, EI2, and EI4—and 31 freely estimated parameters. The model achieved convergence, and the final instrument is provided in Appendix A.

### Data Screening and Distributional Assessment

All 178 questionnaires contained complete responses, and no missing-data imputation was required. Item-level skewness ranged from −1.203 to −0.348, and excess kurtosis ranged from −0.318 to 2.799. Mardia's test indicated significant multivariate skewness, coefficient = 82.042, $\chi^2$ (455) = 2,433.919, $p < 0.001$, and significant multivariate kurtosis, coefficient = 363.691, $z = 56.982$, $p < 0.001$. Mahalanobis-distance screening of the final 13-indicator solution identified 12 observations exceeding the conservative $\chi^2$ (13) cutoff of 34.528 at $p < 0.001$; the maximum $D^2$ value was 77.676. Review of the flagged observations did not identify data-entry errors, incomplete responses, or clearly invalid response patterns, so all cases were retained for the final robust CFA.

**Table 3.** Robust fit statistics for the final second-order CFA

| Fit statistic | Final robust result |
|---|---|
| Yuan–Bentler scaled $\chi^2$ | 74.8 |
| df | 60 |
| p | 0.094 |
| SRMR | 0.029 |
| Robust RMSEA | 0.046 |
| 95% CI robust RMSEA | 0.000–0.076 |
| Robust CFI | 0.989 |
| Robust TLI | 0.986 |

### Model Fit

The final second-order CFA showed good fit to the observed data. The Yuan–Bentler scaled chi-square test was not statistically significant, $\chi^2$ (60) = 74.8, p = 0.094. The SRMR was 0.029, while the robust RMSEA was 0.046 with a 95% confidence interval of 0.000–0.076. The robust CFI was 0.989 and the robust TLI was 0.986. Collectively, these indices support the adequacy of the final measurement model in the present sample. The robust fit statistics for the final second-order CFA are summarised in Table 3.

### Reliability, Convergent Validity, and Shared Variance

Cronbach's α values indicated satisfactory internal consistency for Communication (0.846), Organizational Learning (0.836), Management Commitment (0.920), and Employee Involvement (0.898). AVE values were above 0.50 for Communication (0.738), Organizational Learning (0.641), Management Commitment (0.723), and Employee Involvement (0.747), supporting convergent validity within each dimension. Model-implied correlations among the four first-order dimensions ranged from 0.910 to 0.989. These high correlations, together with the strong second-order loadings, indicate substantial shared variance consistent with the proposed higher-order SCM structure, while also indicating limited empirical separability among the dimensions in the present sample. Internal-consistency and convergent-validity results are presented in Table 4, while the model-implied correlations among the first-order dimensions are shown in Table 5.

**Table 4**. Internal consistency and convergent validity

| Dimension | Cronbach's α | AVE |
|---|---|---|
| Communication | 0.846 | 0.738 |
| Organizational Learning | 0.836 | 0.641 |
| Management Commitment | 0.920 | 0.723 |
| Employee Involvement | 0.898 | 0.747 |

**Table 5**. Model-implied correlations among the first-order dimensions

| | Communication | Organizational Learning | Management Commitment | Employee Involvement |
|---|---|---|---|---|
| Communication | — | 0.989 | 0.975 | 0.927 |
| Organizational Learning | 0.989 | — | 0.970 | 0.923 |
| Management Commitment | 0.975 | 0.970 | — | 0.910 |
| Employee Involvement | 0.927 | 0.923 | 0.910 | — |

Standardised first-order factor loadings ranged from 0.768 to 0.908. The standardised second-order loadings were 0.997 for Communication, 0.992 for Organizational Learning, 0.978 for Management Commitment, and 0.930 for Employee Involvement. These loadings indicate that the four dimensions were strongly represented by the higher-order SCM factor. They are measurement loadings and do not represent directional effects or developmental progression. The complete robust CFA loading estimates are presented in Table 6.

**Table 6**. Final robust CFA loading estimates

| Factor | Ind. | Est. | Robust SE | Std. λ | 95% CI | z | p |
|---|---|---|---|---|---|---|---|
| COM | C3 | 1.000 fixed | — | 0.827 | 0.754–0.899 | — | — |
| | C4 | 1.118 | 0.0631 | 0.887 | 0.816–0.959 | 17.70 | <0.001 |
| OL | OL2 | 1.000 fixed | — | 0.850 | 0.780–0.920 | — | — |
| | OL3 | 0.858 | 0.1617 | 0.768 | 0.584–0.953 | 5.31 | <0.001 |
| | OL4 | 0.898 | 0.1619 | 0.777 | 0.589–0.966 | 5.55 | <0.001 |
| MC | MC1 | 1.000 fixed | — | 0.908 | 0.850–0.966 | — | — |
| | MC2 | 1.023 | 0.0691 | 0.864 | 0.805–0.923 | 14.80 | <0.001 |
| | MC3 | 1.071 | 0.1067 | 0.770 | 0.689–0.851 | 10.03 | <0.001 |
| | MC4 | 0.950 | 0.0839 | 0.822 | 0.715–0.929 | 11.33 | <0.001 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | MC7 | 0.974 | 0.0596 | 0.882 | 0.829–0.935 | 16.34 | <0.001 |
| **EI** | EI1 | 1.000 fixed | — | 0.905 | 0.861–0.949 | — | — |
| | EI2 | 0.996 | 0.0527 | 0.851 | 0.789–0.913 | 18.90 | <0.001 |
| | EI4 | 0.847 | 0.0688 | 0.833 | 0.751–0.915 | 12.31 | <0.001 |
| **SCM** | COM | 1.000 fixed | — | 0.997 | 0.965–1.029 | — | — |
| | OL | 0.951 | 0.0597 | 0.992 | 0.956–1.028 | 15.94 | <0.001 |
| | MC | 1.003 | 0.0509 | 0.978 | 0.948–1.008 | 19.73 | <0.001 |
| | EI | 1.018 | 0.0735 | 0.930 | 0.866–0.995 | 13.86 | <0.001 |

For Communication, standardised loadings were 0.827 for C3 and 0.887 for C4. Organizational Learning was represented by OL2, OL3, and OL4, with standardised loadings of 0.850, 0.768, and 0.777, respectively. Management Commitment was represented by MC1, MC2, MC3, MC4, and MC7, with loadings of 0.908, 0.864, 0.770, 0.822, and 0.882. Employee Involvement was represented by EI1, EI2, and EI4, with loadings of 0.905, 0.851, and 0.833. All freely estimated indicator loadings were statistically significant at $p < 0.001$.

One residual covariance was retained between MC1 and MC3 (estimate = −0.0696, robust SE = 0.0250, standardised estimate = −0.374, z = −2.785, p = 0.005). Safety planning and budgeting share operational content beyond that captured by the general Management Commitment factor. Because this modification was data-informed, it requires independent replication. Full residual parameters are reported in Table 7 (28).

**Table 7**. Residual variances and retained residual covariance

| Indicator | Estimate | Robust SE | Std. | 95% CI (Std.) | z | p |
|---|---|---|---|---|---|---|
| **C3** | 0.20058 | 0.0349 | 0.31625 | 0.1965–0.4360 | 5.741 | <0.001 |
| **C4** | 0.14654 | 0.0516 | 0.21285 | 0.0860–0.3397 | 2.842 | 0.004 |
| **OL2** | 0.15221 | 0.0325 | 0.27749 | 0.1582–0.3968 | 4.684 | <0.001 |
| **OL3** | 0.20272 | 0.0697 | 0.40981 | 0.1260–0.6936 | 2.910 | 0.004 |
| **OL4** | 0.20929 | 0.0766 | 0.39557 | 0.1025–0.6886 | 2.733 | 0.006 |
| **MC1** | 0.09681 | 0.0264 | 0.17580 | 0.0706–0.2810 | 3.672 | <0.001 |
| **MC2** | 0.16153 | 0.0276 | 0.25382 | 0.1515–0.3561 | 5.860 | <0.001 |
| **MC3** | 0.35719 | 0.0597 | 0.40691 | 0.2825–0.5313 | 5.988 | <0.001 |
| **MC4** | 0.19700 | 0.0547 | 0.32454 | 0.1481–0.5010 | 3.602 | <0.001 |
| **MC7** | 0.12285 | 0.0211 | 0.22187 | 0.1283–0.3154 | 5.809 | <0.001 |
| **EI1** | 0.11394 | 0.0222 | 0.18079 | 0.1016–0.2600 | 5.141 | <0.001 |
| **EI2** | 0.19496 | 0.0324 | 0.27562 | 0.1704–0.3808 | 6.011 | <0.001 |
| **EI4** | 0.16372 | 0.0309 | 0.30678 | 0.1703–0.4433 | 5.291 | <0.001 |
| **COM** | 0.00254 | 0.0143 | 0.00587 | −0.0586–0.0704 | 0.177 | 0.859 |
| **OL** | 0.00620 | 0.0145 | 0.01565 | −0.0558–0.0871 | 0.428 | 0.669 |
| **MC** | 0.01977 | 0.0135 | 0.04355 | −0.0147–0.1017 | 1.469 | 0.142 |
| **EI** | 0.06934 | 0.0317 | 0.13432 | 0.0139–0.2547 | 2.188 | 0.029 |
| **MC1–MC3 cov.** | −0.06963 | 0.0250 | −0.37441 | −0.6013–−0.1475 | −2.785 | 0.005 |

The residual variances of Communication, Organizational Learning, and Management Commitment were not statistically significant, whereas Employee Involvement retained a small but statistically significant residual variance. This pattern further supports a strong common higher-order factor while indicating some dimension-specific variance in Employee Involvement (28).

## DISCUSSION

### Interpretation of Key Findings

The second-order CFA provides preliminary support for a measurement structure in which Communication, Organizational Learning, Management Commitment, and Employee Involvement represent four content domains of a higher-order SCM construct in the present sample. The findings describe the structure of workers' perceptions within the study's cross-sectional design.

The retained indicators predominantly represented practices that employees could observe directly in routine work, including accessible and regular communication, structured incident investigation, safety planning, training, budgeting, procedural implementation, hazard reporting, and participation in safety activities. The highest-loading indicators within each dimension—routine safety communication (C4), structured incident investigation (OL2), clear safety planning (MC1), and willingness to report hazards (EI1)—suggest that visible and recurring practices were particularly meaningful in the garment production context.

By contrast, the removed indicators require cautious interpretation. MC5, MC6, and EI3 did not meet the content-validity retention threshold, whereas C1, C2, C5, and OL1 were removed sequentially after combined statistical and substantive review of loading performance, modification indices, changes in model fit, content overlap, and remaining construct coverage. Their removal does not indicate that safety rewards, dedicated safety teams, procedure review, comprehensive communication, communication evaluation, fear-free reporting, or incident-reporting systems are unimportant. Rather, their performance may be specific to item wording, sample composition, overlap with retained indicators, and organisational context and should be reassessed in an independent sample (39).

These patterns should be understood within garment production systems, which commonly involve repetitive operations, interdependent production lines, production targets, hierarchical supervision, and limited worker control over work pace. Routine communication and clear procedures may reduce ambiguity, while incident investigation and worker reporting may provide knowledge about hazards that are not visible to management. Their practical value depends on whether workers feel safe to report, supervisors respond constructively, and employee input results in observable corrective action (1,5,17,40,41).

Exploratory demographic analyses found no associations or group differences that remained statistically significant after Holm adjustment. Thus, the data do not support systematic demographic differences in the four dimension scores. However, unequal group sizes and the predominance of permanent production workers limit inference, and these analyses do not establish measurement invariance (28,38).

Communication was represented by two retained indicators: the availability of channels for promoting safety information (C3) and the routine communication of safety issues (C4). Both indicators demonstrated strong standardised loadings and captured complementary aspects of safety communication. Methodological research indicates that factors represented by two indicators can be estimated within broader measurement models, although additional indicators generally improve measurement stability and construct coverage (42). Hayduk and Littvay (43) further argued that a small number of conceptually strong indicators may be preferable to a larger set of redundant indicators. Accordingly, the Communication factor was retained as a preliminary representation of the construct, while additional indicators should be developed and evaluated in independent samples.

The very high second-order loadings and model-implied correlations are consistent with the specification of the four domains as closely related components of a common higher-order SCM construct. At the same time, their limited empirical separability should be re-examined in independent samples. The retained MC1–MC3 residual covariance further suggests that workers may perceive safety planning and budgeting as more closely connected than the general Management Commitment factor alone explains. Because this covariance was introduced after examining model diagnostics, it should be treated as a sample-specific refinement requiring replication (28).

### Comparison with Previous Studies

The integrated four-domain structure is consistent with Tappura et al. (17), who identified communication, organisational learning, management or supervisor commitment, training, and employee involvement as recurring maturity-model dimensions and emphasised that these domains should not be developed separately. The present findings extend this work by providing preliminary measurement evidence in a labour-intensive garment context and by showing that the four domains are closely related within the higher-order structure.

Organizational Learning remained represented by structured investigation, systematic case analysis, and safety knowledge management. This differs from Tappura et al. (17), whose organisational-learning domain was not retained in their final PLS-SEM model, and may reflect differences in industrial context, instrument design, or respondent visibility of incident-learning practices. The prominence of an integrated safety management system is also consistent with Nævestad and Phillips (22), who argued that mature safety-culture work is often supported by established safety-management arrangements.

The worker-participation findings align with Knode's employee-engagement perspective (40,41), particularly the movement from workers being recipients of safety requirements towards shared ownership. The study extends SCM measurement research to an under-researched garment setting and identifies a concise set of perception-based indicators for further validation.

### Practical and Occupational Health Promotion Implications

From an occupational health promotion perspective, communication and employee involvement should not be treated solely as managerial mechanisms for improving compliance. Accessible two-way communication, reporting without fear of retaliation, participation in incident analysis, and involvement in safety activities provide channels through which workers can express operational knowledge, question unsafe practices, and influence corrective action. These mechanisms may support worker empowerment when employee input is acknowledged, investigated, and translated into visible improvements (17,40,41).

Garment companies should therefore combine formal systems with meaningful participation: clear planning, adequate resources, routine training, consistent procedures, safe reporting channels, feedback on investigation outcomes, and worker involvement in identifying causes and reviewing corrective measures. Production pressures should not discourage reporting. These priorities warrant evaluation in future intervention studies using incident, injury, and occupational-health outcomes (17,22,40,41).

### Conceptual Roadmap for Future Safety Culture Maturity Assessment

Drawing on the retained indicators and relevant safety culture maturity literature, a four-stage conceptual roadmap is proposed to guide the subsequent development of stage-specific, organisation-level maturity assessment criteria. The CFA provided preliminary evidence for the measurement structure, whereas the placement of selected indicators within stages reflects theoretically informed interpretation rather than a tested developmental sequence (10,11,17,25,26).

Stage 1: Foundation Building. This stage prioritises clear safety planning (MC1) and an integrated safety management system (MC7) as formal direction and system infrastructure (20,22). Stage 2: Systematic Prevention. This stage prioritises routine safety communication (C4) and structured incident investigation (OL2), representing regular communication of safety expectations and systematic use of incident information for prevention (17,19). Stage 3: Employee Empowerment. This stage prioritises willingness to report hazards and accidents (EI1) and active participation in safety activities (EI4). These practices reflect greater worker voice and shared responsibility (40,41). Stage 4: Sustainable Excellence. This stage is presented as an aspirational extension rather than as a stage measured by the instrument. Digital technologies, including artificial intelligence, the Internet of Things, and predictive analytics, together with Safety-II, organisational resilience, socio-environmental responsibility, and alignment with Sustainable Development Goal 3 (SDG 3), were not included as questionnaire indicators or tested in the CFA. They are therefore future directions requiring separate conceptualisation and empirical evaluation (26,44,45).

Collectively, the roadmap links the present measurement model to the next phase of instrument development. Subsequent studies should operationalise stage-specific descriptors and scoring rules, validate them across organisations using multiple sources of evidence, and test progression and practical outcomes longitudinally. Until these steps are completed, the roadmap remains a conceptual framework rather than a validated organisation-level scoring system (11,14,25,39,46). The proposed relationship between the measurement model and the subsequent development of organisation-level maturity criteria is summarised in Figure 1.

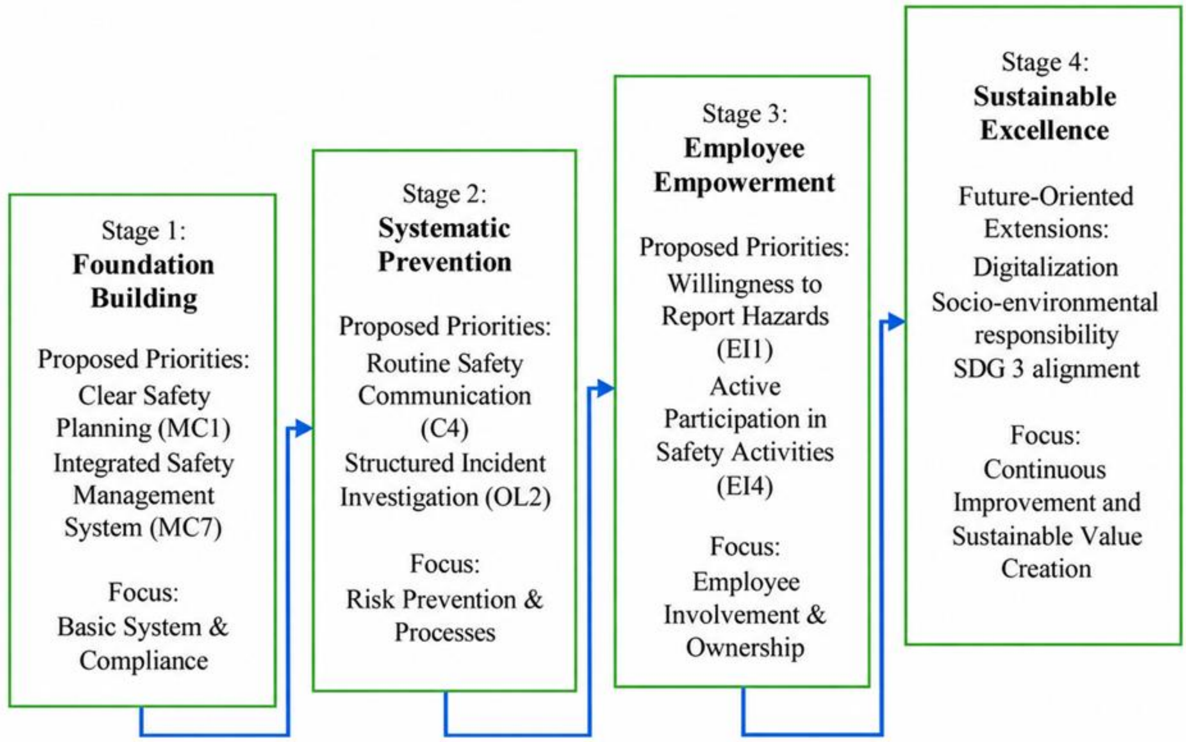


**Figure 1**. Conceptual roadmap linking the preliminary SCM measurement model to future organisation-level maturity assessment.

**Limitations and Cautions**

First, item refinement and final model evaluation were conducted using the same cross-sectional sample; therefore, the findings should be regarded as preliminary measurement evidence. Because the data were based on workers' self-reported perceptions, they may be affected by common-method and social-desirability biases and should not be interpreted as direct evidence of objective safety performance. No a priori model-based sample-size or power analysis was conducted; consequently, the adequacy of the achieved sample cannot be established prospectively from model complexity, despite successful model convergence and generally strong factor loadings.

Second, participation by companies and workers was voluntary. Company identifiers, respondent counts per company, and invitation denominators were not retained; therefore, response rates, intraclass correlations, multilevel effects, and company-level comparisons could not be estimated. Possible selection, voluntary-response, and within-company clustering effects should be considered. The individual perception data also cannot be aggregated or interpreted as organisation-level maturity scores.

Third, the data did not satisfy multivariate normality, and several observations showed unusual multivariate response patterns. Although no invalid cases were identified and robust estimation was applied, some sensitivity of the parameter estimates to the observed distributional conditions cannot be excluded. Communication was represented by only two indicators, limiting the breadth of content coverage. The high shared variance among the four dimensions also limits conclusions regarding their empirical distinctiveness, and the data-informed residual covariance between MC1 and MC3 may be sample-specific.

Finally, the proposed roadmap was not tested as an organisation-level classification system or developmental sequence; its stage criteria and practical effectiveness remain to be established. The predominance of permanent production workers and the small sizes of several demographic subgroups also limit representation of temporary, outsourced, newly employed, and managerial workers.

**Recommendations for Future Research**

Future research should first replicate the 13-item measurement model in independent samples, examine measurement invariance across companies and worker groups, develop additional Communication indicators, and test the MC1–MC3 residual covariance without automatically respecifying the model.

The next development phase should operationalise the conceptual roadmap by defining observable descriptors, scoring rules, and evidence requirements for each maturity stage. These criteria should undergo expert content validation, pilot testing, and reliability assessment before being used to classify organisations. Future data collection should retain company identifiers, respondent counts, and invitation denominators to support response-rate estimation, within-company agreement analysis, multilevel modelling, and cross-company comparison.

Subsequent organisation-level studies should combine worker perceptions with management interviews, document or system audits, and objective safety indicators to evaluate whether the framework differentiates maturity levels. Longitudinal and intervention-based studies should then test movement between stages and associations with incident rates, near-miss reporting, absenteeism, occupational-health outcomes, and other performance indicators. Digital technologies, Safety-II capabilities, resilience, socio-environmental responsibility, and SDG 3 alignment should be operationalised and tested separately before inclusion in an expanded maturity framework.

## CONCLUSION

This study developed and preliminarily validated a 13-item, four-dimensional SCM measurement model comprising Communication, Organizational Learning, Management Commitment, and Employee Involvement among garment workers in the present sample. The second-order CFA demonstrated good robust model fit, and the retained indicators showed satisfactory factor loadings, internal consistency, and convergent validity. Together, the four dimensions represent closely related components of a higher-order SCM construct.

Routine safety communication, structured incident investigation, clear safety planning, hazard reporting, and employee participation were salient indicators in the examined sample. From an occupational health promotion perspective, these practices may support worker empowerment when employees have safe channels to report concerns, participate in analysis, and influence corrective action.

The preliminary measurement evidence provides a basis for the future development of stage-specific, organisation-level maturity assessment criteria. The proposed four-stage conceptual roadmap—Foundation Building, Systematic Prevention, Employee Empowerment, and Sustainable Excellence—organises that next phase of research. Independent cross-company validation, longitudinal testing, and evaluation against objective safety outcomes are required before the framework is used for organisational maturity classification.

## DECLARATIONS

**Author contributions:** Irwan Iftadi: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft, Project Administration. Bambang Suhardi: Conceptualization, Methodology, Supervision, Validation, Writing – Review & Editing. Eko Pujianto: Investigation, Supervision, Validation, Writing – Review & Editing. Retno Wulan Damayanti: Investigation, Supervision, Validation, Writing – Review & Editing. All authors reviewed and approved the final manuscript and agree to be accountable for their respective contributions and for the integrity of the work.

**Conflicts of interest:** The authors declare that there are no conflicts of interest related to this study. The authors confirm that they have no financial or personal relationships with any individuals or organisations that could inappropriately influence or bias the research outcomes. This statement is provided to ensure transparency, objectivity, and the integrity of the publication.

**Declaration of Generative AI And AI-Assisted Technologies in the Writing Process:** During the preparation and revision of this manuscript, the authors used ChatGPT (OpenAI, GPT-5.6 Sol) to assist with language editing, improving clarity, and refining the organisation and presentation of the manuscript. The authors critically reviewed, verified, and edited all AI-assisted outputs and take full responsibility for the accuracy, originality, and integrity of the final manuscript.

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