Increase the Performance of Power Station: Results and Analysis of an Empirical Study of the ISO 50001 Energy Management Systems in the Iraqi Ministry of Electricity

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Abstract: The energy management, according to ISO 50001 can lead to establishing of green engineering in the industries including production energy.
The main purpose of this paper is to investigate and explore the standard ISO 50001 that specializes in the field of energy management.
This study has included aspects of ISO 50001 in the ministry of electricity of Iraq by the survey and distributing the questionnaires to the respondents. This research presents the results of over 163 responders, including 13 managers and over 150 engineers who have the decision to adopt ISO 50001 in the power station at the ministry of electricity of Iraq.
This paper has been used two types of tools SPSS software the first type was a parametric test like the correlations, mean, standard deviation, regression analysis, histograms and P–P plot. But the second type of test was non-parametric tests like Mann-Whitney U test and Kruskal-Wallis H test.
Results presented that 95.1 % of respondents believe that the implementation of the ISO 50001 led increase the efficiency of energy production in the power station while 2.5 % said the difficulty of it.
This study showed 93.9 % of respondents they said that the implementation of the requirements of ISO 50001 in the power station easy. Conversely, that 1.2 % of respondents disagreed that. 50.9 % of respondents said steps the adoption of ISO 50001 is expensive, contrast 47.3 % of respondents said not expensive.
Keywords: ISO 50001; Power station; Continual Improvement; Performance; SPSS.

1. Introduction

In the few last years, the power sector in Iraq has witnessed large motivations to go to implementation energy management system standards. The one that is the most popular standard is the ISO 50001 Energy management systems [1].
The standard ISO 50001 identifies the requirements for maintaining, implementing, and adoption, establishing and improving an energy management system [2].The standard ISO 50001 aims to enable an organization to follow a systematic energy to ensure continual improvement in sector energy performance, as well as it helps the organizations to reduce the energy use and reduce the energy costs [3].
The author has researched the practices of ISO 50001 in the sectors of product energy in the power station in Iraq, a decision was made to take a step further and then get on the certified of ISO 50001.
The main objective of this paper to establish a set of sustainable energy management concepts, adoption ISO 50001 Energy Management Standard in the power station in Iraq. The second objective of this paper analyzes the general efficiency of energy in the power station in Iraq.
Main purpose of this questionnaire was to specify the pivotal elements that effect on the energy efficiency. The data were collected by

(DOI: dx.doi.org/14.9831/1444-8939.2016/4-2/MRR.10)

the survey at the power station in the Iraqi Ministry of Electricity. The data have been analysis by using the statistical software package SPSS.

This paper will check in the many hypotheses that have relation with improving energy. Using correlation, regression, histogram, Mann-Whitney U test and Kruskal-Wallis H test in SPSS.

2. Methodology

This research took about 5 months to finish collecting data from the power station in Iraq. The data of survey, including (managers and engineers who have a decision about adoption to standards ISO 50001 in their power station.

The research process requires a sequence of steps that has been used as shown in Figure 1.

The questionnaire was distributed to respondents in the power station, and the questionnaire has been designed according to the objectives of the study.

The questionnaire was divided into three sections:

(1) Section A: (demographic profile).

(2) Section B: (explained the reasons applying the standard ISO 50001).

(3) Section C: this section includes Independent variable Cost Reduction, Quality Improvement, Organization Environment Performance, Economic Sustainability, Energy Reduction and dependent variable (Adoption ISO 50001).

The questionnaire has been distributed to 163 samples, including Managers and engineers as shown in figure 2.

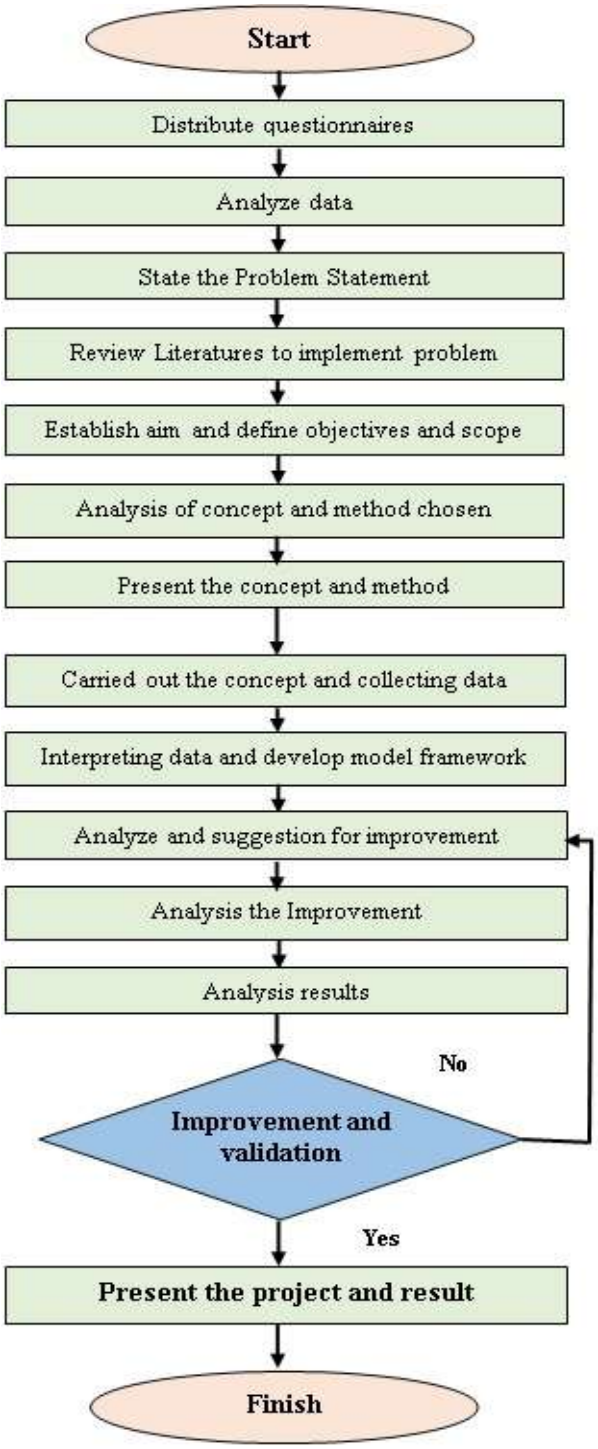

Fig.1. Steps methodology details

(DOI: dx.doi.org/14.9831/1444-8939.2016/4-2/MRR.10)

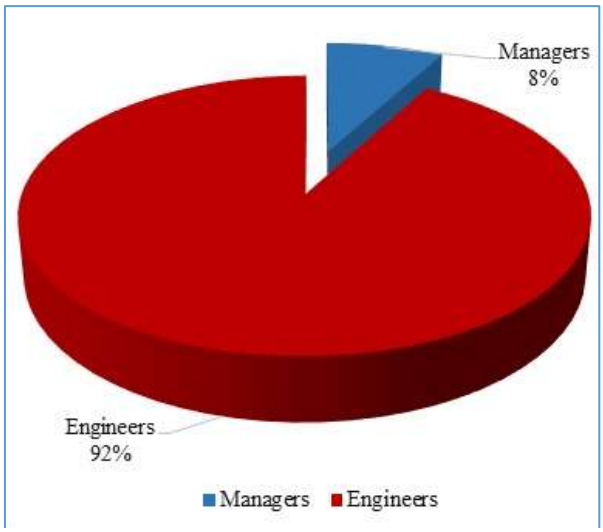

Fig.2. Population of study

3. Research Results and Discussion

3.1 Demographic Characteristics.

The survey of the demographic Included 163 of respondents who are directly responsible for maintaining the quality management systems including 83% of respondents is male and 17% female as shows in table 1.

Table 1. Gender for Participants

Gender	Percent
Male	83%
Female	17%
Total	100%

The age range of respondents un the demographic characteristics was from 35 to 44 years as shown in table 2.

Table 2. Age for Participants

Age	Percent
25–34 years of age	20.9 %
35–44 years of age	65 %
45–54 years of age	9.8 %
55–64 years of age	4.3 %
Total	100 %

The survey included also current employment for the respondents in the power station.
From the results of this survey the largest proportion of the respondents were from the category of engineers by 92% and followed by the category of managers by 8% as a shown in figure 3.

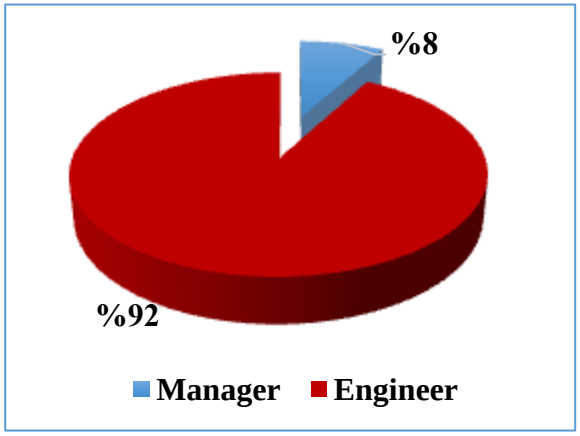

Fig.3. Current Employment

The survey also covered the total cost of the adoption of ISO 50001, the results showed 50.9 % of respondents they confirmed that the implementation of the requirements of ISO 50001 is the high cost. But 47.3 % said the

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adoption ISO 50001 is no expensive compared with the benefit of their application as a shown in table 3.

Table 3. Cost of ISO 50001

Index	Percentage
Yes	50.9 %
No	47.3 %
I don't Know	1.8 %
Total	100 %

3.2 Results of Correlations and Standard Deviation

The correlation coefficient can be defined as a quantitative measure of the kind of correlation and used to examine the statistical relationships between two or more random variables [4].

To check the measure correlation to any two or more random variables the values expected under the model in the correlation coefficient has to be between –1.0 and 1.0 [5]. The results of correlation between dependent and independent variables have been clarified in table 4.

To get the ideal results we must be able to identify "perfectly"(P), the values of P groups can be helpful through using the asterisk system and P value [6]. As it is shown below as:-

P < 0.05 * The significant 95 %
P < 0.01 ** The significant 98%
P < 0.001*** The significant 99%

From table 4. Can see the results of correlation for dependent and independent variables as a show:-

1) The significant of confident between ISO 50001 and Cost Reduction 98% at 0.342**.

2) The significant of confident between ISO 50001 and Quality Improvement 98% at 0.779**.

3) The significant of confident between ISO 50001 and Organization Environmental Performance 98% at 0.380**.

4) The significant of confident between ISO 50001 and Energy Reduction 98% at 0.541**.

Table 4. Results of Correlation between Dependent and Independent variables

	Mean	Std. Deviation	CR	QI	OEP	ES	ER	ISO 50001
CR	3.1376	0.69187	1					
QI	2.6976	0.81671	0.225**	1				
OEP	2.3304	0.55066	0.099	0.060	1			
ES	2.5620	0.77350	0.172*	0.794**	0.055	1		
ER	3.3415	0.61859	0.402**	0.166*	0.277**	0.145	1	
ISO 50001	2.3808	0.43252	0.342**	0.779**	0.380**	0.605**	0.541**	1

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3.3 Test Hypotheses by Regression Analysis

Regression testing is considered one of the most important tests in statistics comes after regression testing. And it is used when we want to know the value of a variable to another variable like a dependent variable to independent variable [7].

1) H1. The first Regression Analysis between the reduction of cost (RC) and implementation of ISO 50001 the proven results the confident level between the dependent variable and independent variables is 99% at (0.342, $p < 0.001$). That mean Implementation of ISO 50001 at the power station leads to reduce the costs of production and consumption of energy as shown in table 5.

2) H2. The second Regression Analysis between the improvement of quality (IQ) and implementation of ISO 50001 the proven results the confident level between the dependent variable and independent variables is 99% at (0.779, $p < 0.001$). That mean Implementation of ISO 50001 at the power station leads to improvement of quality in the power station as shown in table 6.

3) H3. Third Regression Analysis between the performance of environmental (PE) and implementation of ISO 50001 the proven results the confident level between the dependent variable and independent variables is 99% at (0.380, $p < 0.001$). That mean Implementation of ISO 50001 at the power station leads to improve the performance environmental as shown in table 7.

4) H4. The fourth Regression Analysis between the sustainability economic (ES) and implementation of ISO 50001 the proven results the confident level between the dependent variable and independent variables is 99% at (0.605, $p < 0.001$). That mean Implementation of ISO 50001 at the power station leads to create the sustainability economic as shown in table 8.

Table.5 Results of analysis RC & D.V

M	**R**	**R^2**	**ΔR^2**	**Std. E**	**Change**				
					R^2	Δ F	df1	df2	Sig
1	**.342**	**.117**	**.112**	**.40762**	.117	21.38	1	161	.000

5) H5. The fifth Regression Analysis between the reduction of energy (RE) and implementation of ISO 50001 the proven results the confident level between the dependent variable and independent variables is 99% at (0.541, $p < 0.001$). That mean Implementation of ISO 50001 at the

power station leads to a reduction of the consumption energy as shown in table 9.

Table.6 Results of analysis IQ & D.V

M	R	R^2	∆ R^2	Std. Error	Change Statistics				
					R^2	∆ Change	df	df2	Sig
2	**0.779**	**0.606**	**0.604**	**0.2722**	0.606	248.019	1	161	.000

Table.7 Results of analysis PE & D.V

M	R	R^2	∆ R^2	Std. Error	Change Statistics				
					R^2	∆ Change	df	df2	Sig
3	**0.380**	**0.145**	**0.139**	**0.4012**	0.145	27.23	1	161	.000

Table.8 Results of analysis SE & D.V

M	R	R^2	∆ R^2	Std. Error	Change Statistics				
					R^2	∆ Change	df	df2	Sig
4	**0.605**	**0.366**	**0.362**	**0.34**	0.366	92.840	1	161	.000

Table.9 Results of analysis RE & D.V

M	R	R^2	∆ R^2	Std. Error	Change Statistics				
					R^2	∆ Change	df	df2	Sig
5	**0.541**	**0.292**	**0.288**	**0.36**	0.292	66.55	1	161	.000

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3.4 Results of Histogram for Variables

According to the results extracted from all variables we can see that the distributions of histograms have a normal curve, this means all the data are normal, the histograms distribution has been represented first by Karl Pearson [8]. As it is shown in the following figures:

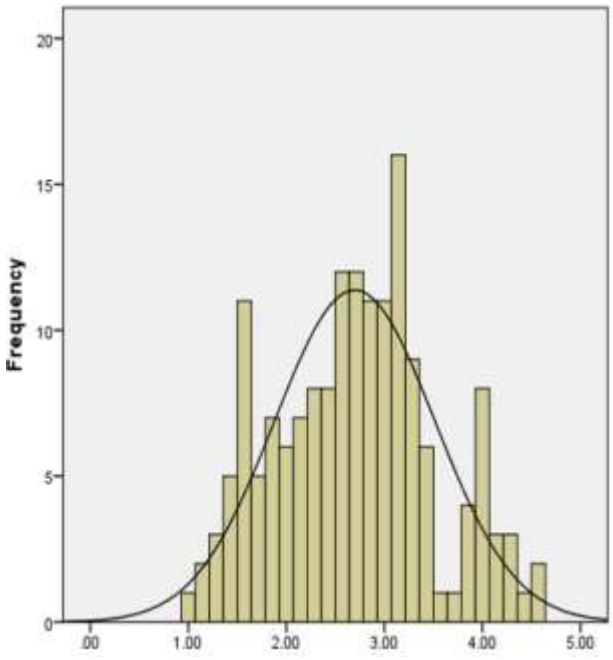


Fig.4. RC Histogram

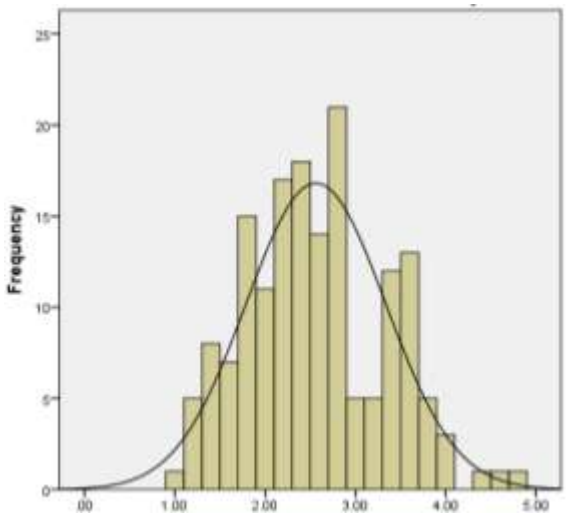


Fig.5. IQ Histogram

Fig.6. EOP Histogram

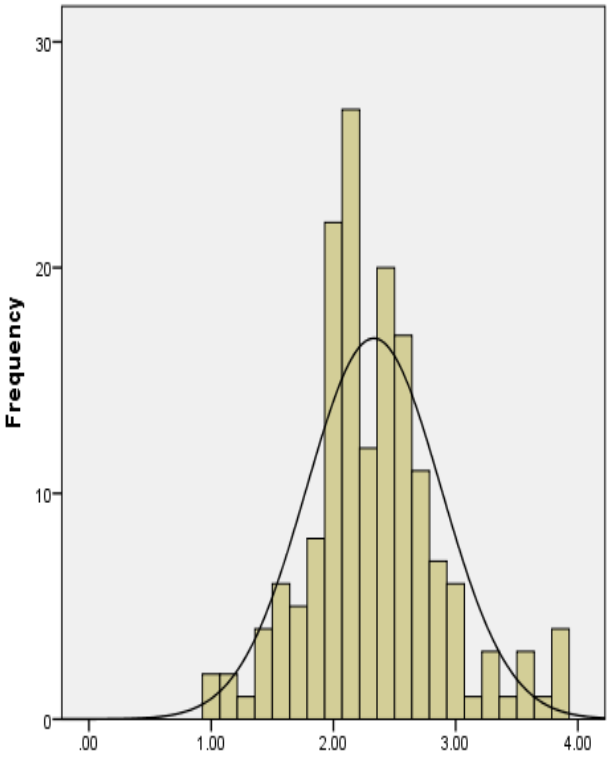
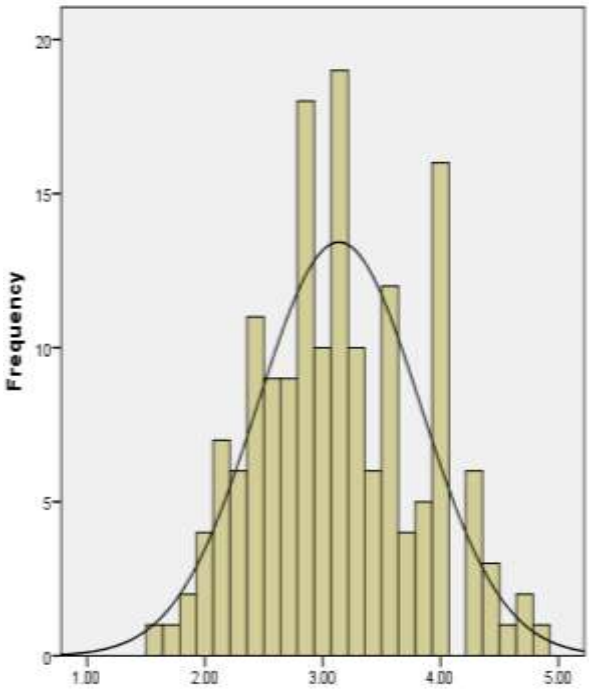


Fig.7. SE Histogram



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