Original Article

Development and Evaluation of Safety Culture Assessment Tool for the Construction Industry in Malaysia

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ABSTRACT: *The lack of a safety culture in the construction sector contributes to accidents in the industry due to the employer's failure to identify the level and the elements of the safety culture that need to be adopted in the work practice. This study aims to assess the safety culture in Malaysia's construction industry using a structured questionnaire adapted based on the Integrated Safety Culture Model as a comprehensive safety culture tool. A total of 119 construction companies and 329 respondents participated in this study. A focus group discussion was organized to review existing tools and applications to make them more reliable and valid for data collection and analysis in the construction industry. The developed questionnaire was then evaluated using the Delphi technique by 30 experts from various backgrounds, especially occupational safety and health in the construction industry. A qualitative and quantitative content validity test was conducted to check the validity of the developed instrument. The results indicated that the designed questions are valid for tackling the safety culture problem at construction sites. The findings also showed that the type of company, grade of the contractor, and size of the company have significant associations with the total safety culture score. The findings also indicated that each safety culture element is important to tackle safety culture issues and need to be applied together in the safety cultural assessment. This study will help the relevant stakeholders understand the level of safety practice in the industry so that they can introduce a suitable safety program to meet their objectives.*

Keywords: *Construction Safety Culture, Construction Safety, Safety Culture Evaluation Tool, Safety Culture Index, Safety Culture Tool*

1.0 INTRODUCTION

Increasing statistics on fatalities and injuries related to the construction industry have become a significant issue in Malaysia. According to the Department of Statistics Malaysia (DOSM, 2022), there were a total of 34,216 occupational accidents recorded in 2022, with 317 resulting in fatalities. The service sector had the highest number of accidents (10,403), followed by the manufacturing (9,906) and construction (4, 324) sectors. Although the construction sector ranked third in terms of the number of injuries, it had the highest rate of occupational fatalities compared with other industries, making it the most dangerous sector. The lack of a safety culture in this sector contributes to the high number of accidents (Misnan et al., 2007). This is because employers fail to identify the level of safety culture in their workplace and what elements of safety culture need to be adopted. Consequently, initiatives and programmes to improve safety culture are inaccurate and ineffective. Accordingly, an appropriate indicator is needed to measure safety culture in the construction industry to reduce accidents and fatalities from construction activities. This study thus examined the correlation between the type of contractor company and the size of the industry using the safety culture score. It also examined the correlation between the elements of safety culture and the correlation between competencies and scores for each safety culture element.

This study provides an overview of the industry safety practices, which will help stakeholders understand the level of safety practices in Malaysian construction companies so that they can introduce suitable safety programmes to meet their objectives.

1. 1 Definition of Safety Culture

Safety culture was introduced when The International Atomic Energy Agencies produced their initial report following the Chernobyl disaster in 1984, when the term ‘safety culture’ first appeared (Cooper, 2000). After the Bhopal disaster in 1984, the International Atomic Energy Agency further elaborated on the safety culture construct when defining it as the assembly of characteristics and attitudes of organizations and individuals (Cooper, 2018). According to the Health and Safety Executive (HSE), a recognised and respected definition or framework of safety culture remains undefined despite many reports, articles, and information dedicated to the subject (HSE, 2005).

Zhang et al. (2002) illustrated the significant disagreement among researchers regarding the definition of safety culture and whether safety culture is inherently different from the concept of safety climate. Zhang et al. (2002) suggested that common terminology and definitions may facilitate improved information sharing and strategies for enhancing safety culture. The evolution of the definition of safety culture began with Wert (2003), who defined it as ‘a work environment where a safety ethic permeates the organization’, a sentiment that can be simplified to equate it to a safety ethic. According to Glendon et al. (2000), safety culture refers to safety attitudes, values, beliefs, regulations, and practices. Tear et al. (2020) explained that individual factors, such as the individual’s role within the organisation, shape the perception and understanding of safety culture. According to Bisbey et al. (2021), safety culture reflects stable norms, values, and practices that influence safety.

Van Nunen et al. (2022) defined safety culture as the safety culture of an organisation that reflects the broad spectrum of established safety-related human, organizational, contextual, and technological aspects that prevail in the entire organisation. It entails observable, tangible factors, such as the safety management of an organisation, the physical working environment, and how individuals behave in relation to safety. Moreover, Mrugalska and Dovramadjiev (2022) concluded that the behaviours and awareness of humans and a positive safety culture directly influence good safety practices, hazard control, incident reporting, and, finally, the number and scope of accidents at work.

1. 2 Safety Culture Model

Although there has been much research regarding safety culture, a tool for quantitatively measuring safety culture has rarely been used in the literature (Wang & Sun, 2012, 2014). A relevant measurement tool that can be applied to this research is the safety culture measurement toolkit and its evaluation index system developed by Wang and Sun (2012, 2014) in their project

named HILAS (Human Integration Into Lifecycle of Aviation Systems, AIP4-CT-2005-516181). In the HILAS project, they proposed an integrated safety culture model (ISCM), which was used as the basis for this research.

2.0 METHOD

2.1 Research Design

A set of questions comprising the main elements of safety culture was based on the ISCM introduced by Wang and Sun (2012, 2014), as shown in Fig. 1.

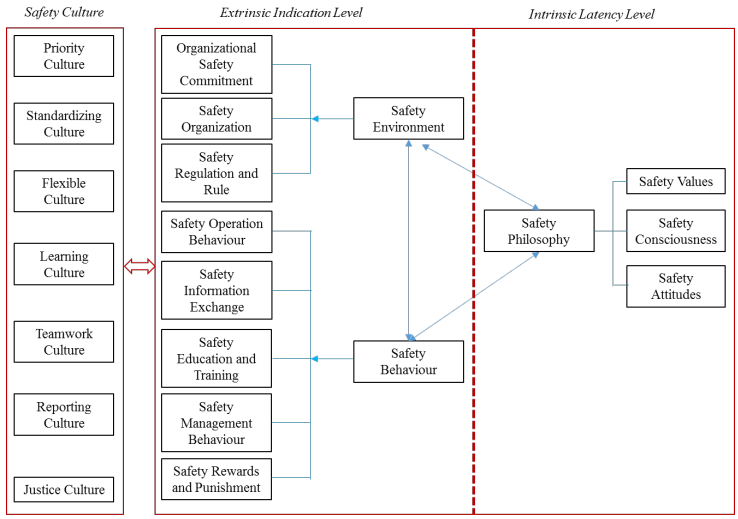

Figure 1: Integrated Safety Culture Model

Further, and a complete analysis of the structure and components of safety culture was conducted. Safety culture has been examined from a different angle, that is, from the perspective of subcultures. The tool for this research paper consists of questions on understanding of 'priority culture', 'standardising culture', 'flexible culture', 'learning culture', 'teamwork culture', 'reporting culture', and 'justice culture'.

2.2 Validity and Reliability

A focus group discussion on the development of a construction safety culture index was organised to review existing tools and applications and make them more reliable and valid for data collection and analysis in the construction industry. Content validity was assessed using a structured questionnaire. The constructed questionnaire was then evaluated using the Delphi technique, involving 30 experts from various backgrounds, particularly in the fields of occupational safety and health in the construction industry.

2.3 Target Population and Respondents

The study's target population and respondents are individuals who work in the construction industry and meet the inclusion and exclusion criteria in Table 1.

Table 1: Criteria for Respondent Selection

Criteria	Details on the population and respondent selection criteria
Inclusion criteria	Top managerial positions include General Manager, Construction Manager, Project Manager, Operation Manager, Safety and Health Manager, Environmental Manager, or any equivalent top managerial level. Middle managerial position such as Safety and Health Officer, Environmental Officer, Site Engineer, Quantity Surveyor or any equivalent middle managerial criteria Low managerial positions such as Site Safety Supervisor, Site Supervisor, Safe Coordinator Site Foreman, or any other equivalent operative employees. Workstation such as working on site or in site office and management office. Company categories include project developer, project consultant, main contractor, sub-contractor, designer, or any company related to the construction project. Classes of companies such as small, medium, and large companies. The company's classes were based on the definition of small medium enterprises (SME) by the Ministry of International Trade and Industry, Malaysia. The annual sales turnover or the number of full-time employees was the basis classification of the types of company in Malaysia, either small, medium, or large company, as follows: - Small companies have sales turnover between RM 250,000 and less than RM 10 million or full-time employees between 5 and 50. - Medium companies have sales turnover is between RM 10 million and RM 25 million or full-time employees between 51 and 150 - Large companies have sales turnover greater than RM 25 million or full-time employees of over 150. The respondent's nationality is any Malaysian citizen working in top, middle, and low managerial positions.
Exclusion criterion	Non-Malaysian employees working in low managerial positions.

2.4 Sample Design

The sample size was divided into two categories to suit the research design, which included a pilot study and descriptive cross-sectional study. A total of 69 construction workers participated in the pilot study. The sample size is the number of workers who work with the contractor.

Calculated sample size:

$$n = \frac{z^2 1 - \alpha/2 \, P(1-P)}{d^2}$$

$$n = \frac{1.96^2 \, x \, (0.50)(0.50)}{0.05^2}$$

Where:

P = estimated proportion

d = desired precision

Sample size = 384

Based on the calculated sample size, a minimum of 384 respondents are required. The 69 respondents involved in the pilot study did not participate again as respondents in the subsequent data collection, representing 384 respondents.

2.5 Research Instrument

The research instrument used in this study was a structured questionnaire designed based on a previous similar study. Personal interviews were conducted using a questionnaire to ensure that the respondents understood the message. It includes the following elements:

Section A: Socio-Demographic

Section B: Safety Sub-Culture (Standardising Culture, Justice Culture, Teamwork Culture, Reporting Culture, Priority Culture, Flexible Culture, and Learning Culture) with eight extrinsic elements (Organizational Safety Commitment, Safety Organization, Safety Regulation and Rule, Safety Operation Behaviour, Safety Information Exchange, Safety Education and Training, Safety Management Behaviour, Safety Rewards, and Punishment)

2.6 Pilot Study

A pilot project was conducted to determine the pretesting. The questionnaire was distributed on a small scale, and researchers noted any comments while the respondents filled out the questionnaire, such as the questionnaire format, time taken to complete the questionnaire, and their understanding of the language being used.

2.7 Data Analysis

All data were analysed using the SPSS for Windows version 17.0 software. Inferential analysis was used to reach conclusions that extended beyond the immediate data.

3.0 RESULTS

A total of 119 construction companies and 329 respondents participated in the study. A total of 69 respondents were involved in the pilot study, and 30 experts from various construction companies were involved in the focus group discussion.

3.1 Evaluation of Safety Culture Tool Content Validity Test

3.1.1 Content Validity Test

A questionnaire consisting of 73 questions in nine sections was constructed based on the literature. The questionnaire was validated using both qualitative and quantitative approaches. The former involved the consideration of comments, opinions, and suggestions made by all panellists, either individually or through group decisions. The instrument was further validated using a quantitative content validity test. The results of the content validity index for both the itemised and scale levels are shown in Fig. 2; both levels are represented by blue and green bars, respectively.

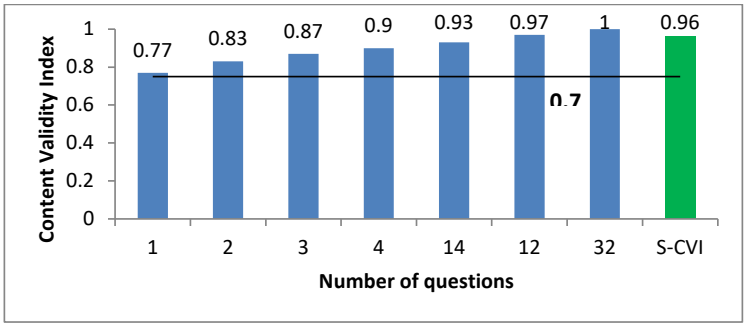

Figure 2: The I-CVI and S-CVI for the Questionnaire Assessment

3.1.2 Reliability Test

The reliability and internal consistency of the questions were tested, and the results are presented in Table 2.

Table 2: Reliability Test of the Items in the Questionnaire

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0.978	0.981	57

3.2 Descriptive Analysis

3.2.1 Socio-demographic Information

Respondents' demographic information is shown in Fig. 3. Most respondents had education up to the diploma and degree levels (120 and 83 persons, respectively). Only one person received a doctorate, whereas 22 respondents had a master's degree. The remaining are at the certificate and lower levels. In addition, most respondents were married, for a total of 220 respondents. A total of 101 respondents were single, two divorced, five widowers, and one a widow. The graph shows that Malay comprised the highest number of respondents (277). This was followed by other nationalities, Chinese, and Bumiputera Sarawak with 16, 15, and 11 respondents, respectively. There were seven Indians among the respondents, and only three were from Bumiputera Sabah. Regarding gender, most participants were male (287 persons), and the rest female (42 respondents). Further, 125 respondents were within the age range of 30–39 years. This was followed by the 20–29 and 40–49 age groups, with 107 and 64 respondents, respectively. There were also 28 respondents were aged between 50 and 59 years, while the remaining five respondents were between 60 and 69 years old.

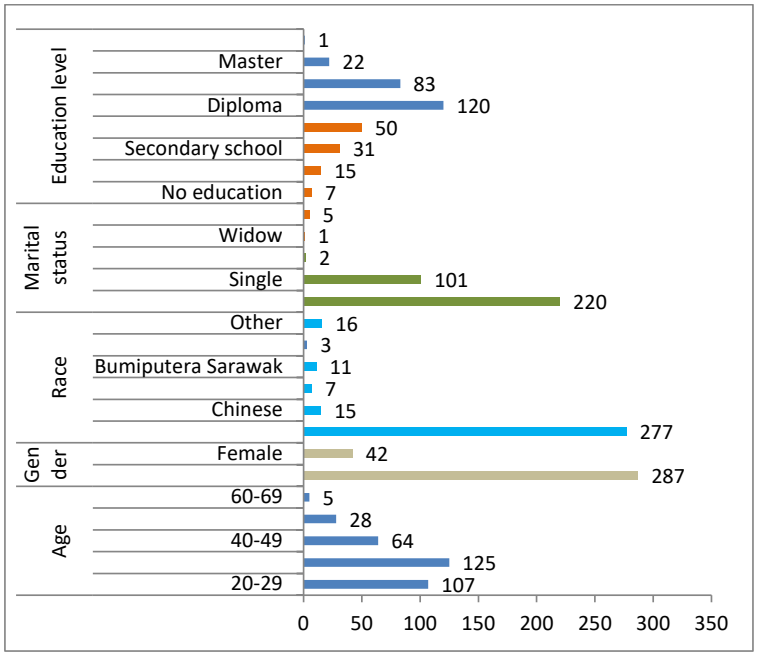

Figure 3: Socio-Demographic Information of the Respondents

An additional descriptive analysis of the total work experience and work experience in construction is shown in Fig. 4. Based on the observations, the highest proportion of respondents had total working experience between six and ten years, and the lowest had experience of more than 40 years. However, regarding working experience in the construction industry, most respondents worked for less than five years in the sector, while only one person worked for 31–40 years and 41–50 years.

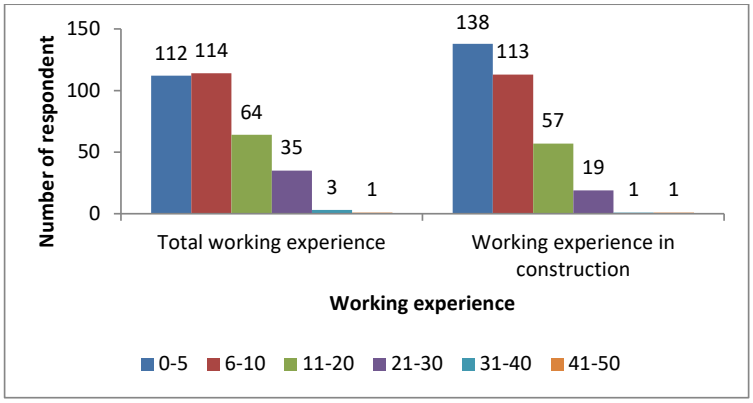

Figure 4: Total Working Experience and Working Experience in Construction

The results of the company distribution based on the five types of companies are shown in Fig. 5.

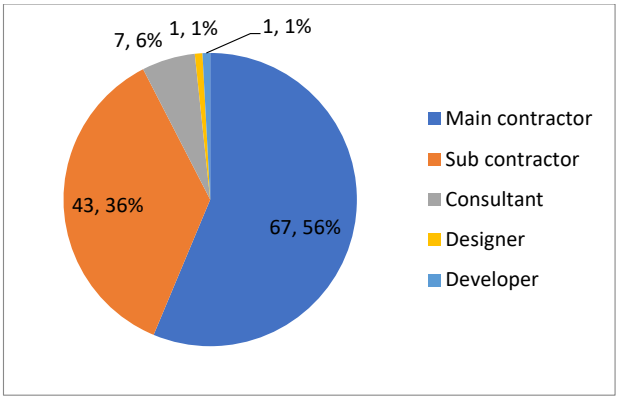

Figure 5: Classification of Companies

The contractor grade distribution is shown in Fig. 6. Most companies (90) were G7 contractors, while 16 companies were G1 contractors. Only four companies hold G2 and G6 licences, three were licenced as G3 contractors, and two were listed as G4 contractors. No company is a G5 contractor.

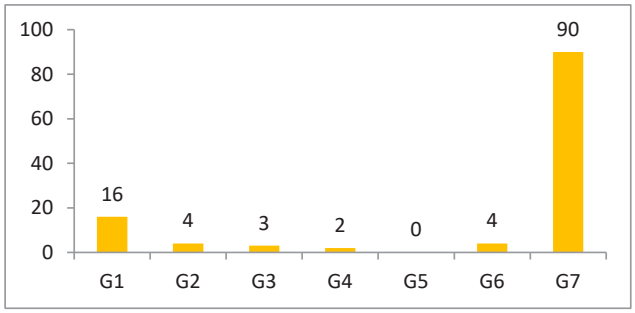

Figure 6: Grade of Contractor License as Approved by the Construction Industry Development Board (CIDB), Malaysia

3.2.2 Mean Score of Safety Culture Elements

Fig. 7 shows the mean scores obtained by the respondents for each section and the total scores they achieved. The maximum possible scores for each section are indicated by the blue lines. Based on the results, respondents' mean score for the Organizational Safety and Health Commitment section was 17.83(±4.31). The subsequent section B, which is Safety and Health Organization, together with section C (Safety and Health Regulation and Rule), showed mean scores of 10.26(±2.68) and 8.53(±2.11), respectively. The respondents' mean score for section D (Safety and Health Management Behaviour) was 11.46(±2.69). The mean scores obtained by the respondents on Safety Operation Behaviour and Safety Education and Training are 8.29(±2.06) and 11.61(±2.70), respectively. The mean scores for the last two sections are 9.67(±2.55) for Safety Information Exchange and 4.15(±1.21) for Safety Reward and Punishment. The mean total score of the respondents was 81.79(±18.84).

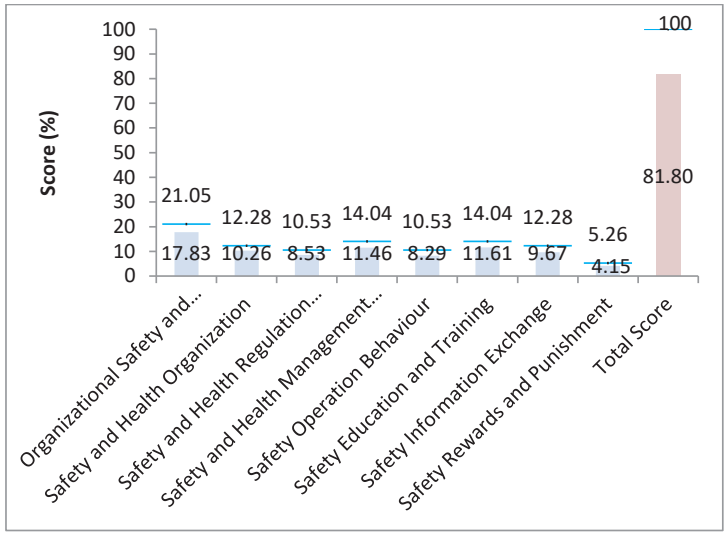

Figure 7: Mean Scores of Each Section and the Total Scores Obtained by the Respondents

3.3 Association and Correlation Test

3.3.1 Association between the independent variables with the safety culture score

Table 3 presents the results of the association test between three independent variables (type of company, grade of contractor, and size of company) and the total safety culture scores obtained by the respondents.

Table 3: Chi-Square Tests

Variable	X^2 Value	df	Level of Significance
Type of company	29.378	12	0.003*
Grade of contractor	24.645	15	0.050*
Size of industry	16.346	6	0.012*

* significance at $p \leq 0.05$

3.3.2 Correlation between the elements of safety culture

Correlation tests were performed between the eight sections of the questionnaire to identify the associations between the sections, as shown in Table 5.

Table 5: Pearson Correlation Test Between Eight Elements of Safety Culture

		1	2	3	4	5	6	7	8
1	Organizational Safety and Health Commitment	-							
2	Safety and Health Organization	**0.808****	-						
3	Safety And Health Regulation and Rule	**0.640****	**0.742****	-					
4	Safety and Health Management Behaviour	**0.734****	**0.776****	**0.771****	-				
5	Safety Operation Behaviour	**0.335****	**0.393****	**0.521****	**0.444****	-			
6	Safety Education and Training	**0.610****	**0.695****	**0.679****	**0.749****	**0.482****	-		
7	Safety Information Exchange	**0.573****	**0.617****	**0.670****	**0.709****	**0.497****	**0.778****	-	
8	Safety Rewards and Punishment	**0.610****	**0.624****	**0.499****	**0.586****	**0.305****	**0.620****	**0.592****	-

** significant at $p < 0.01$ (two-tailed)

4.0 DISCUSSION

4.1 Evaluation of Safety Culture Tool

Based on the Content Validity Test, all 57 questions showed I-CVI greater than the minimum value required, which is 0.75 (Yaghmale, 2003). Only one question showed an I-CVI of 0.77, whereas the highest I-CVI achieved was 1 for 32 questions. At the scale level, the results showed that the obtained S-CVI was very good, at 0.96. The results indicated that the designed questions were valid for addressing safety culture issues at construction sites. Cronbach's alpha, which measures the strength of consistency, was 0.978. Based on the rule of thumb for internal consistency, a score of 0.978 is considered excellent.

A descriptive analysis of the classification of companies showed that the largest proportion is 56% (67 companies), which are main contractors. Subcontractors followed the results for 43 companies (36%). There were seven consulting companies (6%); the remaining were designers and developers, and only one company represented the other categories. The analysis also showed the different grades of contractors involved at construction sites. Most companies (n = 90) were G7 contractors, while 16 were G1 contractors. Only four companies held G2 and G6 licences, three were licenced as G3 contractors, and two were listed as G4 contractors. No company was a G5 contractor in this study. This means that, at a construction site, various people and contractors of different grades are involved in the construction activity, which contributes to safety culture.

Based on the Chi-square tests, the independent variables (type of company, grade of contractor, and size of company) and the total safety culture score obtained by the respondents, type of company, grade of contractor and size of company showed a significant association with the total safety culture score obtained, with p-value less and equal to 0.05.

For the correlation between the eight elements of safety culture, there was a significant correlation between all the elements with a p-value below 0.01. These findings indicate that the elements considered in each section are essential for tackling safety culture issues and must be applied together in safety culture assessments.

5.0 CONCLUSION

The increasing number of deaths and injuries in Malaysia's construction sector is a significant concern, emphasising the urgent need for better safety measures. This includes using accurate tools to assess the safety culture of the construction industry and understanding how different factors such as the contractor's grade and the industry's size affect safety in the construction industry. The contractor grades significantly correlated with the total safety culture score. The findings also indicated that each safety culture element is essential for tackling safety culture issues and must be applied together in a safety culture assessment.

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