Safety and Health at Work 15 (2024) 310–316

Contents lists available at ScienceDirect

Safety and Health at Work

journal homepage: www.e-shaw.net

Original article

Effect of a Safety Leadership Training Including Coaching on Safety Performance and Climate in Wood-processing Companies

Kwangsu Moon *

Department of Psychology, Chung-Ang University, Seoul, Republic of Korea

A R T I C L E I N F O

Article history:
Received 14 May 2023
Received in revised form
12 April 2024
Accepted 19 May 2024
Available online 22 May 2024

Keywords:
Behavior-based safety
Safety behavior
Safety coaching
Safety leadership
Sawmill site

A B S T R A C T

Background: The wood-processing industry has historically exhibited high rates of occupational hazards resulting in illness and injury. One of the major causes of high injury rates is small firm size, as resource constraints generally preclude hiring safety officers. This study examined the effect of a safety leadership training program that included coaching for managers on workers' safety behaviors and safety climate in three wood-processing companies.
Methods: One or two managers at each site participated in this study. The manager training consisted of safety leadership education, safety observation, positive or corrective feedback on workers' behaviors, goal setting, and low-cost rewards for meeting goals. The dependent variable was the percentage of safe employee behaviors recorded on a critical behavior checklist developed for this study. Safety climate was measured before and after the intervention. An AB multiple baseline design across settings was adopted. After the baseline (A), the training program (B) was introduced to each site at different points in time.
Results: After the introduction of safety leadership training, the mean rate of safety compliance increased by 15.3%, from 80.38% to 95.68%, and safety climate scores increased significantly from an average of 3.2 to 3.47.
Conclusion: These results suggest that safety leadership coaching can be effective in improving safety management in small sawmilling sites. Implications, limitations, and possible future research directions are discussed.

1. Introduction

The wood-processing industry has historically exhibited high rates of occupational hazards resulting in illness and injury [1]. Sharp tools and equipment, wood dust, noise, heavy wood and materials, and heat are the main physical risk factors [2]. The industry is often labor-intensive and production-oriented, and workers typically perform at a fast pace, sometimes putting their health and safety at risk [3].

According to the U.S. Bureau of Labor Statistics [4], the average incident rate per 100 full-time workers in all U.S. industries was 2.7, while the incident rate in the sawmill and wood preservation industry was 3.5 in 2021. The occupational safety problems in the Republic of Korea (Korea) wood-processing industry are particularly severe; the rate of work-related injuries and illnesses in 2021 was 14.26 per 1,000 full-time workers, whereas the average rate for all industries was 6.33 [5].

One of the major causes of high injury rates in this industry is the predominance of small firms [1]. There are 17,675 wood-processing companies in Korea; among them, only 1.5% have over 50 workers, while 60.7% have fewer than five workers [5]. For comparison, while the proportion of small firms is generally high in manufacturing industries, 47.4% of firms have fewer than 5 workers and 12.6% of firms have 50 or more workers in the briquette, petroleum products, medicine, and cosmetics manufacturing industries, which have a much lower accident rate (2.99 per 1,000 workers) [5]. Accident prevention is often difficult for small companies because they typically have limited financial resources to

Kwangsu Moon: https://orcid.org/0000-0002-2684-6480
* Department of Psychology, Chung-Ang University, 84 Heukseok-ro, Dongjak-gu, Seoul, 06974, Republic of Korea.
E-mail address: ksmoon@cau.ac.kr (K. Moon).

dedicate to employees' health and safety. For example, they are usually unable to hire safety officers to identify and evaluate occupational hazards and manage the associated risks.

The need for practical programs to reduce industrial accidents in small wood-processing companies is clear. Onowhakpor et al. [6] highlighted a need to improve safety practices to mitigate injuries and accidents among sawmill workers. The UK Health and Safety Executive [7] emphasized that without effective safety leadership, an organization cannot have good safety or accident-prevention practices. Definitions of safety leadership vary; Wu defined it as "the process by which managers interact with employees to establish safety goals, taking into account organizational context and personal factors" [8], and Petersen defined it as "the holistic process of identifying the current state of safety, creating a vision for improvement, and devising a way to achieve the vision." [9]. A growing body of literature suggests that safety leadership is related to employees' health and safety performance and outcomes [10]. Safety leadership is an important way to improve employee safety behavior and decrease accidents, especially in firms that cannot hire a dedicated safety officer.

Existing safety leadership models are based on safety-specific transformational and transactional leadership. The fundamental elements of transformational leadership are idealized influence, inspirational motivation, individualized consideration, and intellectual stimulation. Leaders with high idealized influence demonstrate a strong commitment to safety through their own behaviors, decisions, and actions, while leaders with high inspirational motivation provide compelling reasons for workers to engage in safety behaviors and encourage their participation in training. Intellectual stimulation encourages employees to consider safety improvements, and leaders with high individualized consideration show concern, support, and encouragement for workers' safety [11].

Transactional leadership is based on contingent reinforcement and is primarily exchange-based. In the safety context, transactional leadership establishes clear expectations for safe work by defining workers' roles and the safety policies and procedures necessary for task performance. The approach provides incentives and acknowledgment for exhibiting required safety behaviors and meeting safety objectives. Transactional leadership manages unsafe behavior through active management of exceptions, which means that leaders identify unsafe behaviors, violations of critical safety procedures, problems with equipment, tools, etc., and take corrective action before an incident occurs [11].

Previous studies have often approached safety issues through the lens of the ABC model (antecedents, behavior, consequences), based on Skinner's applied behavior analysis [12]. The Behavior-Based Safety (BBS) program utilizes the ABC model to develop interventions for enhancing safety behavior. A standard BBS program consists of fundamental safety training, safety work instruction, and goal setting (antecedents), followed by periodic observation, feedback, and small rewards (consequences) to modify behavior [13].

Safety climate is shaped by group behavioral norms and managers' leadership exerts a strong influence. Emphasizing safety, engaging in safety-oriented behaviors, and interactions such as modeling or communication can elevate safety's prioritization within a workplace and influence organizational norms [14], making workers more likely to value and appreciate workplace safety.

In sum, workers' safety is dependent on their managers' behavior. Managers provide feedback about their behaviors, enabling employees to adapt their behavior [15]. Effective corrective feedback includes specific information on how workers can comply with safety regulations and meet goals. Providing positive feedback on safety behaviors also contributes to their maintenance and reinforcement [16]. When managers display consistent safety behaviors and communicate to employees that safety is a priority, boosting the safety climate.

To date, previous research on safety leadership has focused on assessing transformational, transactional, and servant leadership styles through questionnaires [11]. However, leaders can adopt a leadership style based on organizational requirements, situations, and challenges [17]. There is a growing body of research on the effectiveness of safety leadership training, and studies have shown that behavioral leadership training increases leaders' safety goal setting, feedback, and listening behaviors and positively impacts safety climate and workers' safety attitudes and behaviors [18]. However, most existing studies have used questionnaires to measure leaders' safety management behaviors or workers' safety performance, which are indirect, "in the moment" measures and can be subject to biases such as social desirability [19]. There is a lack of field research examining whether managers' increased safety management behavior leads to increased worker safety behavior or safety climate [20].

Coaching may be an effective intervention to improve safety outcomes in some environments where safety is critical [21,22]. Wiegand [23] defined safety coaching as "an applied behavior analysis technique that involves interpersonal interaction to understand and manipulate environmental conditions that are directing (i.e., antecedent to) and motivating (i.e., consequences of) safety-related behavior." Similarly, Geller et al. [24] defined BBS coaching as "a process of observation and feedback in order to support safe behaviors and provide constructive feedback on risky behaviors in the workplace."

Coaching at hospital radiology departments [25], large construction sites [24], and manufacturing plants [26] has increased cooperation, communication, and safety behaviors and reduced accidents. Meta-analyses of coaching programs have shown that they have significant positive effects on performance and skills, work attitudes, learning, and goal-directed self-regulation [22], demonstrating that safety coaching can improve workers' safety performance by improving safety observation and communication between site managers and workers in various high-risk working environments.

Therefore, this study investigated the effect of BBS-based safety leadership training including coaching (SLTC) on managers' safety management behaviors, workers' safety behaviors, and perceived safety climate in wood-processing companies.

2. Method

2.1. Participants and setting

This study was conducted at three wood-processing companies in G city of Korea. The three sites were selected because they agreed to participate, had similar work processes (sawmills), and had experienced two or three major accidents within three years. Companies A, B, and C had 9 (one female),16 (four female), and 16 (two female) workers, respectively. The average number of working days per week was five, and the average number of working hours per day was nine. One or two managers per company participated in the coaching program. None of the managers had any previous education or training in safety leadership or BBS programs.

2.2. Measures

2.2.1. Development of the critical behavior checklist

This study developed a critical behavior checklist (CBC) adapted from Sulzer-Azaroff and Fellner [14] to measure workers' and managers' safety behaviors before collecting baseline data. First, the

Critical Behavior Checklist					
Date:	Observer:				
Note. Please don't write name of any observee. When you observe a safety beahvior and risk behavior, check the "Safety" and " Concern" column respectively. If a positive comment or praise on the safety beahvior is provided, check the "Pos. Feed" column, or If the risk behavior is corrected, check the " Corr. Feed" column					
Observation Items	**Safe**	**Concern**	**Pos. Feed**	**Corr. Feed**	**% of Safe**
Beep when the forklift moves or works, drivers check their surroundings when loading and unloading timber					
Comply with forklift speed regulations (20km/hr)					
Use appropiriate fix-wood when loading unsawn timber					
Wear personal protective equipment (earplugs, safety shoes, gloves, protective gear)					
Keeping walkways and work areas clear and organized.					
Maintaining eye contact with their operation when working.					
Inform workers before machine operation to prevent hands or clothes becoming stuck					
If a tree is stuck in a chain or saw, wait until the machine is completely stopped and remove the tree					
Total # & Average % of Safety					
memo:					

Fig. 1. The Critical Behavior Checklist used in this study.
Note. Pos. Feed: Positive feedback, Corr. Feed: Corrective feedback.

status of industrial accidents for each company in the previous three years was classified and the most frequent types of accidents were analyzed. Then, the necessary safety behaviors and conditions at each site were identified based on the lumber industry safety guidelines distributed by the Korea Occupational Safety & Health Agency (KOSHA). Previous studies on risk assessment and accident analysis in the Korean sawmilling industry [27,28] showed that most accidents occurred when the bandsaw broke or became stuck during the process of cutting logs, followed by accidents during the loading and unloading of logs using forklifts. Based on this, two forklift operation items and three wood-cutting items were included in the CBC. Interviews were conducted with one manager and two workers at each site to identify key risk behaviors and conditions, and the extracted behaviors and conditions were verified as appropriate for each company through on-site audits. These procedures yielded 18 items. This list was then given to the manager of each company, who were requested to rate the relative importance of each item on a scale of 1 to 5, with 5 being *extremely important*, 3 being *neutral*, and 1 being *not important at all*. Using these ratings, items were retained if they received an overall rating above three, could be observed frequently, and applied to all companies' safety activities, leaving eight items. These items were operationally defined and grouped into the following three categories: (1) Forklift, (2) Conditions, and (3) Workers' Behavior (Fig. 1). The finalized checklist was then checked for appropriateness.

2.2.1.1. Dependent variables. The main dependent variable was the average safety percentage for all checklist items. The safety percentage for each item was calculated using the following formula: [frequency of safe behaviors / (frequency of safe behaviors +

concerning behaviors) × 100]. The overall average safety percentage was derived using the following formula: [sum of safety percentage of all items / total number of items × 100].

Safety climate was also measured as a dependent variable, using a scale developed by Griffin and Neal [29] and validated in Korean by Kim and Park [30]. The sub-factors of safety climate consisted of management values, communication, education and training, safety regulations, and safety behavior. All 20 items were measured on a 5-point Likert scale.

2.2.1.2. Inter-observer reliability. Managers were trained to ensure the reliability of observational data. The managers practiced together with a researcher until their results exceeded 90% inter-observer reliability (IOR). Since the managers had deep expertise in the tasks and work processes of their companies, they achieved an IOR above 90% after two observations. IOR data was collected from each firm in 15% of the experimental sessions. Managers and researchers independently observed the same checklist item without mutual discussion. The mean IOR for all companies using a frequency ratio was 86.44% (range: 73.9–98%).

2.2.1.3. Independent variable and experimental design. The independent variable was the application of an SLTC to improve safety leadership. Dickerson et al. [25] provided safety coaching training on safety behaviors, feedback, and communication, followed by monthly meetings to evaluate safety behaviors. Another study used safety communication training, weekly safety observations of worker behavior, and feedback every two weeks [31]. A more recent study on coaching used meetings to clarify tasks, provide antecedents for desirable behaviors, provide feedback, offer token rewards, and give praise [32].

An AB multiple baseline across setting experimental design (within-subject design) was adopted to examine the effectiveness of the SLTC. This design is primarily applied in field experimental studies demonstrating intrasubject replication of the intervention, with the same intervention implemented in a staggered fashion across different settings. After the baseline (A) was obtained, the SLTC (B) was introduced sequentially at different times across the three companies.

Baseline: During the baseline observation, managers received no coaching, meaning no instructions or training. They performed their normal tasks and observed conditions and workers' behavior with a researcher using the CBC once per day.

Leadership Training Including Coaching Program: Prior to the first SLTC, managers were provided information on leadership. Using a similar method to general leadership training (lectures, discussions, and goal setting), managers were trained on ways to incorporate safety-specific leadership behaviors into their daily work. Specifically, two safety leadership behaviors were promoted: observation of their own worksite safety and communication with workers on their safe and risky behaviors. In the coaching session, managers developed a personalized plan for setting specific and attainable goals with respect to the two safety leadership behaviors (more than one observation and two instances of feedback per day). In addition, they were trained in and given the opportunity to practice safety communication methods for positive and corrective feedback on workers' behavior and workplace conditions. Through consultation with the managers, safety education was changed from regular concentrated education to a daily toolbox meeting before work. The researchers held weekly safety meetings with managers to provide feedback on the safety ratios of each item and discuss ways to increase scores on items with low safety ratios.

2.3. Procedure

Each manager conducted random safety observations between 9 a.m. and 5 p.m., and each employee working on a machine or task was observed sequentially. Afterward, managers observed forklifts and conditions while walking around the worksite. Each item was checked as *safe* or *concern* according to the CBC observation criteria. Managers observed only once per day during baseline but were asked to make as many observations as possible during the SLTC.

When managers observed, they provided positive feedback (e.g., "You are doing well. This safe work helps improve your safety and health as well those of your coworkers. Thank you for your effort. Please, keep it up.") to employees working safely and checked the "positive feedback" frequency column. When managers provided corrective feedback on risky behaviors (e.g., "If you do not put in earplugs, you will be comfortable right now, but hearing loss may occur later. Please, wear earplugs for your safety and health."), they checked the "corrective feedback" frequency column.

Safety climate was measured anonymously among workers before the start and after the end of the experiment. During work breaks, the researcher explained the purpose of the study, distributed and collected the questionnaires, and provided a $3 coffee coupon as compensation for completing the survey.

2.4. Hypothesis and statistical analysis

To achieve the purpose of this study, the following hypotheses were formulated:

H1. The SLTC will improve wood-processing site managers' safety-leadership behaviors of observation and positive and corrective feedback.

H2. The SLTC will demonstrate a positive effect on actual and perceived workers' safety behaviors.

H3. The SLTC will demonstrate a positive effect on workers' perceived safety climate.

To test the research hypotheses, statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) program, version 25.0 (IBM). A repeated-measures ANOVA and independent t-test were used to examine whether there was a significant difference in the safety percentage of each item and safety climate between experimental conditions.

3. Results

Fig. 2 shows the means and standard deviations of the safety percentages for all items across experimental conditions over time. During the baseline, the average safety percentages were 75.69 ($SD = 7.61$), 81.70 ($SD = 9.10$), and 83.76 ($SD = 6.71$) for Sites A, B, and C, respectively. After the SLTC program was introduced, the percentages increased to 92.75 ($SD = 4.45$), 95.96 ($SD = 4.52$), and 98.32 ($SD = 2.14$) for Sites A, B, and C, respectively. Additionally, during the SLTC, managers averaged 1.88 ($SD = 0.61$) daily observations and 5.03 ($SD = 1.88$) feedback events.

Table 1 summarizes the means and standard deviations of the safety percentages of individual items for each company across experimental phases. Company A showed an average increase of 17.06% in safety percentage ($F = 60.26$, $p < 0.01$, $\eta^2 = 0.40$); Company B increased by an average of 14.25% ($F = 46.19$, $p < 0.01$, $\eta^2 = 0.34$); and Company C increased by an average of 14.56% ($F = 52.27$, $p < 0.01$, $\eta^2 = 0.37$). Safety percentages of most items increased significantly in the SLTC phase compared to the

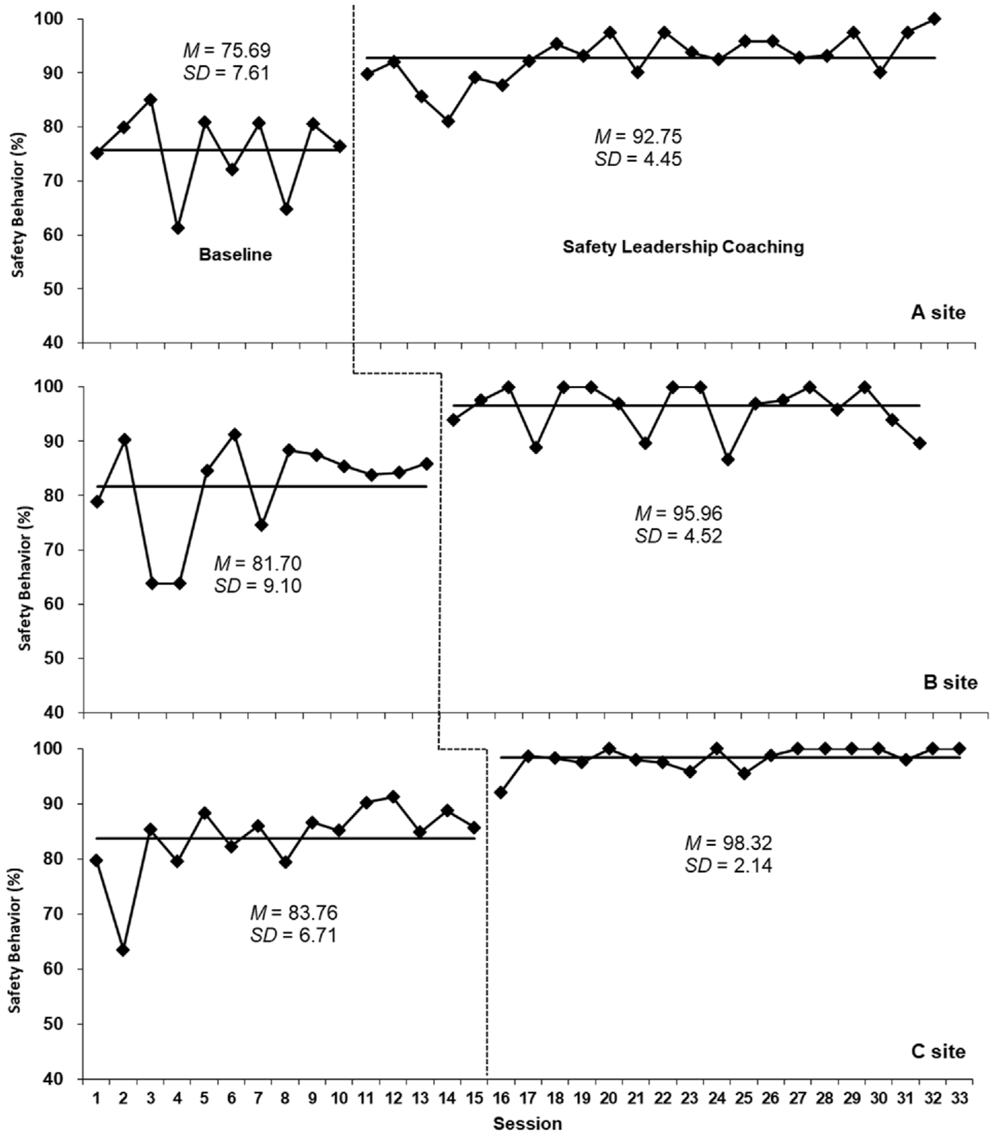

Fig. 2. The means and standard deviations of safety percentages for all items across experimental conditions over time.
Note. M: Mean, SD: Standard Deviation.

baseline. However, while the average percentages of Forklift 1, Condition 1, Behavior 1, and Behavior 2 in Company A, Condition 2, Behavior 3, and Behavior 4 in Company B, and Behavior 1 and Behavior 2 in Company C increased, they did not show statistically significant differences compared to the baseline. The effect sizes for the average baseline–training effects ranged from 0.34 to 0.40.

The post-scores were higher than the pre-scores for each company's safety climate, and analysis of the combined data from all three companies showed the mean scores increased significantly across all sub-factors, with safety leadership showing the largest increase. The effect sizes between pre- and post-mean scores ranged from 0.54–1.76 (Table 2).

4. Discussion

These findings indicate that the SLTC program based on behavioral principles had a positive impact on observed safety behavior, perceived safety behavior, and safety climate among workers. As managers work closely with workers, instructing and supervising their tasks, their safety awareness and management behaviors have a direct impact on workplace safety and workers' safety behaviors. Through actions and guidance, a leader sends clear messages to their subordinates regarding which policies and behaviors are important.

In this study, managers observed workers' behaviors and immediately provided feedback, which generally has a greater effect on behavioral change than delayed feedback. Additionally, the fact that the managers' participation was voluntary likely contributed to the program's effectiveness. The program used in this study also seemed to inculcate a sustained interest in safety among the managers, who were able to observe the checklist items daily, provide feedback, and measure their behavior so that safety management became part of the routine rather than an additional task. In line with previous, these findings suggest that managers' commitment, motivation, and attention are crucial to the success of any safety management program.

These results demonstrate that an SLTC can influence a variety of organizational safety culture factors, which can be interpreted as a spread effect of the intervention. Spread effects, broadly defined,

Table 1
The means and standard deviations of the safety percentages by item across sites and experimental condition and results of the ANOVA

Site	Item	Baseline		Coaching		*MD*	*F*	*p*	η^2
		M	*SD*	*M*	*SD*				
A	Forklift1	88.00	16.87	90.00	14.80	2.00	0.18	0.67	0.00
	Forklift2	81.67	24.15	97.73	10.66	16.06	10.81	0.00	0.11
	Condition1	91.71	14.72	96.36	7.90	4.65	0.61	0.44	0.01
	Condition2	73.33	29.65	91.82	11.81	18.48	9.86	0.00	0.10
	Behavior1	80.00	15.54	89.41	12.92	9.41	3.75	0.06	0.04
	Behavior2	93.33	10.73	96.84	6.30	3.51	0.70	0.40	0.01
	Behavior3	40.00	45.95	86.36	26.04	46.36	32.25	0.00	0.26
	Behavior4	57.50	38.18	93.47	14.81	35.97	29.97	0.00	0.25
	Overall	75.69	7.61	92.75	4.45	17.06	60.26	0.00	0.40
B	Forklift1	84.62	16.64	97.78	6.47	13.16	8.45	0.00	0.09
	Forklift2	87.18	16.88	98.15	7.86	10.97	5.54	0.02	0.06
	Condition1	57.69	18.78	91.67	19.17	33.97	35.92	0.00	0.29
	Condition2	84.62	17.30	92.59	14.26	7.98	2.02	0.16	0.02
	Behavior1	83.43	22.61	98.72	5.44	15.29	10.86	0.00	0.11
	Behavior2	85.21	22.96	96.15	8.85	10.95	7.49	0.01	0.08
	Behavior3	85.64	20.29	98.61	5.89	12.97	2.77	0.10	0.03
	Behavior4	85.26	18.05	93.98	11.72	8.73	1.94	0.17	0.02
	Overall	81.70	9.10	95.96	4.52	14.25	46.19	0.00	0.34
C	Forklift1	84.92	12.97	98.89	4.71	13.97	10.32	0.00	0.10
	Forklift2	79.56	10.70	95.93	7.88	16.37	13.36	0.00	0.13
	Condition1	80.46	23.47	98.89	4.71	18.43	11.46	0.00	0.11
	Condition2	74.13	14.32	96.74	6.38	22.60	17.54	0.00	0.16
	Behavior1	92.67	12.80	100.00	0.00	7.33	2.71	0.10	0.03
	Behavior2	92.24	9.10	98.89	3.23	6.65	2.99	0.09	0.03
	Behavior3	81.71	12.57	99.07	3.93	17.36	5.38	0.02	0.06
	Behavior4	84.37	12.70	98.15	5.39	13.78	5.23	0.02	0.05
	Overall	83.76	6.71	98.32	2.14	14.56	52.27	0.00	0.37

Note. M, Mean; MD, Mean Difference; SD, Standard Deviation.

Table 2
The means and standard deviations of the safety climate across sites and experimental conditions and results of independent *t*-test

Variable	Site	Pre			Post			*t*	*p* (*Cohen's d*)
		M	*SD*	*n*	*M*	*SD*	*n*		
Safety management commitment	A	3.29	0.27	7	3.46	0.33	6	-2.73	0.01 (0.81)
	B	3.41	0.44	8	3.88	0.13	8		
	C	3.84	0.27	8	4.08	0.43	9		
	Total	3.52	0.41	23	3.85	0.40	23		
Safety communication	A	3.04	0.17	7	3.46	0.43	6	-1.89	0.03 (0.54)
	B	3.47	0.43	8	3.72	0.16	8		
	C	3.81	0.22	8	3.75	0.25	9		
	Total	3.46	0.43	23	3.66	0.30	23		
Safety training	A	2.77	0.34	7	3.13	0.30	6	-1.98	0.03 (0.59)
	B	3.08	0.24	8	3.21	0.30	8		
	C	3.45	0.33	8	3.60	0.37	9		
	Total	3.11	0.40	23	3.34	0.38	23		
Safety regulation	A	2.71	0.36	7	2.74	0.58	6	-2.28	0.01 (0.69)
	B	2.50	0.56	8	3.02	0.34	8		
	C	2.96	0.33	8	3.30	0.56	9		
	Total	2.72	0.46	23	3.06	0.53	23		
Safety leadership	A	2.86	0.43	7	3.47	0.27	6	-3.28	0.00 (1.76)
	B	3.23	0.48	8	3.38	0.34	8		
	C	3.00	0.39	8	3.42	0.43	9		
	Total	3.03	0.44	23	3.42	0.35	23		
Safety compliance	A	3.21	0.62	7	3.51	0.32	6	-2.91	0.00 (0.85)
	B	3.50	0.50	8	3.66	0.33	8		
	C	3.31	0.29	8	3.92	0.41	9		
	Total	3.35	0.48	23	3.72	0.39	23		
Safety climate	A	2.98	0.07	7	3.27	0.28	6	-4.35	0.00 (1.27)
	B	3.20	0.03	8	3.44	0.13	8		
	C	3.40	0.04	8	3.64	0.17	9		
	Total	3.20	0.18	23	3.47	0.24	23		

Note. M, Mean; SD, Standard Deviation.

are the effect of an intervention not only on the targeted part of the organization but also on various non-targeted parts of the organization [33]. The sites in this study were not large, which may have contributed to managers' and workers' focus on the SLTC and led to a short-term increase in safety climate. Unlike previous studies, this study observed direct worker behavior in addition to questionnaire measurements, thus increasing the internal validity of the results. These findings are consistent with those of previous studies conducted on-site showing that managers' safety leadership positively affects workers' safety behaviors, safety climate, and accident reduction [13,18,20]. Application of the program used in this study to other small wood-processing factories with high accident and mortality rates could improve safety management, not only in other lumber companies but also in companies in other industries.

Some limitations should be considered when interpreting these results. First, this study was a field study, so it was not possible to use a rigorous true experimental design (with a similar site as a control) to test for causality. Assigning workers from the same company to separate experimental and control groups is also difficult due to the likelihood of interaction among employees and small number of workers. In future studies, selecting a site in a similar industry as a control group and examining the effectiveness of the program with a larger number of small wood-processing enterprises would increase the generalizability of the findings [13,20]. In particular, the generalization of this program would benefit from a study comparing the impact of a similar SLTC in other small businesses, even if the core checklist items are different.

Second, because several treatments (observation, feedback, education, etc.) were simultaneously implemented in the coaching program, it is difficult to determine the isolated influence of each individual treatment. Therefore, a follow-up study with component analysis on which treatment used in this study has the greatest influence on the promotion of safe behavior would be useful—in particular, examining whether the main components of the leadership program in this study (training, observation, TBM, and communication) had significant effects on each of the eight CBC items and on the subfactors of safety climate, as well as their relative influence.

Finally, Site C demonstrated a higher safe behavior during baseline. In general, participants in laboratory or field studies adjust and improve their behavior as a reaction (reactivity) to being observed. The managers' observation was equally present both at the baseline and during the treatment period, so it can be regarded as a constant variable; still, it is possible that the workers' behavior changed because managers made more frequent observations during the treatment period. Therefore, it is necessary to take this into consideration when interpreting the results of this study. On the other hand, some items did not show a significant increase. In particular, Behaviors 1 and 2 did not increase significantly at two of the sites. This suggests that it is not easy to implement new safety behaviors. From a behavioral analysis perspective, it is difficult to adopt safe behaviors because their negative consequences, including inconvenience, encumbrance, and decreased work speed, are experienced more immediately and with greater certainty than the negative consequences of unsafe behaviors, while positive consequences such as accident prevention are experienced less often as uncertain outcomes in a theoretical future. The duration of the treatment may not have been sufficient to shape the behavior, so it is necessary to determine if a longer period of continuous program operation would lead to behavior change. Furthermore, in addition, this study did not examine the effect of the SLTC program on the frequency or severity of industrial accidents. Although no official industrial accidents occurred during the study period, longer-term verification and accident data analyses are needed.

Despite these limitations, this study has practical significance in having developed a coaching program that can enhance safety leadership based on the BBS program and verified the program's effectiveness in the field. In addition, this study offers a safety management approach that is suitable for small wood-processing sites with many hazards, and it is an efficient program from a cost-benefit perspective. However, empirical studies applied to sawmill sites in Korea are still insufficient, and additional studies are needed.

CRediT authorship contribution statement

Kwangsu Moon: Project administration, Writing – original draft, Writing – review & editing.

Conflicts of interest

No potential conflicts of interest related to this article are reported.

Acknowledgments

This work was supported by a National Research Foundation of Korea (NRF) grant funded by the South Korean government. (MSIT) (NRF-2020R1A2C1100183).

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