

Program development for fostering safety culture in multi-tiered organizations –Finding and solving interorganizational issues–

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Although there have been some studies on safety culture, studies on specific methods to foster safety culture have been limited. Moreover, it is deemed necessary to assess and foster safety cultures not only for individual organizations but also inter-organizationally. In this study, we developed a program to foster safety culture. Thereafter, we applied the program to multi-tiered industrial organizations. Hence, this paper focuses on interorganizational approaches. The program consisted of multiple questionnaire surveys, interview surveys, group works, and monitoring surveys. The subjects of the surveys were members of energy plants. As a result, in general, improvements in the safety culture evaluation were seen after the implementation of countermeasures. In the program consisting of multiple surveys and activities, a certain effect of fostering safety culture in multi-tiered organizations was recognized. Henceforth, more studies will be required on the means of assessing and fostering safety cultures in multi-tiered industrial organizations of various types.

key words: safety culture, foster, organization, multitiered, industry

Introduction

In recent years, safety cultures in organizations have drawn much attention to ensure safety in industrial organizations. Studies on defining safety cultures, their constituent elements, and assessment methods have also been pursued (e.g., IAEA, 1991; Schein, 1992). In fact, The authors have developed safety culture assessment tools (SCAT) to provide structures for mutual assessment between the various tiers in organizations (managers, field supervisors, workers) (hereinafter referred to as the “within-organization SCAT”) that have been actually applied in industrial organizations (e.g., Shi, Hosoda, Suganuma, Okumura, Yomura, & Inoue, 2004; Yomura, Hosoda, & Inoue, 2015).

Based on the results of previous studies, authors think that the definition of safety culture is defined by the mutual relationship between 1) the organizational structure (e.g., system, equipment and activities made to ensure safety) 2) the attitude and behavior of or-

ganization members against the structure, and 3) the situation of sharing these subjects between the staff members in the organization (Yomura, Hosoda, & Inoue, 2015). The evaluation index for staff safety attitude against the safety structure consists of 36 items from 10 fields and is based on the ASCOT Guidelines (IAEA, 1996) (see Table 1). To measure the sharing situation in the organization, we divided the organizational members into three tiers and used mutual measurement.

Meanwhile, in the industrial sector, multiple organizations share functions from work planning to implementation. However, the more organizations are involved, the less in volume and accuracy the information is communicated. It is considered difficult to disseminate safety policies of a contractee to fields or to convey the risk information in fields to a contractee. In short, as the organization becomes multitiered, more risks tend to arise not only “within-organization”, but also “inter-organization”. Therefore, it becomes necessary to assess and foster safety

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Table 1 Evaluation fields and items

Evaluation fields (10)	Evaluation items	
	Within an organization (36)	Inter-organization (12)
Safety declaration	recognition	●
	understanding	
	review	
Safety and productivity	penetration	
	priority	●
	level of involvement	
Safety rules	awareness	
	documentation	
	improvement of procedures	
Responsibility, authority and roles	observance of procedures	●
	authority	●
	review of role	
Trouble resolving	participation in improvement activities	
	experience of analysis	
	analysis of human-factors	
	reporting procedure	
	implementation of measures	●
Education and training	involvement in improvement	
	awareness of improvement	
	provision of training	●
	evaluation	
	contents	
Information channel	trouble response training	
	materialization	
	top-down channel	●
Work environment	communication	●
	bottom up channel	●
	understanding of environmental conditions	
Safety activities	attitude to improvement	●
	awareness	
Safety operation	use of safety system	●
	evaluation	
	indirect department	
	use of research institutions	
	external audit	
	service contract	●

cultures not only for each organization, but also for overall inter-organizations. Therefore, we modified the within-organization SCAT and developed SCAT

based on mutual assessments among organizations (hereinafter referred to as the “interorganizational SCAT”) (Yomura, Fujikake, Shi, Hosoda, & Inoue,

Table 2 The program for fostering safety culture in multi-tiered organization

Survey & Involvement	Purpose	Cycle
I. Preliminary questionnaire survey (SCAT)	Understand actual situation	Plan
II. Preliminary interview survey		
III. Discussion of countermeasures	Set theme & Plan countermeasure	
IV. Countermeasure implementation & monitoring research	Implement countermeasure	Do
	Confirm progress Solve the disturbing factor	Check
	Modify plan	Act
V. Posteriori questionnaire survey (SCAT)	Countermeasure effect	
VI. Posteriori interview survey	Understand remaining issue	

2016).

With careful consideration for the reduction of private burden to participants, we selected 12 out of 36 items used for evaluating interorganizational safety culture. For example, “Recognition of Declaration” pertains to when “members know that the plant has issued a safety declaration” and “Priority of Safety” pertains to when “members change their work schedule to ensure safety” (see Table 1).

As we applied SCAT in industrial organizations, the needs of the organizations have shifted from assessment of safety cultures to drafting of countermeasures and development of effective implementation methods. However, as for the means of fostering safety cultures, more studies are still necessary at this stage.

Therefore, the purpose of this study is to develop a program for fostering safety cultures, comprised of several researches and practices, and to implement the program in a multitiered industrial organization in Japan to examine its effectivity.

Methods

1. Subject Organization

The program was intended for a certain contractee, an original contractor, and a subcontractor in the field of maintenance and management of energy plants in Japan. There was a company each for ordering and original contractors while there were several companies chosen for subcontractors. The roles played by each organization with regard to maintenance and management are summarized hereafter. First, the contractee prepares the maintenance plan for the plant

and places work orders based on the plan with the original contractor. The work volume becomes substantial especially in cases where periodic inspections are required for several times a year. Next, the original contractor prepares specific work plans based on the list of works undertaken from the contractee and issues purchase orders to suppliers and subcontractors for required equipment, material, and personnel. Then, the subcontractor procures the required number of professionals with sufficient skills necessary for performing the works undertaken from the original contractor company and, subsequently, actually executes the work undertaken. Thereafter, the original contractor instructs and supervises on-site the work performed by subcontractors. The contractee inspects the work on-site at the time of completion or at a point in time as prescribed. Also, the subcontractor or the original contractor reports to the contractee any defect in the facility found in the work on-site, and the contractee records the information on a facility datasheet for reference in future maintenance plans.

2. Research Method

Several researchers were involved in considering the research method and conducting the research. At times, they had discussions about the research and its method with a number of experienced staff members in energy plants on-site. The overall construction was set as shown in Table 2.

I. Preliminary questionnaire survey (within-organization and interorganizational SCATs)

To quantitatively grasp the status quo of safety cultures within-organization and inter-organization, a questionnaire survey was conducted. This corre-

sponds to the starting point of “Plan” in the PDCA cycle. The questionnaire used the SCAT developed by the authors (Yomura, Hosoda, & Inoue, 2015).

There were 36 items for within-organization SCAT, and 12 for interorganizational SCAT. Both assessments were made on a scale of 1 to 8, ranging from “1. Completely disagree” to “8. Completely agree”.

Mutual assessment among three work classes was made for within-organization, which were made in relation to managers, superintendents, and workers; while mutual assessments among three organizations were made for inter-organizations, which were made in relation to contractee, original contractor, and subcontractor. Scores given for assessment items were averaged out for the assessment value, and served as an index to express the degree of safety attitude taken by the members towards safety arrangements. For the details of the questionnaire and the scoring method, refer to Yomura, Hosoda, & Inoue (2015), and Yomura et al. (2016).

The subjects for the preliminary questionnaire survey were those in charge of maintenance works in the abovementioned subject organizations: 101 staff members of the contractee, 43 staff members of the original contractor, and 54 staff members of subcontractors. Response rates of distributed questionnaires for respective organizations exceeded over 90%.

II. Preliminary interview survey

To explore the specific issues of the vulnerable points in safety cultures discovered in the preliminary questionnaire survey, an interview survey was conducted. The subjects were those staff members engaged in maintenance works in the same three organizations as for the questionnaire survey; four to eight staff members from each job class per organization were interviewed in a group setting. Questions were asked in semi-structured interviews. The following points were confirmed in the talk: the content and status of their work, the issues recognized for each organization, the actual situation, and the background regarding characteristic results of SCAT. The interviews were conducted by three industrial psychology researchers. Two of the three researchers classified the data.

After the preliminary interview survey, the results

were reviewed in conjunction with the findings of the preliminary questionnaire survey to extract the points at issue in safety cultures, which were then fed back to each organization. It was intended to be shared among all parties concerned in order to understand commonly the status quo and to have a sense of ownership over the results.

III. Discussion of countermeasures

Following the foregoing, a working group of 24 staff members was set up, representing job classes in the three organizations (hereinafter referred to as the “WG”) to hold discussions on issues to be tackled among organizations and countermeasures therefor. The WG members were selected as key personnel for work and safety in each organization.

Safety countermeasures and approaches on-site in industrial fields were, in many cases, sent top-down from the administration departments in head offices. However, it is crucial that employees of subject organizations are given incentives to have them commit to this activity. For that purpose, we made the members of subject organizations responsible for operating the WG. We participated as observers and offered to facilitate and provide consultation as needed.

It is often the case that there are several issues regarding safety culture among organizations. However, taking countermeasures for all of them is not realistic. Therefore, the WG was advised in this program to take up one issue only, the one with the highest priority, to be tackled inter-organizationally, for which results could be realized in a year to one and a half years.

Thereafter, the WG formulated countermeasures in concrete terms. In doing so, they were asked to make it clear by specifying the 5W1H (when, where, who, what, why, and how) to improve the viability of such countermeasures. Moreover, the WG was urged to debate the system and rules required for implementing the countermeasures. Up to this point, it corresponds to “Plan” of the PDCA cycle.

IV. Countermeasure implementation and monitoring research

The WG took the initiative in designing approaches based on the plan. Moreover, to confirm the progress of their efforts, monitoring researches were periodically conducted. The authors received pro-

gress reports from the WG, removed the causes of problems, if any, and modified implementation methods, thereby contributing to the enhancement of the viability and effectiveness of their approaches. Since the WG had too many members to carry on meticulous meetings and collect information, subgroups were set up to facilitate proceedings as needed.

V. Posteriori questionnaire survey (within-organization and interorganizational SCATs)

After the countermeasure was taken, to ascertain the changes in safety culture and the remaining vulnerability, another questionnaire survey was conducted. The items of the questionnaire and the methods employed were the same as those for the preliminary questionnaire survey. Likewise, the subjects were the same as the staff members in charge of maintenance works in abovementioned organizations: 44 staff members of the contractee, 60 staff members of the original contractor, and 180 staff members of subcontractors.

VI. Posteriori interview survey

To clarify specific issues of vulnerable points in safety cultures discovered in the posteriori questionnaire survey, another interview survey was conducted. The subjects were those staff members engaged in maintenance works in the same three organizations as the posteriori questionnaire survey. The subjects consisted of a total of 51 people, from five to nine staff members from each job class per organization. They were interviewed in a group setting. Questions were asked in semi-structured interviews. The following points were confirmed in the talk: the status of their work, the issues recognized for each organization, the actual situation, the background regarding characteristic results of SCAT, the changes from the situation at the preliminary interview survey, and the evaluation of WG activities. The interviews were conducted by three industrial psychology researchers. Two of the three researchers classified the data.

After the interview survey, the results were reviewed in conjunction with the findings of the posteriori questionnaire survey, and the effects of the approach were examined to extract remaining points at issue in safety cultures. Finally, these results and suggestions were fed back to each organization.

Each survey was conducted upon prior consent of the subject organization and with its cooperation. Utmost attention was paid to the protection of each survey participant's privacy.

Results

I. Preliminary questionnaire survey (within-organization and interorganizational SCATs)

Since this paper focuses on interorganizational approaches, we dispense with within-organizational results.

In the mutual interorganizational assessment results (see Figure 1), the contractee was found to have high self-evaluation scores, while the original contractor and subcontractors assessed the contractee with low scores, exhibiting a big difference. In particular, the evaluation from the original contractor was generally severe. Among them, the ratings on "Attitude to improvement", "Bottom-up channel", "Service Contract", and "Use of safety system" were particularly low.

II. Preliminary interview survey

We categorized the comments we obtained by their organization and content. Table 3 shows the main contents.

It was observed that delayed and inaccurate ordering by the contractee resulted in causing the original contractor and subcontractors to distrust the contractee. The reasons for such delayed ordering were related to old facilities and insufficient facility data lists. The original contractor and subcontractors pointed out strongly the problem of the contractee in disregarding such information on defective facilities and ordering flaws that had been repeatedly reported. This appears to have resulted in the low interorganizational SCAT.

III. Discussion of countermeasures

After explaining the outline and feature points of this program from the authors, the WG debated the theme regarding the countermeasures to be taken. As a result, they decided to address the theme of "Optimized timing of order placement and information sharing for periodic inspections".

IV. Countermeasures implementation and monitoring survey

Six rounds of WG meetings and 13 subgroup ses-

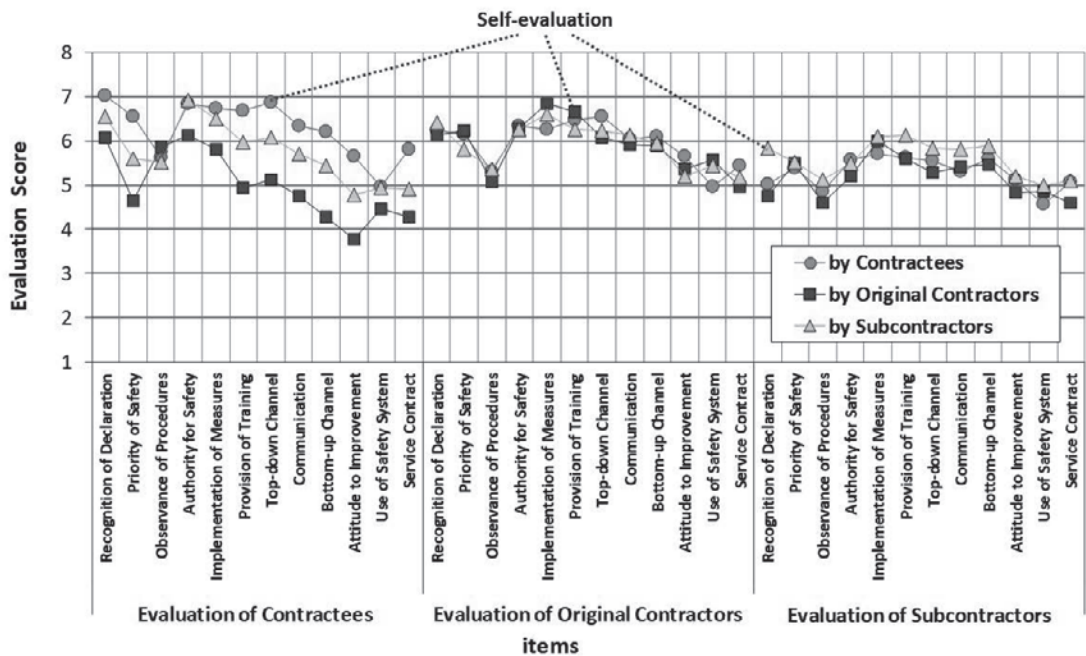


Figure 1 Preliminary questionnaire survey: mutual evaluation of inter-organization at the plant

Table 3 Main contents of a preliminary interview survey

Contractees

- ✓ The same request is issued every time at meetings with the contractor or partner company.
- ✓ We were so busy that ordering was delayed.
- ✓ Because the machine is old, management is difficult.

Original Contractors

- ✓ The order is not received even though the construction period has begun.
- ✓ There are many mistakes in purchase orders.
- ✓ There is a lot of waste in parts and labor costs.

Subcontractors

- ✓ Working in a risky way because of lack of work time.
- ✓ We have repeatedly communicated mistakes to contractees, but they are not improved at all.
- ✓ There is no feedback even if corrections and requests are communicated.

sions were held during a period of 13 months. Primarily, the WG set the direction of activities, based upon which, the subgroup session reviewed information collection and specific methods. Thereafter, the WG determined the necessary revisions and made final decisions. Tangible activities were conducted not by the WG or the subgroup, but were integrated, as much as possible, into regular routine works. The authors exchanged information at times with the secretariat and consulted as to what they should cover in the approach and how they may carry it out.

The specific methods for optimizing the order timing were determined in relation to considering the content and timing of information required to be conveyed inter-organizationally, the specific methods of information sharing, and the methods of reflecting on-site risk information to the database.

The monitoring survey was made six times when the WG met to confirm the specific method and progress. When progress lagged behind schedule, the causes therefor were identified and plans for its resolution were proposed.

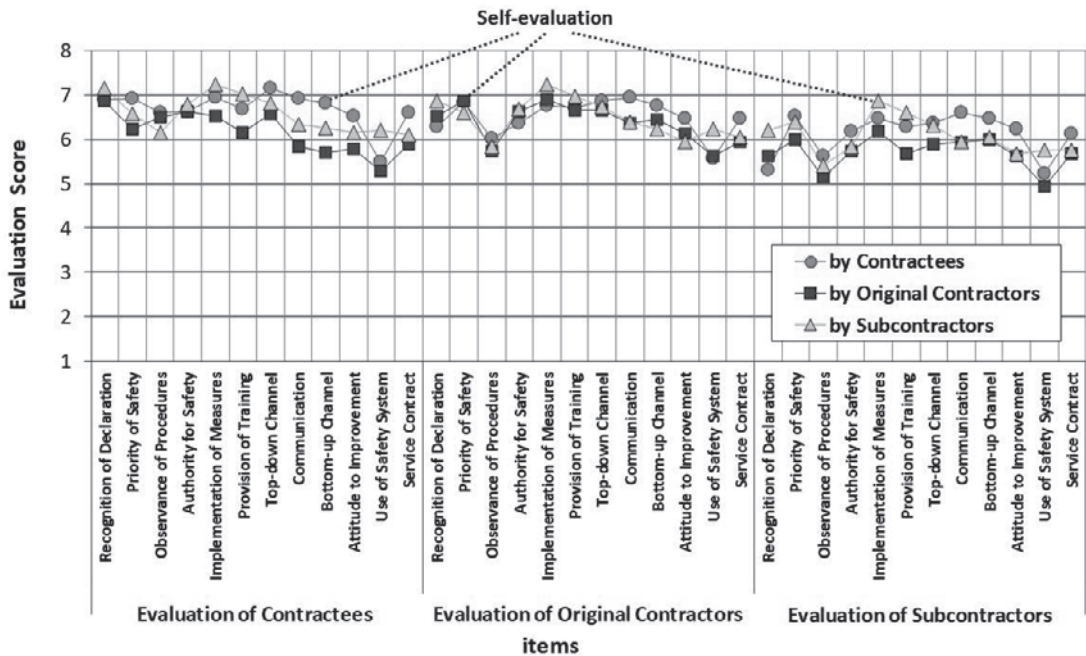


Figure 2 Posteriori questionnaire survey: mutual evaluation of inter-organization at the plant

V. Posteriori questionnaire survey (within-organization and interorganizational SCATs)

In the posteriori questionnaire survey, the contractee's substantially low assessment of the original contractor improved significantly (see Figure 2). For instance, the assessment score regarding the "Attitude to improvement" shifted from 3.76 to 5.79. The average of all 12 items mutually evaluated among the three organizations improved from 5.71 to 6.32 ($F(1, 15946) = 1.27, p < .001$).

VI. Posteriori interview survey

We categorized the obtained comments according to their organization and content. Table 4 shows the main contents.

Orders were placed, except for a few cases, generally according to plans, and early ordering was accomplished. As the accuracy of orders improved by sharing information, it resulted to a reduction in the costs. Furthermore, the overall interorganizational communication improved. Among the subcontractors, there emerged some voluntary movements for safety activities, because of the changes that were developed in the contractee.

However, the original contractor and subcontractors

enumerated problems which remained with the contractee and their workers: transfer of information was inadequate, few site visits, insufficient working knowledge of facilities and jobs on-site, etc.

Discussion

As shown above, a program was developed to foster safety cultures in an energy plant in Japan. While several tasks for organizations to address still remain, there have been some notable effects to the current programs in practice. In this project, the system of work was developed not as a one-time event, but as a continuing one. Therefore, we considered that this effect must be sustainable.

It is important to make use of the SCAT initially at the outset of the program to foster safety cultures. Even among tiers of managers, site superintendents, and workers within an organization, perception gaps tend to exist. Inter-organizationally, the gaps are likely to grow, making the task to fill them more difficult. With organizations assessing each other mutually, the existence of interorganizational risks become visible. By sharing risks inter-organizationally, strong impetuses for improvements may become available,

Table 4 Main contents of a posteriori interview survey

<u>Contractees</u>
✓ Each organization has worked hard using time.
✓ We will continue to provide guidance to departments that are slow to place orders.
✓ Perfection is impossible.
✓ We will improve the rules.
✓ WG initiatives are good.
✓ We began to contact original contractors frequently.
✓ Each organization is willing to do better.
<u>Original Contractors</u>
✓ The timing of ordering has become earlier.
✓ If the order is late, contractees are trying to increase the accuracy.
✓ Increased accuracy and reduced overall costs.
✓ Construction safety has increased.
✓ For better ordering, contractees should look more at the site.
✓ There is no other activity that the three organizations do together.
<u>Subcontractors</u>
✓ Ordering is quicker and we are very helpful.
✓ The accuracy has also improved.
✓ If contractees does not know the contents of the equipment, waste will increase.
✓ Information is not carried over in contractees.
✓ The WG activities were good.
✓ We hope that this activity will continue.
✓ As contractees was about to change, we also started various safety activities.

causing approaches to be highly convincing.

The approach used in tackling one task by a group of three organizations of ordering, original contractor, and collaborating can produce significant effects. However, an activity of this nature is usually rare to see. Before introducing this program, there were many opinions from the contractees and original contractors regarding the difficulty for subcontractors to participate in the WG, particularly because joining the WG does not earn them money. Nevertheless, it was found that subcontractors voiced their intentions to continue their participation in the WG. We, thus, surmise that the subcontractors felt the benefits to their safety, exchanging of opinions, and creating systems for working well.

As was observed in this study, in multi-tiered industrial organizations that have interorganizational perception gaps, the tendency is that bottom-up communication in the hierarchy does not function well (Yomura, Fujikake, Okumura, Shi, Hosoda, & Inoue, 2011). Of course, it is desirable that information flows smoothly in daily business. If, however, the situation does not allow for such smooth flow, then setting up the WG to build routes of information flow

will be an effective way of addressing the issue. At this time, participation in the WG by staff members of each organization from workers to managers served to reflect a wide variety of opinions and made approaches that had high viability in reality possible. At the same time, the specific activities of the WG were communicated widely to other employees. Further, some effects were manifest in promoting communication beyond inter-departments and job classes. However, it does not suggest that a separate route can ensure, at once, a smooth flow of information. It is necessary to engage a third party for a while to work out the smooth flow of information.

Henceforth, more studies will be required for the means of assessing and fostering safety cultures in multi-tiered industrial organizations of various types, such as manufacturing and construction.

References

- IAEA 1991 *Safety culture: A report by the International Nuclear Safety Advisory Group. Safety series. No. 75-INSAG-4*. Vienna: International Atomic Energy Agency,
 IAEA 1996 *ASCOT Guidelines revised edition: IAEA - TECDOC-860*. Vienna: International Atomic Energy

Agency.

- Schein, E. H. 1992 *Organizational Culture and Leadership, 2nd Edition*. San Francisco: Jossey-Bass.
- Shi, G., Hosoda, S., Suganuma, T., Okumura, T., Yomura, T., & Inoue, S. 2004 A study on the development of the safety culture assessment tool in an industrial organization. *Proceedings of the annual meeting of Japanese Association of Industrial/Organizational Psychology*, 19-22 (in Japanese).
- Yomura, T., Hosoda, S., & Inoue, S. 2015 A study on the baseline assessment of the safety culture in the industrial organization—The index of the communication gap between the manager, the field supervisors, and the workers—. *Japanese Journal of Applied Psychology*, **40**(3), 194-202 (in Japanese).
- Yomura, T., Fujikake, K., Okumura, T., Shi, G., Hosoda, S., & Inoue, S. 2011 A study on safety culture issues in multi-layered industrial organizations. *Proceedings of the annual meeting of Japanese Applied Psychology*, 66 (in Japanese).
- Yomura, Y., Fujikake, K., Shi, G., Hosoda, S., & Inoue, S. 2016 Evaluation of comprehensive safety culture including inter-organization in a multi-tiered organization. *Japanese Journal of Applied Psychology*, **42**(Special edition), 67-72.

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