

The Effects of Safety Training on Safety Culture in Construction Industry.

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Abstract

In developing countries like Pakistan, implementation of Health, Safety & Environment (HSE) especially in construction industry is a big deal. Construction industry faces lots of hazards which should be controlled through commitment from top management and finding ways which strengthen the implementation of HSE. In this regards, Safety trainings play a vital role in enhancing the implementation of Health, Safety & Environment (HSE). Effectiveness of safety trainings of different areas like fabrication, work at height and manual handling is measured in this research in which three inferential analysis Pair T-Test, ANOVA and Post Hoc Tukey HSD test were conducted to reach the research objectives. In pair T-test, all areas showed positive compliance after safety training. It meant that training outcomes were effective. In ANOVA, it was observed that compliance level is all areas happened to be different and every area behaved contrarily towards safety. Post Hoc Tukey HSD test proved that fabrication workers excelled in their performance as compared to other areas. They showed more compliance and training ascertained to be more effective in fabrication area.

Keywords:

Health, Safety & Environment, Safety Culture, Safety Trainings, Fabrication, Work at Height, Manual Handling

1. Introduction

In construction industries of Pakistan, it is mandatory to have health safety and environment (HSE) department and it is also the requirement of client to have HSE department. Pakistani industries follow OSHA (Occupational, Safety and Health, UK) standard to implement HSE system. Ultimate purpose of HSE is to save employees especially workers in

every possible way who are more prone to hazards at the workplace. By eliminating hazards at their workplace, their safety & health can only be achieved by taking steps to make their surrounding and workplace safe for them through investment on the maintenance of OSHA standards. It is very crucial to make them aware of HSE system through frequent safety trainings. Safety trainings are the core part of HSE system implementation. Ferika Ozer Sari [1] concluded from his research that employees' trainings have profound effects on occupational safety & health and some of trainings are inevitable. He further explained that some of the necessary trainings are very beneficial for their efficient working.

Workers in construction industries face lots of hazards in their workplace about which they are unaware of. Civil, mechanical and electrical phases have their variant hazards and require customized measures. The minor hazards can lead to major accidents and once avoided can prove to be beneficial and safe condition can be achieved. Safe condition during the workplace can only be achieved when workers have knowledge about the hazards around their workplace. If they don't have awareness regarding hazards, how will they be able to control such situation? Like if they don't know what is the importance of wearing personal protective equipment (PPEs) and how these can save them from injuries and they don't have knowledge of hazards in the workplace and how can avoid them, then how will the safety be assured. This awareness level can only be raised by trainings. Safety trainings help to raise the knowledge level, it can change behavior and attitudes of working. The 'know' part is better than the 'don't know' part and this can make the difference and on the whole this difference can show the overall safety culture of an organization. It's the

safety culture that depicts the overall picture of an organization and its inclination towards safety culture. Safety culture not only indicates the level of compliance of HSE system but also the commitment of top management who has the leading role in its implementation.

The UK health & safety executive [2] defines safety culture as “The product of the individual and group values, attitudes, competencies and patterns of behavior that determine the commitment to the style and proficiency of an organizations health & safety program”.

In construction industry, employer provides personal protective equipment to its employees in order to refrain from hazards. Safety culture of an organization can be judged by the level of compliance to HSE requirement, commitment of top management and everyone’s behavior and attitude towards HSE.

Safety culture can be implemented if its key performance indicators are viewed as core part of its implementation program. Out of which safety trainings impact a lot in furnishing the mindsets of people. Safety training has the prominent role after top management commitment in implementation of safety culture.

OSHA standard requires the use of personal protective equipment (PPE) to reduce employees exposure to hazards when engineering & administrative controls are not able to be applied in reducing these exposures to ALARP (as low as reasonably practicable) level. Compliance of safe conditions in the workplace & worker’s personal protective equipment (PPEs) is measured in this research both before and after safety training provided to workers working in different disciplines. OSHA explains that its responsibility of employers to provide personal protective equipment (PPES) to its employees.

2. Literature Review

The man-made disasters of the 80s and 90s i.e. Piper Alpha, Ladbroke Grove raised the broader issues of organizational acceptance of dangerous or risky practices as mentioned by Cullen [3] Rundmo [4] found that respondent’s violation of safety rules proved to be a strong predictor of risky behavior. Arocena et. al. [5] pointed out that what is an acceptable risk within process of production or construction is continuously negotiated in implicit and explicit ways. Different groups of an organization have their own ideas & beliefs about safety. These groups may be workers, engineers and executives who have different viewpoints about safety, representing safety subcultures. The belief of subcultures regarding safety quite varies among

various levels of an organization as observed by Carl Potter [6].

Cultures are based upon common values, beliefs and norms of an organization. The cultures develop from societal agreements from which attitudes and behavior are constituted. The deviation from the normal behavior has little tolerance as each individual of an organization has a role in reinforcing the behavioral norms as commented by Karl Weick [7]. Hivik [8] found that culture is complex and consists of shared elements e.g. language and attitude of the members of the group. It is shared between people and transferred from one generation to another. It needs to be analyzed on different levels. Safety culture is the set of assumptions and associated practices which permit beliefs about dangers and safety to occur. Health & Safety Commission [9] is of the opinion that organizations with positive safety culture have mutual trust and have confidence in the efficacy of preventive measures. Safety culture is a potential factor to mobilize organization to higher standards of safety. The mindfulness is another essential aspect to arouse and spark the interest as pointed out by Karl Weick [7]. These three concepts indicate importance of safety cultures and safe behavior strategies focusing on the promotion of risk awareness among employees. The idea of safe behavior was particularly emphasized by A. Hopkin [10].

The prominent factors of safety management system are personal factor and safety awareness. Suitable design of personal protective equipment (PPEs) ensure higher quality of work. Awareness on the right use of equipment or tools and wearing PPEs correctly reduced the risks as observed by Zubaidah Ismail [11]. Safety management measures need to be implemented at all levels like leadership, line management, supervisors and workers. The management provides personal protective equipment (PPE) to the workforce. The workers are reluctant to wear any hearing protection due to lack of appreciation of the risks involved. Feelings of PPE wearing as uncomfortable and irritating, adversely affect the speed of job and ability of hearing and warning signals. The right use of PPEs during work can prevent the workers from day to day injuries. These comments were reported by HFRG [12].

As emphasized by Rowlinson et al. [13], the objective of OHS training is to provide workers with knowledge, skills & methodology for performance of the jobs with safety and to bring change in workers’ behavior and organization performance with regard to OHS. All workers have right to know about the hazards of their work during training which should be freely provided in the exercise of the common law duty of care. Posters that could be displayed in the

work areas to serve as memory prompts. Nevertheless, there is evidence that training not only contributes to greater knowledge of HSE but also lowers turnover rates, enhances job commitments, better performance and fewer injuries. It was found that among prevention strategies, safety training has multiple advantages as the workers learn safe behavior and technical skills. It can be used to teach safe behaviors, provide practice time and motivate workers to perform operations with safety. It was also pointed out that safety trainings are not as frequent as highlighted by Rundmo and Haled [4]. Safety training is a core activity emphasizing the known potential hazards and methods of protection which ensure health & safety of workers as pointed out by Cohen & Colligen[14]. The other activities of training should be implemented at work sites to prevent the occurrence of accidents or to reduce their likelihood or severity as a part of safety & health program as remarked by Lyer et al. [15]. Robin et al.[16] concluded from the study that 60% of workers on OSHA hazard communication reported a continued change in practices on year after training while 42% reported continued change two years after training.

3. Research Objectives

Research objectives of the study are to measure effectiveness of safety training for all areas in the construction industry. To determine that the compliance level is equal in all the areas before safety training. To evaluate that the compliance level is equal in all the areas after safety training. To find out which area in terms of safety compliance is better than other.

4. Research Methodology

For analytical study of safety training effects on Safety culture of construction industry, a comprehensive plan of work was devised. There were mix-cultured workers working in a power plant construction at Dera Murad Jamali in Baluchistan, province of Pakistan. The workers were from Descon Engineering Ltd. Lahore, Punjab, Pakistan. Workers belonged to different ethnic and demographic areas having different experiences and some were fresh. A mix of experienced and non-experienced workers was selected so as to depict the entire population. A population of 1500 workers was present at that time of the study.

The research study was divided in three different areas of a power plant construction project in which some workers were involved in work at height, workers doing fabrication job and workers performing in manual handling work. From each area, a sample size of 10 workers was selected and work sampling approach was applied in which 750 observations were completed on each worker using a random sampling technique. On the basis of random

sampling, three observations at different times of day were collected and worker's compliance of some pre-selected safety checks and PPEs were observed both before and after training over a span of 25 days. Sundays were excluded from the research as it was a half day of working and from Monday to Saturday observation were collected.

Workers were not able to understand English language, so the training was provided to them in their local & national language. Training contents were about the work in which they were involved with regard to safety was presented and workplace hazards were communicated. Incident sharing in the form of case study and footages related to their work was shared. It was realized that how their safety is good for an organization and especially for themselves. In the second stage of training, importance of the PPEs was realized that how much an organization is investing on their safety by providing free PPEs. It was also highlighted with sharing of incidents that how PPEs have been good in saving them from injuries. A training of three hours was provided to workers. For one training, five workers were called for and training was provided so as to make training effective and their learning to be useful. A total of six sessions of trainings were completed with the workers in a week with total of 18 hours of trainings and after three days of training, work sampling data were started recording and again 750 observations were collected and their compliance of safety checks and PPEs was gauged. The PPEs provided to workers were according to OSHA standard. SPSS Tool was used to analyze the data and measure the before and after effects of training with comparison.

Fabrication training presentation comprised of 37 slides with an average 1.3 min time of deliverance and total of 49 min. Hazards during welding, cutting and grinding (fabrication) shared with the trainees. Questions with the trainees were asked to get them involved in the training to keep the learning abreast. Three incidents of the kind were shared with workers to make training more effective in terms of knowledge & awareness regarding the hazards. Presentation on work at height consisted of (25) slides averaging 1.5 minutes. Presentation comprising of 38 minutes on average. Workers were asked questions during the presentation if they had understood the specific topics in slides. After the session, a verbal question and answer session of 15 minutes was specified and answers of questions by the workers were provided. Three incidents were shared with regard to work at height over a time period of 60 minutes including small discussions. Third part of training session was discussion about the safety checks and PPEs which were being used by

the workers and it comprised of 1 hour training session. Manual Handling training presentation comprised of 40 slides averaging 1.5 each slide and a total of 60 minutes of presentation followed by questions and answer session 5 Incidents were shared which took 1 hour and detailed discussion carried out with each workers regarding the safety checks and use of PPEs related to their working.

5. Results and Discussion

Data on before and after training regarding mode of all three working viz. fabrication, work at height and manual handling were recorded on the specified Performa. Data thus collected were pooled and arranged in desirable form for statistical analysis. Data was subjected to inferential analysis adopting

Pair T-Test, ANOVA, and Tukey (Post Hoc) analysis to achieve the research objectives.

Summary of no. of observations before and after safety training is shown in Table 1 where not applicable were the observations in which either the worker was idle or not available during the observation. Compliance observations after the safety training in each area found to be increased where in fabrication 563 observations before safety training were in compliance and 661 observed after safety training. Work at height observations before safety training were 585 and rose to be 636 after the safety training. Manual handling observations before safety training were 554 and 620 observed after the safety training. Every area showed positive compliance after the safety training.

Table 1. Summary of observations

Compliance Level	Areas	Fabrication		Work at Height		Manual Handling	
	Before/After	Before	After	Before	After	Before	After
Compliance	No. of Observations	563	661	585	636	554	620
	Percentage	75%	88%	78%	85%	74%	82%
Non-Compliance	No. of Observations	149	80	162	108	187	128
	Percentage	20%	11%	22%	14%	25%	17%
Not Applicable	No. of Observations	38	8	3	4	6	1
	Percentage	5%	1%	0.4%	0.5%	0.8%	1%

The results verified the fact there was good impact of the training on the working efficiency of the workers after training. The data was organized such that lesser the value of mean, better is the effectiveness of training. A consensus was observed between all the areas about positive effects of trainings. An alpha value of 0.5 was set to test the

results and in all the areas outcomes of the trainings were positive. Its mean that we are 95% confident that the training was effective in all three areas, fabrication, work at height and manual handling. Work at height workers performed better than other areas as the mean value 0.06533 is less than as compared to other areas as shown in table.

Table 2. Pair T-Test (Paired Difference)

Before vs. After safety Training	Paired Differences			t	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean		
Fabrication	0.17029	0.36793	0.01343	12.675	.000
Work at Height	0.06533	0.24396	0.00891	7.334	.000
Manual Handling	0.9346	0.30700	0.01122	8.33	.000

In fabrication, it was observed that training was significantly effective as shown in Table 3 as the mean of after safety training is less than that of before safety training with 95% confidence interval. Before safety training the mean value was 1.2992 before safety training and a mean value of 1.1290 observed. Performance of workers 'working at

height' was found better after the safety training as it demonstrates the mean value 1.1556 than before safety training which has mean value of 1.2209. Same compliance level in terms of training effectiveness was observed in 'manual handling' workers where the mean value 1.1744 in after safety training is lesser than that of before safety training

having 1.2678. It meant that training outcomes were constructive and workers showed good compliance.

Table 3. Paired Sample Stats

Areas	Before / After Training	Mean	Std. Deviation	Std. Err. Mean
Fabrication	Before Safety Training	1.2992	.33579	.01226
	After Safety Training	1.1290	.13591	.00496
Work at Height	Before Safety Training	1.2209	.16927	.00618
	After Safety Training	1.1556	.17124	.00625
Manual Handling	Before Safety Training	1.2678	.23785	.00869
	After Safety Training	1.1744	.19121	.00699

It is observed in ANOVA test before the safety training that compliance level in all the departments is different. The result showed that each area responded differently than the other. All factors are significant from each other with 95% confidence

interval. P value observed to be less than alpha value 0.5 as shown below in table 4. It meant that the behaviors were different towards compliance both before and after safety training.

Table 4: ANOVA Results

Factor	Groups	Sum of Squares	Mean Square	F	Sig.
Before Safety Training	Between Groups	2.332	1.166	17.668	.000
	Within Groups	148.231	.066		
	Total	150.563			
After Safety Training	Between Groups	.781	.390	13.881	.000
	Within Groups	63.145	.028		
	Total	63.926			

A post hoc test is needed after we complete an ANOVA in order to determine which group differ from each other. Each area showed different behaviors of safety in comparison. Better compliance level was observed in work at height before safety training as compared to fabrication and manual handling workers. Then manual handling workers were second in number in compliance and better in safety performance in comparison with fabrication workers.

But after safety training, fabrication workers showed much better performance towards safe behaviour after the safety training and excelled in comparison with work at height and fabrication workers. The mean value of 1.2992 was high in fabrication workers before safety training and least performance as compared to other areas but after safety training having mean of 1.1290 depicts their excelled performance.

Table 5: Before safety measure

Department	Subset for alpha = .05		
	1	2	3
Work at Height	1.2209		
Manual Handling		1.2678	
Fabrication			1.2992
Sig.	1.000	1.000	1.000

Then workers working at height showed good compliance and manual handling workers showed better performance but less than both fabrication and work at height workers as shown in table 5 and table 6 and as illustrated in figure 1 and figure 2.

Table 6: After safety measure

Department	Subset for alpha = .05	
	1	2
Fabrication	1.1290	
Work at Height		1.1556
Manual Handling		1.1744
Sig.	1.000	.076

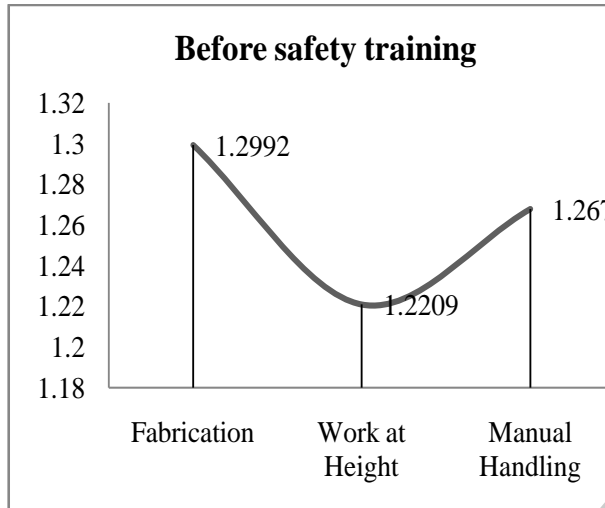


Figure 1: Post Hoc Tukey HSD Test before safety training

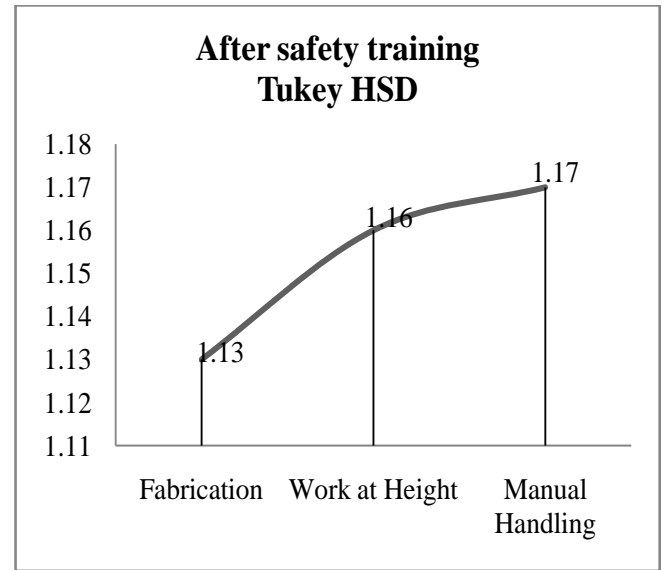


Figure 2: Post Hoc Tukey HSD Test after safety training

Table 7: Post Hoc Tukey HSD Test Multiple Comparisons

Before / After Safety Training	Areas	(J) Department	Mean Difference (I-J)	Std. Error	Sig.
Before Safety Training	Fabrication	Manual Handling	.03141	.01327	.047
		Work at Height	.07835	.01327	.000
	Manual Handling	Fabrication	-.03141	.01327	.047
		Work at Height	.04693	.01327	.001
	Work at Height	Fabrication	-.07835	.01327	.000
		Manual Handling	-.04693	.01327	.001
After Safety Training	Fabrication	Manual Handling	-.04541	.00866	.000
		Work at Height	-.02660	.00866	.006
	Manual Handling	Fabrication	.04541	.00866	.000
		Work at Height	.01881	.00866	.076
	Work at Height	Fabrication	.02660	.00866	.006
		Manual Handling	-.01881	.00866	.076

It is evident from the results in table 7 that training was found to be more effective in fabrication as compared with other areas. Workers of fabrication showed better compliance after the safety training. Compliance level in manual handling and work at height was not so significant, results found to be

same. In multiple comparison, fabrication and manual handling depicted almost the same behaviour, not so significant. P-value of 0.47 being quite close to set alpha value of 0.5. After safety training, manual handling and work at height seemed to be insignificant in comparison. It meant that

performance was almost the same after the safety training.

6. Implications and Future Research

Our results suggest that safety trainings take part in changing the behaviors of workers towards HSE but alone trainings would not increase the workplace safety as also pointed out by Cohen and Colligen³. Other aspects like performance feedback and goal setting should be set with trainings to enhance its effectiveness as emphasized by Lyer et al.¹⁵. Our research doesn't consider the skilled and unskilled perspective of labors and it should be in place during the training program to keep in view the skill-set. Demographic characteristics can also take part in variation of the results and it was not incorporated in the research. Our result shows that compliance level is not similar in every area. Every area behaves differently towards HSE based on their knowledge, awareness and skills, so decision towards implementation of HSE system should be taken accordingly. On the whole, there is lacking in implementation of safety culture in construction industry of Pakistan due to lack of awareness regarding the importance of health, safety and environment and that it can pay off and reduce the cost in the form of insurance and compensation.

7. CONCLUSION

In developing countries like Pakistan, implementation of HSE system is vital to imbed the safety culture. In order for safety culture development, safety trainings are imperative to boost up the safety culture. It was found that aids used during the training, comprising of incident sharing of past experiences, had positive impact and helped in making the training program effective. Demonstration also assisted to be a good tool of effective training, as workers showed good interest and their performance improved after the training. It was also observed that the other aids used in the training like the use of local language for the clearer understanding of the workers proved beneficial. Work sampling approach of observations is better than questionnaire methodology as the biasness in later can be misleading in the results.

8. References

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