Journal of Environmental Health and Sustainable Development

Evaluation of Safety Culture and the Effect of Lean Safety Approach on the Improvement of Safety Culture (Case Study: Sarv Combined Cycle Power Plant [Chadormelo] of MAPNA Operation and Repair Company)

Reza Jafari Nodoushan [1], Ali Reza Hajihosseini [2], Roozbeh Ahmadzadeh [3], Vida Sadat Anoosheh [4*]

[1] *Department of Health, Safety and Environment Management (HSE), School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.*
[2] *Department of Industrial Engineering, Science and Arts University, Yazd, Iran.*
[3] *Department of Industrial Safety Engineering Science and Arts University, Yazd, Iran.*
[4] *Department of Occupational Health and Ergonomics, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran.*

ARTICLE INFO

ORIGINAL ARTICLE

Article History:
Received: 16 June 2022
Accepted: 10 August 2022

***Corresponding Author:**
Vida Sadat Anooshe

Email:
anooshehvida@gmail.com

Tel:
+989135270243

Keywords:
Safety Management, Organizational Culture, Lean Safety Approach, Chadormelo.

ABSTRACT

Introduction: Accidents in the workplace hurt people and sometimes cause death. One of the ways to prevent occupational accidents is to change the behavior and attitude of people towards safety. The present study was conducted to investigate the effect of the lean approach on the promotion of safety culture in Sarv combined cycle power plant of MAPNA exploitation.

Materials and Methods: In this study, to evaluate the safety culture before performing the lean approach interventions, a safety culture questionnaire was distributed among 110 people who were randomly selected from 294 employees of the company. The results were analyzed as pre-intervention data. Then, with the introduction of lean tools that can be implemented in the power plant and their selection by a group of managers who came together for this purpose, the necessary measures were defined and performed in line with the lean approach. After six months from the beginning of the intervention, the questionnaire was distributed and collected among the selected individuals in the second stage.

Results: Based on the findings, safety culture had no significant relationship with the demographic data of the sample. The results of paired t-tests showed that the safety culture score increased in all dimensions after the intervention. As a result, the total safety culture score showed a significant increase compared to the safety culture score before the intervention.

Conclusion: The findings indicated that the pure approach has a great impact on safety culture and it is important to pay attention to it.

Citation: Jafari Nodoushan R, Hajihosseini AR, Ahmadzadeh R, et al. ***Evaluation of Safety Culture and the Effect of Lean Safety Approach on the Improvement of Safety Culture (Case Study: Sarv Combined Cycle Power Plant [Chadormelo] of MAPNA Operation and Repair Company).*** J Environ Health Sustain Dev. 2022; 7(3): 1744-54.

Introduction

Safety and injury prevention affects everyone's life. People face dangers in everyday life. Any safety improvement can lead to a reduction in accidents and injuries [1]. Continuous identification of hazards in the workplace should become a value in the organization [2]. If accidents are identified and eliminated, this will automatically become part of the organization's culture. Safety activities should be integrated with the day-to-day operations of organizations and become part of the lives of managers and employees [3]. It leads to improving their performance, and this is where culture plays a key role in the workplace [4]. Safety culture is more than just managing public programs to comply with safety rules. The structure and shape of the safety

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]

management system must include cultural change. The safety management system can be assessed through how it is supported during the current changes in the organization leadership, the crisis of new employees, and other negative or positive situations. If it is not internalized that the risks of the activities and the risks associated with them must be controlled, the initial safety programs may be lost or ineffective. This view is the safety culture that leads to the continuation of safety programs in the organization [5]. On the other hand, the components of the culture mentioned earlier can be effective in promoting a safety culture or an obstacle to improving the safety culture. It is important to note that to develop safety features in culture, the associated risks must be visibly identified. Strong safety culture includes safeguards for the nature and scope of accidents and hazards [6]. A safety culture is more than simply managing public programs to comply with safety regulations. The structure and form of the safety management system should include a change of culture [7]. Those who are familiar with the term lean are also familiar with the Toyota Production System (TPS). Lean is Toyota's production system. All the lean tools used for continuous improvement at Toyota are now available in the Lean Thinkers toolbox. But this tool is only half the story of Toyota. Along with continuous improvement, another philosophy of TPS is to respect people and what more than just engaging people in securing their workplace [7]. Toyota is known as the pioneer of the use of modern lean movement and undoubtedly the company that reached a level no one had reached before. It used the philosophy, system, and tools [8] of the term "lean manufacturing" that was introduced by Womak et al. in their famous study of automotive production systems around the world. The Toyota MIT-sponsored International Motor Vehicle Program was named "MIT". LAI's definition of lean manufacturing is: “A business system for organizing and managing product development, operations, suppliers, and customer relationships that requires less human effort, less space, less capital, and less time to produce products with less waste”. In accordance with the needs and desires of the customer in comparison with the production system of the previous period, mass production [9], the present study evaluates the safety of culture using pure tools. A significant issue in this research is the use of ten pure safety tools in an industrial environment simultaneously [10]. Lean implementation is based on a change in business culture through employee interaction and participation, so that a group of lean thinkers focuses on the production cycle and time reduction. The common leadership style and some common tools in lean allow improving lean and safety at the same time [11, 12]. Many safety programs today are promoted through remedial action due to non-compliance with safety regulations and audits. Despite what many people think, hanging safety signs and safety slogans is not a proactive activity [13]. They are, at best, safety warnings against accidents. In order to bring about behavioral and physical changes in the workplace, in addition to raising safety awareness, safety programs that are currently obsolete should be thoroughly reviewed and modified. This new method of modifying safety programs, called "lean safety", is a model based on employee commitment and business improvement using the tools that lean thinkers have in their toolbox. Pure safety is a self-serving activity. Those involved in improving proactive safety programs minimize the risk of work-related injuries [14, 15]. The view of the pure approach is not addressed. Due to the high rate of accidents in the power plant industry and the direct relationship between accidents and the behavior of individuals and the level of culture, it seems necessary to take measures to improve the level of safety culture. Given that no study has been conducted on the evaluation of safety culture in the power plant industry and its promotion, the present study aims to investigate the effect of a pure approach as a new approach in the field of safety, on improving the level of the safety culture of evaluating the staff. In this research, after designing safety tools according to the pure approach and using the combination of these tools, the effect of using them on increasing the safety culture in the target community have been investigated.

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]

Materials and Methods

This descriptive-applied study was conducted in Sarv Combined Cycle Power Plant (Chadormelo) using Cochran's sample size determination formula. The action was taken between the sample and the results were collected. Then, the interventions were planned and implemented with a pure approach, which was mentioned in detail. In this regard, all pure safety tools were used simultaneously. The questionnaire was answered in two stages before and after the lean interventions by the sample group. The validity of the questionnaire was confirmed by experts. To assess the reliability, the questionnaire was distributed among 60 staff and completed by semi-monitoring method and Cronbach's alpha was calculated 0.89. With the criterion of $r > 0.7$ and according to the calculated Cronbach's alpha, it was found that the questionnaire has acceptable reliability. It should be noted that Cronbach's alpha coefficient less than 0.6 is generally considered weak, 0.7 is acceptable, and above 0.8 is considered good. Of course, the closer the reliability coefficient is to one, the better.

The questionnaire, which was used in this study to assess the level of safety culture indicators, evaluates 9 components of safety culture. They include 1. Training and understanding of occupational safety and health issues 2. Work pressure to produce more 3. The level of participation of individuals in categories related to safety and health 4. Accidents and quasi-accidents 5. The level of organizational commitment/ management commitment to safety and health 6. Supervisors, direct managers, and production management 7. Laws, instructions, and procedures for safety and health and barriers to safe behaviors 8. Employees' attitudes toward the general state of safety and health 9. Violation and ignorance of safety and health rules and regulations.

It is worth mentioning that personal (demographic) information of employees, such as age, employment history, and education, field of study, marital status, position, and employment unit was also collected through a questionnaire.

Given that each questionnaire has 63 questions and according to the Likert scale, each question can be assigned from 1 to 5 points, if the respondent gives 1 point to all questions, the total score of the questionnaire will be 63 and if gives 5 points, the sum the scores will be 315. Regarding the classification of the score of each dimension of culture, considering that the number of questions in each dimension is 7 questions, the minimum score of each dimension will be 7 and the maximum will be 35, which according to these two numbers, the five spectra was calculated [16, 17] (Table 1).

Table 1: Classification of culture and each culture dimension scores

Levels of culture	Culture score	Score of each culture dimension
Level 1	113-63	12.6-7
Level 2	164-113	18.2-12.6
Level 3	215-164	23.8-18.2
Level 4	265-215	29.4-23.8
Level 5	315-265	35-29.4

Explanation: Levels 1 and 2 indicate a negative culture and levels, and levels 3, 4, and 5 indicate a positive safety culture.

Activities related to the use of pure tools in this research can be summarized as follows

1- 5S Tools: In order to implement this section, 5S groups were formed in each unit, short-term training courses were held for members and each group was responsible for training and implementing the 5S principles, according to the instructions prepared in the unit under its responsibility. In order to check the progress of the project, inspectors were selected who should review the implementation of the mentioned principles at 3-month intervals, complete the relevant checklist, and submit written and illustrated reports on the status of the various units. During this research, an inspection and reporting period was conducted [7].

2- Visual factory tools: In this section, about 200

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]
Jehsd.ssu.ac.ir

banners, posters, and warning signs were installed in different parts of the factory. The preparation of the process map mentioned in this article, is one of the practical measures in the preparation of instructions and implementation methods. It can appropriately indicate the starting and ending point of each process. To this end, process plans were prepared in order to achieve the goals, investigate incidents, etc., and were added to the instructions and executive methods [18, 19].

3-Training tools: Considering that one of the most time-consuming processes in any industrial environment is staff training, in order to expedite the training, in addition to holding training classes for a number of employees, various training methods were used. These methods include distributing tracts and pamphlets, holding TBM (Tool Box Meating) training (short training courses at stations), preparation of training booklets, and distribution via email to all users [20].

4- Infallibility tools: One of the most difficult activities in the industry, in order to secure machines and work processes, is infallibility. In this tool, factors such as proper design and training of employees must be considered and implemented. Due to the short opportunity of this study, infallibility was performed in two different stations, so that guards were installed around the device, which was equipped with micro-switches, and as soon as the guard was opened, they stopped the device [19].

5 -Modeling tools: In this section, statistics and information of Sarv (Chadormelo) combined cycle power plant were used and criteria for achieving the goals were defined in this way. Other power plants of MAPNA Operation and Repair Company were selected for modeling in order to cooperate, and the necessary consultations were carried out through senior managers. With the agreement of the mentioned power plants, bilateral visits and meetings were held and the required information was obtained over time. It should be noted that this tool, like some other pure tools, needs more time to fully implement. Therefore, the modeling process will continue until the desired result is achieved [21].

6 -Continuous flow tool (time cycle): This tool can be used as one of the most complex parts of lean activities and requires a complete overhaul of processes, work cycles, changes in layout, and etc. Accordingly, a station was selected as a pilot and a plan was presented to change the layout. In order to implement this tool properly, consultations were held with one of the companies implementing lean production. It was decided to continue the activities, benefiting from the opinions of this company. It should be noted that the implementation of this tool requires the cooperation of an experienced group in the field of lean manufacturing [20].

7-Standard work tools: In this section, with the cooperation of production units, standard work procedures were defined for all stations and the employees were informed. These procedures also included safety regulations at stations. In this regard, safety instructions, guidelines, and procedures in accordance with HSE standards were prepared and communicated to all employees. In order to implement the instructions correctly, periodic monitoring was performed and the necessary evaluations were performed [20].

The implementation of job safety analysis (JSA) was done in an integrated manner with the participation of all employees in the workstations. Working methods were reviewed and evaluated, necessary corrections were made, required controls were created, and required reviews were planned [22].

8 -Problem-solving tools: In order to study the problems and issues of the factory, managers and bosses are familiar with problem-solving methods, such as the 5 Whys and Ishikawa (fishbone diagram) and in several meetings. Existing problems, such as accidents were analyzed and rooted using this tool [23].

9-Benchmarking tool: One of the most important tools for estimating the progress of programs and evaluating and ensuring the implementation of actions in the right direction is the definition of benchmarks for measuring performance. Therefore, performance measurement criteria were defined, the necessary targeting was done, and the basis of planning

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]

courses was established in this section. Criteria monitoring time periods were defined monthly, quarterly, semi-annual, and annual. These criteria include recordable case rate (RCR), accident frequency rate (AFR), accident severity rate (ASR), and number of work-related illnesses. Based on these criteria, planning to achieve the set goals was done and implemented. It should be noted that these programs, like other measures, require continuity and successive implementation, and evaluation of its effectiveness in the short term will not be responsible [19, 24].

10-Group tools: It is not possible to do some things individually and it is necessary to do it as a group. Bringing different people together with different knowledge, skills, efficiency, personal and social characteristics can help the organization achieve all its goals. Each person in the group is considered as an asset that can achieve the goals. In this regard, different groups were formed in the form of committees to implement different parts of the activities. These include 5S Committees, Disaster Analysis Committees, and Risk Assessment Committees [7].

Results

The findings of the present study show that out of a total of 110 statistical samples, the highest percentage (57.3%) was in the age group of “less than 30 years”. Also, 11.8% of the respondents had a history of less than one year, 41.8% had a history of 1-15 years, and 0.9% had a history of 15-25 years. The degree of diploma respondents was 67.3%, also 34% of the respondents were single and 66% were married. Regarding the job category, 71.8% of the respondents were worker and operator, 10.9% employee and expert, 13.6% shift head and supervisor, and 3.6% were bosses and managers. Moreover, 67.3% of the respondents were employed in the operation unit, 20.9% in the repair unit, 4.5% in the technical and engineering unit, and 7.3% were in other units.

The results of safety culture before and after the intervention show that the greatest effect on the total score of the culture before and after the intervention was related to the dimension of "education and understanding of occupational safety and health issues" and the least effect before and after the intervention was related to the "labor pressure to produce more" dimension.

In examining the questions in each dimension of safety culture, considering that each questionnaire consists of 63 questions in 9 separate sections (culture dimensions), in order to examine the details related to each dimension, the questions related to each dimension were examined. The data obtained from the questionnaire, included in the tables of this section, indicate which of the 7 questions in each dimension showed results.

Question 2 had the greatest impact on the dimension of "training and understanding of occupational safety and health issues". Examining the answers to these two questions shows that most people believe that safety training allows people to do their job safely and without accidents. On the "labor pressure to produce more" dimension, question 6 had the most impact and question 1 had the least impact. Examining the answers to these two questions shows that sometimes there are pressures that make production more important than safety, and on the other hand, management considers the importance of safety along with production.

Question 2 had the most impact and question 6 had the least impact on the "rate of participation of people in categories related to safety and health". According to the answers provided, people believe that they can affect the state of safety and health, and they also believe that they are not properly informed about the results of safety sessions.

On the "accidents and quasi-accidents" dimension, question 3 had the most impact and question 7 had the least impact. The high score of question 3 indicates that, according to the respondents, accidents and quasi-accidents are always properly reported. On the other hand, the low score of question 7 indicates that the respondents believe that management takes place only after the occurrence of accidents.

On the dimension of "organizational commitment/management commitment to safety and health", question 7 had the most impact and

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]

question 5 had the least impact. Examination of the results shows that the improvement of conditions and solutions to safety and health problems is not done quickly enough, but on the other hand, management is confident in its workforce and supports them.

On the "supervisors, direct managers, and production management" dimension, question 2 had the most impact and question 6 had the least impact. The high score of question 2 indicates that employees believe that their supervisors and direct supervisors will assist them in safety matters when needed, while supervisors and direct supervisors admit their mistakes.

In terms of "rules, guidelines, safety procedures, hygiene, and barriers to safe behavior", question 2 had the most impact and question 7 had the least impact. According to the respondents, working conditions do not prevent people from doing their job safely (question 7) and on the other hand, they believe that the risks and dangers of work are exaggerated and many rules and regulations and procedures are extra safety and health.

On the dimension of "employees' attitude to the general situation of safety and health", question 4 had the most impact and question 5 had the least impact. The low score of question 5 indicates that most respondents believe that they are less likely to have an accident at work and at the same time do not believe that co-workers often guide each other to work safely.

On the dimension of "violation and disregard of safety and health laws and regulations", questions 1 and 2 had the most impact, and questions 7 had the least impact. A review of the results indicates that most respondents believe that safety rules and regulations are not properly enforced. On the other hand, when they do things, they ignore the rules and instructions and sometimes change them (Table 2).

Table 2: The effect of each dimension on the total culture score before and after the intervention

Row	The dimension of safety culture	Sum of scores before the intervention	Mean±standard deviation before the intervention	Sum of scores after the intervention	Mean ±standard deviation after intervention
1	Training and understanding of occupational safety and health issues	2439	22.17 ± 4.14	2714	24.67 ± 3.98
2	Working pressure to produce more	1682	15.29 ± 5.27	2114	19.22 ± 5.75
3	The level of participation of individuals in categories related to safety and health	2332	21.2 ± 5.18	2528	22.98 ± 5.57
4	Accidents and quasi-accidents	2344	21.31 ± 3.99	2579	23.45 ± 3.56
5	Organizational commitment / management commitment to safety and health	2041	18.55 ± 4.24	2279	20.72 ± 4.20
6	Supervisors, direct managers, and production management	2304	20.95 ± 4,46	2644	24.04 ± 2.99
7	Laws, guidelines, and procedures for safety and health, and barriers to safe behavior	2211	20.1 ± 4.36	2488	22.62 ± 4.32
8	Employees' attitudes towards the general state of safety and health	2390	21.73 ± 3.55	2530	23 ± 3.23
9	Violation and disregard of safety and health laws and regulations	2350	3.71 ± 21.36	2585	23.5 ± 4.244
10	Total culture score	20093	21.36 ± 3.71	22461	26.00 ± 204.19

Examining the relationship between culture score and age of respondents before and after the intervention shows that less than 30 years has the highest frequency and frequency expected.

The test statistic is 2.125 with 1 degree of freedom and P-value of 0.145, which indicates that there is no significant relationship between "total safety culture score" and "age" demographic data.

Therefore, in analyzing the relationship between culture score and age of respondents, it can be concluded that there is no significant relationship between these two variables before and after the

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]

intervention.

As can be seen in Table 3, the total score of the culture before and after the intervention was between 113 and 315, so that the total score of none of the completed questionnaires was in the score range of the first level (63-113) and in the fifth level (265-315) was only 1 person. In general, it can be concluded that the culture score obtained from the results of the questionnaire before and after the intervention was mostly in the range of 164-215.

Table 3: Frequency distribution of Safety Culture score before and after the intervention

Safety Culture	Before the intervention		After the intervention	
	Frequency	Percent	Frequency	Percent
63-113	0	0	0	0
113-164	5	4.5	5	4.5
164-215	68	61.8	68	61.8
215-265	36	32.7	36	32.7
265-315	1	0.9	1	0.9
Total	110	100.0	110	100.0

According to the sum of previous findings and considering the increase in culture score in each of the evaluated dimensions, the results of summarizing the score of each dimension of culture before and after the intervention were compared. In order to investigate the relationship between score improvement culture before and after the intervention, in 9 dimensions and also examining the relationship between the total score of culture before and after the intervention, paired t-test was used, the results of which can be seen in Table 4.

Table 4 reveals thatthe significance value (P-value) in all dimensions of the culture is less than the error level (0.05). As a result, with 95% confidence, it can be said that there was a significant difference between culture score (in all dimensions and total culture score) before the pure approach intervention and after the pure approach intervention, and the main hypothesis of the research was confirmed (P-value < 0.05).

Based on the results of the study, the mean score of the total culture before the intervention is 182.66 and the mean score after the intervention is 204.19, indicating that the score of the staff culture after the defined actions increased in the lean-approach (Table 4).

Table 4: Comparison of the frequency distribution of scores of 9 dimensions of safety culture before and after the intervention based on the defined levels

Row	The dimensions of safety culture	Before the intervention	After the intervention	P-value
1	Training and understanding of occupational safety and health issues	22.17	24.67	0.000
2	Work pressure to produce more	15.29	19.22	0.000
3	The level of participation of individuals in categories related to safety and health	21.20	22.98	0.009
4	Accidents and quasi-accidents	21.31	23.45	0.000
5	Organizational commitment / management commitment to safety and health	18.55	20.72	0.000
6	Supervisors, direct managers and production management	20.95	24.04	0.000
7	Laws, guidelines and procedures for safety and health, and barriers to safe behavior	20.10	22.62	0.000
8	Employees' attitudes towards the general state of safety and health	21.73	23.00	0.004
9	Violation and disregard of safety and health laws and regulations	21.36	23.50	0.000
10	Total culture score	182.66	204.19	0.000

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]

Discussion

From the general evaluation and comparison of the relationship between the total score of culture and demographic data, it is obtained that the total score of culture before the intervention had a significant relationship with demographic data of employment history and marital status. After the intervention, the total score of culture had a significant relationship with demographic data of employment unit.

Based on the results, a significant value (P-value) was calculated in all dimensions of culture smaller than the error level (0.05). With 95% confidence, it can be said that there was a significant difference between the score of culture (in all dimensions and the score of the whole culture) before the intervention of the pure approach and after the intervention of the pure approach and the main hypothesis of the research was confirmed (P-value < 0.05).

The mean score of total culture before the intervention was 182.66 and after the intervention it was 204.19. It indicates that the score of staff culture increased after performing the actions defined in the pure approach.

According to the results of the analysis, there was a significant relationship between the application of the lean approach in safety and the use of lean safety tools and improving the score of safety culture.

According to the results, the use of this approach has a positive effect on all aspects of culture. According to the initial definition of safety levels, and given that the culture score raised from (182.66 ± 24.495) to (204.19 ± 26.002), although the culture level has not changed and remains at the third level, this level is considered one of the positive levels of culture.

According to the studies, the relationship between culture score after the intervention and marital status was significant. The culture score did not show a significant relationship with other demographic data of the respondents.

The questionnaire used by 9 different dimensions of culture, including education and understanding of occupational safety and health issues, work pressure to produce more, the level of people's participation in categories related to safety and health, accidents and quasi-accidents, organizational commitment/ management commitment to safety and health, supervisors, direct managers, and production management, laws, guidelines, and procedures for safety and health, and barriers to safe behaviors, employees' attitudes to the general state of safety and health, and violations of safety and health rules and regulations. The results before and after an evaluation showed that in all these 9 dimensions, the score of safety culture after the intervention had a significant increase compared to the evaluation score before the intervention. However, the "education and understanding of occupational safety and health issues" dimension had the greatest impact on the overall culture score and the highest score (24.67 ± 3.98) among other dimensions. The highest improvement among the dimensions was related to the dimension "labor pressure for more production", and the post-intervention evaluations showed that the mean score of this dimension increased from 15.29 ± 5.276 to 19.22 ± 5.752. It should be noted that this dimension had the least impact on the overall safety culture score among other dimensions.

The next score of "supervisors, direct managers, and production management" increased from 20.95 ± 4.46 before the intervention to 24.04 ± 2.99. Studies have shown that this dimension has second place in terms of the rate of score improvement among the dimensions. This dimension has also a second-place after "education and understanding of occupational safety and health issues" in influencing the overall score of safety culture.

According to the evaluations, the dimension of "employees' attitude to the general state of safety and health" after the intervention had the lowest promotion among the 9 dimensions of culture. The score of this dimension which was in 21.73 + 3.55 before the interventions, reached 23 + 3.237 after the interventions.

It seems that the measures taken in the field of the lean approach have not had much effect on improving the attitude of employees towards the

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]

general situation of safety and health.

A brief look at the results of the evaluation of the constituent dimensions of culture reveals that the "rate of participation of people in safety and health issues" after the intervention, has grown less than before the intervention. As the score of this dimension has reached 21.2 ± 5.183 to 22.98 ± 5.57, and since this dimension seems to be directly related to the dimension of "employees' attitude to the general state of safety and health", arrangements should be made to use more employee involvement, it changed their attitude towards safety and promoted a safety culture.

Implementing the defined programs in the form of the power plant approach has taken about six months. Obviously, a lot of this time was spent on building the necessary infrastructure. After building the infrastructure, due to the time constraints of the research, a short period of time was allocated to the implementation of programs and the use of tools, but in the short period, upgrade score culture was meaningful. It is predicted that by continuing the process of activity with this approach, it will lead to a significant increase in the safety culture of the organization.

Given that the evaluation of culture has not been conducted with the same perspective as the present study on the simultaneous use of ten pure safety tools in the power industry, it is not possible to accurately compare the results with the results of other research. However, the results can be compared with the research done as follows:

The results of this study are in line with the results of Mohammadfam's study on the promotion of safety culture before and after technical interventions. In this study, the score of culture increased from 287 ± 43.42 to 318.11 ± 31 after technical interventions [25].

A similar study conducted by Sepehr et al. showed the effect of engineering and managerial interventions on the promotion of culture. In this study, the culture score was upgraded from 204 ± 43.42 (negative culture) to 318 ± 3.11 (positive culture) after the interventions. The scores of all aspects of culture after the interventions had a significant increase compared to before the intervention[26], which is in line with the present study.

The results of this study are consistent with Khodaei et al. In this study, the effect of management factors and staff training on safety culture and safety enhancement was identified positive [27].

The lack of a significant relationship between demographic data of age, history, and education with safety culture, after the interventions, was similar to the findings of Jafari Nodooshan et al. The results of the present study are also similar to the study by Halvani et al. showing that there is no significant relationship between age and culture score[28].

Conclusion

The results of this study show that the use of 10 tools of pure safety, simultaneously, affects all dimensions of culture and in a short period is able to make a significant difference in the individual score of culture dimensions and finally the total score of safety culture. According to these results, it can be said that pure tools adequately meet the needs of the industry and the overall promotion of safety. Moreover, these tools address people's views on safety and their participation, which can greatly help advance safety goals in the industry.

Acknowledgment

This study is a part of an MSc thesis in the field of occupational health engineering.

Funding

Thanks are owed to the University of Science and Arts for its financial support.

Conflict of interest

There is no conflict of interest to declare.

References

1. Jo BW, Lee YS, Khan RMA, et al . Robust Construction Safety System (RCSS) for collision

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]

accidents prevention on construction sites. Sensors. 2019;19(4):932.
2. Martin P, Daille-Lefèvre B, Marsot J, et al. New issues for workers safety in the factory of the future. Advances on Mechanics, Design Engineering and Manufacturing II. Springer; 2019.
3. Dissanayake D, Fernando N. Establishing a positive safety culture in rubber manufacturing sector: human factors. Ceylon Institute of Builders. 2014.
4. McKinnon RC. Changing the workplace safety culture. Crc Press; 2013.
5. Antonsen S. Safety culture: theory, method and improvement. CRC Press; 2017.
6. Roughton J, Crutchfield N, Waite M. Safety culture: An innovative leadership approach: Butterworth-Heinemann; 2019.
7. Hafey R. Lean safety: Transforming your safety culture with lean management. Productivity Press; 2017.
8. Elbert M. Lean production for the small company. Productivity Press; 2018.
9. Amir Khani F, Baqir M. Assessing the purity of Iran Khodro Company based on Jackson and Jones model. Public Management. 2012;4(11): 19-30.
10. Crema M, Verbano C. Identification and development of lean and safety projects. Saf Sci. 2016;89:319-37.
11. Crema M, Verbano C. Lean management to support choosing wisely in healthcare: the first evidence from a systematic literature review. Int J Qual Health Care. 2017;29(7):889-95.
12. Kirkegaard ML, Kines P, Nielsen HB, et al. Occupational safety across jobs and shifts in emergency departments in Denmark. Saf Sci. 2018;103:70-5.
13. Howell G, Ballard G, Demirkesen S, et al. Why lean projects are safer. proceedings of the 25th annual conference of the international group for lean construction, herak-lion, Greece; 2017:4-12.
14. Crema M, Verbano C. How to combine lean and safety management in health care processes: A case from Spain. Saf Sci. 2015;79:63-71.
15. Enshassi A, Abu Zaiter M. Implementation of lean tools on safety in construction projects in Palestine. 22nd annual conference Proceedings IGLC, Oslo, Norway; 2014:1205-18.
16. Moghri J, Arab M, Saari AA, et al. The psychometric properties of the Farsi version of "Hospital survey on patient safety culture" in Iran's hospitals. Iran J Public Health. 2012; 41(4):80.
17. Bahrami MA, Chalak M, Montazeralfaraj R, et al. Iranian nurses' perception of patient safety culture. Iran Red Crescent Med J. 2014; 16(4):e11894.
18. Anvari A, Zulkifli N, Yusuff RM. Evaluation of approaches to safety in lean manufacturing and safety management systems and clarification of the relationship between them. World Appl Sci J. 2011;15(1):19-26.
19. Hafey RB. Lean safety gemba walks: A methodology for workforce engagement and culture change. Productivity Press; 2017.
20. Simons PA, Houben R, Vlayen A, et al. Does lean management improve patient safety culture? An extensive evaluation of safety culture in a radiotherapy institute. Eur J Oncol Nurs. 2015;19(1):29-37.
21. Reese CD. Occupational health and safety management: a practical approach. CRC press; 2015.
22. Gnoni M, Andriulo S, Maggio G, et al. "Lean occupational" safety: an application for a Near-miss Management System design. Saf Sci. 2013;53:96-104.
23. Rozenfeld O, Sacks R, Rosenfeld Y, et al. Construction job safety analysis. Saf Sci. 2010;48(4):491-498.
24. Sacks R, Rozenfeld O, Rosenfeld Y, et al. Lean scheduling for safety: development of a time-dependent risk level model. 13th international group for lean construction conference proceedings. 2005:513-20.
25. Mohammadfam I, Neazamodini Z. Effect of technical intervention in promoting safety culture assessment. Jundishapur Journal of Health Sciences. 2010;2(2):66-74.
26. Sepehr P, Mohammadfam I, Yazdi ketabi D,

et al. The effect of engineering and management interventions on improving the level of safety culture indicators in the workers of a rolling mill factory. Dawn Health. 2014;13(3):11-20.

27. kodaee M, Iraqi M, Brani E. Evaluation of safety culture among northern wood and paper companies. Iranian Wood and Paper Sciences Research.2014;29(1):156-69.
28. Jafari Nodooshan R, Halvani GH, Salmani Nodooshan Z, et al. Investigating the relationship between accident and safety culture in textile workers of Yazd city. 2011;3(3):1-7.

[DOR: 20.1001.1.24766267.2022.7.3.6.9]
[DOI: 10.18502/jehsd.v7i3.10725]