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A COMPARATIVE STUDY ON THE IMPACTS OF INTEGRATED AUDIT ON OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENT PERFORMANCE.

By

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Abstract

Introduction: System integration can be achieved in a number of ways and at different levels. In practice all management systems are mutually coordinated systems functioning almost independently. Integration enables synergetic effect and optimum workplace performance on all aspects of Safety, Health, Environment and Quality. **Aim of work:** To evaluate the effect of Occupational Health, Safety and Environmental Protection Management System (HSEMS), integrated audit on Health, Safety and Environmental (HSE) protection performance level of petrochemical companies. The study was designed to evaluate the compliance degree of the organization with International Standardization Organization for environmental management, (ISO 14001) and Occupational Health and Safety Administration Series (OHSAS 18001) requirements in five petrochemical companies to ensure continued effectiveness and efficiency. **Materials and methods:** Performance indicator checklist and a questionnaire were designed to be used as a tool for internal review of HSE directed by OHSAS 18001:2007 and ISO 14001:2004. Relevant data were collected and statistically analyzed. Data collection was performed through various methodologies such as reviewing HSE published documents, safety reports of the companies, conducting interviews and surveys among HSE managers. **Results:** The study indicated that there was a gap between the effectiveness of HSEMS before and after the integrated audit by about 17.8 % at company A, 18.3 % at Company B, 21.5 % at Company C, 31.5 % at Company D, and 10.1 % at Company E. Factor analysis indicated that there was an identity and good correlations between the HSE performance indicators means for all companies. The results after integrated audit on

the studied companies were categorized by a SWOT analysis technique to four areas of strength, weakness, opportunities and threats. **Conclusion:** Although the performance of health, safety and environment at the selected petrochemicals companies seems to be at a high level, the underlined study revealed some weaknesses and threats that affect the efficiency of HSEMS. However, HSE performance indicators were not enough to evaluate the effectiveness of HSEMS. The integrated audit technique is very important to evaluate the effectiveness of HSEMS.

Key Words: Integrated audit, SWOT analysis, integrated HSEMS, HSE performance indicators.

Introduction

Applications of standards on industrial development and trade especially in developing countries face challenges and opportunities (Wilson, 1999). If there is the drive to internationalize standards, the blurring of voluntary and mandatory can have important trade implications for developing countries. The researcher quotes the case of ISO 9000 series, the fastest growing international standard of all time. By certification a company is demonstrating that an internationally recognized system is in place which has been verified by an accredited agency. Standards are detailed specifications for performing certain activities (Boyle, 2002). Certification bodies check/ audit the extent to which the norms are followed and complied with in an organization and certify it. Certified System enables the management of any organization to show their commitment towards Quality (ISO 9001, 1996), Safety, Environment etc. Safety Management Systems include OHSAS 18001, a certifiable standard and BS 8800 which is not a certifiable standard (BS and OHSAS sources). ISO 9001 and ISO 14001 for Quality and Environment Management Systems are certifiable standards (ISO 14001, 1996).

In the last few years some efforts have been developed, in order to evaluate an integrated management system (IMS) – total quality approach .Costella et al., 2009, reported a methodology for assessing health and safety management system based on the three main auditing approaches – structural, operational and performance . The assessment of selected safety performance evaluation methods regarding their conceptual, methodological and practical

characteristics was proposed (Hale et al., 2010). Hence, assessing a management system performance is a critical task. Performance measurement has been defined as the process of quantifying the efficiency and effectiveness of an action.

Integration may be achieved by different ways (Wilkinson and Dale, 2000, Zutshi and Sohal 2005, Salomone, 2008 and Nee, 2009), concluded that quality, environmental and health and safety management systems could be integrated by merging documentation (aligned approach) or by implementing an IMS - total quality approach . This management systems integration reflects the chronological standards publication time (Okrapilov, 2010). This conclusion was also verified by Karapetrovic, 2003.

An organization could adopt three different integration strategies: augmentation, assimilation , ascension or add nothing (Karapetrovic, 2003 and Zeng et al., 2005). There are some techniques to help with the selection of proper strategies; one of the most known ones is the SWOT strategy. This is a tool which enhances the organization capabilities to set long term goals. SWOT (Strength, Weakness, Opportunities and Threats) is a tool for developing strategies which analyze organization opportunities, threats, internal strength points and weaknesses (Chang and Huang, 2006).

Aim of work

The aim of the work is to evaluate the effect of HSEMS integrated audit on the occupational health, safety and environmental protection performance level of some petrochemical companies.

Material and methods

- **Study Design:** A cross-sectional study was designed to identify the impacts of the integrated audit applying a standardized HSE management system audit technique on five petrochemical companies. Audit Plan was set up including all of the petrochemical organization activities during a specific time frame, addressing the key HSEMS elements in such organizations/ companies.
- **Place and duration of study:** the study was conducted on HSEMS of five petrochemicals companies at

Alexandria and Cairo, Egypt from January to December 2015.

- **Study sample:** The criteria used for the final selection were: the size of the organization in terms of number of employees, the minimum number of years of operation, the governmental share in operation, the ISO certification and the nature of business. A questionnaire sheets were distributed on the HSE managers at the five petrochemicals companies (No=165) for reply.

-Study methods:

A questionnaire was designed to cover 16 main elements (16 questions) covering all requirements of OHSAS 18001:2007 and ISO 14001:2004 that are related to the HSEMS. Each element is branched into some sub elements/ requirements. Each main elements and sub elements' questions were closed ones, (answers are YES or NO). A matrix of HSE performance indicators was designed to cover 11 types of indicators such as HSE meetings, job safety analysis and risk assessments, training against plan, number of training hours, medical treated cases, emergency drills, health checks, safety inspections, environmental inspections, tool box talks and number of corrective actions and was distributed on the HSE managers of the studied companies. Each company was asked to fill in the matrix sheet to record the actual figures for such performance indicators during 12 months.

-Scoring System:

The received answers were evaluated quantitatively by using a scoring system, for verifying the answers of the questionnaire. The findings of the audits were evaluated quantitatively. The scores were subjected to statistical analysis to detect the gaps in evaluating the HSEMS's efficiency and effectiveness in case of not doing the auditing process. The scale of the scoring system ranged from 0 to 100 points, where 100 points are allocated to every main single element so as to be measured. If a score of 100 is achieved, this means that the element's requirements are totally achieved/ satisfied and in compliance with the standards. For every main element, the scoring will be: up to 30 points, if suitable procedures are developed; up to 30 additional points if the procedures

are well-documented; up to 40 additional points if the procedures are properly implemented.

-A SWOT analysis: is a tool used for identifying and evaluating the various findings that are raised during the HSE integrated audit on the activities of the selected petrochemical companies. To categorize the findings raised from integrated audit according to the SWOT analysis technique, a range of HSEMS scores that represent the positive and negative results was identified as follows: Strength = 100 to 90, Opportunities = 89 to 80, Threats = 79 to70, Weakness = < 70.

Consent

Verbal consent from the study subjects to participate in the study was obtained before the start of work with assurance of confidentiality and anonymity of the data.

Ethical approval:

Approval of the administrative authority of the Company was obtained. Also, the study protocol was approved by Ethical Research Committee of Institute of Graduate Studies and Research, Alexandria University.

Data management

After data were collected, it was revised, coded and fed into the statistical software IBM SPSS version 20. The given graphs were constructed using Microsoft excel software. All statistical analysis was done using two tailed tests and alpha error of 0.05. P value less than or equal to 0.05 was considered to be statistically significant.

Results

HSE Audits were conducted on five petrochemical companies by using a checklist, the findings were evaluated quantitatively by the same scoring system to compare the score of 16 main elements before and after the integrated HSE Audits, the scores were subjected to statistical analysis to detect the gaps as showed in Table (1) and Figure (1).

Table (1): Descriptive analysis for HSEMS scores before and after integrated audit for each company.

Company Name	Phase				t (P)
	Before IA		After IA		
	HSEMS Score		HSEMS Score		
	Mean	SD	Mean	SD	
Company A	89.1	12.3	70.2	32.2	2.2 (0.038)*
Company B	100.0	0.0	81.7	14.3	5.1 (0.001)*
Company C	100.0	0.0	78.5	15.8	5.4 (0.001)*
Company D	80.5	12.8	68.5	19.3	2.1 (0.048)*
Company E	100.0	0.0	89.9	6.1	6.5 (0.001)*

*: Statistically significant. IA: integrated audit

Table I showed that the HSEMS score at Company A was 89.1±12.3 before the integrated audit and was reduced to 70.2 ±32.2 after the integrated audit; the difference was statistically significant at $P \leq 0.05$, using paired t-test. Similar results were obtained for the other companies.

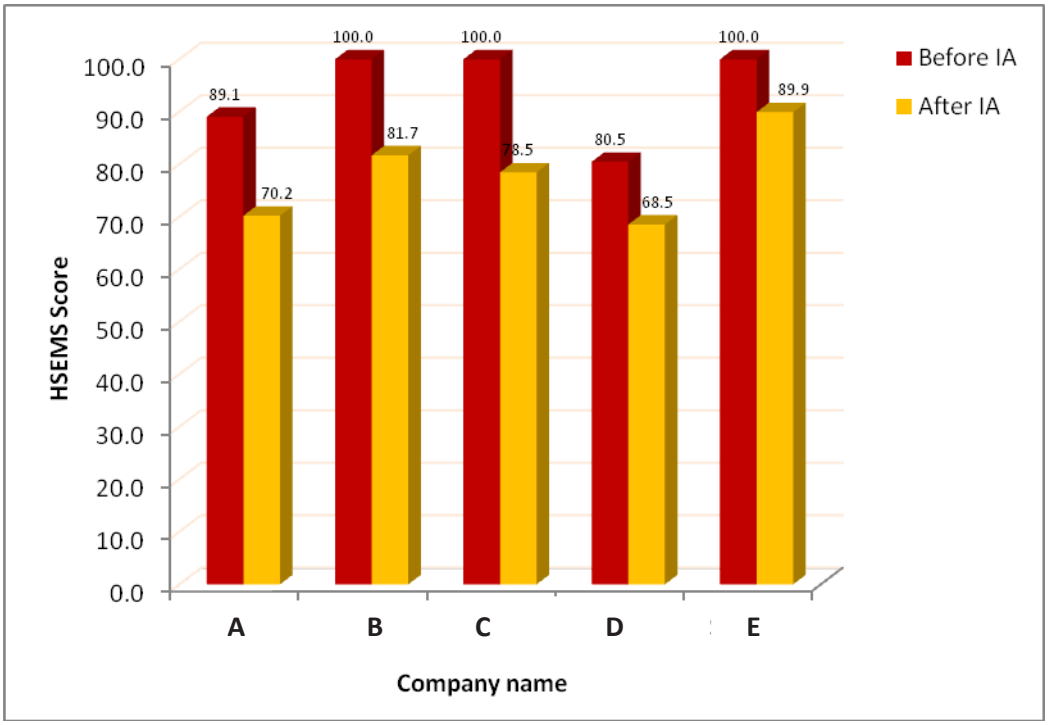

Figure (1): Mean values for HSEMS scores before and after integrated audit for each company.

The underlying analysis indicated that there were differences between the degree of evaluating the effectiveness and efficiency of the HSEMS before and after the integrated HSE audit by about 18.9% for company A; 18.3% for company B; 21.5% for Company C; 12.0% for Company D; and 10.1 % for Company E (Figure 1).

Table (2): Correlation matrix of HSE performance indicators for all companies.

Correlation Matrix												
	Indicators	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Correlation	**#1**	1.000	.131	.163	.117	.241	.432	.357	-.034-	.102	-.175-	.451
	#2	.131	1.000	.401	-.042-	.088	.313	.537	.295	-.214-	.571	.210
	#3	.163	.401	1.000	.149	.350	.172	.306	.010	-.194-	.155	.018
	#4	.117	-.042-	.149	1.000	.717	.021	.229	.042	-.092-	-.138-	-.004-
	#5	.241	.088	.350	.717	1.000	.144	.194	-.038-	-.030-	-.084-	.150
	#6	.432	.313	.172	.021	.144	1.000	.354	.026	.338	-.219-	.460
	#7	.357	.537	.306	.229	.194	.354	1.000	.145	-.070-	.246	.371
	#8	-.034-	.295	.010	.042	-.038-	.026	.145	1.000	.172	-.012-	.125
	#9	.102	-.214-	-.194-	-.092-	-.030-	.338	-.070-	.172	1.000	-.271-	.211
	#10	-.175-	.571	.155	-.138-	-.084-	-.219-	.246	-.012-	-.271-	1.000	-.215-
	#11	.451	.210	.018	-.004-	.150	.460	.371	.125	.211	-.215-	1.000

Indicators:#1- No of HSE Meetings; #2- No of JSA and Risk Assessment; #3 -Maintenance against plan; #4- No of Training hours; #5- Training against plan; #6 -No of Emergency Drills; #7- No of Site Safety inspections; #8- No of Health Checks; #9- No of Environmental Inspections; #10 -No of Toolbox Talks; #11- No of closed corrective actions

Factor analysis was used to discover the identity between HSE performance indicator mean scores for all the studied companies and the factors which were the most contributing to discrepancies. The analysis was done on the level of HSE performance indicators means for all companies during 12 months.

Table 2 showed the correlation matrix which was used to test the nature and strength of relation between two quantitative / ordinal variables (scores and performance). The spearman correlation coefficient (rho) is expressed as the Pearson coefficient. The sign of the coefficient indicates the nature of relation

(positive / negative) while the value indicates the strength of relation as follow: Weak correlation for rho is less than 0.25, intermediate correlation for rho is of value between 0.25-0.74 and strong correlation for values is between 0.75-0.99.

A good correlation was seen between indicators #1 (No. HSE meetings), and three other indicators as follows: #11 "No. of closed corrective actions", #6 "No. of Emergency Drills", and #7 "No. of Site Safety inspections". While indicator #2 "No. of JSA and Risk Assessment" has a good correlation with five indicators #3 "Maintenance against plan", #6 "No. of Emergency Drills", #7 "No. of Site Safety inspections", #8 "No. of Health Checks" and #10 "No. of Toolbox Talks". There was also a good correlation between indicator #3 "Maintenance against plan", and indicator #5 "Training against plan" also between #3 and #7. Indicator #4 "No. of Training hours" and #5 "Training against plan" have a good correlation. Also, indicator #6 "No. of Emergency Drills" has a good correlation with three indicators #7, #9, and #11. At the same time indicator #11 "No. of closed corrective actions" and indicator # 7 "No. of Site Safety inspections" have a good correlation.

Table (3): Kaiser-Meyer-Olkin and Bartlett test of sphericity for factor analysis correlation matrix for HSE performance indicators.

KMO and Bartlett›s Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.514
Bartlett›s Test of Sphericity	**Approx. Chi-Square**	218.202
	Df	55
	Sig.	0.000

Table 3 showed the Kaiser-Meyer-Olkin (KMO) to measure the sampling adequacy. The KMO is an index for comparing the magnitude of the observed correlation coefficients to the magnitude of the partial correlation coefficients. The closer the KMO measure to 1 indicate a sizeable sampling adequacy (0.8 and higher are great, 0.7 is acceptable, 0.6 is mediocre, less than 0.5 is unacceptable).

Reasonably large values are needed for a good factor analysis. Small KMO values indicate that a factor analysis of the variables may not be a good idea. KMO value was 0.514 and the large value of Chi-square (218.202) for Bartlett's test illustrates the adequacy of factor analysis for analyzing HSE performance indicators which was significant at $P \leq 0.05$.

Table (4): Principal component extraction for HSE performance indicators for all companies.

HSE Performance Indicators	Component				Eigen values
	1	2	3	4	
-No of Emergency Drills (#6)	.813				2.836
- No of closed corrective actions (#11)	.771				2.063
- No of HSE Meetings (#1)	.744				1.724
- No of JSA and Risk Assessment (#2)		.865			1.102
-No of Toolbox Talks (#10)		.768			.789
- No of Site Safety inspections (#7)		.592			.701
-Maintenance against plan (#3)		.540			.527
- No of Environmental Inspections (#9)		.578			.490
- No of Training hours (#4)			.919		.443
- Training against plan (#5)			.893		.183
- No of Health Checks (#8)				.918	.141
Extraction Method: Principal Component Analysis					

Table 4 showed the principal component extraction for HSE indicators. The primary objective of this stage is to determine the factors essential to the process. Initial decisions can be made here about the number of factors underlying a set of measured variables. In principal components analysis, linear combinations of the observed variables are formed. The 1st principal component is the combination that accounts for the largest amount of variance in the sample (1st extracted factor). The 2nd principle component accounts for the next largest amount of variance and is uncorrelated with the first (2nd extracted factor). Successive components explain progressively smaller portions of the total sample variance, and all are uncorrelated with each other. Eigen Values, and the Scree Plot are used to decide on how many factors can represent the data, with 2 statistical criteria: the determination of the number of factors is usually done by considering only factors with Eigen values greater than 1; and factors with a variance less than 1 are no better than a single variable, since each variable is expected to have a variance of 1.

The results categorized data into four clusters and revealed that the first extracted component was indicator #6 "No of Emergency Drills" in cluster 1, followed by indicator #11 "No of closed corrective actions" in cluster 1, indicator #1 "No of HSE Meetings" in cluster 1, indicator #2 "No of JSA and Risk Assessment" in cluster 2, indicator #10 "No of Toolbox Talks" in cluster 2, as illustrated by values of coefficients. Considering the Eigen values, the principal extracted HSE successive components were indictors #6 "No of Emergency Drills", #11 "No of closed corrective actions", #1 "No of HSE Meetings", and #2 "No of JSA and Risk Assessment".

A SWOT analysis technique: consist of four areas; Strengths, Weakness, Opportunity and Threats, by using SWOT analysis technique to evaluate the results of HSEMS scores after the integrated audit. The current results revealed that all companies have the followings:

Area of strength:

HSE management system was adequately documented, very good identification of the boundaries and

scope of operation for the HSEMS designed, adequate implementation of procedure for the internal audit of HSEMS and taken into consideration the frequency of the internal HSEMS audit at least one time per year.

Area of weakness:

Improper implementation of the procedure for HSE objectives and their management programs for example, there was no environmental objectives, improper implementation of the procedure for HSE training and awareness, for e.g. process accidents reports are not accurate and the investigation procedure is required to be performed by trained personnel for active involvement, lack of HSE consultation/ HSE information communication for e.g. no safety awareness conducting for the external contractors to be familiar with the hazardous areas in the site. The system for HSE records is weak whereas, there were no risk assessment documents for non-routine works in the site. The procedure for the regular review of the HSEMS by top management is not implemented and there is no management review minute to be distributed to concerned managers for signing.

Area of opportunities:

HSE policy needs to be communicated for all employees properly, identification of HSE responsibilities of all staff at all levels to be clarified, the procedure for the documentation of HSEMS need to be reviewed, low interest of employees is the main concern, emergency plan need to be approved by authority. The procedure for the measure and monitor HSE performance on regular basis need to be reviewed, layout of distribution of emergency equipment is recommended for each hazardous area. Objective evidences of compliance need to be reported in the checklists of legal compliance. Area of threats:

Identifying the environmental impact, aspects and risk of the activities need to be improved, because missing some aspects or risk of activates may lead to accidents, inadequate implementation of procedure of HSE operational control for ex., no calibration certificates or testing for lifting equipment, no warning labels or MSDS on the stored chemical materials containers and environmental instructions to follow in

case of emergency are not demonstrated around site, frequency of accident statistics need to be reviewed, which is considered as lessons learned to prevent the reoccurrence of accidents again.

Discussion

The underlying study was designed to identify the impacts of integrated audit on the HSE management system for five petrochemical companies. Audit plan has been performed and included all organization activities during specific time frame. The study indicated that the integrated audit technique assessed the effectiveness of HSEMS elements through quantitative measurement of the results and showed that there was a difference between the perceived performance indicators by workers and the results of integrated audit. Using a parametric statistical test (Paired t-test) to compare the mean scores for the sixteen elements of the pre designed questionnaire for all companies before and after the integrated audit revealed that there was significant gap for the elements of HSE management system.

Continuous improvement is not only driven by customer expectations but also by priorities and objectives generated internally by the organization. Both standards (ISO 14001and 9001) have the same fundamental systems like documentation control, management system auditing, operation control, audits, corrective and preventive actions are process driven. Research studies (Riemann and Sharratt et al., 1995, Hillary et al., 1997 and Ahmed, 2002,) showed increasing interest by companies towards integration. Implementation of BS 8800 can be concurrent to EMS Standard ISO 14001, and as such identifies the common areas in both management systems for reducing risk. Craddock et al., 1997, and Jarvis et al., 1997, emphasized the importance of continuous improvement in health and safety management systems, but Pooke et al., 1997, did not include continuous improvement, or the measurement of performance, in the list of the essential minimum requirements of an OH and SMS. OHSAS 18001 and BS 8800 indicate the guidelines to integrate the management system with ISO 14001 and BS 8800. It was evident from the current results that the importance of the integrated audit for verifying HSEMS effectiveness, which was in agreement with the study

by Sonja et al., 2013, in Sweden, where the findings showed that the majority (80%) of selected companies are used to a form of the integrated management system and only 12% use EMS. The results indicated that the companies are moving away from the single issue management systems towards the integrated management systems.

Results of integrated audit (Table 1) and factor analysis (Table 4) put emphasis on the role of regulatory compliance in integrating management systems for better system improvement, as was documented by Waite et al., 1997, that recognition of the role that regulatory compliance, environmental protection, health, safety and quality assurance programs play in managing critical risks and make it desirable to integrate these programs with other business management processes. Dealing with separate management systems covering quality, environment and safety issues to ensure that they align with the organization's business strategy can be problematic and IMS is increasingly seen as part of the management portfolio of many organizations. System integration can be achieved in a number of ways and at different levels. In practice all management systems (QMS, EMS, OSHMS, and RMS) are mutually coordinated systems functioning almost independently. Integration enables synergetic effect and optimum workplace performance on all aspects of Safety, Health, Environment and Quality (Corbett and Cutler, 2000). QMS aims at the efficiency of the production process and continuous improvement to meet customer requirements. ISO 14001 also aims to achieve customer requirements but customer is a broad term and includes regulatory, mandatory, governmental authorities etc. Continuous improvement is not only driven by customer expectations but also by priorities and objectives generated internally by the organization. Both standards have the same fundamental systems like documentation control, management system auditing, operation control, and audits, corrective and preventive actions and are process driven (Downs, 2003).

A company needs to develop a core framework for the management of SHE issues that are required to be

implemented across all its operations as part of the drive for excellence in management. The underlying results illustrated the value of integrated audit (Table 1) in improving safety performance which was in agreement with results of other studies (Riemann & Sharratt, 1995, and Hillary, 1997, Salomone, 2008, Hale et al., 2010 and Gillen et al., 2013).

The chemical industry has produced guidance on joint Occupational Health and Safety Management Systems (OHSMS) and Environmental Management Systems (EMS) and a number of organizations have now started to move down to this integration path. Research studies showed increasing interest by companies towards integration. Implementation of BS 8800 can be concurrent to EMS Standard ISO 14001, and as such identifies the common areas in both management systems for reducing risk (Riemann and Sharratt, 1995, and Hillary, 1997, Salomone, 2008, Gillen et al., 2013). According to Hale et al., 2010, however, this potential for comparison/benchmarking within or between organizations is rather limited; the measured safety climate appears to be a strong predictor for safety performance, which makes it a very appealing construct for researchers, managers and OSH professionals.

Conclusion and Recommendations

Although the performance of health, safety and environment at selected petrochemicals companies seems to be at a high level but the underlined study puts a spot on some weaknesses and threats that adversely affect the efficiency of their HSEMS. Also, it was shown that, HSE performance indicators are not enough to evaluate the effectiveness of HSEMS. The integrated audit technique is very important to evaluate the effectiveness of the HSEMS. A suitable scoring system is a good measure to quantify the results of an audit, converting them into scores which can be used to compare the systems effectiveness evaluation through the integrated audit. The results of the current study put emphasis on integrated audit as a useful tool to improve level of compliance of HSEMS with requirements of ISO 14001 and OHSAS 18001 standards, to support decision makers and to enhance

HSE performance. Thus, the underlying tools are recommended to be applicable within companies to strengthen HSE performance and alleviate processing gaps.

Conflict of interest

Authors have declared that no conflict of interests exists.

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