

Development a model to evaluate the performance of contractors in health ,safety and environment area(Case of Study: Water and wastewater Company of Qazvin)

¹Arezoo Akbari , ²Ahmad Esakhani

1-The graduate of MA Excutive management , Management Department, Qazvin Azad University, Qazvin, Iran

2-Assistant Professor, Management Department, Kharazmi University, Tehran, Iran

Abstract

Introduction: the health and safety of employees in the working environment is one of the increasingly important matters in any organization. In recent years, the rapid trend of outsourcing and factors such as lack of legal requirements and careless ness in monitoring the implementation of health, safety and the environment (HSE) principles in the contracts of the contracting companies, has led to alarming growth in the rate of indices associated with occupational accidents, and therefore increasing importance of subjects associated with evaluation of contractors HSE performance. The present study is an attempt to provide a model for evaluation of contractors' HSE performance in the Qazvin province water and wastewater Co.

Methodology: this analytical-applied study was conducted in 2015 on a sample size of 176 individuals. The standards of the researcher-made questionnaire were extracted from three models namely EFQM excellence, human resources excellence model and

the HSE-MS. First the reliability and validity of the questionnaires were evaluated through the Lawshe and Chronba''s alpha methods and the standards were expert judged by the HSE experts.

The KMO and Bartlett's test was used to determine the adequacy of the data and the fitness of standards and items was evaluated through confirmatory factor analysis. Considering the data collected through questionnaires, the impact factor of the standards was determined by AMOS21 software.

Findings: the final HSE performance evaluation model consists of 8 criteria and 14 sub-criteria and the highest and lowest impact are attributed to human resources and planning respectively. The final model was confirmed by 5 HSE experts.

Conclusion: the proposed model can be used to evaluate the performance of the industrial and contracting units from the HSE point of view and can serve as a basis for planning and implementation of appropriate management measures

Keywords: Performance Evaluation, safety, health, environment, contractors

Introduction

In recent years, with implementation of government policies (Article 44 of the constitution) regarding the reduction of governmental organizations' size, we have witnessed rapid and extensive transference of services to contractors, which includes transference of responsibilities and the associated occupational risks. Considering the contractors employ a significant percentage of human resources in order to implement their projects, they play a vital role in elevation of HSE (Aalayi& Shaker, 2010).Therefore, in selection of contractors, organizations should not only evaluate their technical competence, credibility and financial stability, but pay special attention to their management and performance in the field of safety, health and environment in order to prevent accidents which lead to Financial, credit and time losses, as well as severe industrial, social and human damages. According to US. Bureau of Labor statistics, 4585 occupation-related accidents occurred in this country during 2013 and this number rose to 4679 accidents in 2014, which indicates an increase of 2% compared to the previous year (www.bls.gov.iif,2015). In addition, according to the statistics released by the HSE convention of Europe, 1.4% of workers in England, 1.8% in Spain and Italy, 3.1% in France, and 0.7% in Poland experienced occupational accidents during 2013 (www.hse.gov.uk,2015). According to the reports of Statistics as well as Economic and Social ComputingBureau of social security Administration, more than 18000 occupational accidents have occurred throughout the country during 1393, leading to waste of 1 million working days on recovery of workers as well as loss of 33000 thousand working hours due to hospitalization of workers. In addition, according to the reports, 121 workers lost their lives due to occupational accidents during 2014 which shows a rise of 3.4% compared to the previous year (of Statistics as well as Economic and Social ComputingBureau of social security administration, 2014).

The HSE Management System pursues accidents through analysis of their root causes. And then provides some solutions for prevention or minimization of accidents through comprehensive investigation of different conditions in working environments. However, it should be noted that in any working environment, the HSE system should be apt for the environmental conditions, the type of activity and the accidents. This condition has shown that the type of HSE management system is considerably associated with the degree of accidents and damages resulting from that (Abbaspour et al, 2014). In the current highly competitive world, many companies have realized that HSE management should be regarded as an inseparable and necessary part of the organization and consider it as important as other types of management in the system. The final aim of the HSE management system is to protect people, the society, assets and the environment (Farshad et al, 2006). Considering that the present study mainly attempts to provide a model for evaluation of the HSE system's performance in the water and wastewater company, and no comprehensive and specialized has ever been provided for evaluation of performance from the HSE perspectives, and all the previous studies have merely dealt with HSE management and the strategies of risk reduction in projects, the findings of the present study can help organizations to perform sustainable evaluations of their HSE System performance and use the evaluation outputs as basis for development of management plans and measures.

Review of literature

Many studies have been conducted in this regard during the last decades, some of these studies are provided below. Tom et al (2004) conducted a study on 200 large and medium manufacturing companies in China to investigate the status of safety management in industries and identify the risk-prone activities in the construction sites as well as the factors affecting the safety of sites. The findings showed that the constructors' behavior is the most concerning issue in the safety management of construction sites. Such behaviors include Lack of personal protective equipment, lack of safety meetings and lack of safety instructions. The results of this study also showed that insufficient knowledge of senior managers and project managers about safety, lack of instruction in this regard, and inattention of operational staff to the safety principles are among the main factors affecting the safety performance in the construction projects (Tam et al-2004). Thomas et al (2005) conducted an study on 180 individuals including contractors, consultants and employers in Hong Kong and provided a framework for evaluation of contractors' safety performance. The results showed that factors such as "implementation of safety management system" and "acceptance of health and safety rules" were the most important factors among the factors of safety performance evaluation (Thomas et al, 2005). Enshasi et al (2008) conducted an study on 60 construction subcontractors to investigate the safety performance of them in the construction industry in the Palestine. The study concluded that reported accident rates will decrease among subcontractors and their workers if new workers are trained well in the work site and they are informed about dangerous places, and if a workable safety plan is well preplanned. The results also showed that reported accident rates increased among subcontractors when using old, unsafe equipment and due to the complexity or difficulty in the construction sites features (Enshasi et al, 2008).

In a study conducted by Patrik Manu et al (2013), 50 medium to large UK contractors were randomly selected and invited to take part in the study. They used a bonus plan for subcontractors in order to reduce losses. They first investigated other non-traditional modes of employment (subcontract) in UK and provided some reasons such as "the avoidance of workers' compensation cost" for that. To assist with the data analysis, a 5 step process based on Creswell's (2009) guide for qualitative data analysis was used. The results showed that employing a series of constant subcontractors and implementing a bonus plan for compliance with safety and protection standards in workshops and also using subcontracting HSE managers with direct responsibility for the safety of workers, can mitigate the losses in the working environment (Manu et al, 2013).

In a longitudinal (cross-sectional) study of the construction accidents in 201 projects in Uganda, Irumba (2014) conducted a spatial analysis of construction accidents using ordinary least squares regression and spatial regression modeling. The method used in this study is a triangulation method. The three most prevalent causes of accidents in Kampala are mechanical hazards (i.e. struck by machines, vehicles, hand tools, cutting edges, etc.), being hit by falling objects and falls from height. Congestion, a phenomenon which arises when there is evidence of high building density amidst many fulltime workers on site, is discussed. Policies on regulating working hours, provision of safety equipment, equipment maintenance and on standards of acceptable building densities can mitigate accidents occurrence (Irumba, 2014).

The overview of the previous studies indicate the importance of safety in conduction of industrial and project activities, and show that observance of the safety principles can be effective in mitigation of accidents and improvement of work quality. Considering that performance is not evaluated from the HSE perspective in the previous studies, and the outsourcing and contracting activities are on the rise, leading to increasing number of occupational accidents, the management system seem to be in need for development of a model to elevate and evaluate the performance of industrial organizations and contractors from the HSE point of view. The present study is an attempt to bridge in this gap and satisfy the needs of organizations in this regard.

Methodology

The present study which was conducted in 2015 is an analytical- applied study, because output results of this study can be used to identify the evaluation criteria of HSE performance and its final model can be used to evaluate the performance of industrial and contracting units. The population of this study includes the project managers (employers) and contractor managers, HSE experts and consultants and the contractors of water and wastewater Co (325 individuals) and using Morgan formula a sample size of 176 subjects (at the confidence level of 95%) was selected.

In this study, first all the performance evaluation models, regulations, instructions, requirements, check lists, and questionnaires associated with HSE and HSE performance evaluation were investigated in detail in order to extract the criteria and sub-criteria associated with the subject matter. After consideration of features and evaluation trend of the existing models at the national and international level as well as their strength and weakness points, it was concluded that the model to be used in the present study should follow a trend similar to the 7 criteria of the HSE management system or the 9 criteria of the EFQM excellence and human resources excellence models, so that all the provisions of the management system requirements may be included in the evaluations and the evaluation trend can be clear-cut and standard. In this stage, a researcher-made questionnaire with 9, main criteria, 15 sub-criteria and 37 items was developed. For development of this questionnaire, the questionnaires associated with the 3 models in the previous stage were brought together and every single criteria, sub-criteria and item in them were evaluated. For example, if a criteria was common in all the 3 questionnaires, all the items related to that were evaluated and the most comprehensive ones were extracted. Similarly, all the criteria which affected the HSE performance of the contractors were identified according to the literature and the evaluation models. These criteria are provided in table 1 below:

Table 1: criteria and sub-criteria extractive

	criteria	Sub-criteria	Item
1	Human resources	Improvement, planning, and management of human resources	Participation of employees in formulation of human resource plans in the field of HSE Management of human resource employment and promotion in line with realization of HSE objectives
		Identification and development of employee's knowledge and competence	HSE training courses and employment of personnel with the required capabilities and skills Promotion and encouragement of employees and contractors in the field of HSE according to their performance
		contractors	Selection of suitable contractors based on HSE requirements in projects The organization and contractor's

			control over HSE performance of subcontractors in the project and organization
2	Risk management and evaluation	Identification and evaluation of risk	<p>Identification and evaluation of risks and environmental factors in design, construction and implementation processes</p> <p>Prioritization of occupational risks and environmental factors according to risk analysis results</p> <p>The degree of compatibility between the performance indicators and occupational processes is of great importance in risk analysis</p>
		Risk control	<p>Formulation and conduction of control measures based on evaluation of occupational risks and environmental factors</p> <p>Formulation of executive techniques for application of control measures in order to reduce or eliminate risks</p>
3	Policy and strategy	Policy and strategy	<p>Formulation and upgrade of HSE policies and strategies according to the missions of the organization</p> <p>Notification and release of HSE strategies to the employees</p>
4	Establishment and monitoring	revisions	<p>Periodic Monitoring of the HSE performance indicators in the organization and project</p> <p>Periodic and regular examinations and safety inspections for the employees in the projects</p> <p>Release of contractor audits results to control activities and ensure their compliance with the HSE standards</p>
		events	<p>Development of methods for recording, reporting and analyzing the events in accidents as well as the sensible environmental effects resulting from activities in the projects</p> <p>Investigation and analysis of events in order to determine the root cause within the organization and project</p>
5	Management revisions	Management revisions	Accessibility of management revision outputs for information purposes and consultation of the staff

			<p>in the organization</p> <p>Investigation of the problems associated with the HSE performance of subcontractors in the management review meetings</p> <p>Management Considerations of OHSAS 18001- ISO 14001 - HSE – MS standards requirements</p>
6	leadership	<p>development of organizational outlooks, values and excellence</p>	<p>Formulation and development of organizational HSE outlook as well as HSE organizational culture and management ethics by the leaders</p> <p>Excellence of leaders, their familiarity with HSE concepts and their participation in the improvement measures</p>
		<p>Support of organizational developments</p>	<p>instruction, support and empowerment of employees (by leaders) in order to achieve developments in the field of HSE</p> <p>leaders recognition of organizational development internal and external triggers in the field of HSE</p>
7	Organizational resources	Organizational resources	<p>Procurement of individual, engineering and management control solutions based on HSE standards in the projects</p> <p>The need for allocation of the required resources for contractors and projects according to the HSE annual programs</p> <p>Evaluation and review of the resources available to the employees in terms of HSE</p>
8	planning	<p>HSE plans and projects</p>	<p>the procedures for implementation of HSE plans by the contractor in the (HSE -PLAN) projects</p> <p>determination of the necessary time tables to achieve the HSE goals</p>
		<p>Unexpected and emergency conditions</p>	<p>Determination of potential emergencies resulting from occupational risks and environmental factors in the projects</p> <p>Formulation of Guidelines for each identified emergency condition</p>

			Preparation of (MSDS) Material Safety Data Sheet for flammable and explosive chemicals procedures for gaining access to the necessary information in the emergency conditions (such as site maps, dangerous information and...)
9	Effective communication	Effective communication	Installation of HSE sign and notices in the bulletins of the project and the organization Encouragement of the employees to increase their innovation in the field of HSE Development of a systematic executive technique for exchange of HSE information between contractors and the employees

The researcher-made questionnaire consisting of criteria, sub-criteria and items was distributed, in person or through Email, among 20 HSE experts (MA or PhD of HSE) who had already accepted to participate in the study as expert judges. According to content validity results in the form of CVR and CVI, as all the questionnaire items have gained CVI scores higher than 0.79, CVI is regarded as the confirmed scale in this study. As for CVI, the results showed that the 9 criteria with their 15 sub-criteria and 37 items have obtained validity scores higher than 50%. In the next stage, the Chronbach's alpha method was used to measure reliability. The obtained chronbach's Alpha value (0.863) showed that 86% of the answers have been similar to one another $p < 0.001$ indicated that there has been a significant correlation between the questions in each section.

KMO and the Bartlett's test were used to measure the sampling adequacy and homogeneity of observations to be used in factor analysis respectively. Considering the significant value of KMO index (0.864) and Bartlett's test results, both the number of samples for the factor analysis and the homogeneity of between the observations were deemed adequate.

Finally, the structural equations were modeled. In this process, first the relationship between the observed variables and the latent variables was investigated and the insignificant factor loads at the 0.05 error level were removed. In all the fitness indicators, first every single factor was investigated using specific software in order to test the adequacy of each item on the factor and use the tested criteria and sub-criteria to develop a comprehensive and applied model for evaluation of contractor's performance in the parent companies such as water and wastewater companies.

Findings

According to the findings extracted from the distributed questionnaires through factor analysis, $0.08 > \text{RMSEA}$ and $0.07 > \text{RMR}$ were regarded as badness of fit criteria and $0.90 < \text{GFI}$ CFI AGFI as goodness of fit criteria. According to table 2 and 3, the sub-criteria (sub-model) results are as follows:

Table 2: Fit criteria Indicators fit criteria model

RMSEA	CFI	AGF I	GFI	RMR
.044	.974	.900	.980	.090

Table 3: The sub-criteria (sub-models)

item	Load factor	Critical rate	The significance level
R1)leadership(
R2)leadership(.628	7.142	***
KH)Policy and strategy(.621	7.851	***
MA1)human resources(.699	8.924	***
MA2)human resources(.830	8.338	***
MA3)human resources(.756	8.007	***
ER1)Establishment and monitoring(.717	6.153	***
ER2)Establishment and monitoring(.520	7.737	***
MS)Organizational resources(.686	7.017	***
T1)planning(.608	5.211	***
T2)planning(.431	5.958	***
A1)Risk management and evaluation(.501	7.471	***
A2)Risk management and evaluation(.656	7.873	***
B)Management revisions(.701	7.514	***

The main criteria required fitting indicators Tables 4 and 5 as follows:

Table 4: Fit criteria Indicators model

RMSEA	CFI	AGFI	GFI	RMR
.033	.898	.822	.901	.032

Table 5: meaningful results and again the statements of contractors HSE performance Water and wastewater Co

item	Load factor	Critical rate	The significance level	Result
leadership	.659			
Policy and strategy	.699	8.032	***	accepted
Human resources	.838	9.267	***	accepted
Establishment and monitoring	.691	7.952	***	accepted
Organizational resources	.608	7.129	***	accepted

planning	.532	6.330	***	accepted
Risk management and evaluation	.764	8.643	***	accepted
Management revisions	.676	7.806	***	accepted

in general, 9 main factors were extracted from the studies and given that the criterion items for the effective communication were not in a significant level according to table 6, the effective communication was removed from among the 9 main factors considered for identification of HSE performance in the final model.

Table 6: significant results and again after the statements of effective communication

item	Load factor	Critical rate	The significance level
Items (21)	.198		
Items (22)	.192	1.518	.129
Items (23)	.818	.507	.612

As for the criteria, the “human resources” had the most significant effectiveness (0.84) and its sub-criteria in the effectiveness include: improvement, planning and management of human resources (0.83), identification and development of employee’s knowledge and competence (0.76) and contractors (0.72), evaluation and management of risk (0.76), ranked second in this order and its sub-criteria in effectiveness order include: risk control (0.70), evaluation and identification of risk (0.76).

Policy and strategy rank third in this regard with the effectiveness of 0.70. In addition, establishment and monitoring (0.69) with some sub criteria such as events (0.69) and revision (0.52) ranked fourth and In this regard.

Management review (0.68), and leadership (0.66) with some sub-criteria such as formulation of outlooks, organizational values and..... (0.63) and support for organizational developments (0.62) was also of great importance in this regard. Organizational resources (0.61) and planning (0.53) with some sub-criteria such as unexpected and emergency conditions (0.5) and HSE programs and projects (0.43) ranked the lowest order in terms of effectiveness importance.

The final model with 8 criteria of HSE performance evaluation such as leadership, strategy and policy, human resources, risk management and evaluation, planning, establishment and monitoring, management review, as well as 14 sub-criteria and 34 items was identified and then approved by 5 HSE experts. This model is provided in figure 1.

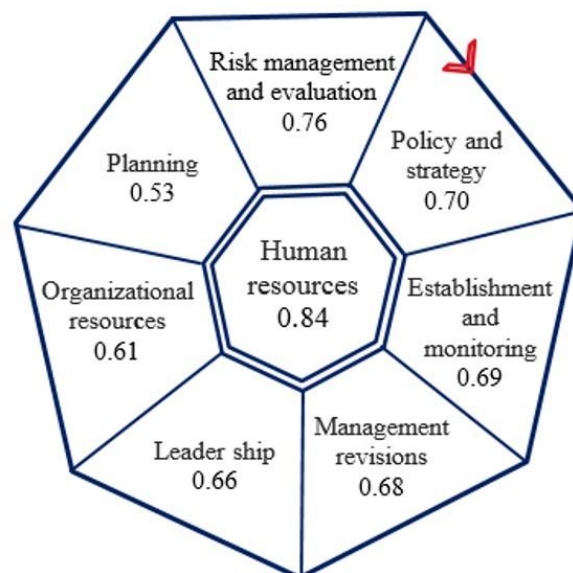


Figure 1: Criteria for evaluating the performance of contractors HSE perspective

Discussion and conclusion

The results of the present study suggest that all the aspects of criterion selection are taken into account in this study and 8 main criteria of the final model serve as the core of HSE performance evaluation and could also serve as the basis for evaluation of contractors' performance in the water and wastewater Co. according to the findings of this study, human resource is the most important capital of organizations, because currently great importance is attached to this factor in achievement of high and sustainable productivity. Human resources can use their capabilities and knowledge to develop or achieve the required capital or liquidity, and also draw on their body, mind and expertise for raw materials and machineries to help organizations achieve high productivity and effectiveness. On the other hand, considering the environments where projects are underway, the human resources are always at risk. These risks mainly result from inattention to the safety and prevention principles or lack of knowledge about them. Therefore, it can be concluded that prevention of accidents in the working environments can protect part of the human and capital resources which are among the factors of economic productivity and thereby prevent the psychological stresses of the injured workers and their families. Evaluation and management of risk ranked second in terms of importance because, consideration of the available opportunities and risks in the industries and evaluation of their capacity for dealing with the existing risks and uncertainties is of great importance in the contemporary world. Risk management and evaluation enables the managers to provide a balance between the financial and operational costs and the protective measures, and to support organizational goals and achieve their interests through protection of business procedures. In addition, risk management and evaluation allows for providing appropriate reactions to each risk and determining the degree of consistency between the performance indicators and the occupational processes. Policy and strategy ranked third in this regard, because it provides us with the perspectives, objectives and principles of performance as well as the management requirements in terms of HSE, on the other hand, the safety policies and regulations have a significant effect on the safety of projects. The establishment and monitoring index can be used to investigate the conduction procedures of planning criteria, the performance and revision indices, their monitoring, as well as the required corrective actions. Management review is also one of the important criteria in this study, because sustainable review of management in all affairs can help to eliminate the root causes of problems and to plan preventive measures against their reoccurrence in similar environments. Leadership is also an important criterion because leaders formulate the outlooks, the core values and organizational strategies in any organization, actively participate in formulation of business processes and serve as a role model in development of HSE culture. Organization resources and planning are also important criteria in this field, because the planning criteria allows for close consideration of how the work plans and activities determined at the risk management and evaluation level are implemented. In the criterion of organization resource criterion great importance is attached to provision of resources control, organization and documentation for effective HSE performance as well as the need for allocation of required resources in order to deal with and mitigate the effects of emergency conditions, as well as development plans, maintenance of different unit facilities and new HSE performance audits.

Comparison of the results obtained from the present study and the previous ones shows that factors such as: "implementation of safety management system" "acceptance of health and safety rules" and "insufficient knowledge of project managers and lack of training courses and inattention of operational personnel to the safety principles" which were considered the most important factors among the safety performance evaluation factors in the studies conducted by Thomas et al (2005) and Tom et al (2004) are consistent with the results of the present study in terms of "leadership" and "human resources". The results of Enshassi et al (2008) showed that "training the workers and right ways of using the equipment" are among the important and effective factors in safety performance and mitigation of occupational accidents, this results are consistent with the results of the present study (in terms of "human resources" with the highest importance of 0/84). The results of the study conducted by Patrik Manu (2013) for mitigation of work environment casualties in 50 subcontractor companies showed that employment of "HSE managers" and implementation of a bonus plan for observance of safety principles and protective measures in the workshops can lead to mitigation of casualties in the work environments. The results of this study are consistent with the results of the present study (in terms of "human resources" with the highest importance of 0.84). Urumba (2014) investigated 201 construction projects in Uganda. The results showed that "risk management and evaluation" and "development of constructional

regulations” can be useful for mitigation of occupational accidents. These results are consistent with the results of the present study (in terms of “risk evaluation and man agent” with importance rate of 0.76). In the present study attempts are made to propose a comprehensive model for evaluation of contractors’ performance in the water and wastewater companies. So that, by application of this model for sustainable evaluation of contractors from the HSE perspectives, the employers can prevent many irreparable human and financial losses that can threaten the industries, societies and employers.

Implication for practice:

By assigning appropriate scores to each criteria and sub-criteria, The proposed model for evaluating the performance of contractors in the water and wastewater companies can be useful for selection of suitable contractors. In addition, this model can help to determine the weak points of contractors in the main criteria and sub-criteria and therefore provide the contractors with the preventive and corrective solutions against the identified weak points.

According to the identified factors in this model for evaluation of contractors’ performance from the HSE perspective, these factors are suggested to be tested in the form of a structural model.

Implication for research:

Considering the necessity of evaluating contractors’ performance in terms of HSE, the researchers are recommended to conduct new studies to obtain new models so that the ground for comparison and selection of optimal models may be provided

Researchers are recommended to develop Exclusive HSE performance models for each industry commensurate with their activities as well as the risks they encounter. The researchers are recommended to provide instructions for ranking the indices in evaluation of contractors’ HSE performance

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