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Research Report

Evaluation of Comprehensive Safety Culture Including Inter-Organization in a Multi-Tiered Organization

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The division of labuor and outsourcing have been increasing in many industrial sectors in Japan. In order to establish a comprehensive safety culture covering all related organizations, it is insufficient to measure and develop safety culture only within an individual organization. This study aims to measure inter-organizational safety culture in industrial organizations, consisting of a contractee, an original contractor and subcontractors. A questionnaire survey was conducted for maintenance personnel in an energy plant. The questionnaire survey revealed that this plant have poor inter-organizational safety culture evaluation results due to very low scores from the original contractor and subcontractors, even though they scored excellently at contractee in-house evaluation (‘manager–field supervisor–worker’ mutual evaluation). From the exercise, the importance of evaluating comprehensive safety culture including inter-organization was confirmed.

key words: safety culture, organization, multitiered, industry

Introduction

In recent years, to ensure safety in the industrial organization, the safety culture of organization has been regarded as important. A numbers of studies have conducted regarding the definition of safety culture, it’s element and it’s evaluation (e.g., IAEA, 1991; Cox & Cox, 1991; Schein, 1992; Ostrom, Wilhelmsen, & Kaplan, 1993; Reason, 1997). In these studies, method of cognitive and behavior that are related to the staff safety such as, attitudes, believes, values, the safety activity and it’s structure in the organization and the situation of sharing these subjects between the staffs in the organization are regarded as the main element of the safety culture.

Therefore, the authors base on these studies results, think that the definition of safety culture is defined by the mutual relationship between 1) the structure of system, facilities, activities made to ensure safety 2) the attitude, behaviors of organization members against them and 3) situation of sharing these subjects between the staffs in the organization. In addition, according this definition, we have developed the Safety Culture Assessment Tool (SCAT) for industrial organization to enable them to understand it’s safety culture easily and can evaluate the safety culture specifically and comprehensively (Shi, Hosoda, Suganuma, Okumura, Yomura, & Inoue, 2004; Yomura, Hosoda, & Inoue, 2015).

Evaluation score and shared score are 2 safety culture evaluation indexes (Figure 1). The evaluation score is the evaluation index for the staff safety attitude against the safety structure, and the shared score is the evaluation index for determining the evaluation’s agreement degree between the staffs in the organization.

To measure the sharing situation in the organization, we divided the organizational members into 3

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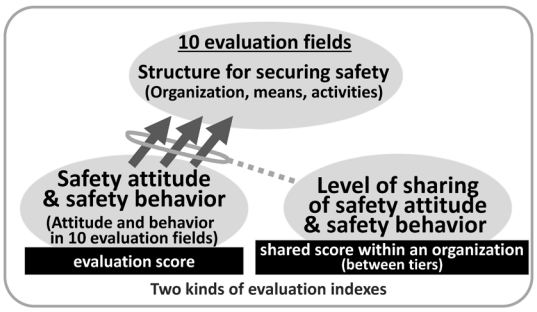

Figure 1 Evaluation indexes of the tool
Note: Evaluation score and shared score are safety culture evaluation indexes in SCAT.

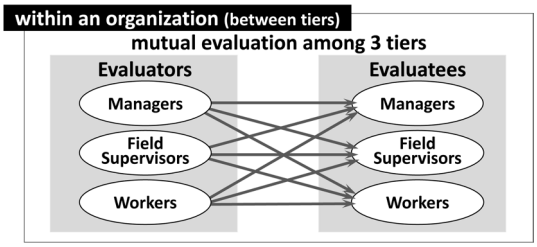

Figure 2 Evaluation structure within an organization
Note: Each person evaluated their own tier and the other tiers within the organization.

following tiers and made it mutually measurement (Figure 2).

1) Manager: the person whose rank is higher than the field supervisor and run the management.

2) Field supervisor: the general management who has the lowest organizational tier and is the responsible of workplace.

3) Worker: the person who has not generally any subordinate in the organization.

The SCAT evaluation consists of 36 items from 10 fields and has been made based on ASCOT guideline (IAEA, 1996), ASCNI report (HSC, 1993), and Survey Tools (HSE, 1997), Cheyne, Cox, Oliver, & Tomas (1998), Cox & Cheyne (1998), Wilpert (1999) (Table 1).

On the other hand, in recent years, in many sectors of industry in japan, division of labor and outsourcings have increased (Ministry of Health, Labour and Welfare, 2013) and the number of the organization that all productive activity are carried out by itself has decreased tend. For example, in the maintenance section of energy plant, several organizations conduct the related work from the drawing up the plan to the enforcement by role sharing as bellow:

1) Contractee: drawing up the maintenance plan

2) Original contractor: drawing up the work plan specifically

3) Subcontractor: enforcement the work

These organizations communicate and coordinate

Table 1 Evaluation fields and items

Evaluation fields (10)	Evaluation items	
	Within an organization (36)	Inter-organization (12)
Safety declaration	Recognition	●
	Understanding	
	Review	
	Penetration	
Safety and productivity	Priority	●
	Level of involvement	
	Awareness	
Safety rules	Documentation	
	Improvement of procedures	
	Observance of procedures	●
Responsibility, authority and roles	Authority	●
	Review of role	
	Participation in improvement activities	
Trouble resolving	Experience of analysis	
	Analysis of human-factors	
	Reporting procedure	
	Implementation of measures	●
	Involvement in improvement	
	Awareness of improvement	
Education and training	Provision of training	●
	Evaluation	
	Contents	
	Trouble response training	
	Materialization	
Information channel	Top-down channel	●
	Communication	●
	Bottom up channel	●
Work environment	Understanding of environmental	
	Conditions	
	Attitude to improvement	●
	Awareness	
Safety activities	Use of safety system	●
	Evaluation	
	Indirect department	
Safety operation	Use of research institutions	
	External audit	
	Service contract	●

Note: ● are 12 items on inter-organization.

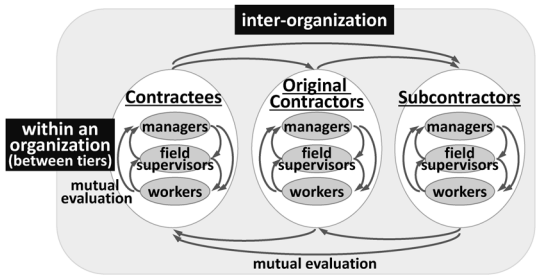

Figure 3 Comprehensive safety culture
Note: Within an organization is between tiers, inter-organization is between organizations.

mutually to running organization safety. So, related organizations increase and if the organizations have the multi-layer structure the risk may occur not only within an organization but between the organizations as well. For example, if the original contractor draws up the plan without the awareness of the facilities or methods of work, the subcontractor's staffs may be forced to do work against their will and receive injuries. On the other hand, the safety policies taken by the ordering organization may cause the unsafe movement in the original contractor and subcontractor.

So, to ensure the entirely safety it is not enough to consider the safety culture of one organization. But the comprehensive studies conducted on the safety culture including the relationship between several organizations can hardly be seen.

Therefore, the purpose of this study is to evaluate of safety culture inter-organization in the industrial organization, including contractee, original contractor and subcontractor by using the SCAT (Figure 3).

Methods

1. Questionnaire Survey

We researched on the contractee, original contractor and subcontractor of an energy plant which are related to the maintenance management. The original contractor was the subsidiary company of contractee. At this plant, there was one contractee and one original contractor but multiple subcontractors. The number of participants (maintenance staffs) is as bellow: contractee 100, original contractor 43, subcontractors 54, and the response rate was more than 90%.

Our questionnaire was consisted of two parts: 1) evaluation of safety culture for within an organization, 2) evaluation of safety culture for inter-organization.

1) Evaluation of safety culture within an organization

We used the SCAT for evaluating of safety culture for within an organization.

The reply each person evaluated both his own tier and the other person's tier in his own organization (Figure 2). So, each person should reply to 1same question 3 times for 3 tiers. Questionnaire respondents were asked 36 questions about each of the three tiers, thus they were asked 108 questions in total. They were asked the following question: "As a member of your particular tier within the company, how do you feel that the managerial, field supervisor, and worker tiers contribute to all aspects of safety?" Participants used 8-point Linkert-type scales (1. disagree ~8. strongly agree) to respond to each items.

Evaluation score: the mean value of evaluation which each tier conducted about the each item.

Shared score: first, for example, the difference between mean of evaluation by manager about the manager and the mean value of evaluation by the other 2 tiers about the manager was selected as the basic data. Then, after removing the total sum of basic data by the unbiased variance of all scales, and reducing an effect of variance within the tiers, we selected it as logarithm. This shared score goes up and down when the inter-tier evaluation coincidence increase and decrease. Then, we used the data of 427 organizations and standardized both evaluation score and shared score (mean value: 50, standard deviation: 10) and then called them standardized evaluation score and standardized shared score.

For more details such as SCAT items, evaluation structure and calculation method of index please refer to Yomura, Hosoda, & Inoue (2015).

2) Evaluation of safety culture inter-organization

We made modification of SCAT and evaluated the safety culture for inter-organization.

With careful consideration for reduction of private burden to participants, we selected following 12 items of 36 items used for evaluation of safety culture for inter- organization: "Recognition of Declaration", "Priority of Safety", "Observance of Procedures", "Authority for Safety", " Implementation of Measures", "Provision of Training", "Top-down

Channel", "Communication", "Bottom-up Channel", "Attitude to Improvement", "Use of Safety System", "Service Contract" (Table 1).

We selected the items had been regarded as more important items for safety culture of inter-organization and added 3 items to the all item of information channel field. All these procedures were conducted by several researcher of industrial-organization psychology using the opinion of target organization staffs.

Contractees, original contractors and subcontractors all evaluated each other and themselves with regard to inter-organizational safety culture evaluation (Figure 4). Each organization was including managers, field supervisors and workers.

Each respondent evaluated 12 items regarding about three tiers, thus they answered questions. Participants used 8-point Linkert-type scales (1. disagree ~8. strongly agree) to respond to each items.

Evaluation score: the mean value of evaluation which each tier conducted about the each item (Figure 5). And as the number of data was small, the standardization procedure was not conducted about inter-organization.

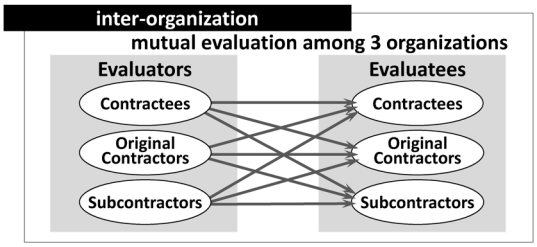

Figure 4 Evaluation structure inter-organization
Note: Each person evaluated their own organization and the other organization at the plant.

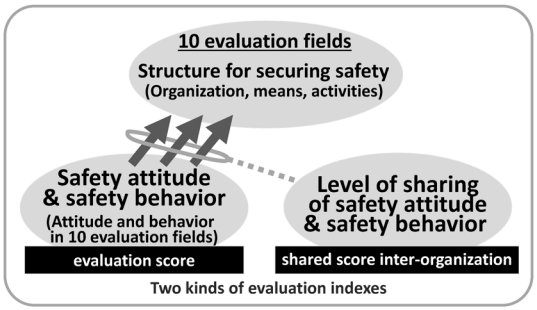

Figure 5 Evaluation indexes of the tool inter-organization
Note: Evaluation score and shared score are safety culture evaluation indexes inter-organization.

2. Ethical considerations

We explained the safety officer and the person responsible in each organization about the study purpose, content and convinced them their personal information would be protected from leaking. And also we received the agreement of organizational representative in the labor union as long as we could. The period for reply was 2 weeks and the participants could get the questionnaire takeaway. After filling up them, the put it into an envelope and input it to the collection box equipped in their workplace. We did our best to strictly control the personal information of participant to prevent leakage to outside and after finishing analysis disposed the questionnaire.

Results

1. Evaluation of safety culture within an organization

The results of standardized evaluation score and standardized shared score that are regarded as the safety culture evaluation index is shown in form of two-axel that is called SCAT-MAP (Figure 6). When the horizontal axis (standardized evaluation score) has a high degree, the safety attitude and behavior has a high level too. When the vertical axis (standardized shared score) shows a high degree it means that, in the same organization (between tiers), recognition falls in line (with each other). So, we are able to find out the relative position of organization safety culture through these two-axes.

We showed the comprehensive results of our target, contractee, original contractor and subcontractor by using SCAT-MAP. According to the results, contractee has the high (top right) degree at both evaluation score and shared score (Figure 6). In contrast, original contractor and subcontractor have relatively low degree and are plotted to lower-left direction. To put it shortly, from the safety culture for within an organization perspective, the contractee has higher level of safety culture than original contractor and subcontractor.

2. Evaluation of safety culture inter-organization

Then, according to the figure 7, we can find out that there is a significant difference in several items between the self-evaluation and evaluation from others in the contractee (i.e., "Priority of Safety", $F(2, 182)=14.395$, $p<.001$; "Attitude to Improve-

ment", $F(2, 168)=12.183$, $p<.001$). Contractee showed high degree of evaluation value of contractee approximately. In contrast, original contractor and subcontractor have a lower degree of evaluation value of contractee. Specifically, we can see the low evaluation value by original contractor about "Priority of Safety", "Bottom-up Channel", "Attitude to Improvement", "Use of Safety System" and "Service Contract". On the other hand, however the evaluation of contractee within an organization (mutual evaluation between manager, field supervisor and worker) is a great value, but evaluation of original contractor and subcontractor about the contractee has a low value.

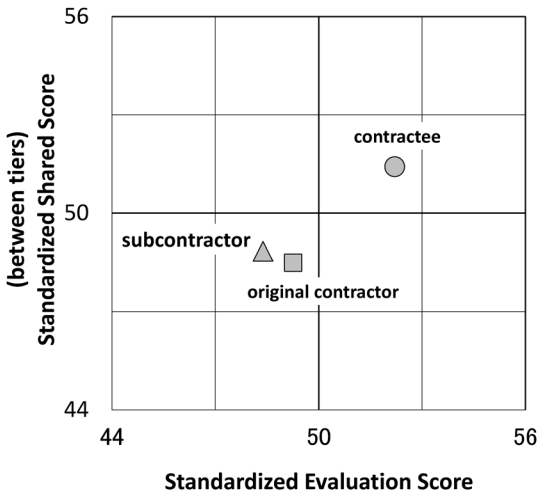

Figure 6 SCAT MAP: Overall evaluation, within an organization

Note: The higher (right) on the x-axis, the higher revel of the attitude toward safety. The higher (top) on the y-axis, the higher the degree of agreement regarding the safety situation.

Discussion

In this study, we actually evaluated the safety culture about the within an organization and inter-organization which is consisted of contractee, original contractor and subcontractor by using SCAT. According the results, we could find out the evaluation of safety culture was high within an organization but also low inter-organization.

When all tiers, manager, field supervisor and worker evaluate themselves highly, both evaluation score and shared score goes up as well. From the safety culture perspective these kind of organization as shown in the first quadrant of SCAT-MAP are regarded as the ideal organization (Yomura et al., 2015). But maybe it is not true. It may is just an excessive feeling of self-satisfaction. To ensure the safety in the industrial place, it is very important to make it clear if this organization is an ideal organization or it is just an excessive feeling of self-satis-

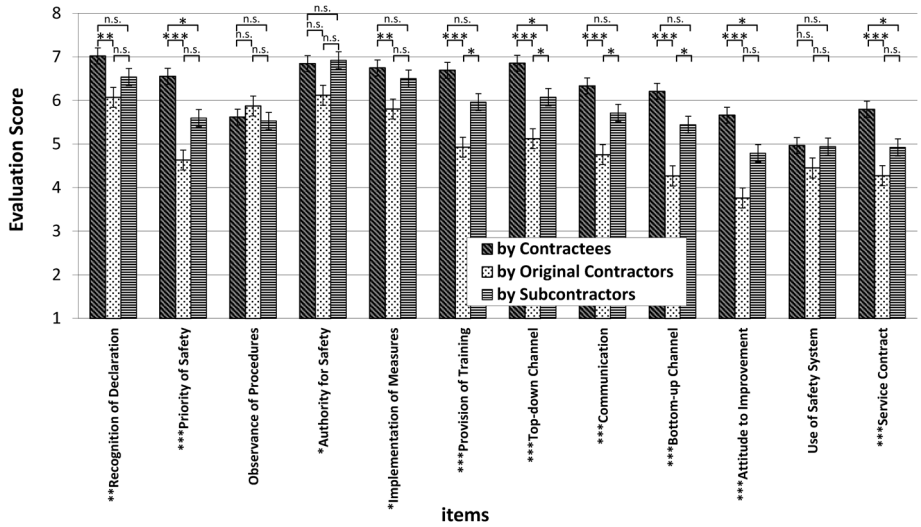

Figure 7 Mutual evaluation of contractees, inter-organization at the Plant

Note: The higher evaluation score, the higher level of the attitude toward safety.
Error bars reflect within-subjects SEM. Asterisks indicate significant differences ($^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$, *n.s.*: not significant) by ANOVA and Tukey HSD.

faction. Therefore, this study which evaluated the safety culture not only for within an organization but also for inter-organization would be useful to ensure the safety.

As mentioned in the opening sentence, presently in many sectors of industry in japan, division of labor and outsourcings have increased (Ministry of Health, Labour and Welfare, 2013). When a company decided to outsource, make it's operation efficiency and try to make cost reduction the risk information is prevented from flowing. In these cases, it is necessary to evaluate the related safety culture throughout the entire organization firstly, and then, according to it's results it is required to heighten the safety culture level by sharing the safety policy, information and structure more actively.

Naturally, we were not able to find out exactly why contractee evaluate their own organization highly and why original contractor and subcontractor show a low evaluate about the contractee. We hereafter will be able to clarify the fragile parts of safety culture more specifically by making clear the cause of the evaluation and the disagreement inter-organization by interview surveys.

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