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Improving TBM Communication Systems for Foreign Construction Workers

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Abstract

Purpose: This study experimentally verified the effectiveness of an improved Tool Box Meeting (TBM) delivery system designed to mitigate safety risks stemming from language barriers among foreign construction workers. **Research design, data and methodology:** Involving 120 workers across five sites, the experimental group received a four-week intervention featuring native language support, pictograms, and designated safety leaders, while the control group received standard Korean-based verbal instruction. **Results:** Independent samples t-test analysis revealed that the experimental group demonstrated statistically significant improvements compared to the control group in understanding of safety knowledge (t = 5.42, p < .001), safety practice behavior (t = 4.89, p < .001), and TBM satisfaction (t = 6.13, p < .001). The intervention effect was most pronounced in satisfaction (Cohen's d = 1.50), with Vietnamese workers exhibiting the most positive outcomes. **Conclusions:** These findings provide empirical evidence that integrating visual and linguistic support into TBMs meaningfully enhances safety compliance and understanding. The study concludes that the construction industry should adopt nationality-tailored TBM processes, supported by multilingual content and on-site safety leaders, to ensure effective safety management for a diverse workforce

Keywords: TBM, Foreign Workers, Safety Education, Communication System, Construction Safety

JEL Classification Code: J28, J61, L74, K32

1. Introduction

1.1. Research Background and Necessity

Due to the aging workforce and a shortage of skilled domestic labor in the construction industry, the employment of foreign workers is surging. According to 2025 statistics, foreign workers account for 3.4% of the total domestic employed population, reaching approximately 1.01 million individuals. However, the industrial accident mortality rate for foreign workers is 2.4 times higher than that of domestic workers. Over the past five years, the frequency of industrial accidents among foreign workers has shown a steady upward trend, with total casualties recorded at 9,219 in 2024. Notably, these accidents are concentrated in the construction and manufacturing sectors, which accounted for approximately 75% of all foreign worker industrial accidents as of 2024).

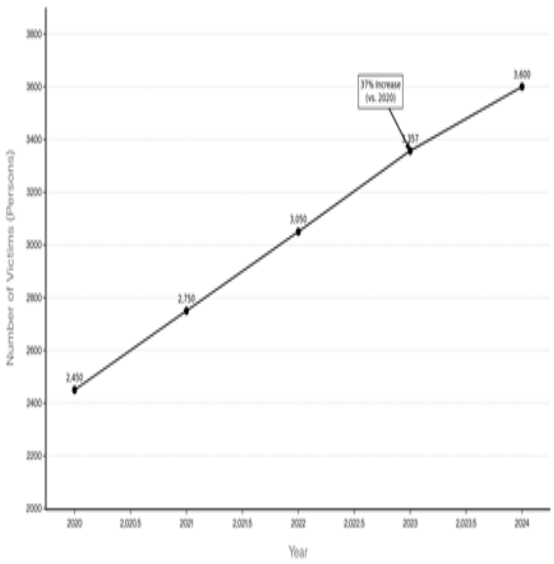

Figure 1: Trend of Industrial Accidents Among Foreign Workers in Construction (2020–2024)

As illustrated in **Figure 1**, the number of industrial accident victims among foreign construction workers has shown a consistent upward trend. Specifically, the number of victims rose from 2,450 in 2020 to 3,357 in 2023, representing a significant **37% increase** over the three-year period. This escalating pattern continued into 2024, highlighting the urgent need for improved safety communication systems tailored to this demographic. Kang, D. G. (2025). *Increase in…*

Tool Box Meeting (TBM) is a core safety activity that shares risk factors before work and enhances safety awareness, but it is not effectively communicated to foreign workers due to language barriers. The Ministry of Employment and Labor has pointed out that foreign workers are more exposed to danger due to language barriers and emphasized the necessity of producing non-verbal and native language educational content. Therefore, this study focuses on empirically verifying the intervention effects of an advanced. TBM communication model for foreign construction workers. Furthermore, by conducting an in-depth analysis of differences in acceptability based on nationality, it aims to propose optimal operational strategies suitable for immediate practical implementation.. Ministry of employment Labor. (2025). Best practices for safety management of foreign workers.

1.2. Research Scope and Method

This study conducted a four-week experiment involving 120 foreign workers across five construction sites located in Gyeonggi Province and Incheon Metropolitan City from September to October 2025. Participants were randomly assigned to either the experimental group (n=60) or the control group (n=60). To verify the intervention effects, the study comprehensively analyzed pre- and post-surveys, observational assessments, and near-miss data. Specifically, the level of safety knowledge acquisition, behavioral changes, and satisfaction with TBM were quantitatively evaluated. Data were analyzed using SPSS 26.0 to identify differences between groups and trends over time. The specific analytical methods employed included independent samples t-tests, one-way analysis of variance (ANOVA), and repeated measures ANOVA.

2. Theoretical Background

2.1. Concept and Effect of TBM

TBM is a self-regulatory prevention activity in which risk assessment results are delivered to workers for 5 to 15 minutes before work, and work methods and countermeasures for risk factors are shared. TBM has a significant disaster prevention effect compared to the short time invested, and it improves safety awareness by forming a consensus on risks among workers. For effective TBM, small-scale participation of 4 to 10 people is ideal, and while it is limited to a maximum of 20 people, all workers performing the relevant work must participate. Ministry of employment Labor. (2025). Best practices for safety management of foreign workers. Key prerequisites determining the success of TBM operations include systematic training to strengthen the competency of TBM leaders, the sharing of specific hazard factors based on risk assessments, and the establishment of a sophisticated interpretation and translation support system to resolve language barriers for foreign workers. The Korea Occupational Safety and Health Agency (KOSHA) (2025) presented the standard TBM process as: Preparation Phase (identification of risk factors, preparation of visual materials), Delivery Phase (adherence to checklist order, confirmation of understanding), Participation Induction Phase (collection of questions, feedback), and Recording and Follow-up Phase (signatures of attendees, confirmation of action on risk factors). Ministry of employment Labor. (2025). Best practices for safety management of foreign workers.

2.2. Current Status and Challenges of Safety Education for Foreign Workers

The primary challenges facing foreign workers at domestic construction sites have been identified as difficulties in linguistic communication and low satisfaction with safety education. Lee (2021) demonstrated through empirical analysis that not only internal factors, such as safety consciousness and practice levels, but also external factors, including the

duration and method of training, are significant variables driving the improvement of safety education systems. Consequently, the study emphasized the necessity of mandating native-language safety education for foreign workers, introducing a safety certification system, and expanding safety education hours.

Meanwhile, the Korea Institute of Civil Engineering and Building Technology (2015) aimed to enhance accessibility for foreign workers by developing an e-learning-based safety education model. However, although multilingual translation systems and app-based TBM solutions are increasingly being deployed at sites, academic attempts to determine their actual intervention effects remain relatively limited. In particular, the absence of experimental research addressing the impact of advancing routine safety communication channels—such as TBM—on safety behavior underscores the academic and practical significance of this study

2.3. Review of Prior Studies and Differentiation of Research

Existing studies have focused on identifying problems with safety education for foreign workers and suggesting institutional improvement plans, and there is a lack of research experimentally verifying the effect of improving the delivery system of TBM, which is conducted daily at actual sites. In addition, research on customized delivery systems considering differences by nationality is also insufficient. This study is differentiated from prior studies in that it quantitatively proves the effectiveness of the improved TBM communication system through a control group-experimental group design and presents concrete guidelines applicable to the field by analyzing the differences in effects by nationality (Vietnam, China, Myanmar).

3. Research Method

3.1. Research Hypotheses

The hypotheses of this study are as follows:

H1: The application of a systematically improved TBM information delivery model will have a significant positive effect on the level of safety knowledge acquisition among foreign workers.

H2: It is predicted that the experimental group exposed to the advanced TBM communication system will demonstrate a significantly improved rate of safety behavior practice at actual construction sites compared to the control group.

H3: The user-friendly improved TBM delivery method will act as a factor that positively enhances the satisfaction with TBM activities as perceived by foreign workers.

H4: The effect of the improved TBM delivery system on the dependent variables (knowledge, behavior, and satisfaction) will show statistically significant differences based on the workers' nationality (country of origin).

3.2. Experimental Design and Subjects

This study applied a Pretest-Posttest Control Group Design. The subjects were 120 foreign workers working at five construction sites (3 apartment construction sites, 2 commercial facilities) in Gyeonggi-do and Incheon Metropolitan City. The distribution by nationality was 45 Vietnamese (37.5%), 40 Chinese (33.3%), and 35 Myanmarese (29.2%). The research subjects were divided into an experimental group (60 people) and a control group (60 people) through random assignment, and there were no significant differences in demographic characteristics (age, gender, education, duration of stay) between the two groups (p>.05).For the experimental group, TBM was conducted by applying the following three improvement elements:

① **Native Language nterpretation/Translation Support:** Translating and providing TBM contents into Vietnamese, Chinese, and Burmese using professional interpreters or AI translation apps.

② **Utilization of Pictorial Materials (Pictograms): Materials (Pictograms):** Establishing and utilizing a database of pictorial materials visualizing risk factors and safety rules.

③ **Designation of Safety Leaders by Country:** Designating skilled workers capable of communicating in Korean for each nationality as safety leaders to support the re-delivery of TBM contents and Q&A.

For the control group, the existing Korean-centered verbal delivery method of TBM was maintained. The experimental treatment was conducted for 10 to 15 minutes before the start of work every morning for 4 weeks (20 days), and consistency was secured using a standardized TBM checklist.

3.3. Measurement Tools

In this study, three key dependent variables were measured. First, the understanding of safety knowledge consisted of a total of 10 items designed to measure the degree of comprehension regarding risk factors and safety rules conveyed during TBM. Each item was rated on a 5-point Likert scale ranging from 'Do not understand at all' (1 point) to 'Fully understand' (5 point). As a result of verifying the reliability of the

measurement tool, the Cronbach's α coefficient was calculated at .89, confirming high internal consistency.

Second, **Safety Practice Behavior** consisted of 8 questions observing and evaluating the degree of application of TBM contents to actual work sites (Cronbach's α = .85), and safety managers filled out an observation checklist on a weekly basis. Third, **TBM Satisfaction** consisted of 6 questions measuring the ease of understanding TBM contents, willingness to participate, and degree of help (Cronbach's α = .82).

Additionally, the following auxiliary indicators were collected:

TBM Participation: Recording the frequency of opinions presented and the number of questions.

Number of Near-miss Reports: Trends in the number of near-miss accident reports.

TBM Operation Checklist: Checking the qualitative level of TBM operation as shown in <Table 1>.

Table 1: TBM Operation Quality Checklist

Inspection Item	Details	Improvement Action
1. Content Preparation	Prepare photos/pictures of risk factors for today's work	Construct Visual Material DB
	Prepare multi-language (Myanmar/Vietnam/Chinese) materials	Use translation apps or standard kits
2. Delivery Process	Conduct TBM according to the checklist order	Standard SOP education
	Confirm understanding (asking back, demonstration)	Introduce "Designate 3 people → Re-explain" rule
3. Induction of Participation	Collect questions/opinions from foreign workers	Allocate "Safety Word of the Day" time (2 mins)
	Provide positive feedback to those who present opinions	Operate a reward system for excellent opinions
4. Recording & Follow-up	Secure signatures of TBM attendees	Mobile app automatic attendance
	Confirm action on pointed-out risk factors	Re-confirm at 16:00 on the day

3.4. Data Collection and Analysis

Data collection involved a pre-test conducted during the first week of September 2025, followed by a four-week experimental intervention, and concluded with a post-test in the first week of October. To ensure the linguistic validity of the survey items, the questionnaires were distributed after completing a translation and review process into the workers' native languages by professional interpreters from the respective countries. During the data collection process, the research team and on-site safety managers adopted a method of directly distributing and collecting the questionnaires, thereby achieving a 100% response rate with no missing data. Statistical processing of the obtained data was performed using the IBM SPSS Statistics 26.0 program, and the specific analysis steps were as follows. First, descriptive statistics such as mean (M) and standard deviation (SD), as well as frequency analysis, were calculated to identify the sociodemographic characteristics of the subjects and the overall trends of the major variables. Second, an independent samples t-test was performed to determine whether statistically significant differences existed between the two groups (experimental and control) following the experimental intervention. Third, a one-way analysis of variance (One-way ANOVA) was applied to examine differences in educational effects according to the participants' country of origin (Vietnam, China, and Myanmar).

4. Research Results

4.1. Comparison of TBM Effects Between Groups

The results of comparing the post-scores of the experimental group and the control group are shown in <Table 2>. Understanding of safety knowledge showed a significant difference with 4.32±0.51 for the experimental group and 3.68±0.63 for the control group (t=5.42, p<.001, Cohen's d=1.11). Safety practice behavior was 4.18±0.47 for the experimental group and 3.71±0.58 for the control group (t=4.89, p<.001, Cohen's d=0.89), and TBM satisfaction was 4.45±0.49 for the experimental group and 3.52±0.71 for the control group (t=6.13, p<.001, Cohen's d=1.50). In all areas, the experimental group was statistically significantly higher. The effect size analysis showed the largest effect in TBM satisfaction (d=1.50), meaning that native language interpretation/translation and pictorial materials significantly improved the TBM experience itself for foreign workers.

Table 2: Comparison of TBM Effects Between Experimental and Control Groups

Measurement Area	Experimental Group (n=60) *M±SD*	Control Group (n=60) *M±SD*	*t*	*p*	Cohen's *d*
Safety Knowledge Understanding	4.32±0.51	3.68±0.63	5.42	<.001	1.11
Safety Practice Behavior	4.18±0.47	3.71±0.58	4.89	<.001	0.89
TBM Satisfaction	4.45±0.49	3.52±0.71	6.13	<.001	1.50

This demonstrates that intervention elements such as native language translation, visual aids, and the designation of safety leaders substantially improve TBM effectiveness for foreign workers. In particular, an analysis of the score gains between pre- and post-tests revealed that the experimental group recorded a remarkable increase ranging from approximately 2.1 to 2.8 times that of the control group. This suggests that the modified TBM delivery system effectively enhanced the workers' learning efficiency

4.2. Differences in TBM Effects by Nationality

The results of the analysis by nationality are shown in <Table 3>. Vietnamese workers showed the highest scores with safety knowledge 4.51±0.42, safety practice 4.37±0.39, and satisfaction 4.63±0.41. Chinese workers showed safety knowledge 4.26±0.48, safety practice 4.12±0.46, and satisfaction 4.38±0.52, while Myanmarese workers showed safety knowledge 4.15±0.59, safety practice 4.03±0.53, and satisfaction 4.29±0.57. The one-way ANOVA results confirmed significant differences by nationality in all areas: safety knowledge (F=4.18, p<.05), safety practice (F=3.89, p<.05), and satisfaction (F=3.42, p<.05).

Table 3: Differences in TBM Effects by Nationality (Analysis within Experimental Group)

Nationality	Safety Knowledge *M±SD*	Safety Practice *M±SD*	Satisfaction *M±SD*	Average Stay (Months)
Vietnam (n=23)	4.51±0.42^{a}	4.37±0.39^{a}	4.63±0.41^{a}	18.3±6.2
China (n=20)	4.26±0.48^{ab}	4.12±0.46^{ab}	4.38±0.52^{ab}	24.7±8.9
Myanmar (n=17)	4.15±0.59^{b}	4.03±0.53^{b}	4.29±0.57^{b}	12.1±4.8
F	4.18*	3.89*	3.42*	-

**p<.05, ^{ab}: No significant difference between same letters in Scheffé post-hoc test*

The post-hoc test confirmed a significant difference between Vietnamese and Myanmarese workers (p<.05), while Chinese workers were at an intermediate level with no significant difference from either group. This difference is interpreted as being due to familiarity with the Korean language, average duration of stay, and qualitative differences in native language translation materials. In the case of Vietnamese workers, it is analyzed that the relatively well-established Vietnamese interpretation infrastructure in Korea and active sharing of safety information through the Southeast Asian worker community had a positive influence.

4.3. Contribution by Improvement Element and Change in Participation

Additional survey results for the experimental group showed that the most helpful element for improving TBM understanding was native language interpretation/translation (68.3%), followed by the use of pictorial materials (23.3%) and the designation of safety leaders (8.4%). Safety leaders were evaluated as having a large indirect effect by supporting the site adaptation of new foreign workers and functioning as a continuous safety communication channel.

As a result of analyzing TBM participation, the average frequency of opinion presentation per person in the experimental group increased 7-fold from 0.3 times per week before the experiment to 2.1 times per week after the experiment, while the control group showed a minimal increase from 0.3 times to 0.5 times. The number of near-miss reports also increased 3.2 times in the experimental group compared to before the experiment, confirming that the improved communication system activated safety communication and improved risk perception ability.

Table 4: Field Evaluation Results by Key TBM Element (Experimental Group)

Evaluation Item	Importance Mean (1~5)	Current Performance Mean (1~5)	Improvement Priority
Provision of multi-language safety materials before TBM	4.72	4.35	1st

Attachment of native language signs in hazardous places	4.58	3.87	2nd
Confirmation of understanding by foreman (asking back)	4.51	4.18	3rd
Operation of on-site safety education center	4.23	3.62	4th
Manager's listening attitude when opinions are presented	4.65	4.41	-

As shown in <Table 4>, foreign workers perceived the provision of multi-language safety materials (importance 4.72) as the most important, followed by the manager's listening attitude (4.65) and the attachment of native language signs (4.58). As a result of analyzing the gap between importance and current performance, the attachment of native language signs in hazardous places (gap 0.71) and the operation of safety education centers (gap 0.61) were derived as areas requiring priority improvement.

5. Conclusion and Recommendations

5.1. Summary of Research Results

This study experimentally verified the effectiveness of improving the TBM communication system for foreign workers. The experimental group, which applied native language interpretation/translation, pictorial materials, and designation of safety leaders, showed significantly higher effects in all areas compared to the control group: understanding of safety knowledge (17.4% improvement), safety practice behavior (12.7% improvement), and satisfaction (26.4% improvement). By nationality, Vietnamese workers showed the highest response, and among the improvement elements, native language interpretation/translation was confirmed to have made the greatest contribution. This empirically proves that the language barrier is a key obstacle to safety education for foreign workers.[2][1][4]

5.2. Practical Recommendations

Based on the empirical findings of this study, we propose the following specific practical strategies to maximize the efficiency of TBM operations at actual construction sites. First, education on foreign safety communication for TBM leaders should be strengthened, and a TBM quality management system using the checklist in <Table 1> should be established. Second, real-time interpretation support should be expanded by deploying interpretation personnel for each country or introducing AI-based multi-language translation systems. Recently developed mobile TBM apps support 8 languages including Vietnamese, Chinese, and Burmese, and are highly usable in the field with voice recognition and automatic translation functions .

Third, intuitive visual aids, such as pictograms, should be standardized, and the installation of multilingual safety signs in hazardous areas must be made mandatory. According to the analysis data in Table 4, while foreign workers perceived the 'installation of native language safety signs' as highly important, their actual perceived performance was low. Consequently, this item falls within the 'Concentrate Here' quadrant, which demands urgent action, indicating that priority resource allocation is necessary. Fourth, a safety leader system for each country should be established, and incentives (payment of allowances, support for certification, etc.) should be provided to safety leaders to ensure the sustainability of the system.

From an institutional perspective, it is necessary to revise the Enforcement Rules of the Occupational Safety and Health Act to expand safety education hours for foreign workers (from the current 8 to 16 hours) and to establish a mandatory clause for native language education. Furthermore, a 'Foreign Worker Safety Competency Certification System' needs to be introduced. While granting official qualifications to personnel who complete the designated curriculum, tangible financial incentives—such as reductions in industrial accident compensation insurance premiums—should be provided to workplaces that hire these verified workers, thereby encouraging voluntary safety management.

5.3. Limitations and Suggestions for Future Research

Despite the significance of empirically addressing safety communication issues among foreign workers at construction sites, this study contains several limitations regarding its scope and methodology, as follows. First, due to the short-term experiment of 4 weeks, long-term effects and actual accident rate reduction effects could not be identified. It is necessary to verify whether TBM improvement leads to a decrease in the industrial accident rate through longitudinal studies of 6 months to 1 year or more in the future. Second, given that the sample in this study was limited to workers from three specific countries—Vietnam, China, and Myanmar—caution is required when generalizing the results to the entire foreign construction workforce. Future research should ensure external validity by incorporating a more diverse range of nationalities, including workers from

Cambodia, Nepal, and Uzbekistan. Third, by simultaneously applying three improvement elements to the experimental group, the independent effect of each individual element could not be accurately separated. Future research needs to apply a Factorial Design to analyze the main effects and interaction effects of each improvement element. Fourth, since it was limited to large-scale construction sites (apartment construction, commercial facilities), the applicability to small-scale sites or other industries (manufacturing, shipbuilding, etc.) requires further verification. Future research directions suggest: ① verification of the effectiveness of smart TBM systems using AI voice recognition and real-time translation technology, ② development of experiential foreign safety education programs using VR/AR technology, and ③ research on the influence of foreign workers' safety culture perception and cultural differences by country on safety behavior. It is hoped that this study contributes to guaranteeing the safety rights of foreign workers and improving the safety culture of construction sites .

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