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Safety Climate Measurement: A Survey of Indonesian Infrastructure Construction Projects

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Abstract: Research has shown that safety climate (SC) structures are unique to a specific region. This highlights the need to conduct studies across diverse regions and cultures, particularly in developing countries, which are often overlooked by researchers. Thus, this study aimed to investigate the SC factors in Indonesian infrastructure construction projects (ICPs) and understand the underlying factor constructs. This study adopted a quantitative approach using a 45-item SC questionnaire that was validated in prior research and tailored to account for region-specific dimensions. Data were collected from 333 participants across five large transportation infrastructure projects in Indonesia. Statistical, descriptive and exploratory factor analysis (EFA) were employed along with Scree plot graphic and Horn Parallel Analysis to identify SC factors. The results identified three key SC factors: (1) Management commitment and communication (MCC), (2) Work practices and applicability of safety rules and procedures (WPAS) and (3) Responsibility for safety and safety resources (RSSR). These factors explained a total variance of 50.96%, with MCC contributing the most at 32.61%. While MCC and RSSR achieved satisfactory performance levels, with a mean score of 4.08 and 4.07, respectively, WPAS fell below expectations (a mean score of 2.69), highlighting the gaps in the implementation of safety practices and compliance with safety regulations. This study revealed that management commitment was pivotal to improving SC, emphasising the need for clear communication and resource allocation. However, significant improvements were required in safety practices and adherence to procedures, particularly at decentralised infrastructure sites. For further research direction, this study recommends confirmatory factor analysis to validate these findings and explore the influence of different stakeholder profiles, such as organisational hierarchy and work experience, on SC perceptions. These insights could guide targeted interventions to enhance ICP safety.

Keywords: Safety climate, Construction safety, Infrastructure projects, Exploratory factor analysis, Indonesia

INTRODUCTION

In many countries, the construction sector plays a vital role in social development and economic growth by contributing significantly to infrastructure and employment. Paradoxically, this sector has been designated as one of the most harm-prone industries, owing to its high

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rate of occupational accidents and fatalities (Mohammadi, Tavakolan and Khosravi, 2018). National Social Security for Workers of Indonesia reported that approximately 30% of total occupational accidents belong to this sector (Mangiring and Lestari, 2018). In addition to this report, approximately 10% of the 2000 recorded fatalities at workplaces occurred in the construction industry (Loosemore et al., 2019). Although health and safety standards in construction project workplaces have been intensively promoted and implemented for many decades, the safety climate in this field remains disappointing, particularly in developing countries (Rafique, Ahmed and Ismail, 2021).

Various studies have been undertaken to investigate safety climate (SC) in different sectors over the past four decades. In the construction industry, SC studies have been conducted on diverse types of projects across regions and cultures (e.g., Zahoor et al., 2017a; Hon, Chan and Yam, 2013; Zhang et al., 2021; Gao et al., 2016; Choudhry, Fang and Lingard, 2009). Interestingly, research has consistently shown that no generic consensus has emerged on SC constructs and that they are relatively inconstant. Researchers have concluded that disagreements and instability are induced by regional differences, industry types, languages and cultures (Flin et al., 2000; Kiani et al., 2022). All causes also characterise the divergence in sample populations, types of SC statements and the naming of dimensions (Cooper and Phillips, 2004). In addition to the divergences, SC construct choice also depends on researchers' ideas and preferences (Kiani et al., 2022).

The structure of SC is important for portraying the organisation's culture of safety at a definite time (Ma and Yuan, 2009; Griffin and Curcuruto, 2016), safety performance (Yousefi et al., 2016) and accident avoidance (Zhou, Goh and Li, 2015). Recent studies have found a strong link between SC and safety behaviour (Rafique, Ahmed and Ismail, 2021). It can lessen employees' risk tolerance, foster safer choices in the workplace (Bhandari and Hallowell, 2022) and discompose the impact of human-technology interactivity on safety if the SC is unfavourable (Masudin et al., 2024). However, SC is unique for a particular population.

Several studies have been conducted to investigate SC dimensions from a broader perspective, with more studies conducted in developed and emerging regions than in developing regions. Studies in Indonesia were almost overlooked, despite its large construction market size and unstandardised health and safety reports of its construction industry. Similarly, Zahoor et al. (2017a) advocated an investigation to determine whether variance in SC occurs in developing countries and cross-cultural backgrounds. According to Barbaranelli, Petitta and Probst (2015), an interrelationship exists between SC and national culture. Therefore, this study investigated SC in the Indonesian construction sector and determined its factor construct. This study provided an important opportunity to advance the understanding of the instability of SC dimensions and how the main SC factors differed in the context of regional dimensions and project types.

LITERATURE REVIEW

SC is best understood by first defining organisational climate, referring to employees' shared perceptions of a company's policies, practices and procedures, both formal and informal (Hon, Chan and Yam, 2013). It emerges from the interaction between organisational structure and employees' sense-making of their environment (Ashforth, 1985) and represents the observable elements of the underlying organisational culture (Schein, 2010). The concept of SC has undergone significant development over three decades of research, shaped by diverse studies that have approached it from different research angles, theoretical frameworks and levels of analysis.

Since first popularised by Zohar in 1980, numerous definitions of SC have been proposed (Luo, 2020). SC is understood as a broad concept representing an organisation's safety values, as seen through the safety-related beliefs held by its employees (Williamson et al., 1997). For instance, SC refers to employees' shared perceptions of the importance and the right priority of safety, safety policies, procedures and practices in their organisation (Oah, Na and Moon, 2018; Griffin and Neal, 2000). Another definition states that SC is the result of an institutional atmosphere and depicts the safety perception of employees in their work environment (Neal, Griffin and Hart, 2000). SC is also regarded as a potent scale method for occupational accident anticipation, which can proactively determine safety problems before they trigger an accident (Seo et al., 2004; Zahoor et al., 2017b). SC is also considered a tangible representation of a safety culture, observable through symbols and policies and is viewed as a way to assess the evolving status of a safety culture (Cheyne et al., 1998). In essence, SC is a transient psychological perception of safety that is influenced by immediate situational and environmental factors. It offers a snapshot of an organisation's safety culture at a specific point in time and reflects the cognitive interpretation of the safety work environment, operational practices, organisational rules and management actions.

Recently, discussions and disagreements have existed regarding the factors that constitute SC. The dimensions identified in different studies, particularly in the field of construction, are shown in Table 1.

Table 1. SC factors in the construction industry

Studies	Factors	Number of Factors
Probst et al. (2019)	1. Demonstrating management commitment 2. Aligning and integrating safety as a value 3. Ensuring accountability at all levels 4. Improving site safety leadership 5. Empowering and involving workers 6. Improving communication 7. Training at all levels 8. Encouraging owner/client involvement	8
Alruqi, Hallowell and Techera (2018)	1. Supervisor's safety role 2. Management commitment to safety 3. Safety rules and procedures 4. Individual responsibility to health and safety 5. Training	5
Zahoor et al. (2017a)	1. Management commitment and employees' involvement in health and safety 2. Safety enforcement and promotion 3. Applicability of safety rules and safe work practices 4. Safety consciousness and responsibility	4
Gao et al. (2016)	1. Top management commitment 2. Co-workers' caring and communication 3. Co-workers' role models 4. Supervisors' expectation	4
Wu et al. (2015)	1. Safety priority; safety supervision 2. Training and communication 3. Safety rules and procedures 4. Safety involvement	4
Cigularov et al. (2013)	1. Management commitment to safety 2. Supervisor support for safety 3. Safety practices 4. Work pressure	4
Hon, Chan and Yam (2014)	1. Management commitment to OHS and employee involvement 2. Applicability of safety rules and work practices 3. Responsibility for health and safety	3
Kines et al. (2011)	1. Management safety priority, commitment and competence 2. Management safety empowerment 3. Management safety regulations 4. Worker safety commitment 5. Worker safety priority and risk non-acceptance 6. Safety communication 7. Learning and trust in co-worker safety competence, worker trust	7

(*Continued on next page*)

Table 1 *Continued*

Studies	Factors	Number of Factors
DeArmond et al. (2011)	1. Safety compliance 2. Safety participation	2
Zhou, Fang and Mohamed (2011)	1. Management commitment 2. Safety regulations 3. Safety attitude 4. Safety training and workmates' support	4
Choudhry, Fang and Lingard (2009)	1. Management commitment and employee involvement 2. Inappropriate safety procedures and work practices	2
Fang, Chen and Wong (2006)	1. Safety attitude and management commitment 2. Safety consultation and safety training 3. Supervisor role and workmate role 4. Risk taking behaviour 5. Safety resources 6. Appraisal of safety procedure and work risk 7. Improper safety procedure 8. Worker involvement 9. Workmate influence; competence	10
Seo et al. (2004)	1. Management commitment to safety 2. Supervisor safety support 3. Co-worker safety support 4. Employee participation in safety-related decision making and activities 5. Competence level of employees with regard to safety	5
Mohamed (2002)	1. Commitment 2. Communication 3. Safety rules and procedures 4. Supportive environment 5. Supervisory environment 6. Workers' involvement 7. Personal appreciation of risk 8. Appraisal of work hazards 9. Work pressure 10. Competence	10
Glendon and Litherland (2001)	1. Communication and support 2. Adequacy of procedures 3. Work pressure, personal protective equipment 4. Relationships 5. Safety rules	6
Dedobbeleer and Béland (1991)	1. Management commitment to safety 2. Worker involvement in safety	2

(*Continued on next page*)

Table 1 *Continued*

Studies	Factors	Number of Factors
Zohar (1980)	1. Management attitude towards safety 2. Work pace and safety 3. Effects of safe conduct on promotion 4. Effect of safe conduct on social status 5. Perceived risks 6. Perceived importance of safety training 7. Perceived status of safety officer 8. Perceived status of safety committee	8

Source: Extended from Umar (2020) and Chen et al. (2019)

Table 1 presents different SC dimensions for the construction industry. This finding confirmed variations in SC dimensions in different industries. Zahoor et al. (2017a) believe that divergences in the SC dimension are caused by several factors, including varying SC definitions, causing inconsistent understanding, sample/population variation in different industries and regions and potential researcher bias during SC dimension analysis. In general, prior studies have focused on generalising measurements to specific industries and organisations.

The most common approach is the quantitative research method (Sunindijo and Zou, 2012; Lingard, Cooke and Blismas, 2011), which is more robust than qualitative techniques (Guldenmund, 2000). A self-explained questionnaire containing a psychometric measurement scale was frequently used (Yousefi et al., 2016; Kiani et al., 2022). SC measurement is inherently tied to the specific environment, operations, processes and practices of each industry. An SC survey instrument offers a relevant way to analyse various employee subgroups at the industry level based on organisational categories. In addition, questionnaires, interviews and similar tools can tap into inner feelings rather than through external observation, which help assess individual perceptions and attitudes (Luo, 2020). SC questionnaires principally contain statements that cover several aspects involving employees' perceptions of how the organisation considers safety in its operations, including regulations, procedures and practices (Griffin and Neal, 2000; Zohar, 2010). The questionnaire also includes aspects influencing workplace safety, such as employee training, management perception, safety priorities, supervisor attitude, safety equipment and perception of work accidents (Tomás, Cheyne and Oliver, 2011).

Zohar (2010) urged researchers to design an SC index for each industry type to discover new ideas and dependent SC perceptions. Existing studies provide reliable and valid SC assessments that can be adopted to forecast the quality of safety performance in organisations. For instance, the SC assessment questionnaires recommended by the UK Health and Safety Executive (HSE) contained 71 statements. Fang, Chen and Wong (2006) used an 87-item questionnaire to measure SC at Hong Kong construction sites. The Hong Kong Occupational Safety and Health Council (OSHC) established an SC index consisting of 38 questions and was adopted by Hon, Chan and Yam (2013) to determine SC dimensions in repair, maintenance, minor alteration and addition works in Hong Kong and Gao et al. (2016) to evaluate SC in international construction sites. Zahoor et al. (2017a) used a 45-item questionnaire, which was originally a 38-item questionnaire of the Hong Kong OSHC with seven statements added to study SC in Pakistan's construction projects. In addition to the aforementioned studies and institutions, several scholars developed SC assessments that have been applied in different industries. A Nordic occupational safety research team developed the 50-question Nordic Safety Climate Questionnaire-50 (NOSACQ-50). It was used for the construction industry in five Nordic countries as well as the Swedish food industry (Kines et al., 2011) and an Iranian steel company (Yousefi et al., 2016). Marin et al. (2019) developed a 40-item chemistry laboratory SC survey (CLASS) and tested its validity and reliability on a group of students enrolled in laboratory classes in Mexico. Similar SC questionnaires were employed in university laboratories in Pakistan (Ahmed et al., 2024) and China (Liu et al., 2023). The decisions made by researchers significantly influence factor analysis and labelling, suggesting that factor structures across different studies may share more similarities than initially apparent.

However, the factors applicable to specific regions, cultures and industries could not be elicited from studies proposing and validating SC. There was also a lack of consistency of many factors with findings from diverse contexts and methodologies, implying the presence of some universal SC factors, such as management commitment to safety, peer safety support, employee engagement in safety and workers' level of safety competence (Luo, 2020). There was a noticeable lack of empirical research on SC measurement in Indonesia, particularly in the construction industry and, more specifically, in infrastructure projects. Although the literature review has identified some helpful theories, significant limitations exist. Furthermore, systematic investigations into the relationship between SC and organisational safety performance were urgently needed in the Indonesian context.

METHODOLOGY

This study adopted the 45-item SC questionnaire employed by Zahoor et al. (2017a). The questionnaire originated from the 38-item SC scale of the Hong Kong OSHC (OSHC, 2008) with the addition of seven SC statements. Despite the existence of several SC assessment scales in the literature, this study used the 38-item SC questionnaire from the 71-item SC questionnaire of the

UK HSE (1997) which is a well-refined questionnaire as it has undergone many rounds of development, testing and validation in various studies to assess construction SC and that it includes includes almost all the essential items discovered by many researches (Khan, 2017). Zahoor et al. (2017a) added the significance of regional and cultural values (e.g., Bahari and Clarke, 2013; Zhou, Fang and Mohamed, 2011) and feedback from experts during the pilot study highlighted in previous studies. Consequently, this study added two academics and three industry professionals and seven additional items (SC39–SC45) were added to anticipate the region-specific dimensions uncovered by the existing SC scale. Although this study did not focus on measuring cultural or regional aspects, several studies agreed that there was a strong relationship between SC and national culture (Gao et al., 2016; Barbaranelli, Petitta and Probst, 2015). This study was the first attempt to employ a 45-item SC in Southeast Asia.

The study questionnaire consisted of two parts. The first part contained 10 questions about the respondents' demographic information, including organisation, position, age, gender, work hours per week, education level, length of work with the current company, work experience in construction projects, safety training and smoking habits. In the second part, which comprised 45 items of the SC scale, respondents were asked to rate their level of agreement on a five-point Likert scale, with 1 indicating strongly disagree and 5 indicating strongly agree. A similar measurement scale has been employed in several similar studies to identify and construct SC factors, such as Fang, Chen and Wong (2006), Choudhry, Fang and Lingard (2009), Hon, Chan and Yam (2013), Gao et al. (2016) and Zahoor et al. (2017a). The questionnaire was provided in Bahasa Indonesia.

Gathering the responses in a consistent environment from employees at various levels, representing different stakeholder organisations, was attempted because sampling of the questionnaire can greatly impact the generalisability of the results. Questionnaires were distributed to construction workers, operators, mechanics, foremen, surveyors, staff, engineers, supervisors and management personnel of five large under-construction transportation infrastructure projects in Indonesia. These projects were located at four locations in two major islands, Java and Sumatra. These projects shared similar environments. They were located in suburban and rural areas, new development projects, large-scale in terms of size and represented the two largest islands with the largest populations.

The questionnaires were completed by a group of 15 to 25 respondents directly under the supervision of the investigators. Prior to distributing the questionnaire, respondents were informed of its significance and requested to complete it honestly. From numerous studies applying exploratory factor analysis (EFA), Lingard and Rowlinson (2006) pointed out that only 10% of small samples (with a 2:1 ratio between sample size and observed variables) yielded accurate solutions. A minimum subject-to-variable ratio of two was recommended (Kline, 2014). However, having at least 5 to 10 cases per measure or a sample size of 200 was generally recommended to ensure the effective use of confirmatory factor analysis (CFA) and guarantee reliable results (Hair et al., 2019; Oke, Ogunsami and Ogunlana, 2012). Since there was no rigid consensus regarding sample size suitability for conducting EFA and CFA, a sample size of 100 was considered poor, 200 was fair and 300 was good (Khan, 2017). A total of 333 samples were successfully collected and analysed using EFA, reflecting Bagozzi (2010) and Molwus, Erdogan and Ogunlana (2013) or the common rule of a minimum of 5 to 10 cases per measure or at least 200 samples to guarantee robust results (Hair et al., 2019; Oke, Ogunsami and Ogunlana, 2012).

Table 2 presents the respondent demographics. According to Table 2, over 87% of the study respondents were contractors and subcontractors. Front line workers and others (equipment operators, mechanics, land surveyors, welders, drivers, traffic guards and general helpers) contributed 38.4% of the study respondents. In addition, 69% of respondents aged ranged from 20 to 40 years old and the majority were men (88.60%).

Table 2. Profile of respondents

Demography	Category	Frequency	%
1. Organisation	Owner	8	2.40
	Contractor	231	69.40
	Subcontractor	60	18.00
	Consultant	25	7.50
	Others	7	2.10
	Unidentified	2	0.60
2. Position in organisation	Front line worker	40	9.00
	Foreman	14	4.20
	Supervisor	51	15.30
	Site engineer	31	9.30
	Construction manager	12	3.60
	Safety officer	30	9.00
	Project administration staff	60	18.00
	Others	98	29.40
	Unidentified	7	2.10

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Table 2 *Continued*

Demography	Category	Frequency	%
3. Age	Under 21 years old	11	3.30
	21 to 30 years old	156	46.80
	31 to 40 years old	74	22.20
	41 to 50 years old	65	19.50
	51 to 60 years old	20	6.00
	Above 60 years old	4	1.20
	Unidentified	3	0.90
4. Gender	Male	295	88.60
	Female	37	11.10
	Unidentified	1	0.30
5. Working hour per week	Less than 40 hours	43	12.90
	41 to 48 hours	88	26.40
	49 to 56 hours	83	24.90
	More than 56 hours	105	31.50
	Unidentified	14	4.20
6. Education level	Elementary	5	1.50
	Junior/Senior high school	114	34.20
	Diploma level	54	16.20
	Higher education	154	46.20
	Unidentified	6	1.80
7. Length of service in current company	Less than 1 year	57	17.10
	1 to 5 years	172	51.70
	6 to 10 years	43	12.90
	11 to 15 years	22	6.60
	More than 15 years	31	9.30
	Unidentified	8	2.40
8. Experience in construction project	Less than 5 years	149	44.70
	5 to 10 years	87	26.10
	11 to 15 years	44	13.20
	16 to 20 years	26	7.80
	More than 20 years	23	9.90
	Unidentified	4	1.20

(*Continued on next page*)

Table 2 *Continued*

Demography	Category	Frequency	%
9. Safety training	Certified	82	29.60
	Yes (uncertified)	101	30.30
	Not yet	144	43.20
	Unidentified	4	1.80
10. Smoking habit	No smoke	155	46.50
	Smoke, not when working	104	31.20
	Smoke, when working	72	21.60
	Unidentified	2	0.60

Bartlett's test of sphericity and Kaiser-Meyer- Olkin (KMO) scores were used to evaluate data appropriateness. The significance value of the Bartlett test should be smaller than 0.05, while the KMO score, which is the measure of sampling adequacy, should be greater than 0.5 (Shan et al., 2015). The KMO value of 0.9 or above is considered marvellous, 0.8 or above is meritorious, 0.7 or above is middling, 0.6 or above is mediocre, 0.5 or above is miserable and below 0.5 is not at all acceptable (Hair et al., 2019). In addition to performing EFA, the data correlation matrix needed to include several coefficients of 0.3 or higher (Oladinrin and Ho, 2016; Yang et al., 2009). These tests confirmed the presence of significant correlations among certain observed variables within the data matrix (Hon, Chan and Yam, 2013). Also, the Statistical Program for Social Sciences (SPSS) was used to perform the EFA. Eigenvalues greater than one were set for factor extraction (Hair et al., 2019; Seo et al., 2004). According to Bökeoğlu and Koçak (2016), this method could have accuracy issues due to the sampling error effect on eigenvalues of correlation matrices, as it leads to an excessive number of factors. The researchers suggested that the correlation matrices obtained from randomly selected samples should be compared with those gained from actual samples. In addition to the eigenvalue method, the results of the scree plot graphic and Horn parallel analysis (HPA) were reviewed to determine the ideal factor number (Bahari and Clarke, 2013; Hon, Chan and Yam, 2013).

In the SPSS program, the dataset was rotated to obtain a better interpretation of the factor structure. Varimax rotation, an orthogonal rotation method, was chosen because it "minimises the number of variables with high loadings on each factor" (Pallant, 2020). This rotation method simplifies the interpretation of the EFA results (Akintoye, 2000) and is broadly employed in research relevant to construction management (Ameyaw and Chan, 2015). Furthermore, the factor loading cut-off point and minimum score for communality were set as 0.5 and 0.4, respectively, for each variable to increase the significance results. Coefficients of variables smaller than 0.3 were pressed to maintain a cross-loading of at least 0.2 to simplify the factor matrix (Hair et al., 2019; Zahoor et al., 2017a). Three minimum variables were preserved for each extracted factor to achieve an acceptable level of reliability (Zhou, Fang and Mohamed, 2011). Finally, the Cronbach's coefficient alpha scores of each factor construct were assessed to estimate reliability and internal consistency. According to Gün, Temizkan and Bumin (2021), an alpha score less than 0.50 is not acceptable, 0.51 to 0.59 is acceptable, 0.60 to 0.69 is acceptable, 0.70 to 0.89 is good and above 0.89 is excellent.

RESULTS AND DATA ANALYSIS

The results of the KMO and Bartlett's tests indicated an excellent level (KMO = 0.891) of sampling adequacy with a significance value of less than 0.05, based on Bartlett's test of sphericity (as shown in Table 3). Correlations among certain SC variables were indicated by the presence of multiple coefficients of 0.3 or higher in the correlation matrix, as presented in Table 4.

Table 3. KMO and Bartlett's test

Parameter	Value
KMO measure of sampling adequacy	0.891
Bartlett's test of sphericity	
Approx. chi-square	5,141.565
df	990.000
Sig.	–

Then, the study analysed the dataset's eligibility for EFA. The extraction method, utilising the eigenvalue criterion, yielded 12 components with eigenvalues of 1 or above. All variables exhibited communality scores above 0.4, with certain factor loadings below 0.5. Simultaneously, cross-loadings with a variation of less than 0.2 were noted.

According to Figure 1, the Scree plot graphic recommended four to six methods to determine the number of factors. HPA advised the preservation of three appropriate factors. The HPA indicated that only the first three factors based on eigenvalues resulted in higher scores than their respective Horn's percentile scores. This attests to the fact that both the Eigenvalues and the Scree plot offered a greater number of factors than the HPA. Because HPA proposed the most accurate technique (Pallant, 2020), instead of eigenvalues of 1, the process of extraction was repeated with a fixed number of factors (3). A comparison of the eigenvalue scores, scree plot graphic and HPA is presented in Table 5.

Table 4. Correlation matrix among variables

	Variables																					
	SC08	**SC11**	**SC12**	**SC13**	**SC14**	**SC15**	**SC16**	**SC20**	**SC21**	**SC22**	**SC24**	**SC26**	**SC27**	**SC28**	**SC29**	**SC32**	**SC33**	**SC34**	**SC35**	**SC38**	**SC39**	**SC45**
SC08	1.00																					
SC11	−0.22	1.00																				
SC12	0.39	−0.22	1.00																			
SC13	0.30	−0.25	0.44	1.00																		
SC14	−0.22	0.34	−0.06	−0.09	1.00																	
SC15	0.51	−0.26	0.39	0.28	−0.16	1.00																
SC16	0.37	−0.18	0.39	0.39	−0.10	0.34	1.00															
SC20	−0.13	0.31	−0.18	−0.07	0.39	−0.22	−0.23	1.00	1.00	1.00												
SC21	0.47	−0.18	0.43	0.38	−0.26	0.46	0.51	−0.24														
SC22	0.34	−0.12	0.44	0.42	−0.09	0.29	0.37	−0.10	0.57													
SC24	0.32	−0.17	0.46	0.36	−0.10	0.31	0.42	−0.15	0.47	0.54	1.00											
SC26	−0.26	0.46	−0.18	−0.15	0.34	−0.19	−0.23	0.34	−0.30	−0.10	−0.16	1.00										
SC27	0.32	0.02	0.24	0.17	−0.09	0.34	0.25	−0.09	0.37	0.38	0.21	−0.12	1.00									
SC28	0.45	−0.18	0.35	0.36	−0.12	0.56	0.34	−0.09	0.52	0.38	0.34	−0.23	0.42	1.00								
SC29	−0.09	0.30	0.04	0.05	0.30	−0.15	−0.06	0.39	−0.11	0.05	−0.05	0.43	0.06	−0.09	1.00							
SC32	−0.27	0.32	−0.24	−0.14	0.42	−0.32	−0.24	0.52	−0.38	−0.21	−0.25	0.43	−0.18	−0.26	0.43	1.00						
SC33	0.33	−0.06	0.27	0.23	−0.14	0.36	0.38	−0.22	0.42	0.35	0.32	−0.14	0.37	0.37	−0.05	−0.31	1.00					

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Table 4 *Continued*

	Variables																					
	SC08	**SC11**	**SC12**	**SC13**	**SC14**	**SC15**	**SC16**	**SC20**	**SC21**	**SC22**	**SC24**	**SC26**	**SC27**	**SC28**	**SC29**	**SC32**	**SC33**	**SC34**	**SC35**	**SC38**	**SC39**	**SC45**
SC34	0.41	−0.17	0.33	0.27	−0.18	0.44	0.44	−0.22	0.47	0.38	0.43	−0.21	0.35	0.45	−0.06	−0.35	0.54	1.00				
SC35	−0.25	0.35	−0.19	−0.11	0.47	−0.21	−0.27	0.40	−0.35	−0.10	−0.19	0.41	−0.08	−0.18	0.29	0.39	−0.18	−0.19	1.00			
SC38	0.40	−0.19	0.26	0.28	−0.15	0.46	0.38	−0.07	0.44	0.37	0.33	−0.23	0.35	0.41	−0.04	−0.22	0.37	0.42	-0.25	1.00		
SC39	0.41	−0.18	0.24	0.26	−0.19	0.34	0.40	−0.14	0.44	0.37	0.35	−0.22	0.32	0.44	−0.05	−0.34	0.30	0.47	-0.26	0.49	1.00	
SC45	0.33	−0.07	0.27	0.31	−0.18	0.31	0.35	−0.15	0.46	0.34	0.25	−0.19	0.34	0.46	−0.04	−0.25	0.41	0.47	-0.26	0.38	0.45	1.00

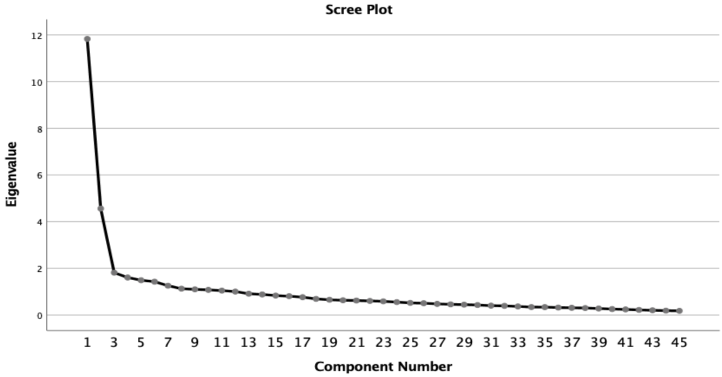

Figure 1. Scree plot graphic

Table 5. Comparison of eigenvalues, scree plot and HPA

Factor	Eigenvalue > 1	Scree Plot	HPA Percentile	Decision
1	11.830	Accepted	1.876303	Accepted
2	4.560	Accepted	1.755823	Accepted
3	1.814	Accepted	1.684476	Accepted
4	1.606	Accepted	1.629171	Rejected
5	1.490	Rejected as scree plot curve straightens up after Factor Number 4	1.575730	Rejected
6	1.427		1.526515	Rejected
7	1.255		1.488358	Rejected
8	1.128		1.437324	Rejected
9	1.099		1.405744	Rejected
10	1.077		1.369169	Rejected
11	1.045		1.332107	Rejected
12	1.004		1.293466	Rejected

The results of the extraction process based on three fixed factors were subsequently reanalysed. Of 45 SC variables, only 22 items were retained, explaining the total variance of 50.96%. Factors 1, 2 and 3 explained 32.611%, 11.850% and 5.852% of the variance, respectively. The minimum communalities score was 0.431, which was higher than 0.4 and the factor loadings of each variable exceeded the minimum required value of 0.5. The use of the varimax rotation method was used because the factors were not correlated (Zahoor et al., 2017a). Consequently, the three extracted factors with their related variables can be defined (as shown in Table 6).

Table 6. Factor structure of safety climate

Variable	Statement	Factor Loading	Communalities	Mean
SCF1	MCC			
	Eigenvalue = 7.174; Cronbach's alpha = 0.867; Mean = 4.08; Standard deviation = 4.897			
SC34	Management always motivates and praises the employees for working safely.	0.689	0.550	4.09
SC27	Time pressures for completing the jobs are reasonable.	0.678	0.465	3.82
SC33	My immediate boss often talks to me (safety talks) about health and safety matters.	0.670	0.472	4.05
SC45	Supervisors carry out the job hazard analysis before start of each activity.	0.666	0.474	4.12
SC28	Regular safety inspections are very helpful to improve the health and safety of works.	0.645	0.516	4.22
SC39	Safety posters and publications are effectively used for safety awareness.	0.623	0.460	4.20
SC38	I think management here does enough to follow up recommendations from safety inspection and accident investigation reports.	0.619	0.452	3.90
SC21	There is always good communication here between management and workers about health and safety issues.	0.576	0.605	4.06
SC15	The company/management encourages suggestions/feedback from the employee, on how to improve health and safety.	0.568	0.447	4.02
SC08	The company really cares about the health and safety of the people who work here.	0.524	0.431	4.33
SCF2	WPAS			
	Eigenvalue = 2.607; Cronbach's alpha = 0.814; Mean = 2.69; Standard deviation = 5.236			
SC29	Some jobs here are difficult to do safely due to physical conditions of site.	0.696	0.498	3.06

(Continued on next page)

Table 6 (*Continued*)

Variable	Statement	Factor Loading	Communalities	Mean
SC20	Some of workforces pay little attention to health and safety rules and procedures.	0.685	0.485	3.01
SC26	Work health and safety is not my concern – it is not my responsibility.	0.685	0.509	2.12
SC32	Not all the health and safety rules and procedures are strictly followed here.	0.680	0.572	2.69
SC14	Little is done to prevent the accidents until someone gets injured.	0.665	0.466	2.86
SC35	Supervisors sometimes turn a blind eye to people who are not observing the health and safety procedure.	0.653	0.474	2.43
SC11	Some health and safety rules or procedures are difficult to follow as they are either too complex or not practical.	0.612	0.521	2.65
SCF3	RSSR			
	Eigenvalue = 1.287; Cronbach's alpha = 0.784; Mean = 4.07, Standard deviation = 2.840			
SC13	All the people who work in my team are fully committed to health and safety.	0.729	0.559	4.20
SC12	People here always wear their personal protective equipment when they are supposed to.	0.726	0.582	4.00
SC24	Sufficient resources are available for health and safety here.	0.657	0.528	3.96
SC22	There are always enough people available to get the job done according to the health and safety procedures.	0.614	0.555	3.99
SC16	There is always good preparedness for emergency here.	0.502	0.447	4.22
Cumulative % of variance = 50.31; Cronbach's coefficient alpha = 0.708				

Table 6 contains information on the study data reliability and validity. The Cronbach's coefficient alpha values for all factor constructs were above the safe threshold of 0.7, indicating a good level of construct reliability. The alpha scores of the extracted factors ranged from 0.784 to 0.867. Similarly, the Cronbach's score for the complete dataset was 0.708, which was slightly higher than 0.70, indicating that the scale had good internal consistency and reliability. Reasonable standard deviation scores for all SC factors indicated an acceptable rate of data variability. The content validity of the SC scale has been confirmed in numerous studies (Hon, Chan and Yam, 2013; Zahoor et al., 2017a; Gao et al., 2016). All the items in each SC factor described almost the same construct, indicating face validity. Similarly, all items gained factor loadings above 0.5, indicating convergent validity. Finally, discriminant validity was obtained as cross-loading does not exist within the value of 0.2 and the factor correlation matrix presents values less than 0.7 (as shown in Table 7).

Table 7. Factor correlation matrix

SC Factors	MCC	WPAS	RSSR
MCC	–		
WPAS	0.329	–	
RSSR	0.588	0.022	–

DISCUSSIONS

The findings of the current study revealed differences and similarities to prior similar studies. In terms of the number of factors constructed, this study concurred with those of Hon, Chan and Yam (2013) who yielded a three-factor structure with 22 variables. The three-factor solution of this study explained 50.96% of total variance, which was higher than the results obtained by Fang, Chen and Wong (2006) and Hon, Chan and Yam (2013) at 47.6% and 48.20%, respectively. On average, the result of variance explained by three factors in this study was higher than most of the previous similar studies that could only explain less than 50% of the total variance (Bahari and Clarke, 2013; Choudhry, Fang and Lingard, 2009; Fang, Chen and Wong, 2006; O'toole, 2002; Zhou, Fang and Wang, 2008; Zhou, Fang and Mohamed, 2011), indicating comparable result findings. The three-SC dimensions also verified the SC factor statements defined in most research.

In comparison to the study by Zahoor et al. (2017a), the current study yielded different findings. This was most likely because of the adoption of their 45-SC variables with seven of the 22 SC variables. In this study, two variables (SC33 and SC38) were related to management commitment, four items (SC20, SC32, SC14 and SC35) associated with the applicability of safety rules and procedures and work practices and one item (C22) linked with individual responsibility and safety resources. Of the four SC items connected to safety implementation, only SC20 reached a satisfactory performance level (mean

3.01), while the others did not. Perhaps the applicability of safety rules and procedures and work practices was a major problem and the main issue for infrastructure construction projects (ICPs) in Indonesia. The findings also confirmed that SC variables in ICPs were significantly different from those in building projects and repair, maintenance, alteration and addition works. Additionally, of the seven SC statements added by Zahoor et al. (2017a), only two items (SC39 and SC45) appeared in this study, affirming that cultural and regional differences (Pakistan and Indonesia) influenced the SC variables.

Management Commitment and Communication

MCC were the most important SC of ICPs. This factor appears in every SC study on the construction industry using different terminologies (as shown in Table 1). In this study, the factor attained an acceptable performance rate (mean 4.08) and the highest percentage of variance (32.61%). An in-depth analysis of the related SC statements of ICPs found that a company's concern about people's health and safety in the project (SC08) constitutes the leading indicator of the SC of ICPs. Management commitment to safety has a significant impact on safety management enhancement in construction projects (Hon, Chan and Yam, 2013; Lingard, Cooke and Blismas, 2012). It is directly connected to safety leadership and is crucial for establishing safety policies and providing adequate resources for safety initiatives (Fang and Wu, 2013; Wu et al., 2015; Mohamed, 2002). This can increase compliance with safety rules and procedures and lessen the risk-taking attitude of workers (Fang, Chen and Wong, 2006). According to Zohar (1980), this factor plays a pivotal role in embodying a decisive safety culture by considering safety as an integration of production system components.

The factor has also been identified in several SC studies on the construction sector, such as in Gao et al. (2016). Management participation and commitment to safety includes allocating reasonable time to complete tasks (SC27), follow-up site inspection (SC28) and good communication by discussing health and safety matters (SC34, SC33 and SC21) (Choudhry, Fang and Mohamed, 2007). Furthermore, the management's contribution to safety can be observed from safety officers being empowered to conduct job hazard analysis (SC45) (Gao et al., 2016). Of the 10 SC scales of ICPs, two SC items (SC27 and SC38) had average scores ranging from 3.82 to 3.90. Wu et al. (2015) argued that the MCC factor has a significant influence on all the SC factors of ICPs; therefore, a slight improvement in management commitment and communication items would positively influence the advancement of safety performance. As a result, reasonable time allocation to complete tasks (C27) and follow-up safety inspections and reports (C38) may enhance safety performance in ICPs.

Responsibility for Safety and Safety Resources

The RSSR factor was found with slightly different terminologies from Alruqi, Hallowell and Techera (2018) (individual responsibility to health and safety), Zahoor et al. (2017a) (safety consciousness and responsibility) and Hon, Chan and Yam (2014) (responsibility for health and safety). Only in Fang et al. (2006) did safety resources exist as an SC dimension. While workers' responsibility for safety can be observed from the involvement and attention paid to workers' behavioural safety (Wu et al., 2015), safety resources reflect the investment allocated by management towards safety, which is 1.0% of the project scope for optimal safety investment (Shohet, Luzi and Tarshish, 2018). This factor had a 4.07 mean score, which fell slightly below the prime factor (mean = 4.08). This score indicated good consciousness (Barling, Loughlin and Kelloway, 2002) among employees about their responsibility for safety. However, this factor explained the minimum variance (5.85%) in the data set. A review by Zahoor et al. (2017a) showed that the SC variables regarding this factor spread among other factors, including management commitment and employees' involvement in health and safety (SC13, SC12 and SC24) and safety enforcement and promotion (SC16). In a study by Hon, Chan and Yam (2013), SC statements were found only in management commitment to OHS and employee involvement factors (SC13 and SC16).

A careful analysis of the SC variables in this factor showed that SC16 had a higher performance level (mean = 4.22), followed by SC13 with a mean score of 4.20. Similar to the first factor influencing other SC factors, a minor improvement could remarkably increase the safety performance. In the case of SC in ICPs, the availability of sufficient safety resources could be the focus (SC24 and SC22). This recommendation is in line with the findings that one of the leading issues in infrastructure project safety is the difficulty in finding or having safety resources (Choudhry, Fang and Ahmed, 2008; Bottani et al., 2009) and a lower budget for safety investment (Enshassi, Arain and Al-Raee, 2010; Ammad et al., 2020).

Work Practices and Applicability of Safety Rules and Procedures

The factor of WPAS did not reach a satisfactory performance level (mean = 2.69). However, it explained the second-highest variance (11.85%) in the dataset. This implied that the implementation of safety rules and procedures in ICPs was relatively weak, owing to the characteristics of the work sites in ICPs. A careful analysis of each SC variable revealed that any improvement of this factor in ICPs should focus on implementing: (1) safety rules and regulations and (2) safe work practices. In the context of safety implementation, actions can be directed towards compliance with safety rules and procedures (SC29, SC20 and SC35). Gao et al. (2016) opined that the form of action in SC could be a management policy and concrete actions from supervisors. Thus, management should actively involve project supervisors in communicating to workers that safety is the top priority in conflicting demands between productivity and safety (Sparer et al., 2013).

In addition, the direct impact of organisational culture on safety could be reduced by the project distance from the head office (Swuste, Frijters and Guldenmund, 2012). Thus, practical actions and attitudes of site supervisors can epitomise organisational commitment to safety. Lingard, Cooke and Blismas (2009) substantiated that the presence of supervisors' SC, such as supervisory personnel, significantly assists in the effectiveness of safety performance in road construction and maintenance groups. In terms of safety responsibility, safety behaviours at work can be promoted by involving co-workers (Meliá et al., 2008; Brondino, Silva and Pasini, 2012; Lingard, Cooke and Blismas, 2011) by means of working health and safety (SC26) and following safety rules and procedures (SC32). Generally, using the relationship between construction workers may lead to the development of safety beliefs as they are closer and believe more in each other.

CONCLUSION

The SC scale is adopted in construction projects from various cultures and regions to measure safety performance. However, the investigation of SC in Indonesian ICPs is scarce due to more attention being paid to general construction, building projects and repair, maintenance, alteration and addition work. This study aimed to determine the SC factors for ICPs in Indonesia. The SC data were gathered from a questionnaire survey distributed to five under-construction transportation infrastructure projects scattered across four provinces in Indonesia (Jakarta, West Java, Riau and Aceh). The EFA, used to identify the SC factors in Indonesian ICPs, found that in 22 SC items, three SC factors: (1) MCC, (2) WPAS and (3) RSSR explained 50.31% of the total variance. The MCC factor achieved the highest performance, followed by the RSSR factor. The MCC and RSSR factors explained 32.61% and 5.85% of the total variance, respectively. Another SC factor, WPAS, explained 11.85% of the total variance; however, it could not achieve a satisfactory performance level. Each factor showed good reliability and internal consistency for all the SC items as a group.

This study concludes that SC in ICPs in Indonesia needs significant improvement, particularly in the context of work practices and the applicability of safety rules and procedures. The lack of safety applicability was characterised by disobedience and indifference to health and safety rules and procedures. Furthermore, the irresponsible attitudes of construction workers and project supervisors, combined with the physical conditions of infrastructure sites which were not concentrated in one area, complemented the substandard safety performance. Project stakeholders should pay more attention to the enforcement of safety rules and procedures and simultaneously, actively involve project supervisors in monitoring and warning people who ignore health and safety procedures in a project.

In conclusion, this study provides the latest picture of SC in the ICPs in Indonesia and insights into the significance of each SC factor. This may help project participants execute ICPs to centralise their efforts in the dimension of disregarded and significant SC variables. The use of an existing SC scale in different types of projects, regions and cultures constituted one of the contributions of this study to the research domain of construction safety. The consequence is variance in SC factors, which may not have been identified in past research, such as the RSSR factor. This study did not attempt to develop and validate a scale to measure SC in ICPs, which could observe the correlation among SC factors. Thus, for future research, this study recommends CFA through structural equation modelling to investigate the significant relationships among factors/variables. In addition, the current study overlooked the exploration of SC scales from different stakeholder profiles, such as organisation and work experience. Therefore, it would be interesting to consider the SC variables from diverse perspectives.

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