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Making a Structure to Evaluate HSE Performance of Contractors in Civil Projects

Farbod Redaei[1], Seyed Shahab Khamesi[2], Seyed Saman Khademi Zavareh Ardestan[3]
[1]Assistant Professor, Islamic Azad University of Chalus Branch, Iran
[2,3]Graduate Student, Construction Engineering and Management, Islamic Azad University of Chalus Branch, Iran
([1]redaei.iauc@yahoo.com, [2]khamesi_omran@yahoo.com, [3]saman.khademi54@yahoo.com)

Abstract- Since the main objective in HSE landscape of most companies is control and reduction of risks, indexes must be evaluated and determined to indicate these actions (control and reduction of risk). Utilization assets such as employees' knowledge and skills, cooperation among various sectors, services quality, information technology, and organizational culture are number of value-creating activities of organizations in present era. This research is applied according to objective and has descriptive-qualitative methodology. The tools of this research for data collection to determine characteristics of model are evaluation, survey (by free interviews with experts), and surveying research. Characteristics of a proper model to evaluate contractors HSE in civil projects are identified at the beginning of research by open-end questionnaires given to experts about HSE and also librarian studies. After initial validation, the obtained initial results were attributed weight according to their importance level using analytical hierarchical process (AHP). The identified indexes and the distributed weights were evaluated using the given questionnaires to experts. Finally, the designed structure was executed for a group of engineering and civil organization contractors to evaluate validity of the designed model. Thus, the proper executive policy is providing necessary resources to separate HSE to identify and determine the improvement opportunities for organization performance based on HSE.

Keywords- *HSE, Performance Evaluation, Civil Projects, AHP*

I. INTRODUCTION

Although, there is a lot of general information about measuring performance these days, this knowledge is still little about specific performance of immune systems. For example, managers can use various patterns to evaluate general performance of their organization easily today using positive indexes, the reactive and pessimist indexes such as frequency of accidents, only number of occupational death and similar cases are emphasized in most domestic organizations. In this regard, the mentioned issues in this research try to identify proper indexes to evaluate their performances with aim of identification the best contractor company combination in an engineering and civil organization. Various studies show that unsafe behaviors are the main factor of resulted accidents by work; as though, direct rate between unsafe accidents and accidents occurrence were emphasized in various studies [(Mohamad fam & etc. 2008) & (Andrew 2010)]. Therefore, safety preventive approach, identification, evaluation, and control of such indexes that construct unsafe behaviors have been considered as main strategies to promote safety before their change to catastrophic accidents. Obviously, vulnerable companies to occupational accidents can be identified and controlling actions can be institutionalized based on findings by evaluation of such indexes among contracting companies. (Mohamad fam et al., 2010)

II. PROBLEM STATEMENT

Since success criterion and accuracy of each action is exploring the present conditions and feedback of them, studying and comparison HSE performance by a definite model is considered necessary. (Dana T., 2009) There are various supervisory procedures and parameters to evaluate performance in order to manager health and safety of environment (HSE). Some of these cases have general dimension and some others are specific. Selection evaluation parameters can be used to execute benchmarks or determination performance level and consequently better management of losses (wastes) (Hashemi et al., 2007) In other words, important indexes of health and safety of environment (HSE), measurement, analysis, and control it can be very effective on increasing safety coefficient, health level, and also optimum usage of environment and resources. Therefore, this research tries to formulate a model for contractors by identifying effective indexes on HSE performance of an organization in urban civil projects to be considered as a proper scale by organization in this field. (Mohammadi et al., 2009)

III. IMPORTANCE AND NECESSITY OF RESEARCH

In spite of the significant importance of this issue in supervisory issues on contractor, HSE hasn't unfortunately been so much mentioned in contractors' performance evaluation literature, and cases such as massive and price advance for project and sometimes qualitative issues have been emphasized. (Azadeh et al., 2008). Since there isn't a proper and united structure to evaluate HSE performance of contractors yet in this field, the objective of this research is providing a model by exploring literatures for all contractors to be evaluated.

IV. Methodology

This research is qualitative-descriptive. First literature of organization performance evaluation and also HSE in civil projects was studied first and then rank of HSE was studied in performance evaluation models. After free interview with number of HSE experts, applied characteristics and indexes to evaluate HSE performance in civil projects were studied. The determined indexes were weighted using AHP technic based on their level of importance. Later, the identified indexes and the attributed weights were evaluated by the attributed questionnaires to the SHE experts according to their validity. At the end of research, an accurate study in civil projects of civil and engineering organization was done by research model to evaluate reliability of model.

V. Statistical population and sample

Statistical population of this study includes indexes of health, safety, and environment (HSE) in fields of HSE performance evaluation in civil projects. In order to collect data, ideas of HSE experts were used in various industrial and academic fields. Therefore, people ideas were used in this research in three classifications by a semi-directed free interview. These three classifications include professors of universities: this sector includes: 1-familiar people with evaluation and management of HSE risks or evaluation technology practically and theoretically. 2-Mangers, supervisors, and experts of HSE in industry were used for more application of research results using ideas of this HSE expert group in oil, gas, and petrochemical industries. 3-Counselors, teachers, and authorities in fields of counselling and education field that were selected for their close familiarity and relationship with various industries.

VI. Literature

P. Shafiei Moghadam (1999-2000) evaluated safety in a petrochemical industrial unit by "Safety Audit" technic as MSc thesis of occupational health, school of health, Tehran University of medical sciences that safety indexes were provided well in this research.

M. Mohammadipour's article was "selection contractors using modern performance evaluation technics in south oil-rich areas". Author in this research provided a propose space by a case study about evaluation and technics of evaluation contractors. M. Bashirinasab, A.Gholamreza, S. Farzaneh have a research under the title of "evaluation and management of HSE risks in oil, gas, and petrochemical industry" in collection of conference articles of the first national conference of infrastructure management and engineering in Tehran University (2009). This research could show proper path in this field by mentioning related issues to risk evaluation and its classification to identify related issues to HSE and related indexes. S.J. Hashemi, A. Mojarradian, S., Izadpanah had a research under the title of "evaluation, supervision, and management of HSE performance in upstream oil and gas industries" in the second national conference of HSE safety and management (2007). This article evaluated HSE performance in oil industry that smooth path of reaching to the proper structure for this research according to the similarity of the issues of both studies by this assumption that the designed indexes in civil projects are relatively different.

VII. Using Modern Technics of HSE performance evaluation in various industries

Since the main objective in HSE landscape of most countries is control and reduction risks, indicator indexes of these actions (control and reduction risks) must be determined and evaluated in this era, using assets such as employees knowledge and skill, cooperation among various sectors, services quality, information technology, and organizational culture are the value-creating activities of organizations. Mohammadi, (2008) and Hydari et al., (2008) created conditional balance evaluation technic to control and manage organization strategy besides evaluating motive forces, success in future, and results of actions in past. In this technic, organization landscapes, and strategies by customer view, internal processes learning and financial growth and view toward goals, indexes, inventions, and executive actions are explained. (Mohammadi, 2008)

VIII. Auditing health, safety, and environment management

An independent, systematic, and documented- purposeful process to obtain considerable evidences to determine HSE management system and the adapted results with auditing criterion needs a well-established system that must be proper for health, safety, and environment to reach goals and policies. Documentation indicates totality of HSE management system and a reference to determine related executive methods to establish HSE management design of company. Formal revision is senior management about HSE management efficiency and condition and its establishment to care with HSE issues, policies, regulation, and new goals that are resulted from working space change. Since the objective of this research is providing HSE performance evaluation of contractors' in civil projects, this part of research is related to literature review about HSE performance evaluation and technics. In addition, types of civil projects and related risks are studied. Brief studies of performance evaluation show that macro and general mentions to HSE consideration, and a proper model to evaluate all contractors with united index haven't been identified and formulated. However, what is mentioned in this research, deeper attention to HSE issues in organization performance evaluation. In the rest of research, a model based on identification and determination indexes is designed to find a proper criterion for HSE performance evaluation of organization in civil projects.

This identification is done by librarian studies and interview with experts. After identification the indexes using AHP, they were weighted based on the level of importance. The identified indexes and attributed weights were given to

experts using questionnaire. Their validity was checked. At the end, the prepared model was executed for a group of civil project contractors to evaluate validity of the designed model. The obtained results are compared to the conditions of this research.

IX. Providing a Model to Determine Indexes and Weight Them

After data collection by experts and its analysis, the introduced indexes were divided to 5 main groups according to content and the discussed issues whose results are in table (1).

It must be mentioned that these results are shown without considering their weight coefficient/importance. In order to determine weight regarding to frequency and also identify sub-set indexes, each index classification is normalized for future decisions by the related formula.

X. Validity of Criterions and Their Related Weights

After calculation of indexes, a questionnaire was formulated to evaluate validity of their weights and was given to experts, 28 of whom answered to the questions. The obtained results from experts' ideas are collected for the main criterions as table (3).

TABLE I. GROUPING INDEXES AFTER THEIR CLASSIFICATION

Row	Attributed classification to the stated index	Number of sub-set index	Frequency of designed index by expert
1	Related indexes to HSE management system	40	25
2	Indexes for safety consideration in civil projects	124	25
3	Indexes for health considerations in civil projects	41	25
4	Indexes for environment considerations in civil projects	8	21
5	Indexes for urban landscape considerations in civil projects	5	14

TABLE II. IDENTIFIED FIELDS FOR RELATED INDEXES GROUPS TO HSE MANAGEMENT SYSTEM

Row	Attributed classification to the stated index	Number of identified indexes	Frequency of designed index by expert	Calculated weight (Normalized)
1	Policies, goals, HSE-Plan	4	20	0.19
2	Evaluation secondary contractors	3	18	0.13
3	Communications	3	17	0.12
4	Risk management	2	16	0.08
5	Organizational structure	3	15	0.11
6	Human resources management	2	12	0.06
7	Culture making	3	8	0.06
8	Reaction in emergency conditions	4	8	0.08
9	Auditing	1	6	0.01
10	Reporting and analysis events	1	6	0.01
11	Working permission	2	5	0.02
12	Education	9	5	0.11
13	Management revision	3	2	0.01

TABLE III. OBTAINED RESULTS FROM VALIDATION OF THE MAIN CRITERIONS

Row	Attributed classification to the stated index	The mean attributed score	Index weight
1	Related indexes to HSE management system	4	0.21
2	Indexes for safety consideration in civil projects	9	0.47
3	Indexes for health considerations in civil projects	4	0.21
4	Indexes for environment considerations in civil projects	1	0.05
5	Indexes for urban landscape considerations in civil projects	1	0.05

That was designed in comparison to the identified weight $(W_1 = 0.19, W_2 = 0.58, W_3 = 0.19,\ W_4 = 0.03, W_5 = 0.01)$ to determine validity of structure, and Cronbach's alpha coefficient was used to find out how much experts perceptions are similar about questions. In addition, Likert scale was used. The law in Likert scale is based on assumption of items similarity.

Cronbach's alpha coefficient is calculated using the following relation:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} S_i^2}{\sigma^2}\right) \quad (1)$$

In which, K is number of questions, S_i^2 is variance of ith question, and σ^2 is variance of total questions (Payandeh et al., 2009).

The following path is used to calculate Cronbach's alpha coefficient by SPSS software:

Analyze> Scale> Reliability Analysis…

If you like to check how much the removal of each question influence on Cronbach's alpha coefficient, click on choice "statistics" after the opened window "Reliability Analysis Reliability Analysis", and select "Scale if item deleted" in part "Descriptive for".

Output of SPSS software for the related data to management system will be as following:

TABLE IV. OBTAINED RESULTS FROM VALIDATION OF HSE MANAGEMENT SYSTEM SUB-CRITERIONS

Cronbach's Alpha	N of Items
0.855	13

As it is seen, the calculated alpha is 0.85% that is acceptable amount.

TABLE V. OBTAINED RESULTS FROM SAFETY CONSIDERATIONS SUB-CRITERIONS

Cronbach's Alpha	N of Items
0.812	18

The calculated alpha for safety consideration is 81% that is acceptable amount.

TABLE VI. OBTAINED RESULTS FROM HEALTH CONSIDERATIONS SUB-CRITERIONS

Cronbach's Alpha	N of Items
0.834	8

In addition, the calculated alpha amount for health consideration is 83% that is acceptable amount.

TABLE VII. OBTAINED RESULTS FROM VALIDATION OF ENVIRONMENT CONSIDERATIONS SUB-CRITERIONS

Cronbach's Alpha	N of Items
0.795	8

On the other hand, the calculated alpha for environment considerations is 79% that is acceptable amount. The calculated alpha amount for urban landscape considerations is 76% that is acceptable amount, too. Obviously, as Cronbach's alpha index is nearer to 1, internal consistency among questions will be more, and questions will be more homogenous. Cronbach's coefficient reliability knows 45% low, 75% acceptable and average, and 95% high. Therefore, it is obvious that low alpha value must be studied that removing which questions can increase its value. According to the obtained results and the analysis, the minimum Cronbach's alpha coefficient belongs to the related questions to urban landscape with 76% and the maximum is related to HSE management system considerations with 85% which show validity of the determined indexes and their weights are confirmed.

XI. SELECTING PRIOR CONTRACTOR ABOUT HSE FIELD BY AHP

In the next phase, after determination the main criterions and sub-criterions, AHP is determined. Main criterions and sub-criterions are determined after determination and identification the goal. In this analysis, according to the obtained score from the designed checklists, the obtained score from each contractor are compared and decision to determine the prior contractor was made in HSE field. Indexes and also number of questions about each criterion was weighted and were normalized by arithmetic mean after determination indexes adaptation. A questionnaire was designed and given to HSE experts to determine the identified importance of each criterion and sub-criterion. Then, Cronbach's alpha coefficient was calculated using PSS software and Likert scale. Based on software output, the maximum alpha coefficient was related to indexes of HSE management system with 85% and the minimum was related to urban landscape consideration with 76% which shows acceptance of the designed structure validity. Finally, the prior contractor in HSE field was identified according to AHP model and the prepared and evaluated checklists. The obtained results from analysis are shown in the next part about scoring forms.

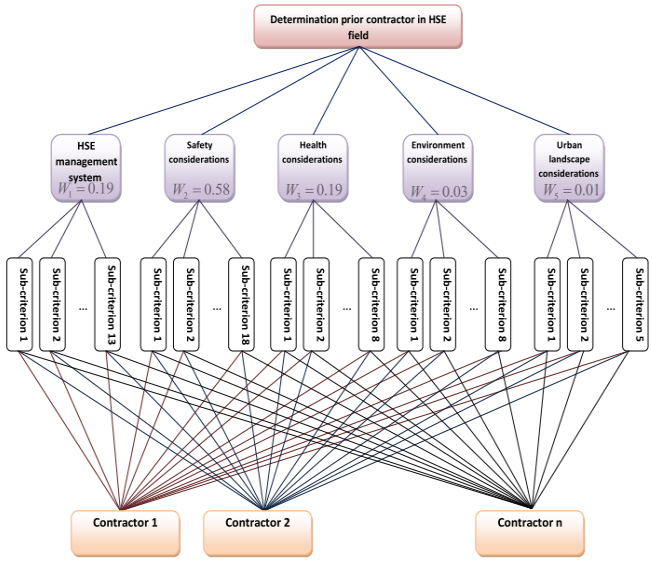

Figure 1. The checklists Phases of system management process of the prior contractor in HSE field according to AHP model

25 HSE experts were interviewed to determine characteristics of a HSE performance evaluation model and totally 5 main criterions with sub-criterions were identified.

XII. Evaluation of Contractors

Several projects among the existed projects in civil engineering organization were selected for more studying and evaluation in HSE field after documentation of the present projects and their importance level in city. The prepared checklists were filled by HSE unit investigators of civil engineering organization who were well trained about evaluation based on checklist. The checklists were prepared and the results of evaluation are as following:

A. Discussion and Results

As it was mentioned previously, the following questions are answered according to this research;

1) What are important indexes in health, safety, and environment fields in civil projects?
2) How is importance coefficient of each index evaluated?
3) How can HSE performance of an organization measure in civil projects?
4) How will HSE performance evaluation model influence on contractors of urban civil engineering organization?

To answer these questions, first HSE performance evaluation in civil projects was studied, then experts in HSE field were interviewed, and finally combination of then was classified in 5 main groups including HSE management system, safety, health, environment, and urban landscape. The second question of this research was answered using a semi-directed free interview with a group of experts, attention to frequency of indexes repetition, and number of defined sub-sets was attributed to each index for each criterion using a weight normalization technic. The third question of this research was answered using determined indexes and attributed weights, a checklist was prepared to evaluate performance of an active organization in HSE field. Although, this new model has limitations, interviews about model validity was obtained relatively well to cover the mentioned characteristics as this model could reach to more than totally 81% scale based on analysis in previous chapter. Nonetheless, there are some suggestions for more study in this field to get better results regarding to the obtained results from interview (scaling forms) and implicit findings of this research.

XIII. Executive Policies

Identification, analysis, and evaluation HSE risks of civil activities identify potential risks, evaluate their effects and recognize necessary actions to reduce risks for all executive steps of a civil activity by considering necessities, national, regional, and international laws and regulations in HSE fields, and using HSE experts ideas to execute civil activity to provide financial resources and facilities for HSE plans, protection installation, equipment, improvement infrastructures, and also new development plans.

- ✓ Training risks and HSE aspects of civil activities to employees and contractors
- ✓ Providing financial resources for HSE auditing to identify and determine improvement performance condition of an organization based on HSE landscape
- ✓ Documenting related documents (policies and goals, roles, evaluation results, laws, procedures, and instructions, emergency condition designs contracts and agreements, known HSE aspects in civil activities
- ✓ Preparing and using materials safety data sheet (MSDS)
- ✓ Preparation emergency management design for preparation and reaction against potential evidences.
- ✓ Influencing health and hygiene condition of employees, refining pollutants and environmental aspects of civil activities
- ✓ Using personal protective equipment (PPE) and safety equipment and fire appropriate climate, and physical condition of employed people in civil part

XIV. Conclusion

HSE performance evaluation in civil sector is one of very important issues in contractors' evaluation plans that haven't been mentioned unfortunately. On the other hand, safety, health, and environment issues (HSE) have been mentioned in organizations nowadays under the consideration of relativity of these issues and also organization costs reduction in management of these fields as a comprehensive system. Anyway, risk is evaluated as the most principal element in HSE management system individually in various fields of safety, health, and environment. Achieving to the model that is

able to show adaptation activities of a contractor with each discussed issues in this thesis comprehensively is one of the important issues in each organization. It was tried in his research to answer this matter by an initial model. According to interview (as a scoring form), the provided model has advantages and disadvantages that was tried in his research to provide suggestions for more study to improve this model. In addition to the studies and also research results, some suggestions are given to improve HSE condition in employ and hire contractors in organizations.

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