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An Empirical Study of Workers' Knowledge, Attitudes, and Practices (KAP) Regarding Safety Risk Across Demographic Factors and Active BBS Organizations: A Factorial MANOVA Approach

(Kajian Empirik Pengetahuan, Sikap dan Amalan Pekerja (KAP) Berkenaan Risiko Keselamatan Merentasi Faktor Demografi dan Organisasi BBS Aktif: Suatu Pendekatan Faktor MANOVA)

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ABSTRACT

Construction is a high-risk sector, and construction workers engage in several activities that may expose them to grave risks. The conduct and qualities of workers may influence their awareness of workplace health and safety. Consequently, the purpose of this study was to investigate the knowledge, attitude, and practise (KAP) of employees regarding occupational safety in relation to individual characteristics and the interaction of the BBS programme at Malaysian construction sites. The one-way and two-way tests of multivariate analysis of variance were performed. Findings showed significant disparities in mean KAP scores across employee characteristics in relation to safety issues. Furthermore, the relationship between the BBS programme and personal characteristics was important in terms of employee safety attitudes and practises at the analysed construction sites. Enhancing safety (KAP) reduces employees' divergent perceptions of workplace health and safety while simultaneously enhancing safety behaviour.

Keywords: Behaviour-based safety; construction personnel; safety attitude; safety knowledge; safety practice; safety risk

ABSTRAK

Pembinaan ialah sektor berisiko tinggi dan pekerja binaan terlibat dengan pelbagai aktiviti yang boleh mendedahkan mereka kepada risiko besar. Kelakuan dan kualiti pekerja boleh mempengaruhi kesedaran mereka tentang kesihatan dan keselamatan tempat kerja. Oleh itu, tujuan penyelidikan ini adalah untuk mengkaji pengetahuan, sikap dan amalan (KAP) pekerja berhubung keselamatan pekerjaan berkaitan ciri individu dan interaksi program BBS di tapak pembinaan di Malaysia. Ujian sehala dan dua hala bagi analisis pelbagai variasi bagi varians telah dilakukan. Hasil menunjukkan perbezaan ketara dalam min skor KAP untuk ciri pekerja berhubung isu keselamatan. Tambahan pula, hubungan antara program BBS dan ciri peribadi adalah penting dari segi sikap dan amalan keselamatan pekerja di tapak pembinaan yang dianalisis. Meningkatkan keselamatan (KAP) mengurangkan persepsi berbeza pekerja terhadap kesihatan dan keselamatan tempat kerja sambil meningkatkan tingkah laku keselamatan pada masa yang sama.

Kata kunci: Amalan keselamatan; kakitangan pembinaan; keselamatan berasaskan tingkah laku; pengetahuan keselamatan; risiko keselamatan; sikap keselamatan

INTRODUCTION

Safety and health in the construction industry is the requirement that personnel provide a safe and healthy workplace for themselves and anyone who may be affected by its actions. Due to the higher rate of serious and fatal accidents in the construction sector compared to other industries, developing safety in the construction industry has remained a top priority in practically every country throughout the world (Ho et al. 2000). According to statistics from the International Labor Organization

(ILO), the construction industry has an atypically high number of reported accidents worldwide (International Labor Organization 2022). Similar to other emerging nations, the building business in Malaysia is becoming increasingly advanced and lucrative. According to the Malaysian Department of Occupational Safety and Health (2021) (DOSH) (Table 1), fatal accidents and injuries are still prevalent in this industry.

According to Sousa and Teixeira (2004), construction workers have twice the risk of being wounded and three times the risk of dying compared to those in other industries. Identifying hazardous factors that threaten safety is important so that actions can be planned to address the consequences of the hazard (Zamzuri & Isa 2022). According to Stanley (as referenced in Ogwueleka 2013), the majority of injuries in the construction business can be avoided by implementing an appropriate safety culture. A safety and health culture can be fostered by the implementation of work organisation procedures, the provision of information and training to employees, and the use of tools for inspection activities. These tasks are primarily concerned with the employee's knowledge, attitude, and practise. Companies with a solid occupational safety and health management system achieve acceptable levels of both safety and productivity (International Labor Organization 2004).

Preventative actions to improve health and safety in the construction industry could only be successful if workers' bad behaviour on building sites sparked concern (Tam & Fung 2008). A portion of this worry may relate to the personal traits and behavioural safety of employees in relation to knowledge, attitude, and practise. Since Zahoor et al. (2017), few studies have focused on evaluating the various safety behaviour and individual characteristics on the perception of safety KAP in developing countries, it is necessary to further investigate the relationship between employees' various safety behaviour and their characteristics on the perception of safety KAP in the construction industry. Thus, this research investigates the Knowledge, Attitude, and Practices (KAP) of construction industry personnel about safety across individual characteristics and the application of Behavior-Based Safety (BBS) in the Malaysian construction industry. The results serve to examine the influence of these two parameters on employees' perceptions of (KAP) to improve the safety and health of businesses as a whole. The relationship between employee safety knowledge, attitude, and practise and individual characteristics and BBS implementation is depicted in Figure 1.

TABLE 1. Occupational accident statistics by sector for Year 2021

Sector	NPD	PD	Death	Total
Hotel and Restaurant	125	1	0	126
Utilities (Electricity, Gas, Water and Sanitary Service)	198	1	8	207
Finance, Insurance, Real Estate and Busines Services	264	4	17	285
Construction	147	5	65	217
Transport, Storage and Comunication	281	5	6	292
Manufacturing	4015	206	48	4269
Wholesale and Retail Trade	182	3	2	187
Public Service and Statutory Authorities	68	2	4	74
Mining and Quarying	44	4	8	56
Agriculture, Forestry and Fishery	939	18	16	973
Total	6263	249	174	6686

Note: PD - Permanent Disability, NPD- Non Permanent Disability
Source: Department of Occupational Safety and Health Malaysia

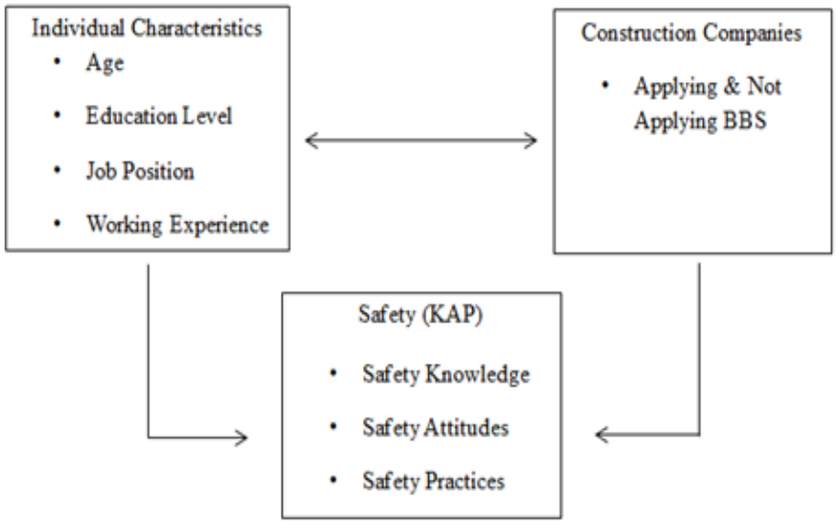

FIGURE 1. Study model

SAFETY KNOWLEDGE, ATTITUDE AND PRACTICE (KAP) ACROSS INDIVIDUAL CHARACTERISTICS

Knowledge of workplace safety enables employees to take responsibility for ensuring safety at work. Possessing a suitable safety attitude may involve being enthusiastic about safety-related activities, such as complying with safety policies and regulations at work or participating in safety training. Using safety measures in the workplace is an action that can prevent accidents. All of the aforementioned components (workers' safety knowledge, attitude, and practise) are essential for the mitigation and control of hazards and risk in order to ensure the highest degree of workplace safety and health (Onowhakpor et al. 2017).

Knowledge, attitude, and methods for practising health may vary greatly between demographic groups, depending on their unique social, cultural, or economic characteristics. The intervention for support, communication, and social mobilisation requires segmenting the survey population to reach specific audiences. The characteristics of the sample population may be related to geography, age, religion, socioeconomic status, language, and ethnicity (World Health Organization 2008). Consequently, examining the unique features of workers in relation to their perceptions of safety KAP is significant, as it enables organisations to make more informed decisions regarding employee safety training for improved performance.

Idungafa and Charles (2019) investigated the socio-demographic characteristics linked with knowledge of occupational hazard and safety measures among employees of selected downstream petroleum companies in Nigeria. They asserted that age, sex, and religion were strongly connected with employees' good level of awareness and practise on occupational hazard and safety measures, as well as their positive conduct on preventative measures. According to Nee and Sani (2011), there were notable mean differences observed in the associations between respondents' knowledge and their working experiences, attitudes and the training they attended, as well as the relationship between practise and gender. These differences were observed in the assessment of knowledge, attitudes, and practises among food handlers at residential colleges and canteens. Furthermore, the study conducted by Siti Nurul Ain, Sahilah and Razalee (2018) examines the significance of knowledge, attitude, and practise within the context of food handlers in Kuala Pilah. The researchers reach the conclusion that there is a need to prioritise continuous training programmes that specifically target the enhancement of knowledge, attitude, and practise regarding food utensil cleanliness among food handlers. Kurina, Wayne and Lendel (2015) found no significant gender differences in farmers' knowledge, attitudes, and perceptions of occupational health and safety risks. In addition, a substantial difference was discovered

between distinct farmer attitudes and characteristics (age and occupation) and the extent of communication attempts. Evaluation of demographic determinants on employees' safety perceptions in the construction sector by Han et al. (2019) indicated that education level did not influence employees' perception of safety hazards/accidents, but it could affect other general safety attitudes among managers and workers. Reportedly, there are gender-based perceptions of safety that vary significantly. Middle-aged personnel (37 to 46 years old) have a tendency to underestimate the safety risks associated with frequently encountered hazards. Age, gender, and education level have not been fully addressed in the construction safety subculture. In reality, socio-demographics play a vital role, since several researches have assessed workers' ability to estimate safety hazards, and the results indicate that employees perceive safety risk differently in identical situations (Ricci et al. 2021). Using the following hypothesis, this study endeavoured to analyse some of these socio-demographic indicators in the Malaysian construction workplace that were more essential to stakeholders.

Hypothesis 1: In construction sectors, perceptions of employee knowledge, attitude, and practises (KAP) regarding their individual characteristics vary.

BENEFITS OF BEHAVIOR-BASED SAFETY (BBS) ON SAFETY KNOWLEDGE, ATTITUDE, AND PRACTICE (KAP)

BBS is a peer-to-peer safety behaviour learning system. Concerns about one another's safety at work ultimately emerged (Kaila 2006). Employers have a responsibility to provide all necessary and practical steps to protect employees from health risks in the workplace. Evidence-based interventions that can improve work conditions or even target behaviour can benefit from evaluating employees' knowledge, attitudes, and practises about occupational safety and health on a daily basis (Goh & Chua 2016). Aiming employees' behaviour results in a decrease in accident occurrences at work, according to numerous research (Nunu, Kativhu & Moyo 2018). As a result, Behavior Based Safety (BBS) has become a crucial instrument in the majority of organisations for forming employees' behaviour and attitudes in a way that makes them aware and ensures that their actions and attitudes do not put them at risk for accidents (Sulzer-Azaroff & Austin 2000). A careful reading of the literature shows that demographic factors have a major impact on both the safety climate and personal safety behaviour (Jafari et al. 2014). Chi, Chang and Ting (2005) looked at construction site accidents in relation to demographic factors such age, gender, and job experience. They discovered that the perception of employees' safety conduct could be affected by demographic factors. Employees' self-reports of safe behaviour are substantially correlated with age, gender, educational attainment, and ethnicity, according to research by Nelson, Bolen and Kresnow (1998).

The KAP model states that a person's knowledge and attitude will impact behaviour linked to safety. According to this viewpoint, giving employees the appropriate knowledge about health hazards at work and how those hazards affect their well-being through (for example, brochures, safety courses, and safety campaigns) can alter their behaviour (Dyreborg et al. 2022). Notwithstanding the empirical data supporting the influence of safety knowledge, attitude, and practise on safety behaviour as well as the importance of individual traits, it is difficult to locate studies examining the connections between these factors in the context of Malaysian construction. As a result, the purpose of this study (Hypothesis 2) is to examine the relationship between the BBS programme and an employee's individual traits towards safety (KAP) in the workplace setting of construction.

Hypothesis 2: BBS implementation and individual characteristics (Age, Employment Position, Working Experience, and Education Level) influence employee knowledge, attitude, and practise (KAP) (Dependent Variables) in construction sectors.

METHODS

DATA COLLECTION

Data were gathered during the COVID-19 pandemic in the first quarter of 2021 for a cross-sectional study to evaluate the safety knowledge, attitude, and practise of construction employees in Malaysia. The knowledge, attitude, and practises of the workforce regarding occupational safety and health, which are unavoidable at workplaces, are investigated using a structured questionnaire. The questionnaire is divided into two sections. The first is demographic, asking about the respondent's age, education, employment status, and work history in addition to whether or not they use BBS in their organisation. The second section of the questionnaire consists of 19 questions that gauge an employee's perceptions of their level of safety-related knowledge (6 questions), attitude (6 questions), and

practises (7 questions). The survey questions were taken from research studies by Vinodkumar and Bhasi (2010, 2009). The survey items were coded so that a value of one set up to a response of strongly disagree, a value of two set up to a response of disagree, a value of three set up as neutral, a value of four set up as agree, and a value of five set up to a response of agree strongly. Prior to the actual data collection, a pilot study was conducted, and the instrument's dependability was determined (Table 4).

TABLE 2. Questionnaire items

	Safety knowledge
1	I know how to perform my job in a safe manner
2	I know how to use safety equipment and standard work procedures
3	I know how to maintain or improve workplace health and safety
4	I know how to reduce the risk of accidents and incidents in the workplace
5	I know what are the hazards associated with my jobs and the necessary precautions to be taken while doing my job
6	I know what to do and who to report if a potential hazard is noticed in my workplace
	Safety practice
1	I know safety issues have high priority in site training programs
2	I know training given to me is sufficient to enable to me to assess hazards in workplace
3	I declare that company training facilities and materials are in good condition
4	I witness that newly recruits are trained adequately to learn safety rules and procedures
5	I declare workers are involved in designing their own optimal safety learning processes
6	I know that it is important to encourage others to use safe practices
7	I declare that company safety training method is easy to understand
	Safety attitude
1	I feel that it is important to maintain safety at all times
2	I always carry out my work follow the safety rule and legislations
3	I feel that it is necessary to put efforts to reduce accidents and incidents at work place
4	I feel that it is important to encourage others to use safe practices
5	I feel that it is important to promote safety programmes
6	I feel that observing both the safe / unsafe behaviors of individuals and giving them feedback will improve the safety levels

To inform respondents of the purpose of the research being conducted, potential benefits, and instructions on how to complete the questionnaire were included in the questionnaire design. Before it, electronic versions of this structured, self-administered questionnaire were distributed to some Malaysian safety experts (three safety managers, a certified BBS trainer and two senior lecturers on safety and management study) besides construction workers (a foreman and an expert worker) through social media (WhatsApp) apps, and they were invited to participate. This was done for face and content validity. Responses were optional and kept in confidence. This study was given the go-ahead by the Universiti Kebangsaan Malaysia's Research Ethics Committee, and was given the approval number (UKM PPI/111/8/JEP-2019-816) for it.

Google forms as an online data collection platform were used to distribute questionnaire and collect data, due to the necessity of social distancing. A total of 189 questionnaires were collected, 16 were invalid and 173 respondents (more than the minimum required sample size (N=168)) were surveyed at 15 different construction sites including residential, commercial, and infrastructure projects throughout Malaysia (Wilayah Persekutuan, Selangor, Sarawak, Melaka and Sabah).

The total number of participants per group (sample size determination), is given using the following formula:

$$n = [(a + b + 1) * (p + q + 1)]$$

$$* \left[f^2 * \frac{(p + q + a + b + 2)}{(1 - R^2)} \right] \text{(Steven 2009)}$$

where n is the total number of participants required for the study; a is the number of predictors; p is the number of dependent variables; q is the number of covariates (if any); R^2 is the proportion of variance explained by the IVs; and f^2 is the effect size.

A total sample size of at least 168 participants would be required for a 3 dependent variable and 2 independent variable MANOVA with $a = 2$, $b = 4$, $p = 3$, and assuming a small effect size (f^2=0.1), a low-moderate R^2 value of 0.5, a power of 0.80, and a significance level of 0.05. The calculation is as follows:

n = [(2 + 4 + 1) * (3 + 0 + 1)] * [0.1 * (3 + 0 + 2 + 4 + 2) / (1 - 0.5)]

n = 42

Round up to the nearest integer to get the total sample size:

N total = $n * b$ *N* total = 168 (42 * 4)

In this study 87.3% of respondents (n= 151) were male and 12.7% (n=22) were female with mean age of 33.7 years old (SD= 9.74). Respondents average work experience was 10.4 years (SD= 8.04). Majority of respondents were workers with the rates of 36.4% (n=63) followed by managers 28.3% (n=49), supervisors 24.9% (n=43) and senior managers 10.4% (n=18).

DATA ANALYSIS

The research population's condition and the employees' perceptions of the safety KAP were examined based on their characteristics and the application of BBS, and descriptive and inferential statistics were used to do so. To do this, the internal consistency of the instrument's variables was examined using a reliability test. Additionally, the MANOAVA (One-way MANOAVA and Two-way MANOAVA) tests were used to test the associated hypothesis to fulfil the study's main objectives.

Factorial MANOAVA (Multivariate Analysis of Variance) is used to examine the effects of two or more independent variables (age, education, job position, and work experience) on various dependent variables (knowledge, attitude and practice). It is a MANOAVA extension that enables researchers to look at the effects of two or more variables on a variety of dependent variables. Factorial MANOAVA is used to examine potential interactions between independent variables and identify their primary influences on the dependent variables. Multiple factors' effects on various variables are tested using this method. It is an effective tool for examining the interactions between variables and figuring out their primary impacts on the dependent variables.

Factorial MANOAVA is like MANOAVA but includes phrases for independent variable effects. All analyses are performed with just 2 independent variables at a time, even if we are looking at 5 of them. One-way MANOAVA will be used to test H1, while two-way MANOAVA will be used to test H2. The general mathematical equation (Model Equations) for the two-way MANOAVA with three dependent variables can be written as follows:

$$Y = X\beta + E$$

where Y is an n *x* 3 matrix representing the three dependent variables namely *safety knowledge,attitude,and practice* (*Y*1.*Y*2,*Y*3 *respectively*); *X is an n* x (a-1)*

(b-1) design matrix representing the grouping structure based on the two independent variables *A and B whereby A and B* are all the demographics factor such as: (*age,education,job position,working experience and BBS status*). It consists of dummy variables to encode the groups formed by the combinations of levels of *A and B*. *β is a* ((*a*-1) * (*b*-1)) *x* 3 matrix of unknown parameters, where each element *βij* represents the effect of the ith group on the jth dependent variable. *E* is an n x 3 matrix of residual errors, representing the deviation between the observed data and the estimated model.

The goal of a two-way MANOVA is to estimate the parameters *β*, test for the significance of the effects of the independent variables and their interaction and assess the overall significance of the model. The results can indicate whether the grouping structure defined by the combinations of has a significant effect on the three dependent variables simultaneously. The related hypothesis are as follows:

Test for Main Effects

The null hypothesis for each test is that the means of the dependent variable are the same across all levels of the independent variable. If the null hypothesis is rejected, it suggests that the means of the dependent variable significantly differ among at least one level of the independent variable.

the hypotheses for testing the main effect of A on *Y*1, *Y*2, and *Y*3, are safety knowledge, attitude and practice, respectively:

H: $\mu A1 = \mu A2 = ... = \mu A(a\text{-}1)$

Ha: *At least one* μAi *is different*

Similarly, we can perform a one-way ANOVA to test the main effect of B on each dependent variable.

Test for Interaction Effect:

To test the interaction effect (*A* * *B*), we can use a two-way ANOVA for each dependent variable. The null hypothesis is that the interaction effect between *A and B* is not significant, meaning that the combined effect of *A and B* on the dependent variable is not different from the sum of their individual effects (*A and B* are all the demographics factors such as: (*age, education, job position, working experience and BBS status*).

The hypotheses for testing the interaction effect between *A* and *B* on *Y*1,*Y*2,and *Y*3 are:

*H*0: There is no interaction between *A* and *B*.

Ha: There is an interaction between *A* and *B*

Test for Overall Model Significance:

The overall significance of the two-way MANOVA model is tested using multivariate tests such as Wilks' Lambda ($\lambda = |E| / (|E + H|)$, |E| represents the determinant of the residual (error) covariance matrix). The test assesses whether there are significant differences in the combined effects of the independent variables (A and B) on the vector of dependent variables (*Y*1, *Y*2, and *Y*3) across all groups formed by their combinations.

The null hypothesis for these multivariate tests is that there are no significant differences in the combined effects of *A* and *B* on the dependent variables:

*H*0: *The model has no significant effect on the dependent variables* (*Y*1,*Y*2,*Y*3).

Ha: *The model has a significant effect on at least one dependent variable*.

If the null hypothesis is rejected, it suggests that the two-way MANOVA model has a significant effect on the vector of dependent variables, indicating that the grouping structure [1]defined by the combinations of A and B has a multivariate effect on the dependent variables.

Results

Before verifying each study hypothesis, Tables 3, 4 and Figure 2 summarised study descriptive statistic, instrument reliability and data set normality, respectively. This study's instrument has strong internal consistency with an average score of 0.87. Figure 2 showed all three dependent variables had normal distributions.

Individual Safety Knowledge, Attitude, and Practise (KAP): 1 Way-MANOVA

The first hypothesis examined employee knowledge, attitude, and practice (KAP) concerning occupational safety in construction sectors. This study uses one-way MANOVA to compare independent groups (age, education, job position, and work experience) on more than one continuous dependent variable (knowledge, attitude and practice).

TABLE 3. Frequency and percentage of employees' demographic variables and BBS implementation (N=173)

Variable	Frequency	Percentage
Age (years)		
<25	36	20.8
25-35	71	41.0
36-45	38	22.0
>45	28	16.2
Education		
School Level (SPM and below)	60	34.7
Skill Certificate	16	9.2
Diploma	39	22.5
Degree	35	20.2
Master	23	13.3
Job position		
Senior Manager	18	10.4
Manager	49	28.3
Supervisor	43	24.9
General Worker	63	36.4
Work experience (years)		
<5	43	24.9
5-10	68	39.3
11-15	22	12.7
16-20	13	7.5
>20	27	15.6
BBS practicing		
Yes	100	57.80
No	73	42.19

Note: SPM = end of the secondary education cycle certificate.

TABLE 4. Reliability statistics

Variables	Cronbach's Alpha (n = 173)
Safety knowledge	0.88
Safety attitude	0.90
Safety practice	0.83

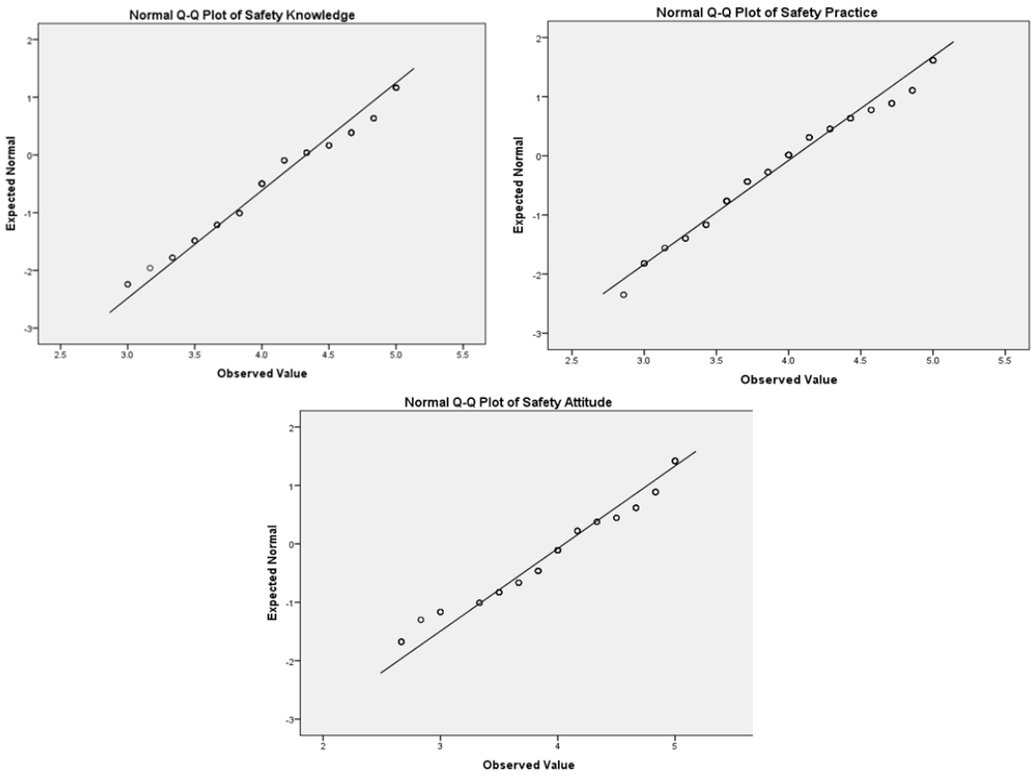

FIGURE 2. Normality assumption

Table 5 shows KAP survey means by employee age group. Findings showed significant mean differences between age groups and employee perceptions of safety knowledge (F= 3.70, p< 0.05) and attitude (F= 4.77, p< 0.01), but not safety practise (F=2.37, p > 0.05). At 90% confidence interval (CI), safety practise was significantly different by age group [3.94, 4.25]. Safety knowledge ($\eta^{2=}$0.057) and safety practise ($\eta^{2=}$0.042) were less affected by age than safety attitude ($\eta^{2=}$0.078). Safety knowledge, attitude, and practise are greater among older personnel. Table 6 demonstrates that employee safety training perspective does not differ by education level (F=1.11, p >.1). Nevertheless, safety knowledge and attitude significantly affected employee evaluations (F= 2.67, p< 0.05 and F= 6.53, p < 0.01). Hence, higher-educated construction workers may comprehend attitude better. Skilled workers have superior site safety knowledge. Educational level had a stronger influence on safety attitude than safety knowledge (η^2 = 0.135 vs. 0.060). Although no significant differences were found in employee safety practise, the mean value showed that employees with the highest education (Master degree) paid less attention to safety.

Table 7 shows how employment status affects safety (KAP) perception. The results show that individuals with various job positions had distinct safety knowledge (F= 4.09, p <.05) and attitude (F= 8.13, p <.01) at their workplace, but no significant difference was found between job position and safety behaviour (F=2.08, p >.1). Job status also strongly influences safety attitude (η^2 = 0.126). General employees had a lower mean score on safety knowledge and attitude in the examined work environment, indicating that associated authorities need to enhance their perception and performance.

This research found substantial variations in workers' working experience, safety practise, and attitude (Table 8). At 90% CI [3.87, 4.27], safety practise was significant. Different working experience had a greater impact on safety attitude than safety practise (η^2 = 0.152 vs. 0.046). Working experience did not significantly affect safety knowledge (F=1.85, p >.1). Employees under five and over twenty years old had high mean scores. That implies construction workers with five to twenty years of experience require greater safety training.

TABLE 5. KAP differences based on employee's age group

	Age						
	<25 (n=36)	25-35 (n=71)	36-45 (n=38)	>45 (n=28)	F	P values	Partial Eta Squared
Safety Knowledge	4.13±0.58	4.27±0.56	4.25±0.55	4.59±0.51	3.702	0.013	0.062
Safety Practice	4.20±0.51	4.00±0.66	3.93±0.61	4.26±0.53	2.374	0.072	0.040
Safety Attitude	4.01±0.57	3.90±0.87	4.07±0.55	4.48±0.47	4.779	0.003	0.078

P<0.1

TABLE 6. KAP differences based on employee's education level

	Education							
	School Level (n=60)	Skill Certificate (n=16)	Diploma (n=39)	Degree (n=35)	Master (n=23)	F	P values	Partial Eta Squared
Safety Knowledge	4.15±0.57	4.54±0.40	4.22±0.65	4.46±0.53	4.35±0.48	2.676	0.034	0.060
Safety Practice	4.02±0.56	4.22±0.49	4.13±0.74	4.14±0.64	3.87±0.49	1.111	0.353	0.026
Safety Attitude	3.70±0.84	4.15±0.48	4.29±0.56	4.25±0.67	4.22±0.43	6.532	0.000	0.135

P<0.05

TABLE 7. KAP differences based on employee's job position

	Job Position						
	Senior Manager (n=18)	Manager (n=49)	Supervisor (n=43)	General Worker (n=63)	F	P values	Partial Eta Squared
Safety Knowledge	4.49±0.47	4.47±0.52	4.18±0.64	4.16±0.53	4.097	0.008	0.068
Safety Practice	4.30±0.53	4.11±0.57	3.90±0.72	4.09±0.57	2.083	0.104	0.036
Safety Attitude	4.29±0.54	4.28±0.48	4.18±0.66	3.72±0.83	8.132	0.000	0.126

P<0.05

TABLE 8. KAP differences based on employee's experience

	Work experience							
	<5 (n=43)	5-10 (n=68)	11-15 (n=22)	16-20 (n=13)	>20 (n=27)	F	P values	Partial Eta Squared
Safety Knowledge	4.16±0.66	4.24±0.48	4.42±0.53	4.43±0.68	4.46±0.54	1.850	0.122	0.042
Safety Practice	4.17±0.75	3.97±0.53	3.93±0.51	3.98±0.63	4.29±0.59	2.007	0.096	0.046
Safety Attitude	4.30±0.63	3.78±0.77	3.85±0.68	4.08±0.57	4.49±0.45	7.516	0.000	0.152

P<0.1

BBS IMPACT TOWARDS SAFETY KNOWLEDGE, ATTITUDE, AND PRACTICE (KAP): 2-WAY MANOVA

The second hypothesis examined how BBS implementation and staff characteristics affect safety knowledge, attitude, and practise (KAP) in construction sectors. Two-way MANOVA is employed since the two independent factors (employee demographics and BBS) affect the three dependent variables (safety knowledge, attitude, and practices). Age and BBS had a statistically significant interaction impact on safety knowledge, attitude, and practise, F (9, 396) = 3.116, p =.001; Wilks'.847. Table 9 demonstrates that age group and BBS programme strongly affect safety attitude (p=0.000).

BBS-applied enterprises had a higher mean safety attitude score by age group than non-applied companies (Table 10). BBS-using employees over 45 years old had the greatest safety attitude impression (M= 4.58). BBS improves safety attitude across age groups, as seen by the lowest mean score of employees without BBS. The results also showed a significant interaction impact between education and BBS on safety knowledge, attitude, and practise, F (12, 426) = 1.887, p =.034; Wilks'.872. Table 11 shows that this interaction specifically connected to employees' safety attitude (p=0.001), but employee's education level and BBS programme did not significantly affect perception of safety knowledge and safety practise in examined construction sites. BBS programme implementation and personnel education increase safety attitude (Table 12). BBS practitioners had a higher mean safety attitude.

School education level employee had the lowest mean safety attitude score for both BBS and non-BBS companies. BBS practitioners had a higher mean score (M=4.22) than non-practitioners (M=3.17). This study also found a statistically significant interaction impact between job position and BBS on the combined dependent variables (safety knowledge, attitude, and practise), F (9, 396) = 2.409, p =.033; Wilks'.895. Table 13 shows that employment position and BBS programme interact to affect safety attitude (p = 0.002) and practise (p= 0.074). Nevertheless, employment status and BBS installation did not affect safety awareness.

Table 14 shows that BBS programme users had a better mean score for job-related safety attitude and practise. Senior manager with highest mean score (M = 4.58) had higher safety attitude in examined work setting. The BBS-applied construction site's supervisors (M = 4.29) and general employees (M = 4.24) had similar safety attitudes. BBS improves worker safety by interacting with their working situation. BBS organisations also had high worker participation (M = 4.47) in safety practises. Hence, BBS monitoring and positive reinforcement improved general workers' safety practises.

The results demonstrate no significant interaction impact between workers' working experience and BBS implementation on the combined dependent variables (safety knowledge, attitude, and practise), F (12, 426) =.996, p =.452; Wilks'.929. It reveals that working experience and BBS programme did not affect employee safety knowledge, attitude, and practise in examined construction work environment (Table 15). Table 15 showed that BBS programme can individually affect employees' safety attitude and practise (p =0.000) in tested work setting.

TABLE 9. Tests of between-subjects effects

Source	Dependent variables	F	p value
Age	Safety Knowledge	3.502	0.017**
	Safety Practice	2.834	0.040**
	Safety Attitude	8.034	0.000***
BBS	Safety Knowledge	0.012	0.914
	Safety Practice	14.584	0.000***
	Safety Attitude	22.693	0.000***
Age * BBS	Safety Knowledge	0.172	0.915
	Safety Practice	0.570	0.635
	Safety Attitude	7.388	0.000***

**Sig at 5%, ***Sig at 1%

TABLE 10. KAP differences based on interaction between BBS implementation and age

		Age			
	Applying BBS	<25	25-35	36-45	>45
	Yes	(n=21)	(n=41)	(n=22)	(n=16)
	No	(n=15)	(n=30)	(n=16)	(n=12)
Safety Knowledge	Yes	4.15±0.50	4.23±0.58	4.25±0.57	4.61±0.44
	No	4.12±0.69	4.33±0.54	4.26±0.54	4.56±0.61
Safety Practice	Yes	4.35±0.54	4.22±0.68	4.09±0.55	4.33±0.52
	No	3.99±0.38	3.70±0.52	3.71±0.64	4.15±0.56
Safety Attitude	Yes	4.16±0.65	4.37±0.56	4.14±0.58	4.58±0.43
	No	3.80±0.34	3.25±0.81	3.98±0.51	4.36±0.51

TABLE 11. Tests of between-subjects effects

Source	Dependent Variables	F	p value
Education	Safety Knowledge	2.428	0.050**
	Safety Practice	1.048	0.384
	Safety Attitude	7.394	0.000***
BBS	Safety Knowledge	0.134	0.715
	Safety Practice	10.773	0.001***
	Safety Attitude	15.928	0.000***
Education * BBS	Safety Knowledge	0.038	0.997
	Safety Practice	1.194	0.315
	Safety Attitude	5.109	0.001***

**Sig at 5%, ***Sig at 1%

TABLE 12. KAP differences based on interaction between BBS implementation and education

		Education				
	Applying BBS	School Level	Skill Certificate	Diploma	Degree	Master
	Yes	(n=30)	(n=7)	(n=30)	(n=21)	(n=12)
	No	(n=30)	(n=9)	(n=9)	(n=14)	(n=11)
Safety Knowledge	Yes	4.14±0.47	4.47±0.45	4.21±0.63	4.46±0.56	4.34±0.53
	No	4.16±0.65	4.59±0.38	4.25±0.76	4.45±0.52	4.36±0.43
Safety Practice	Yes	4.34±0.54	4.38±0.47	4.20±0.76	4.28±0.56	3.90±0.28
	No	3.70±0.39	4.09±0.49	3.88±0.64	3.92±0.71	3.84±0.67
Safety Attitude	Yes	4.22±0.66	4.40±0.39	4.31±0.53	4.46±0.65	4.22±0.45
	No	3.17±0.65	3.96±0.46	4.24±0.69	3.95±0.60	4.22±0.43

TABLE 13. Tests of Between-Subjects Effects

Source	Dependent variables	F	p value
Job Position	Safety Knowledge	4.101	0.008***
	Safety Practice	4.410	0.005***
	Safety Attitude	9.388	0.000***
BBS	Safety Knowledge	0.051	0.822
	Safety Practice	18.436	0.000***
	Safety Attitude	22.745	0.000***
Job Position * BBS	Safety Knowledge	0.271	0.846
	Safety Practice	2.353	0.074*
	Safety Attitude	5.117	0.002***

*Sig at 10%, ***Sig at 1%

TABLE 14. KAP differences based on interaction between BBS implementation and job position

		Job position			
	Applying BBS	Senior Manager	Manager	Supervisor	General Worker
	Yes	(n=6)	(n=30)	(n=33)	(n=31)
	No	(n=12)	(n=19)	(n=10)	(n=32)
Safety Knowledge	Yes	4.61±0.49	4.43±0.50	4.17±0.68	4.18±0.41
	No	4.43±0.48	4.54±0.55	4.15±0.54	4.18±0.64
Safety Practice	Yes	4.47±0.40	4.19±0.48	4.01±0.75	4.47±0.47
	No	4.21±0.58	3.97±0.67	3.51±0.44	3.72±0.39
Safety Attitude	Yes	4.58±0.46	4.34±0.46	4.29±0.60	4.24±0.68
	No	4.15±0.54	4.19±0.50	3.83±0.76	3.21±0.64

TABLE 15. Tests of between-subjects effects

Source	Dependent variables	F	p value
Experience	Safety Knowledge	1.708	0.151
	Safety Practice	2.419	0.051**
	Safety Attitude	10.121	0.000***
BBS	Safety Knowledge	0.054	0.816
	Safety Practice	12.861	0.000***
	Safety Attitude	28.195	0.000***
Experience * BBS	Safety Knowledge	0.342	0.849
	Safety Practice	0.567	0.687
	Safety Attitude	1.659	0.162

**Sig at 5%, ***Sig at 1%

DISCUSSIONS

Behaviours at work impact safety and productivity. Labour accidents are largely caused by employees' dangerous actions, according to studies (Nguyen 2020). According to Dainty, Bryman and Price (2002), boosting employee engagement and autonomy facilitates all lean construction approaches and improves organisation efficiency and effectiveness. The benefits of employee engagement in construction are well recognised. Thus, this study examined how staff characteristics and BBS programme practice affect safety (KAP) perception.

SAFETY KNOWLEDGE, ATTITUDE, AND PRACTICE (KAP) ACROSS INDIVIDUAL CHARACTERISTICS

This study found substantial disparities in employee knowledge, attitude, and behaviours (KAP) concerning occupational safety in construction industry. Safety knowledge and attitude varied by age, education, and work category. Employees under 25 and between 25 and 35 exhibited worse safety awareness and attitude, respectively. It is also found that employees with the lowest education level and employment rank had the weakest safety awareness and attitude. It was clear that younger workers and those with less education and lower employment positions should focus on increasing their safety knowledge and attitude to improve construction site safety. Nevertheless, education level and employment position did not affect safety practise at analysed construction sites. Nonetheless, study found minimal significant differences between employee age groups and safety practise at 90% confidence interval. Findings showed that personnel between 25 and 45 years old and 5 to 20 years of working experience had a worse impression of safety practise, requiring more attention to improve safety at examined construction sites. Safety involves several operations on a building site; thus all personnel must participate. Relevant authorities must address workers' diverse safety practises. Employees with varying levels of work experience have varied safety attitudes, according to the study. Meaning that there is a deficiency on the perception of safety attitude on employees with reference to work experience, and associated organisations must focus more on employees with various working experience and strive to balance their viewpoint towards safety attitude on investigated construction site.

Kyaw, Oo and Mya (2015) found similar results on construction employees' knowledge, attitude, and practise of occupational hazard safety measures. Socio-demographic factors affect occupational safety measures, they said. Their findings showed that, age, education, job duty, worker type, and skill training attendance were found to have statistically significant influence on employees' knowledge, but there was no correlation between socio-demographic variables and employees' practice. Nasab et al. (2009) assessed workers' knowledge, attitude, and behaviour towards occupational safety and health in a petrochemical complex and found significant mean differences between workers' safety knowledge and level of education and between workers' attitudes with different age groups and job experiences. They also found substantial mean differences between safe conduct and workers' age and working hours. In Ablon et al. (2019)'s study on construction workers' knowledge, attitude, and practises (KAP), socio-demographic characteristics including age, married status, education, job type, and more affected KAP on work risks. Construction employees' knowledge levels did not differ by civil status, educational achievement, or job category, they found. Nonetheless, age groups have statistically significant differences in knowledge ratings. According to this study, elder workers aged 46 and older had a much better degree of knowledge than younger workers. This suggests that senior employees can occasionally learn self-protection.

According to this study and related literature, while planning, implementing, and offering safety and health programmes, organisations should consider employees' age, education, and employment position. After each significant modification, construction managers should evaluate employees' safety knowledge (KAP) and offer system and employee comments. Hence, each building site must undergo ongoing auditing, inspection, observation, and feedback sessions.

BEHAVIOR BASED SAFETY (BBS) AND PERSONAL CHARACTERISTICS AND SAFETY (KAP)

BBS implementation and individual factors (age, education, and organisational position) affected construction workers' knowledge, attitude, and practise (KAP). Employee safety attitude perception was associated with strong significant mean differences of this interaction. In addition, BBS implementation and employee organisational position had a modest significant mean difference on safety practise. Results demonstrate that personnel with varied socio-demographic backgrounds in examined construction sites who applied BBS programme had better mean score on safety attitude knowledge than those who did not. The highest-educated,

oldest, and most senior personnel had the best safety attitudes. However, no significant interaction between BBS programme and employees' working experience shows that employees with different working experience had almost similar perception of safety (KAP) and BBS programme could not make differences via working experience on their safety knowledge, attitude, and practise.

BBS methods focus on identifying and changing key safety behaviours to reduce workplace injuries and losses. These safety management methods urge employees to make safe conduct a habit so they operate safely without thinking (Li et al. 2015). Geller (2001) said that BBS programmes focus on acting people into thinking differently rather than addressing internal awareness or attitudes to think people into behaving differently, hence the relationship between personal traits and safety attitude is vital.

BBS implementation requires employee participation in decision-making, according to Cooper (1999). They should be informed throughout. Without personnel in the BBS programme, the programme will fail. Hence, BBS requires workers from varied backgrounds to have similar awareness of their organization's safety and health programme. According to this study, there was no significant interaction between personnel characteristics and BBS programme on safety awareness at surveyed construction sites. BBS encourages employees to enhance safety, which may boost workplace performance (Cox, Jones & Rycraft 2004; Dejoy 2005). BBS contact with job position improves safety, according to one study. In reality, BBS improves employer-employee communication. Leaders (employers) said that BBS information helps employees communicate with their employers about dangers exposure instead of just complaining about safety difficulties. Leaders can also demonstrate how they manage threats based on data. These acts increase employees' faith in their leaders and give them confidence that the company is serious about safety. Consequently, the more successful BBS process collaborates to improve safety practises (Spigener, Lyon & McSween 2022). Hence, considerable interaction between BBS programme and employment position to enhance safety practise at researched construction sites is noteworthy.

BBS also promises to give businesses the tools to modify workers' safety attitudes and habits (Jasiulewicz-Kaczmarek, Szwedzka & Szczuka 2015). This conversion will work better with employee socio-demographic characteristics. 'Attitude towards behaviour' refers to the positive or negative judgement of self-performance of the activity to be completed (Zulkifly et al. 2021). A good BBS programme promotes safety-oriented behaviour. Consequently, at the tested construction sites, considerable interaction between employee age, education, and organisational position and BBS programme on safety attitude was accepted.

BBS should prioritise employee safety mindset above company safety programme, according to the aforementioned arguments. When participating in BBS, employees' personalities affected their safety attitudes. Hence, creating an effective BBS programme using demographic information is required in investigated work environments.

Conclusion

This article examined ways to assess employees' safety knowledge, attitude, and practises using BBS program and demographic data. A questionnaire was taken online. According to the study, personnel in researched construction sites had diverse knowledge, attitudes, and practises regarding health and safety concerns based on socio-demographic characteristics. Results also showed that BBS programme and personal factors affected employee safety attitude and practise. Varying perspectives on safety knowledge, attitude, and practise make it difficult to discover potential for safety performance and industrial success. To eliminate dangers and ensure safe operations, employees' safety behaviour and performance must be understood. Using BBS will also enable investigated construction sites adapt employee safety attitudes of diverse socio-demographic characteristics to improve workplace safety and health. Consequently, examined firms should focus more on knowledge, attitudes, practise, and behaviour as supplement activities to improve employee occupational safety and health.

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