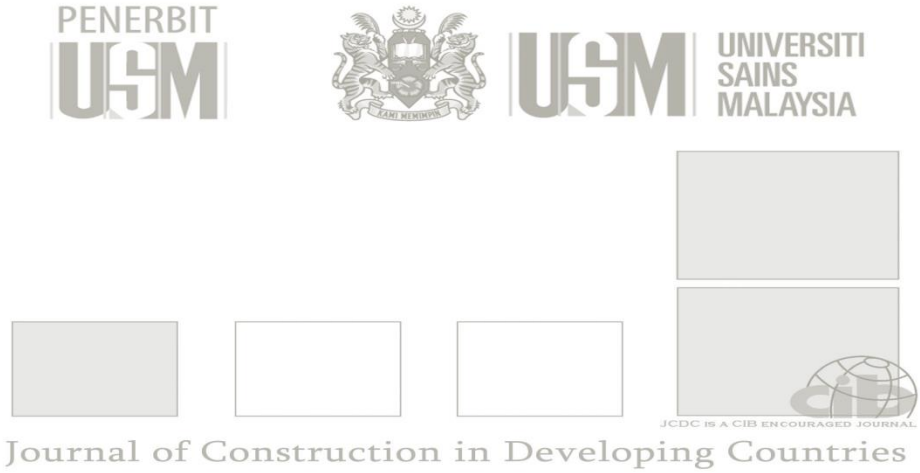

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Assessment of non-verbal safety training for construction novices: A comparative experiment in Japan and Malaysia

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Abstract: Safety and health training for construction novices is becoming increasingly important to prevent work-related accidents in construction projects, both in developed and developing countries. A comparative experiment was conducted among over 100 undergraduates studying the basics of construction management in Japan and Malaysia to compare the effectiveness of the teaching methods among the students in both countries. Statistical analyses were performed using SPSS 16.0. Although basic safety training, such as the use of personal protective equipment and lifting operations, can be emphasised verbally or nonverbally during regular training, safety training related to high-risk activities, such as work at height, is more effective when conducted through nonverbal methods. Statistically, the nonverbal method results in less variations in understanding among students than the verbal method; regardless of their nationality, construction novices were able to score higher points after nonverbal training. We

determined that nonverbal safety and health training methods were effective for training construction novices. In future, the government or relevant authorities should design nonverbal safety teaching content related to construction safety based on the prevailing conditions in the country.

Keywords: Nonverbal, construction safety, novices, Japan, Malaysia

INTRODUCTION

The construction industry is hazardous because of the complexity of the working environment (Fang and Wu, 2013), heavy reliance on the migrant workforce (Ismail et al., 2018), and challenges such as language barriers (Oswald et al., 2019) and different cultures of safety on construction sites. Although the construction industry accounts for 5%–10% of workforce employment, it has a high rate of recorded accidents, accounting for 30% of all fatal occupational accidents globally (International Labour Organization (ILO), 2021).

Nearly 80% of fatal construction accidents are caused by unsafe worker behaviour (Liu and Tsai, 2012; Li et al., 2015; Department of Occupational Safety and Health (DOSH), 2020). A lack of safety training negatively affects construction safety performance (Priyadarshani, Karunasena and Jayasuriya, 2013). Young workers (18–24 years old) are vulnerable to safety problems and accidents in the workplace due to inadequate safety and health training and a lack of safety awareness (Ajslev et al., 2017; Hanvold et al., 2019).

Researchers have conducted preliminary studies on the level of effectiveness of safety training assessments, focusing on monitoring the effectiveness of safety training from both organizational and worker perspectives, which helps organizations better understand what makes training effective or ineffective (Vignoli, Punnett and Depolo, 2014). However, the effectiveness of safety training methods and their implementation in the construction industry remains controversial owing to a weak safety culture, unclear worker attitudes, and a lack of understanding regarding safety training programs (Ajslev et al., 2017).

Current safety training settings fail to develop the necessary risk awareness among construction workers (Albert, Hallowell and Kleiner, 2014; Albert et al., 2014), and existing safety training methods in developing countries tend to be low-engagement methods. Some researchers have argued that low-engagement methods such as video demonstrations are not ideal for educating construction workers (Guo et al., 2012).

Moreover, safety training for construction workers is voluntary in the Malaysian construction industry, which may lead to a high incidence of construction accidents, especially among novices such as university students who may be young and inexperienced in the construction field. Therefore, safety training must be implemented as early as possible before working at construction sites to improve worker risk identification (Cheng and Wu, 2013).

There is limited research on the content and methods of novice construction safety training and the effectiveness of such training methods. It

is important to examine whether the use of nonverbal safety training content is effective in enhancing construction safety awareness among construction novices (even if they have no on-site experience) and whether it helps to develop risk identification skills that current safety training settings fail to do. Therefore, this study aimed to assess the effectiveness of safety training materials for construction novices. The objectives were as follows: 1) to identify safety training content that would enhance novices' understanding of safety knowledge on construction sites and 2) to compare effective teaching methods used among construction novices from different countries of origin to achieve a certain level of safety knowledge. The following section describes the current status of construction safety training in developed and developing countries and safety training content and methods used in the construction industry.

LITERATURE REVIEW

Construction Safety Training in Developed and Developing Countries

In Japan, the construction accident rate (per 1,000 employees) that was recorded as 7.26 in 1996 reduced to 4.50 in 2019 after the establishment of the Japan Industrial Safety and Health Act (JISHA) in 1972 (JISHA, 2020). In Malaysia, the number of construction accident increased by almost 41% from 232 cases in 2018 to 326 cases in 2019 after the launch of the Occupational Safety and Health Master Plan 2016-2020 (DOSH, 2020). Several studies have investigated the safety and health performance of developed and

developing countries (Teo, Theo and Feng, 2008; Raheem et al., 2011), and the results have shown significant differences in accidents rates.

Japan has made remarkable improvements in safety and health by reducing accident rates. This improvement is consistent with the implementation of the JISHA (1972). For instance, Article 59 of the law stipulates that employers should provide all workers with construction-related safety and health education, including i) how to handle hazardous harmfulness of materials or machinery, ii) how to use safety devices, devices that control harmful substances, or personal protective equipment (PPE), iii) operation procedures, iv) inspections at the commencement of work, v) causes and prevention of illnesses related to the work, vi) housekeeping and cleanliness maintenance, vii) emergency measures and evacuation in case of accidents. The above enforcement action demonstrates the Japanese government's commitment to promoting safety education for construction workers, which in turn increases workers' safety awareness and reduces accidents at construction sites.

In Malaysia, the provisions of the Occupational Safety and Health Act (OSHA) 514 are based on a self-regulatory approach. The act stipulates that employer should provide the necessary training to employees. In addition, the Malaysian Occupational Safety and Health Management System (OSHMS) guidelines state that organizations should develop their own safety training modules on specific topics for workers and implement them with the help of qualified personnel. However, the standards for construction safety

training are low, and the contents of necessary safety education are not specified in the act.

Research has shown that providing safety training is effective in educating and changing worker behaviours regarding construction safety issues by enhancing situational awareness of construction sites (Li, Chan and Skitmore, 2012a; Jeschke et al., 2017; Winge, Albrechtsen and Mostue, 2019; Vignoli et al., 2021; Wang, Jiang and Blackman, 2021). Studies have shown that a safety program is most effective during the plan preparation and pre-construction phases; thus, it is necessary to educate construction novices beforehand (Esmaeili and Hallowell, 2012). Moreover, age is a key factor contributing to unsafe behaviours and accidents, and young people are less likely to use protective equipment (Lombardi et al., 2009). Therefore, focusing on the developmental characteristics of young workers who interact with hazards is essential in developing effective preventive interventions (Sámano-Ríos et al., 2019).

Construction Safety Training Contents

Safety training can enable the cultivation of a safety culture and improve the safety motivation of workers in high-risk industries (Hutchinson et al., 2022). Therefore, safety training should address these issues to effectively reduce construction accidents. Fall protection, PPE, tools, material handling and lifting are common concerns for large and small construction companies (Cunningham et al., 2018). However, falls from heights have the highest frequency and fatality rates among all types of accidents at construction

sites, which are attributed to workers' unsafe behaviours, non-compliance with work-safe procedures, and improper use of PPE (Nadhim et al., 2016; Hoła et al., 2017; Muhamad Zaini et al., 2020). Although falls from heights are common and critical accidents, they have not received sufficient attention from stakeholders (Nadhim et al., 2016). Taking precautions is the most important method of protection at the site, and education and training are primary priorities in preventing accidents. Therefore, there is a need for effective methods to prevent construction accidents by providing safety training content for construction novices in response to these accidents.

Safety Training Methods

Various safety training methods have been introduced to shape the safety behaviours of construction workers. Many developed countries, such as the United States, the Republic of Korea, and China, are developing computer software, including virtual reality technology, to facilitate learning by providing virtual environments, thereby improving learning outcomes (Teizer, Cheng and Fang, 2013; Evaoff et al., 2016; Hou et al., 2017; Li et al., 2018; Nykänen et al., 2020; Zhang et al., 2020; Zhu et al., 2022). In particular, less information presented in a visual format, such as a video, is the best for stimulating learning across age groups (Wallen and Mulloy, 2006). However, training using low-engagement methods is common in the construction industry (Cunningham et al., 2018).

Traditional safety training, also known as low-engagement methods, includes classroom lectures, videos, toolbox meetings, text-based print

materials, and audio-visuals and can reduce accidents by improving workers' knowledge acquisition and by behaviour alteration (Blanchard and Simmering, 2014; Gao, Gonzalez and Yiu, 2019). Moreover, because of limited budgetary allocations for construction safety, construction companies implement such training regularly, as it sufficiently enhances workers' safety knowledge (Gao, Gonzalez and Yiu, 2019).

The use of nonverbal materials, such as short videos (with or without audio aids), for better knowledge transfer to construction novices has the potential to address safety issues (Zujovic, Kecojevic and Bogunovic, 2021). Using videos to communicate safety and health information to workers onsite has proven popular among workers (Edirisinghe and Lingard, 2016). Visual teaching gives the receiver a sense of reality and deepens memory. Research has shown that the use of visualization in safety training leads to better and easier understanding of safety content by workers and enhances their interest in safety training (Bust et al., 2008; Li, Chan and Skitmore, 2012b). The use of videos as a teaching method can aid in effectively delivering information and maximize the learning experience (Brame, 2016). Furthermore, nonverbal safety materials have been implemented in Japan (Ministry of Health, Labour and Welfare, 2023).

Researchers have found that younger workers, who possess less safety knowledge than experienced workers, are likely to be concerned about safety and are willing to learn (Loosemore and Malouf, 2019; Shuang et al., 2019). Thus, although effective delivery of safety training and knowledge is

based on worker preferences such as age, educational background, and culture (Baseline Survey Construction Report, 2015), lack of a uniform language may lead to miscommunication in safety education (Ismail et al., 2018; Arif et al., 2021). As low-engagement methods are common in the construction industry, they allow trainers to introduce novices to basic safety knowledge in a relatively short period, forming a better foundation for learning (Pui Teck and Mohd Asmoni, 2015).

To the best of our knowledge, few studies have been conducted on safety training for novice construction workers. As more young workers of different nationalities join construction sites and face challenges, such as lack of experience, language barriers, and cultural differences (Li, Tang and Chau, 2019), the use of nonverbal safety training may be effective in raising safety awareness among construction workers. As part of creating a safety culture, using a combination of images and text, video lectures, and oral presentations during early safety training is essential to protect workers from construction accidents (Başağa et al., 2018). Researchers have claimed that safety training should be conducted in stages, beginning with the use of rational and less engaging methods to impart declarative safety knowledge (Brahm and Singer, 2013).

RESEARCH METHODS

Given that this was a cross-national experiment, the participants had to be volunteers who would work in the construction industry in the future and

currently held the relevant qualifications. A total of 136 undergraduates were recruited by the authors at their respective institutes to participate in this experiment to capture differences in the understanding of safety knowledge among construction novices of different nationalities after receiving training using different safety training methods. A total of 71 Japanese undergraduates (Project Management in Building Construction) and 65 Malaysian undergraduates (Construction Management) volunteered to participate in the experiment, and their ages ranged between 20–24 years.

Convenience sampling was used in this study. Convenience sampling is most commonly used in the exploratory phase of research to obtain information quickly and efficiently (Sekaran, 2003). All the participants had similar educational qualifications and had studied the same courses related to building construction safety at their respective universities; thus, the study population was similar, and it was possible to draw implications about how different safety training methods affect different nationalities. In addition, sample sizes larger than 30 and smaller than 500 are considered appropriate for most studies (Sekaran, 2003). Shuang et al. (2019) conducted a similar experiment to explore the relationship between age, sex, and accidental unsafe behaviours. Shuang et al. (2019) interviewed safety managers to determine their perceptions of the safety of workers of different ages and genders in the construction industry. However, this comparative approach provides insights rather than quantitative data. The quantitative approach provides a "snapshot" of the experimental data, whereas the qualitative

approach helps in gaining an understanding and provides information to develop a theory (Fellows and Liu, 2022).

In this study, a comparative experiment was used to compare the performance of two groups of novices (of the same age range) from different countries after receiving training through different teaching methods. As non-parametric tests do not involve distributions and are more flexible in their application, they were used to examine the similarities and differences between the two groups using a rank sum test (Fellow and Liu, 2022).

The mean scores of participants for the two safety training methods were compared, and the results were analysed using frequency statistics among the groups to interpret each question in each section. As the data from the two groups were not normally distributed (Figure 1), the Mann-Whitney U test, a non-parametric test, was used to measure the discrepancy between the mean ranks of the two groups (Fellows and Liu, 2022). The Mann-Whitney U test ranks all values ascending with a p-value; the smaller the p-value (less than 0.05), the more significant the difference between the two groups. The details of these tests are provided below.

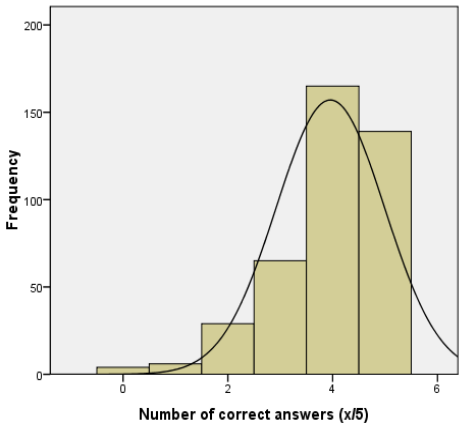

Figure 1. Overall distribution of responses

Overview of the experiment

An experiment was conducted in two countries with a group of instructors over a specified period. The participants were categorised into two independent groups based on their nationality, and Japanese and Malaysian instructors introduced the experiments to participants in each group. The medium of instruction was Japanese for Japanese participants and English for Malaysian participants via the default platform. The two independent groups were further segregated into two subgroups to impart training using different training methods. For instance, one subgroup received training on a safety method with verbal explanations, texts, and pictures, while the other group received training only using video content without verbal explanations or subtitles (Table 1). Each participant was immediately assessed after the safety training. *Google* Forms were used for safety training assessments to control response times. Safety training and assessment for each subgroup lasted approximately one hour.

		Training method		
Group	Population	Verbal	Nonverbal	total
1	Malaysian undergraduates	33	32	65
2	Japanese undergraduates	36	35	71
	Total	69	67	136

Table 1. Experiment population

Rationale of the Safety Training Contents and Questions Design

The safety training contents used in the experiment were produced by *Planex*, Japan, based on the realities of the Japanese construction industry and to suit Japanese construction practices. They may be useful for the Malaysian

construction industry, as construction accidents, such as falls from height, being caught in between, or hit, or crushed, are similar in both countries. However, as the safety training content was designed for the Japanese construction culture, and given the differences in safety culture between the two countries, the training content may have created a sense of unfamiliarity for Malaysian participants and led to differences. The selected training content was based on common accident types and causes reported by DOSH and JISHA. The duration of safety training is positively correlated with construction risk awareness (Yao et al., 2021). Therefore, the safety education contents produced by *Planex* Japan consists of ten safety elements, each consisting of less than two minutes of content to capture students' attention and optimize learning (Brame, 2016). The contents of the safety training for the ten elements were categorised into three sections: PPE, work at height (WaH), and lifting operations and site cleanliness. Participants received the same safety training content, such as how to wear PPE (including a safety helmet and full harness type of safety belt), how to use hand tools, how to work safely on a portable workbench, up and down work, housekeeping at the construction site, and lifting operations at the site via the default platform. These topics reflect unsafe working behaviours, procedures, and site conditions, as suggested by Liu and Tsai (2012).

The assessment questions were designed according to the safety training contents produced by *Planex*, Japan. With reference to the health, safety and environment tests for operatives and specialists published by the Construction Industry Training Board, UK, multiple choice questions (MCQs)

with four options were used for the assessment. MCQs are widely used in higher education because of their high reliability, rapidity and openness to item analysis (Denhad, Nasser and Hosseini, 2014). They help determine how well a student understands the test material, and allows students to succeed when they have the required knowledge. Three experts formulated and reviewed the questionnaire.

The questions were designed according to the safety training sections (five questions per section). The questions were prepared in Japanese and English to accommodate all participants and eliminate language issues. The participants were requested to answer the questions via a *Google* form provided by the instructors after the safety training. Each question that participant answered correctly, counted towards their average score for that section.

DATA ANALYSIS

The obtained data were statistically analysed using the Statistical Package for the Social Sciences (SPSS, version 16.0). The mean rank of the correct answers for each group with different safety training methods was analysed.

ANALYSIS OF THE FINDINGS

The test scores were compared to determine the immediate effectiveness of both training methods. First, participants test scores were compared between the groups, based on whether verbal or nonverbal training methods were

used. The average score of the participants in 3 sections out of 15 were 10.94 (Group 1 verbal), 11.34 (Group 1 nonverbal), 12.03 (Group 2 verbal) and 13.06 (Group 2 nonverbal). All participants scored 4 or more (Group 1 verbal: 4.09, non-verbal: 4.31; Group 2 verbal: 4.31, non-verbal: 4.54) on the PPE section. However, participant scores for the WaH section were less satisfactory (Group 1 verbal: 2.58, nonverbal: 2.84; Group 2 verbal: 3.28, nonverbal: 3.63). Finally, participants scored 4 or more (Group 1 verbal: 4.27, nonverbal: 4.19; Group 2 verbal: 4.44, nonverbal: 4.89) as the average score for lifting operations and site cleanliness. The average scores for the three sections are shown in Figure 2.

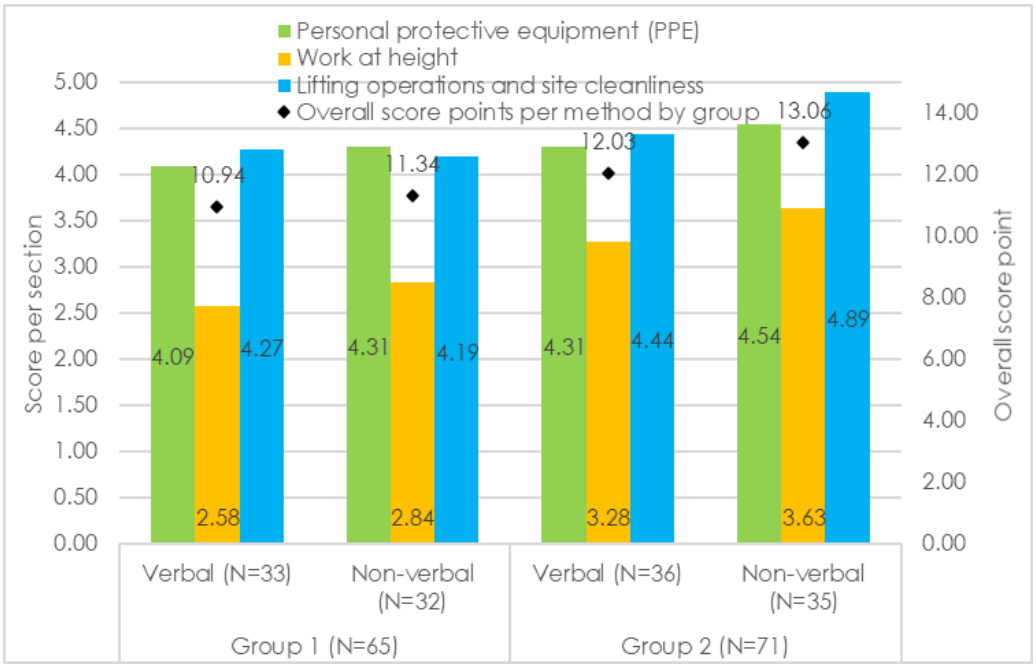

Figure 2. Overall scores for verbal and nonverbal methods

Trend of Answers per Section

The trend of answers to questions on PPE, WaH and lifting operations and site

cleanliness are shown in Figures 3–7, 8–12 and 13–17, respectively. The discussion is presented accordingly.

Personal Protective Equipment (PPE)

For the first question, "*The safest way to wear a safety helmet*", 88% and 94% of the participants from Group 1, and 86% and 89% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*Straight and deep headgear*" (Figure 3).

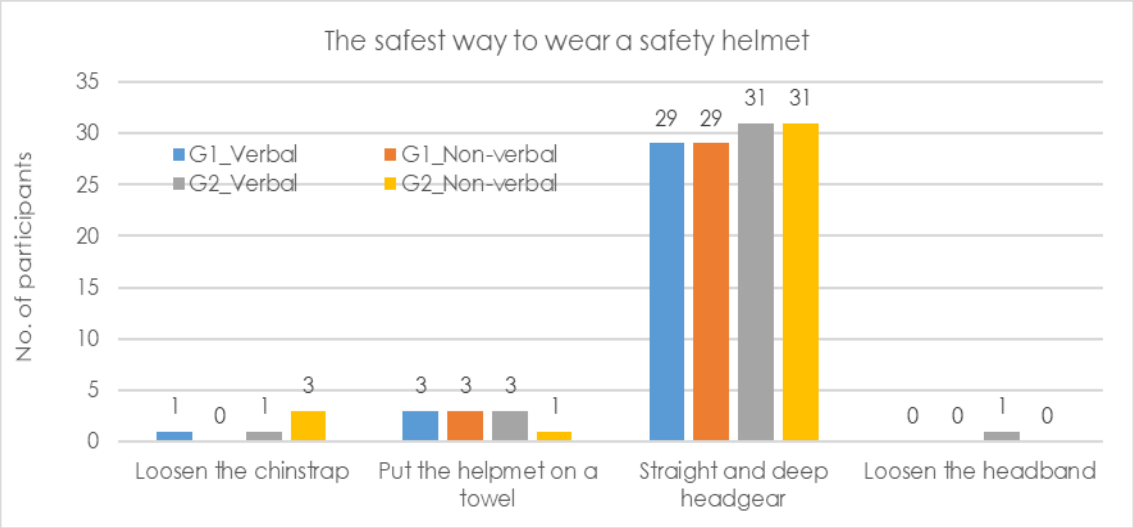

Figure 3. Safest way to wear a safety helmet

For the second question, "*The safest material for work gloves*", 33% and 50% of the participants from Group 1, and 56% and 74% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*Leather*" (Figure 4).

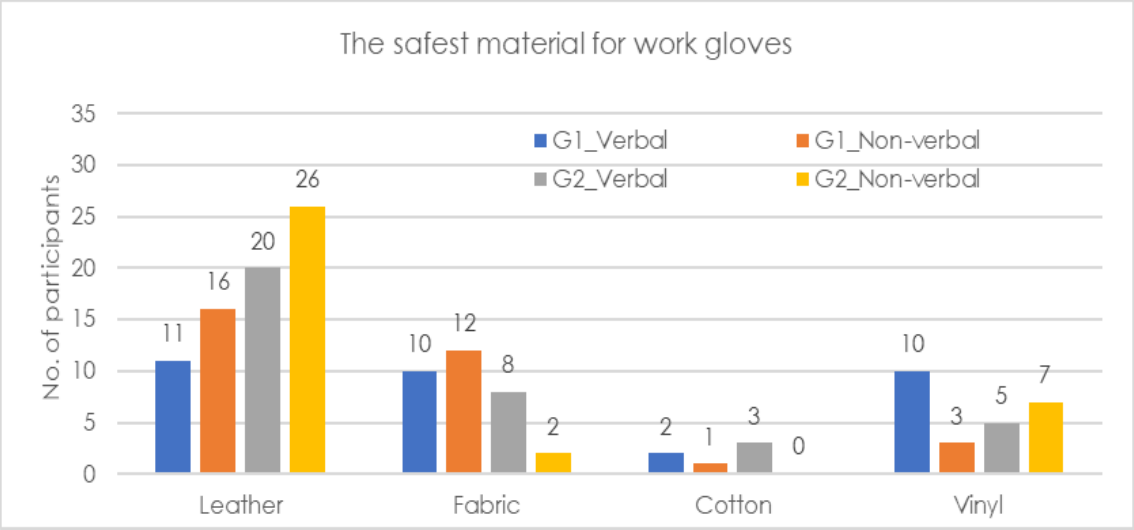

Figure 4. Safest material for work gloves

All participants correctly answered the following question: "*The most appropriate footwear for use during construction*" (Figure 5).

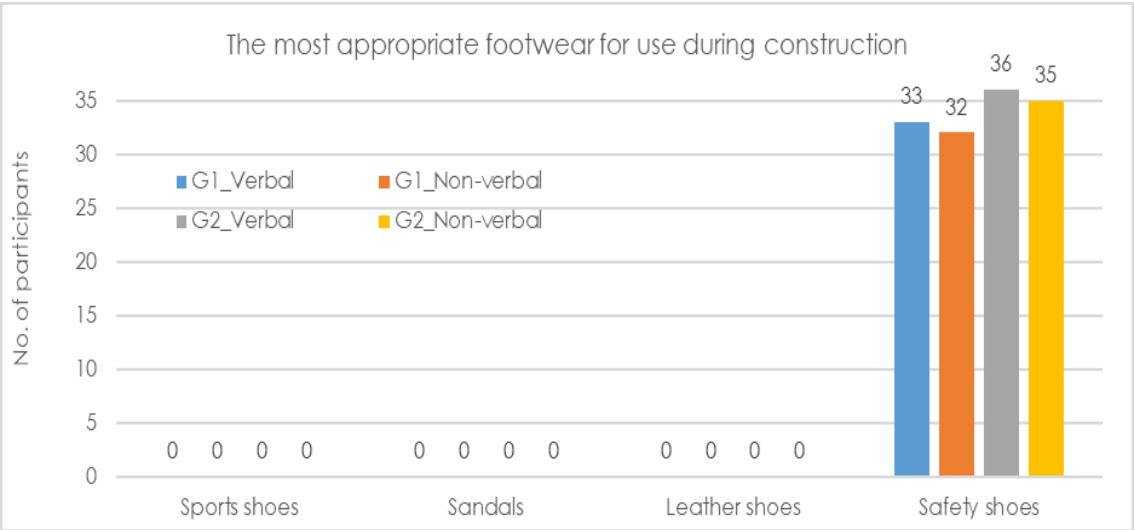

Figure 5. Most appropriate footwear for use during construction

For the next question, "*The most inappropriate work clothing*", 88% and 94% of the participants from Group 1, and 92% and 91% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "A *short-sleeved shirt*" (Figure 6).

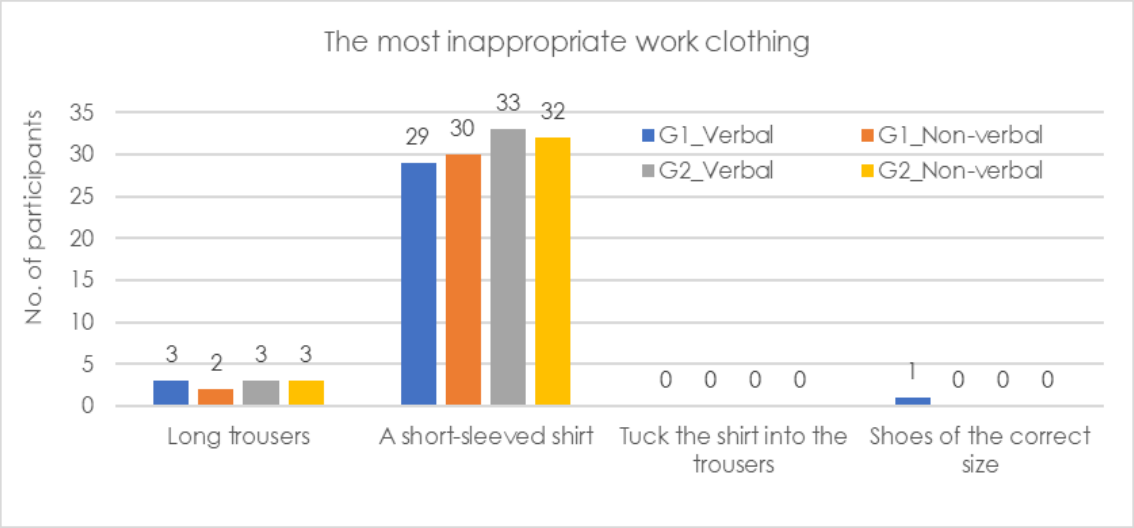

Figure 6. Most inappropriate work clothing

For the last question, "*When is a safety helmet not needed on-site?*", 100% and 97% of the participant form Group 1, and 97% and 100% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "In the *rest room*" (Figure 7).

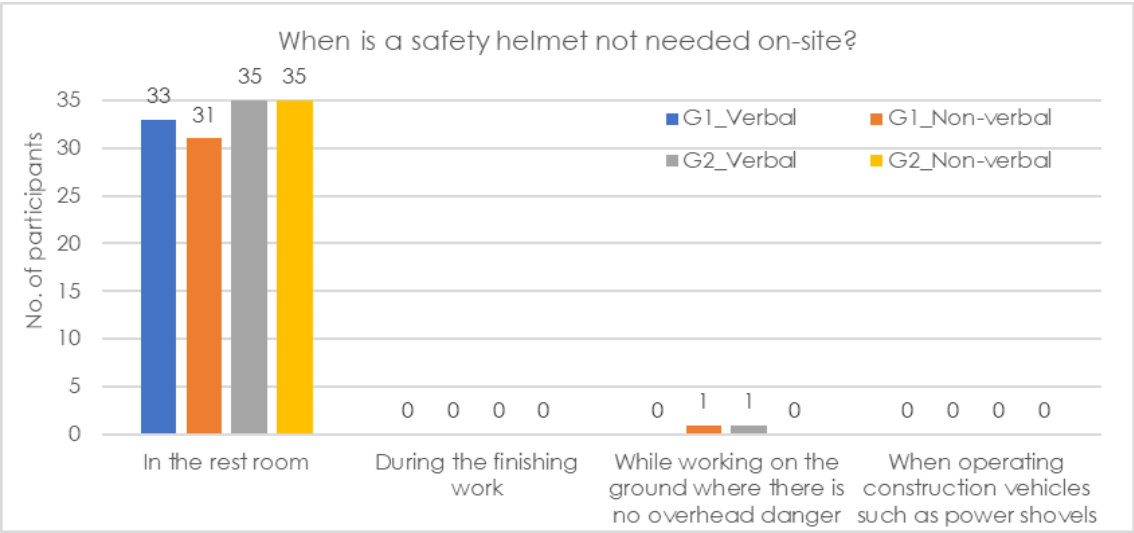

Figure 7. When is a safety helmet not needed on-site

Overall, the nonverbal training group scored higher than the verbal

training one in the PPE section. Most of the participants correctly answered all four questions for the PPE section except for the question "*The safest material for work gloves*". Although the safety training content showed the type of work gloves to be used when performing tasks on-site, about half the participants, mainly those in the verbal groups, gave different answers, such as "*fabric*", "*cotton*", or "*vinyl*", instead of "*leather*".

Work at Height

WaH is considered a critical risk at most construction sites. For the question, "*The most inappropriate precaution to take when working on and under scaffolding*", 55% and 56% of the participants from Group 1, and 69% and 86% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*You are safe if you wear a helmet*" (Figure 8).

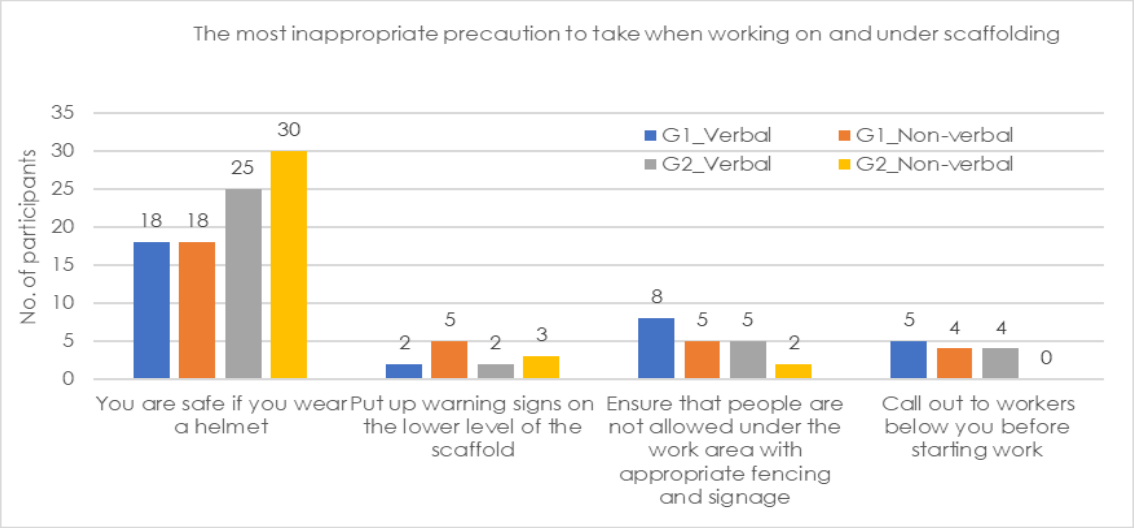

Figure 8. Most inappropriate precaution to take when working on and under scaffolding

For the next question, "*The most inappropriate action when you notice*

that a scaffold member has come loose", 58% and 63% of the participants from Group 1, and 64% and 77% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*Do nothing*" (Figure 9).

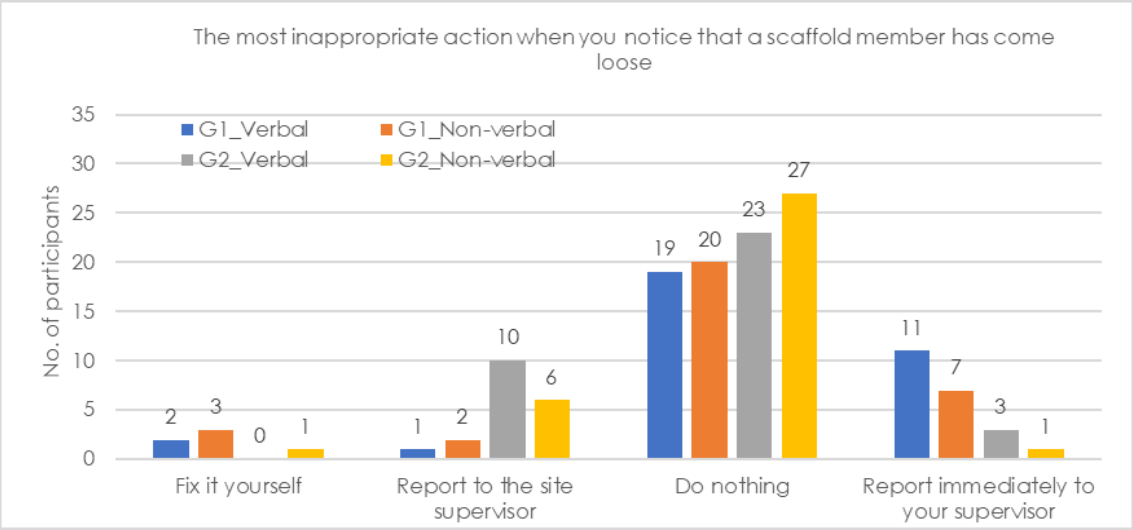

Figure 9. Most inappropriate action when you notice that a scaffold member has come loose

For the following question, "*The most appropriate procedure for unloading a load after working on a workbench*", 70% and 78% of the participants from Group 1, and 97% and 100% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*Leave the load on the workbench and unload it after you have dismounted*" (Figure 10).

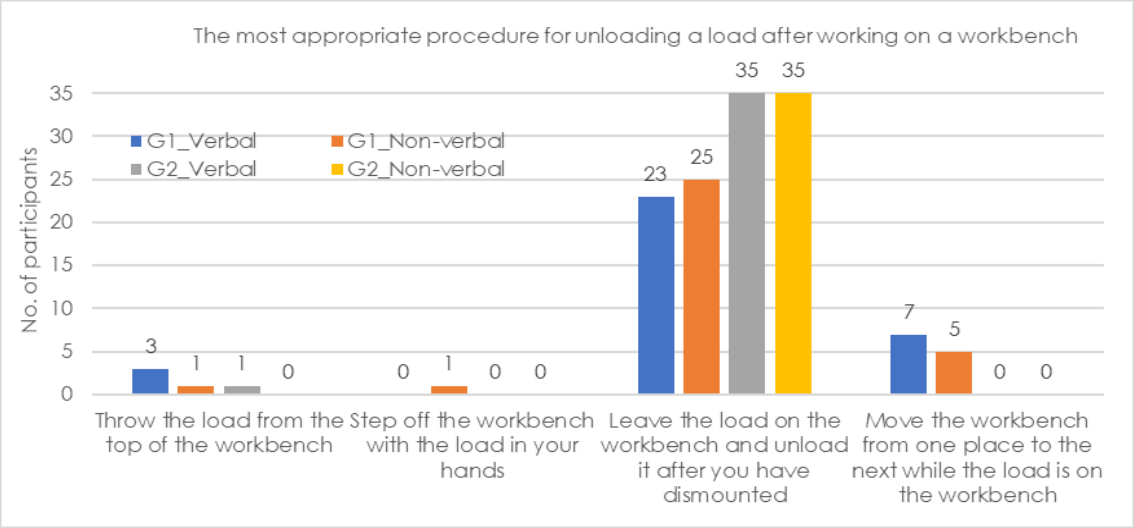

Figure 10. Most appropriate procedure for unloading a load after working on a workbench

For the next question, "*The most inappropriate when working with scaffolds*", 73% and 84% of the participants from Group 1, and 94% and 100% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*Leaving materials on scaffolds*" (Figure 11).

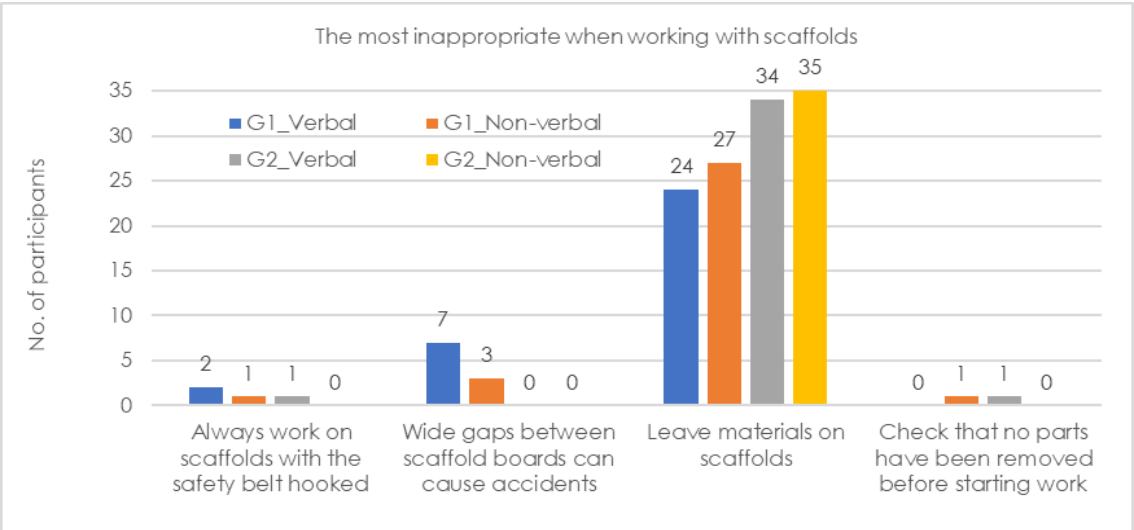

Figure 11. Most inappropriate when working with scaffolds

For the last question, "*The most appropriate height for the hook of the safety belt when working on the workbench*", one participant each who received verbal and nonverbal training, respectively, from Group 1 and 1 participant who received verbal training from Group 2 correctly answered "*As high as possible*" (Figure 12).

Figure 12. Most appropriate height for hook of safety belt

Unfortunately, all participants obtained lower WaH scores regardless of the training method used. In response to the question "*The most appropriate height for the hook of the safety belt*", about 74% of the participants from the verbal training groups and 80% from the nonverbal training groups answered "*Height between waist and chest*". In addition, some participants in Group 1 and Group 2 selected "*Fix yourself*", "*Report to the site supervisor*" and "*Report immediately to your supervisor*" for the question "*The most inappropriate action when you notice that a scaffold member has come loose*". Besides, some participants in Group 1 selected "*Move the workbench from one place to the next while the load is on the workbench*" and "*Throw the load from the top of the workbench*" for the question "*The most*

appropriate procedure for unloading a load after working on a workbench".

Lifting Operations and Site Cleanliness

Surprisingly, both groups scored high on questions regarding lifting operations and site cleanliness, for both training methods. For the first question, "*The most inappropriate behaviour during lifting operations*", 82% and 72% of the participants from Group 1, and 75% and 91% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*Monitoring close to the load*" (Figure 13).

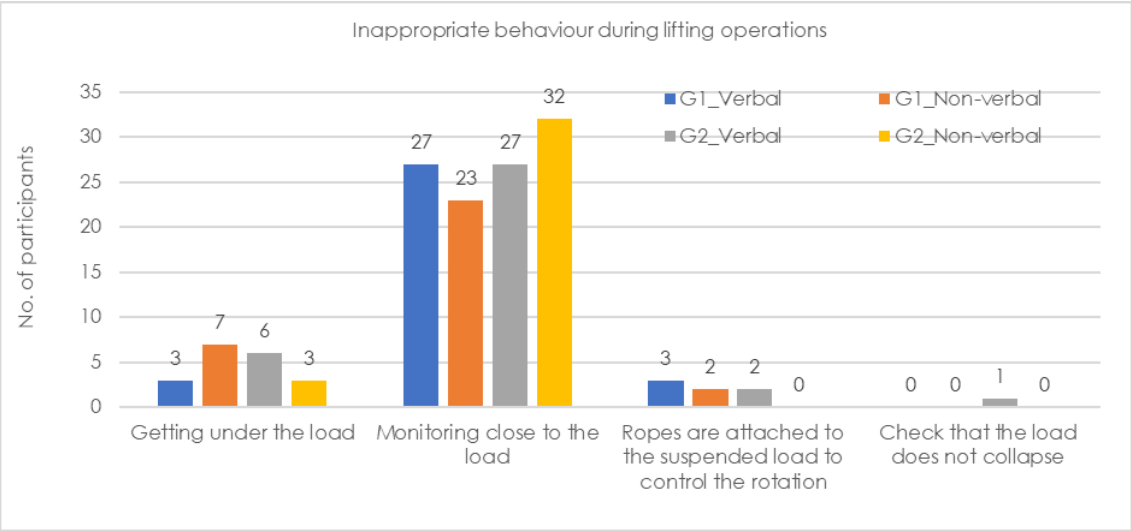

Figure 13. Inappropriate behaviour during lifting operations

For the second question, "*The most inappropriate way to give instructions to a crane operator*", 97% of the participants from Group 1, and 83% and 97% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*Operators make their own decisions*

without instructions" (Figure 14).

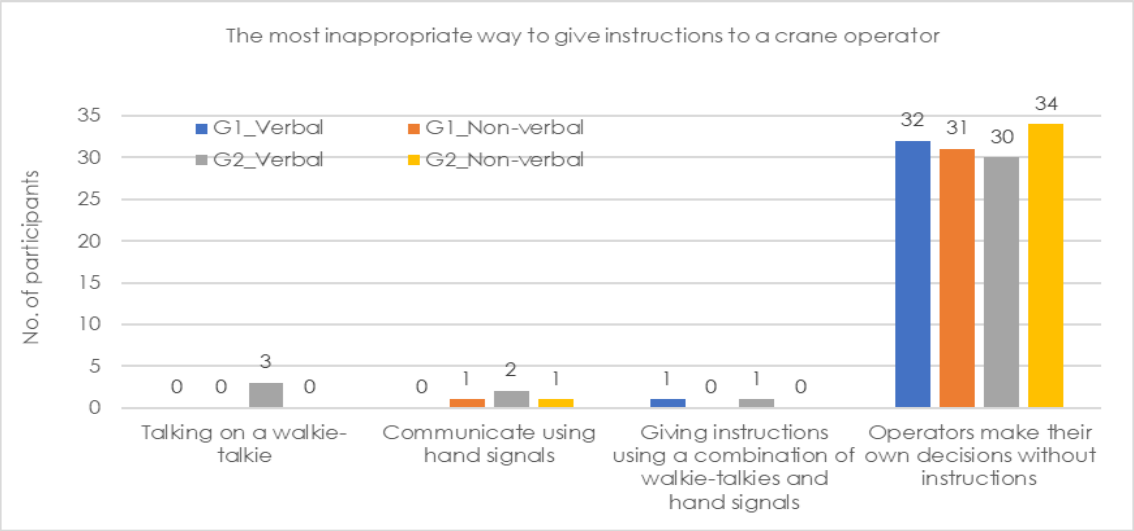

Figure 14. Most inappropriate way to give instructions to a crane operator

For the next question, "*The most inappropriate reason for keeping the work area clean*", 91% and 94% of the participant from Group 1, and 92% and 100% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*To run around the work area*" (Figure 15).

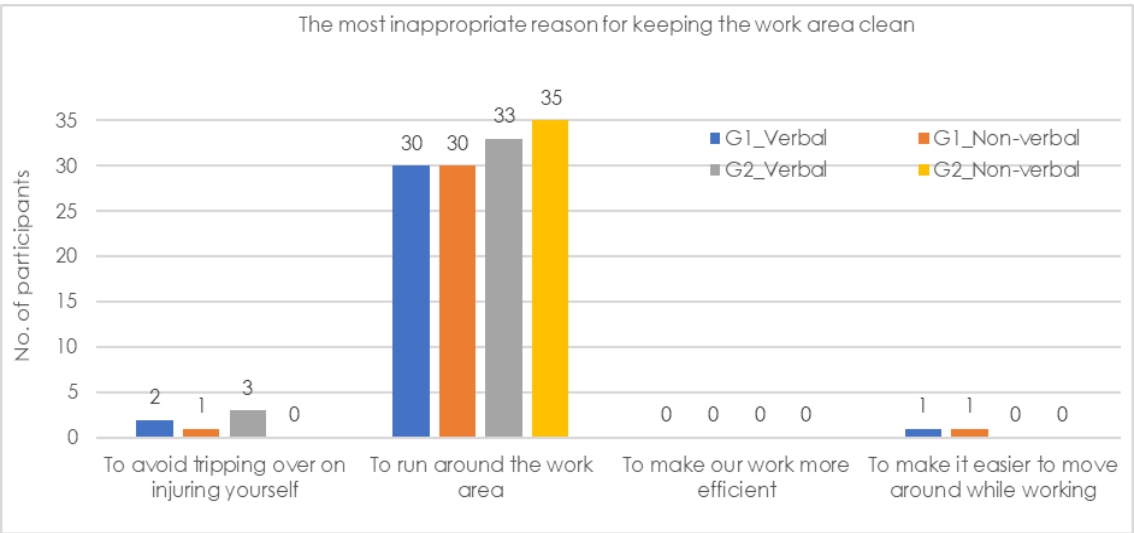

Figure 15. Most inappropriate reason for keeping the work area clean

For the next question, "*Responsible for keeping the work area tidy*", 97% and 94% of the participants from Group 1, and 97% and 100% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*People working on site*" (Figure 16).

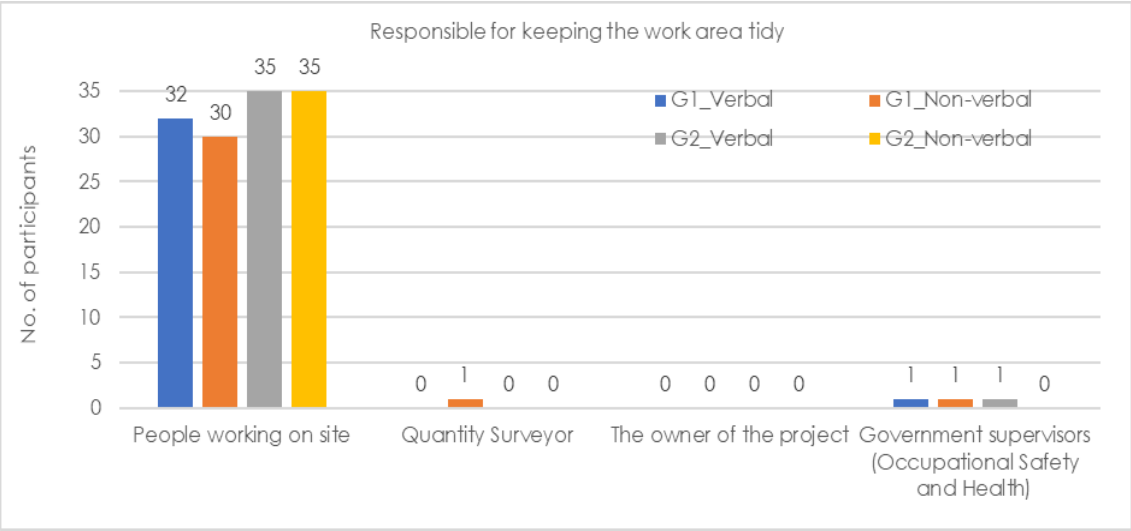

Figure 16. Responsible for keeping the work area tidy

For the last question, "*The most inappropriate in relation to safety passages on site*", 61% and 63% of the participants from Group 1, and 97% and 100% from Group 2 who received verbal and nonverbal training, respectively, correctly answered "*Material may be placed so as to extend beyond the safety corridor*" (Figure 17).

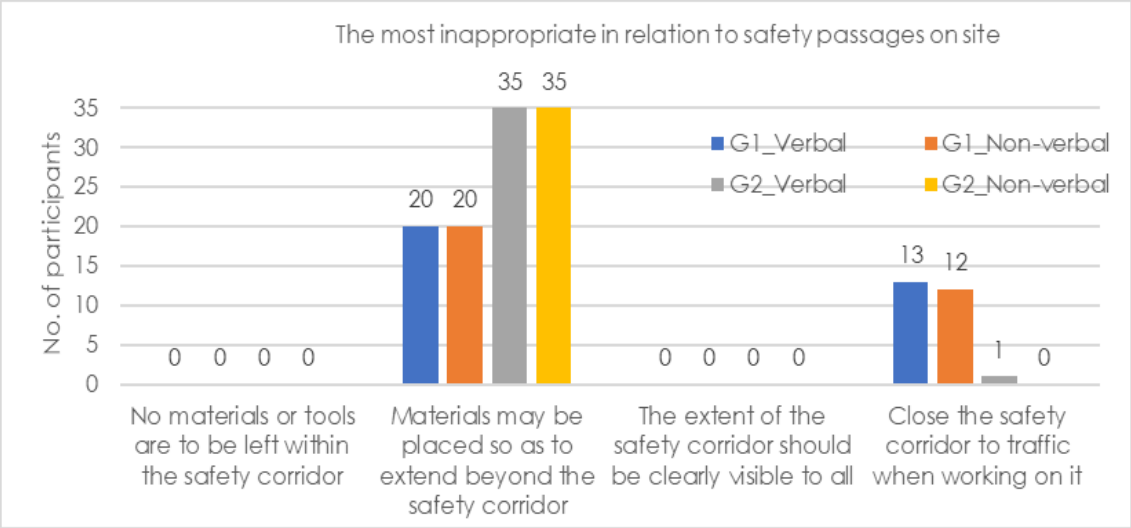

Figure 17. Most inappropriate in relation to safety passages on site

There were some differences between the participants owning to inexperience and different cultural backgrounds. For instance, some participants in Group 1 and Group 2 responded to the question "*The most inappropriate behaviour during lifting operations*" by answering "*Getting under the load*" and "*Ropes are attached to the suspended load to control the rotation*". Moreover, about 40% of Group 1, which received both verbal and nonverbal training, responded to the question "*The most inappropriate in relation to safety passages on site*" with "*Close the safety corridor to traffic when working on it*". This could be due to different housekeeping practices at Malaysian construction sites. However, the difference was not significant, as participants scored well with both training methods.

Nonverbal Training Method

In terms of comprehension, the majority of participants in both training

methods were able to score four or more in all three sections, especially those who received training with the nonverbal training method were able to answer the questions correctly (Figure 1). The results indicated that regardless of nationality, participants had a clear understanding of basic safety knowledge and were able to score high on all sections after receiving nonverbal safety training. It can be claimed that the verbal method clearly conveys what needs to be said, but respondents can only understand it within the scope of the explanation. Understanding the content may not be sufficient to apply the knowledge (Arif et al., 2021), especially for those with no field experience.

In terms of the effectiveness of the training methods, the nonverbal method created a strong impression of the level of danger in the respondents compared to the verbal training method, thus creating interest in what was being explained and imparting relevant safety knowledge to the participants.

As shown in Table 2, no significant differences were found between the groups trained using the verbal and nonverbal methods for the PPE section; and no significant differences were found for among those trained using verbal training methods between the groups for lifting operations. Based on the responses, there was no significant difference between the two groups in terms of their basic knowledge of PPE, lifting operations, and site cleanliness, and their level of understanding of safety was similar.

Methods		Verbal			Nonverbal		
	Contents	PPE	Work at height	Lifting / sling operations and site cleanliness	PPE	Work at height	Lifting / sling operations and site cleanliness
Mean rank	Group 1	31.44	28.56	32.76	30.73	26.98	24.17
	Group 2	38.26	40.9	37.06	36.99	40.41	42.99
Mann-Whitney U		476.5	381.5	520	455.5	335.5	245.5
Wilcoxon W		1037.5	942.5	1081	983.5	863.5	773.5
Z		-1.564	-2.703	-0.99	-1.477	-3.122	-4.688
p-value (<0.05)		0.118	0.007	0.322	0.14	0.002	0.000

Table 2. Mann-Whitney U test between nationalities for both methods

Therefore, the use of verbal or nonverbal methods for imparting safety knowledge has the same effect on novices regardless of their nationality. These training methods can impart the relevant safety knowledge to construction novices as proven by Brahm and Singer (2013).

However, there was a significant difference ($p<0.05$) in the WaH section for the verbal training method between Groups 1 and 2, and in the WaH and lifting operations sections for the nonverbal training method between Groups 1 and 2. Thus, the answers provided by the participants from Groups 1 and 2 showed significant differences due to the different safety cultures in the two countries (Figure 8-12). For instance, the safe use of scaffolding and workbenches on site are unfamiliar to novices, especially those in Group 1, as they tend to be more "uncertain" than Group 2 regarding questions in the WaH section. Most participants in Group 2 had a clear understanding of the use of workbenches and scaffolding on site, as they are commonly used at Japanese construction sites. Therefore, it is recommended that cultural differences should be considered in safety training to achieve better safety knowledge transfer.

Even though participants' scores were less satisfactory for the WaH section, which may be due to misunderstandings during the safety training as these participants did not have field experience of using scaffolding and wearing safety harnesses on site, the nonverbal training groups still scored higher than the verbal groups. Notably, the use of nonverbal training methods enables novices to gain safety knowledge easily and effectively.

It is important to note that the safety training content used in this experiment was developed in Japan to adapt to Japanese construction practices. Consequently, it is often easy for Japanese students to understand the dangers of construction sites by looking at pictures and comprehending the training content. The results showed that Malaysian students gave different answers to questions in the WaH and site cleanliness sections. Overall, Malaysian students scored slightly fewer points in all three sections compared to Japanese students when both training methods were used, as Malaysian students had a low level of safety knowledge. Owning to the uniqueness of safety culture, there are some safety practices that are only found at Japanese construction sites; for instance, appropriate practices related to safety passages on sites may be unfamiliar to those from the Malaysian construction industry, and Malaysian students may not be familiar with the terminology used at Japanese construction sites.

As WaH is a high-risk activity on construction sites, training methods should be further improved and adapted to construction sites in both countries to enhance risk identification. Further research should focus on the

contents of high-risk activities to fulfil the needs for safety culture and practices, and should be produced by the country of origin to eliminate cultural differences. This will allow for better knowledge transfer for construction novices.

CONCLUSION

The study objectives were achieved through a comparative study. This study provides didactic findings that construction novices have a good understanding of the basic knowledge of the use of PPE, WaH and lifting operations. The safety training contents for PPE and lifting operations are useful and necessary for construction novices, irrespective of whether verbal or nonverbal methods are used, as both methods enable novices to clearly understand basic safety knowledge, regardless of nationality. Most novices were able to answer the questions correctly using these two components. It can be interpreted that there were no significant differences in basic safety knowledge between novices, irrespective of the training method. Therefore, providing construction novices with regular verbal or nonverbal safety training focused on PPE and lifting operations would be effective in educating them about safety awareness.

In terms of teaching methods, the verbal method is sufficient for basic knowledge transfer, such as PPE; while the nonverbal method is more effective for use in high-risk activities, such as WaH on sites. The use of nonverbal methods is effective among novices, regardless of nationality. In

particular, all nonverbal subgroups (Malaysian and Japanese students) scored higher than the verbal ones at WaH after the training. The immediate results show that the nonverbal training method is sufficient to develop necessary risk recognition to train novices for risk activities compared with the verbal method, regardless of nationality. The results showed no significant differences among construction novices of different nationalities. Notably, video content must be customised for scenes or situations that have not received much attention in Malaysia. This method can assist construction novices and practitioners to achieve a better understanding of high-risk activities and relevant construction site safety knowledge. There is an urgent need for safety training for high-risk activities, such as WaH, for construction novices, especially Malaysian ones, to enhance their risk recognition ability.

Educators and policymakers should not overlook the importance of basic construction safety training. The experiment was conducted with construction novices who were undergraduate students of construction-related programs. This study can be used as a reference by educators and policymakers in safety education programs to design teaching methods for high-risk activities so that workers from different backgrounds, with or without field experience, can learn effectively. Further customised training content for high-risk activities, such as WaH, is necessary to suit the site safety culture in the Malaysian construction industry.

REFERENCES

Ajslev, J., Dastjerdi, E. L., Dyreborg, J., Kines, P., Jeschke, K. C., Sundstrup, E., Jakobsen, M. D., Fallentin, N., & Andersen, L. L. (2017). Safety climate and accidents at work: Cross-sectional study among 15,000 workers of the general working population. *Safety Science*, *91*, 320–325. https://doi.org/10.1016/j.ssci.2016.08.029

Albert, A., Hallowell, M. R., Kleiner, B., Chen, A., & Golparvar-Fard, M. (2014). Enhancing Construction Hazard Recognition with High-Fidelity Augmented Virtuality. *Journal of Construction Engineering and Management*, *140*(7), 1–11. https://doi.org/10.1061/(asce)co.1943-7862.0000860

Albert, A., Hallowell, M. R., & Kleiner, B. M. (2014). Enhancing Construction Hazard Recognition and Communication with Energy-Based Cognitive Mnemonics and Safety Meeting Maturity Model: Multiple Baseline Study. *Journal of Construction Engineering and Management*, *140*(2). https://doi.org/10.1061/(asce)co.1943-7862.0000790

Arif, M., Nasir, A. R., Thaheem, M. J., & Khan, K. I. A. (2021). ConSafe4All: A framework for language friendly safety training modules. *Safety Science*, *141*(May), 105329. https://doi.org/10.1016/j.ssci.2021.105329

Baseline Survey Construction Report. (2015). Health and safety attitudes and behaviours in the New Zealand workforce: A survey of workers and employers. Cross-sector report. (A report to WorkSafe New Zealand and Maritime New Zealand). (April 2015). Retrieved from https://www.sitesafe.org.nz/globalassets/guides-and resources/research/worksafe.pdf

Başağa, H. B., Temel, B. A., Atasoy, M., & Yıldırım, İ. (2018). A study on the effectiveness of occupational health and safety trainings of construction workers in Turkey. *Safety Science*, *110*, 344–354. https://doi.org/10.1016/j.ssci.2018.09.002

Blanchard, P., & Simmering, M. (2014). Training delivery methods. Encyclopedia of Business. https://www.referenceforbusiness.com/management/Tr-Z/Training-Delivery-Methods.html.

Brahm, F., & Singer, M. (2013). Is More Engaging Safety Training Always Better in Reducing Accidents? Evidence of Self-selection from Chilean Panel Data. Journal of Safety Research, 47, 85-92 https://doi.org/10.1016/j.jsr.2013.09.003

Brame, C. J. (2016). Effective educational videos: Principles and guidelines for maximizing student learning from video content. CBE Life Sciences Education, 15(4),es6.1-es6.6. https://doi.org/10.1187/cbe.16-03-0125

Bust, P. D. Gibb, A. G. F., & Pink, S. (2008). Managing construction health and safety: migrant workers and communicating safety messages. Safety Science, 46 (4), 585-602.

Cheng, C. W., & Wu, T. C. (2013). An investigation and analysis of major accidents involving foreign workers in Taiwan's manufacture and construction industries. *Safety Science*, *57*, 223–235. https://doi.org/10.1016/j.ssci.2013.02.008

Cunningham, T. R., Guerin, R. J., Keller, B. M., Flynn, M. A., Salgado, C., & Hudson, D. (2018). Differences in safety training among smaller and larger construction firms with non-native workers: Evidence of overlapping vulnerabilities. Safety Science, 103, 62-69. https://doi.org/10.1016/j.ssci.2017.11.011

Dehnad, A., Nasser, H., & Hosseini, A. F. (2014). A Comparison between Three- and Four-Option Multiple Choice Questions. Procedia Social and Behavioural Sciences, 98, 398-403. https://doi.org/10.1016/j.sbspro.2014.03.432

Department of Occupational Safety and Health (DOSH). (2020). Retrieved from https://www.dosh.gov.my/index.php/statistic-v/occupational-accident-statistics

Edirisinghe, R., & Lingard, H. (2016). Exploring the potential for the use of video to communicate safety information to construction workers: case studies of organizational use. Construction Management and Economics, 34(6), 366–376. https://doi.org/10.1080/01446193.2016.1200736

Esmaeili, B., & Hallowell, M. R. (2012). Diffusion of Safety Innovations in the Construction Industry. *Journal of Construction Engineering and Management*, *138*(8), 955–963. https://doi.org/10.1061/(asce)co.1943-7862.0000499

Evanoff, B., Dale, A. M., Zeringue, A., Fuchs, M., Gaal, J., Lipscomb, H. J., & Kaskutas, V. (2016). Results of a fall prevention educational intervention for residential construction. Safety Science 89, 301-307. https://doi.org/10.1016/j.ssci.2016.06.019

Fang, D., & Wu, H. (2013). Development of a Safety Culture Interaction (SCI) model for construction projects. Safety Science, *57*, 138–149. https://doi.org/10.1016/j.ssci.2013.02.003

Fellows, R., & Liu, A. (2022). Research Methods for Construction. Fifth Edition. Wiley-Blackwell. A John Willey & Sons, Ltd. Publication.

Gao, Y., Gonzalez, V. A., & Yiu, T. W. (2019). The effectiveness of traditional tools and computer-aided technologies for health and safety training in the construction sector: A systematic review. *Computers and Education*, *138*(May), 101–115. https://doi.org/10.1016/j.compedu.2019.05.003

Guidelines on Occupational Safety and Health Management Systems (OSHMS). (2011). Retrieved from https://www.dosh.gov.my/images/dmdocuments/glx/ve_gl_oshms.pdf

Guo, H., Li, H., Chan, G., & Skitmore, M. (2012). Using game technologies to improve the safety of construction plant operations. *Accident Analysis and Prevention*, *48*, 204–213. https://doi.org/10.1016/j.aap.2011.06.002

Hanvold, T. N., Kines, P., Nykänen, M., Thomée, S., Holte, K. A., Vuori, J., Wærsted, M., & Veiersted, K. B. (2019). Occupational Safety and Health Among Young Workers in the Nordic Countries: A Systematic Literature Review. *Safety and Health at Work*, *10*(1), 3–20. https://doi.org/10.1016/j.shaw.2018.12.003

Health, safety and environment test for operatives and specialists. (2019). *Construction Industry Training Board (CITB)*. Sand Martin House, Bittern Way, Peterborough, UK.

Hou, L., Chi, H. L., Tarng, W., Chai, J., Panuwatwanich, K., & Wang, X. (2017). A framework of innovative learning for skill development in complex operational tasks. Automation in Construction, 83 (March), 29-40. https://doi.org/10.1016/j.autcon.2017.07.001

Hoła, B., Nowobilski, T., Szer, I. & Szer, J. (2017). Identification of factors affecting the accident rate in the construction industry. Procedia Engineering, 208, 35–42. https://doi.org/10.1016/j.proeng.2017.11.018

Hutchinson, D., Luria, G., Pindek, S., & Spector, P. (2022). The effects of industry risk level on safety training outcomes: A meta-analysis of intervention studies. *Safety Science*, *152*, 105594. https://doi.org/10.1016/j.ssci.2021.105594

International Labour Organization (ILO). (2021). Safety and health at work. Retrieved from https://www.ilo.org/global/topics/safety-and-health-at-work/lang--en/index.htm

Ismail, R., Palliyaguru, R., Karunasena, G., & Othman, N. A. (2018). Health and safety (H&S) challenges confronted by foreign workers in the Malaysian construction industry: A background study. *The 7th World Construction Symposium*, *July*, 277–287.

Japan Industrial Safety and Health Association (JISHA). (2020). Retrieved from https://www.jisha.or.jp/english/statistics/index.html

Japan Industrial Safety and Health Act (JISHA) (1972). Retrieved from https://www.japaneselawtranslation.go.jp/en/laws/view/3440

Jeschke, K. C., Kines, P., Rasmussen, L., Andersen, L. P. S., Dyreborg, J., Ajslev, J., Kabel, A., Jensen, E., & Andersen, L. L. (2017). Process evaluation of a Toolbox-training program for construction foremen in Denmark. *Safety Science*, *94*, 152–160. https://doi.org/10.1016/j.ssci.2017.01.010

Li, H., Chan, G., & Skitmore, M. (2012a). Multiuser visual safety training system for tower crane dismantlement. Journal of Computing in Civil Engineering, 26 (5), 638-647. https://doi.org/10.1061/(asce)cp.1943-5487.0000170

Li, H., Chan, G., & Skitmore, M. (2012b). Visualizing safety assessment by integrating the use of game technology. *Automation in Construction*, *22*, 498–505. https://doi.org/10.1016/j.autcon.2011.11.009

Li, H., Lu, M., Hsu, S. C., Gray, M., & Huang, T. (2015). Proactive behavior-based safety management for construction safety improvement. *Safety Science*, *75*, 107–117. https://doi.org/10.1016/j.ssci.2015.01.013

Li, R. Y. M., Tang, B., & Chau, K. W. (2019). Sustainable construction safety knowledge sharing: A partial least square-structural equation modeling and a feedforward neural network approach. *Sustainability (Switzerland)*, *11*(20). https://doi.org/10.3390/su11205831

Li, X., Yi, W., Chi, H. L., Wang, X., & Chan, A. P. C. (2018). A critical review of virtual and augmented reality (VR/AR) applications in construction safety. *Automation in Construction*, *86*, 150–162. https://doi.org/10.1016/j.autcon.2017.11.003

Liu, H. T., & Tsai, Y. L. (2012). A fuzzy risk assessment approach for occupational hazards in the construction industry. *Safety Science*, *50*(4), 1067–1078. https://doi.org/10.1016/j.ssci.2011.11.021

Lombardi, D. A., Verma, S. K., Bernnan, M. J., & Perry, M. J. (2009). Factors

influencing workers use of personal protective eyewear. *Accident Analysis and Prevention 41 (4),* 755-762 https://doi.org/10.1016/j.aap.2009.03.017

Loosemore, M., & Malouf, N. (2019). Safety training and positive safety attitude formation in the Australian construction industry. *Safety Science*, *113*, 233–243. https://doi.org/10.1016/j.ssci.2018.11.029

Ministry of Health, Labour and Welfare. (2023). Workplace safety site: Various teaching materials/tools. Available online at https://anzeninfo.mhlw.go.jp/# (Access 18 Nov 2023)

Muhamad Zaini, N. Z., Mat Salleh, M. A., Fikri Hasmori, M., & Haslinda Abas, N. (2020). Effect of Accident Due to Fall from Height at Construction Sites in Malaysia. *IOP Conference Series: Earth and Environmental Science*, *498*(1). https://doi.org/10.1088/1755-1315/498/1/012106

Nadhim, E. A., Hon, C., Xia, B., Stewart, I., & Fang, D. (2016). Falls from height in the construction industry: A critical review of the scientific literature. *International Journal of Environmental Research and Public Health*, *13*(7). https://doi.org/10.3390/ijerph13070638

Nykänen, M., Puro, V., Tiikkaja, M., Kannisto, H., Lantto, E., Simpura, F., Uusitalo, J., Lukander, K., Räsänen, T., Heikkilä, T., & Teperi, A. M. (2020). Implementing and evaluating novel safety training methods for construction sector workers: Results of a randomized controlled trial. *Journal of Safety Research*, *75*, 205–221. https://doi.org/10.1016/j.jsr.2020.09.015

Occupational Safety and Health Act 514 (OSHA) (1994). Retrieved from https://www.dosh.gov.my/index.php/legislation/acts-legislation/23-02-occupational-safety-and-health-act-1994-act-514/file

Oswald, D., Wade, F., Sherratt, F., & Smith, S. D. (2019). Communicating Health and Safety on a Multinational Construction Project: Challenges and Strategies. *Journal of Construction Engineering and Management*, *145*(4), 04019017. https://doi.org/10.1061/(asce)co.1943-7862.0001634

Priyadarshani, K., Karunasena, G., & Jayasuriya, S. (2013). Construction safety assessment framework for developing countries: A case study of Sri Lanka. *Journal of Construction in Developing Countries*, *18*(1), 33–51.

Pui Teck, A. G., & Mohd Asmoni, M. N. A. (2015). A review on the effectiveness of safety training methods for Malaysia construction industry. *Jurnal Teknologi*, *74*(2), 9–13. https://doi.org/10.11113/jt.v74.4518

Raheem, A. A., Hinze, J. W., Azhar, S., Choudhry, R. M., & Riaz, Z. (2011). Comparative analysis of construction safety in Asian developing countries. *6th International Conference on Construction in 21st Century (CITC-VI) "Construction Challenges in the New Decade", 5-7 July*, *Kuala Lumpur Malaysia*, 623–630. https://goo.gl/ifD7GO

Sámano-Ríos, M. L., Ijaz, S., Ruotsalainen, J., Breslin, F. C., Gummesson, K., & Verbeek, J. (2019). Occupational safety and health interventions to protect young workers from hazardous work – A scoping review. *Safety Science*, *113*, 389–403. https://doi.org/10.1016/j.ssci.2018.11.024

Sekaran, U. (2003). Research methods for business: A skill building approach. John Wiley & Sons.

Shuang, D., Heng, L., Skitmore, M., & Qin, Y. (2019). An experimental study of intrusion behavious on construction sites: The role of age and gender. Safety Science. 115, 425-434. https://doi.org/10.1016/j.ssci.2019.02.035

Teizer, J., Cheng, T., & Fang, Y. (2013). Location tracking and data visualization technology to advance construction ironworkers' education and training in safety and productivity. *Automation in Construction*, *35*, 53–68. https://doi.org/10.1016/j.autcon.2013.03.004

Teo, E. A. L., Theo, H., & Feng, Y. (2008). Construction health and safety performance in developing and developed countries: A parallel study in South Africa and Singapore. *Proceedings of the CIB W99 14th International Conference on Evolution of and Directions in Construction Safety and Health, Gainesville, Florida, US*, 485–499.

Vignoli, M., Nielsen, K., Guglielmi, D., Mariani, M. G., Patras, L., & Peirò, J. M. (2021). Design of a safety training package for migrant workers in the construction industry. *Safety Science*, *136*(January). https://doi.org/10.1016/j.ssci.2020.105124

Vignoli, M., Punnett, L., & Depolo, M. (2014). How to measure safety training effectiveness? Towards a more reliable model to overcome evaluation issues in safety training. *Chemical Engineering Transactions*, *36*(January), 67–72. https://doi.org/10.3303/CET1436012

Wallen, E., S., & Mulloy, K. B. (2006). Computer-based training for safety: Comparing methods with older and younger workers. Journal of Safety Research, 37 (5), 461-467. https://doi.org/10.1016/j.jsr.2006.08.003

Wang, Z., Jiang, Z., & Blackman, A. (2021). Linking emotional intelligence to safety performance: The roles of situational awareness and safety training. *Journal of Safety Research*, *78*, 210–220. https://doi.org/10.1016/j.jsr.2021.06.005

Winge, S., Albrechtsen, E., & Mostue, B. A. (2019). Causal factors and connections in construction accidents. *Safety Science*, *112*(October 2018), 130–141. https://doi.org/10.1016/j.ssci.2018.10.015

Yao, Q., Li, R. Y. M., Song, L., & Crabbe, M. J. C. (2021). Construction safety knowledge sharing on Twitter: A social network analysis. Safety Science, 143, 1-19. https://doi.org/10.1016/j.ssci.2021.105411

Zhang, Y., Liu, H., Kang, S. C., & Al-Hussein, M. (2020). Virtual reality applications for the built environment: Research trends and opportunities. Automation in Construction, 118(January), 103311. https://doi.org/10.1016/j.autcon.2020.103311

Zhu, X., Li, R. Y. M., Crabbe, M. J. C., & Sukpascharoen, K. (2022). Can a chatbot enhance hazard awareness in the construction industry? Frontiers in Public Health, 10(3). https://doi.org/10.3389/fpubh.2022.993700

Zujovic, L., Kecojevic, V., & Bogunovic, D. (2021). Interactive mobile equipment safety task-training in surface mining. *International Journal of Mining Science and Technology*, *31*(4), 743–751. https://doi.org/10.1016/j.ijmst.2021.05.011