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Investigating the relationships between Energy management system (EMS) based on EN16001:2009 implementation andefficiency

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ABSTRACT

This paper want to clarify the importance and reflex of energy management and the cost of it and their parameters on system survival regarding Jyoti Prasad Painuly (2009) Improving energy efficiency is considered one of the most desirable and effective short-term measures to address the issue of energy security, and also reduce the emission of greenhouse gases. However in final cost of factories products energy cost has its slice.Analysis of questionnaires with SPSS 18 shows that implementing energy management base on EN16001:2009 contributes positively to the organization survival and final cost of products.

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INTRODUCTION

Several organizations have goals regarding renewable energy use. For example, the federal government has a goal of 7.5% renewable energy for its facilities. Green-building rating systems set percentage goals such as 2.5%, 7.5% and 12.5%. Further, some organizations set the goal of “net zero” utility energy use for a facility (100% renewable). This analysis examines how to meet the goal, whatever it is, while minimizing life-cycle cost. Organizations that operate a lot of real property need a structured, credible, but affordable method of identifying and prioritizing renewable energy projects prior to detailed evaluation.(Tom Halfman 2011) A convenience food manufacturer, a major brewer, a small town in Kansas, a Navy base on an island, and the National Zoo have all asked NREL to help them determine how to meet their renewable energy goals at minimum life-cycle cost.(Andy Morgan 2010) It is important to acknowledge that energy efficiency measures are prerequisite to renewable energy measures. In this analysis we size renewable energy systems to meet the specified load, assuming that cost effective efficiency measures have already been taken(Andy walker 2008) Effective environmental management is one of the most complex challenges facing management. There are high levels of technical, regulatory and market uncertainty as well as many stakeholders and complex issues to address. It is implied that companies dealing well with this high level of complexity have the sophistication to succeed in other parts of the business and thereby earn superior returns. Energy management is an important aspect of environmental performance which also poses a complex challenge to management. As a result, it is likely that energy management performance is also a strong indicator of management quality and stock market potential. (Yang *et al*., 2005)

The I.S. EN 16001:2009 Energy Management Systems Standard was developed to ensure that energy management becomes integrated into organizational business structures, so that organizations save energy, save costs and improve energy and business performance. However, in itself, the standard does not establish absolute requirements for energy performance nor does it guarantee optimal energy outcomes. (EN 16001)

I.S. EN 16001:2009 is structured and based on existing management standards such as ISO 9001 and ISO 14001. It also includes guidance on the use of the standard which primarily has its focus on the Management systems aspects. (Karapetrovic, S., & W. Willborn, 1998)

The reminder of the paper is structured as follow. Section 2 presents literature review of QMS and EN 16001. In section 3, research hypotheses are presented. Section 4 analyses the data of case study. Finally, in section 5 conclusion and future studies are developed.

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Literature review:

Energy management system , EN 16001:

I.S. EN 16001:2009 is structured and based on existing management standards such as ISO 9001 and ISO14001. It also includes guidance on the use of the standard which primarily has its focus on the management systems aspects. In recognition of the significant technical component necessary to maximize the benefits of I.S. EN16001:2009, Sustainable Energy Ireland (SEI) has, in consultation with relevant stakeholders, developed this technical guideline. (Hoyle, D., 1998)

This guideline identifies technical stages and processes of an energy management system. It provides a range of possible methodologies and approaches which could be used in both satisfying the standard and ensuring the development and operation of an effective and documented Energy Management System. (Michael Bell, Vincent Omachonu, 2011).

The aim of the standard is to put practices in place that are effective, and result in measurable energy Savings. In practice, an effective energy management system should result in:

• Organizations taking action to improve energy efficiency,

• A continual improvement year-by-year and an improved performance in energy usage,

• More thorough analysis of areas with potential for energy saving being carried out, if no action on energy efficiency is being taken.

Activities related to the technical stages and processes of the system include:

• It is essential to develop an understanding – primarily through data collection – of energy use and the factors that drive it.

• The organization should demonstrate an understanding of the energy requirements for significant energy users.

• In setting objectives and targets, the use of energy performance indicators (EPIs) at both management and operational levels is a key activity.

• A register of energy saving opportunities should be established, prioritized and fed into the energy management program.

• With EPIs in place, information obtained from monitoring and measuring energy usage can beused to review and modify the system.

• The management review ensures that top management are responsible for assessing overall performance and recommending changes. (Christos Fotopoulos,*et al*., 2011)

The management system provided for in I.S. EN 16001:2009 and associated guidance, should be considered as a support tool to assist implementation of energy management and cost reducing program. This technical guideline outlines methods of how to establish, operate and maintain these program.(Leonardo, A. SedevichFons, 2011).

Continues improvement:

Continuous improvement is an ongoing effort to improve products, services or processes. These efforts can seek “incremental” improvement over time or “breakthrough” improvement all at once. (Andrea Chiarini, 2011).

Among the most widely used tools for continuous improvement is a four-step quality model—the plan-do-check-act (PDCA) cycle, also known as Deming Cycle or Shewhart Cycle:

Plan: Identify an opportunity and plan for change.

Do: Implement the change on a small scale.

Check: Use data to analyze the results of the change and determine whether it made a difference.

Act: If the change was successful, implement it on a wider scale and continuously assess your results. If the change did not work, begin the cycle again. Other widely used methods of continuous improvement — such as Six Sigma, Lean, and Total Quality Management — emphasize employee involvement and teamwork; measuring and systematizing processes; and reducing variation, defects and cycle times. (Barry, L.M. Mak, 2011).

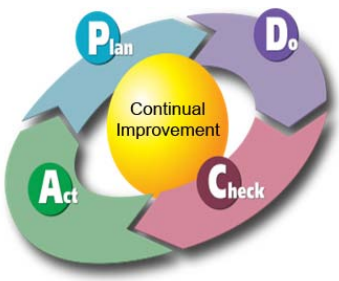

Fig. 1: continual improvement cycle

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Efficiency:

Energy efficiency is simply the process of doing more with less. The goal is to accomplish the same tasks and functions as before while using less energy.

From the building perspective, it is usually best to approach energy efficiency measures according to the appropriate site or building system. In addition, the greatest savings and performance are obtained through an integrated design process (particularly for new construction). Common areas of focus include:

- Site planning, landscaping &hardscaping
- Building envelope/shell (foundation, walls, and roof)
- Mechanical (HVAC&R, water heating, pumping)
- Electrical (motors, transformers, etc.)
- Lighting
- Appliances
- Office equipment & plug loads

Further, for those projects that are considering the use of self-generation to cover all or a portion of the thermal and/or electrical loads of the home or business, it is always advised that the facility be made as efficient as possible prior to sizing and procurement of the self-generation system (Iñaki Heras, 2011).

Projects should not only "meet" all applicable energy codes, but "exceed" them by using higher efficient systems or incorporate additional measures. Likewise, the owner and design team should consider related green building techniques and sustainability best practices to optimize the total energy and environmental life-cycle impacts of the project. (Abdullah, M.S.*et al*., 2011)

Of particular importance is the opportunity to "do it right the first time" where it is difficult or economically prohibitive to alter the structure after it is constructed and occupied. (Avinash Kumar Srivastav, 2011)

Typical Energy Savings by End-Use for Residential Include:

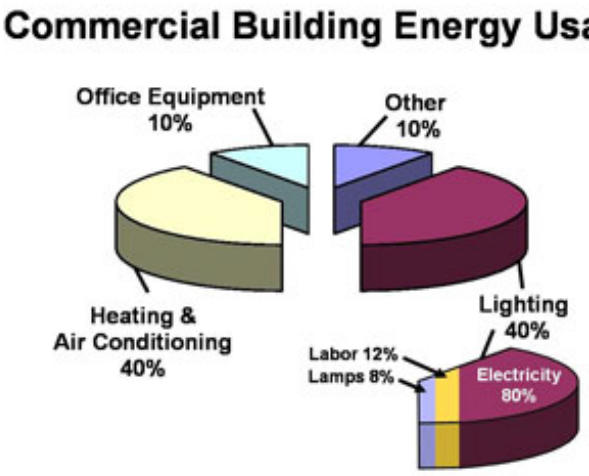

Fig. 2: commercial usage

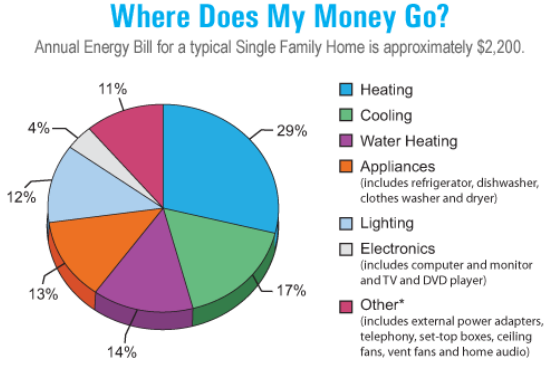

Fig. 3: economy of energy

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Case study:

Gathering information is the most important factors of any research. For studying the relationship between variables, 38 Questionnaires were sent to 35 company that received EN 16001 certificate from a valid certificate body (CB). The goal of this questionnaire is "measuring the impact of EN 16001 on Efficiency". Choices of questions are of Likert continuum. Regarding 1 to 5 scores, 1 is strongly week and 5 means strongly high.

Research hypotheses and research methodology:

After collecting questionnaires from companies, we have used SPSS 18 for finding relationships between efficiency and independent variables.

Here, dependent variable is the organizational survival that managers think their organization can reach and independent variables are Energy planning, Employee training, Energy measuring, Age of facility, Environment factors.

So, research hypotheses are as follow.

H1- Energy analysis has a positive and direct relation with efficiency.

H2- Employee training has a positive and direct relation with efficiency.

H3-Energy measuring has a positive and direct relation with efficiency.

H4-Age of facility has positive and direct relation with efficiency.

H5-Environmental factors have positive and direct relation with efficiency.

For testing hypotheses, this paper has used Pearson's correlation coefficient. For predicting efficiency of any organization, in this paper we have developed a regression model.

Data analysis:

Pearson's correlation coefficient for the relationship between efficiency and independent variables are shown in table 1.

Table 1: Pearson's correlation coefficient between variables

		Energy Analysis	training	measuring	Facility Age	Environmental Factor
efficiency	Pearson Correlation	.827**	.797**	.860**	.770**	.804**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	35	35	35	35	35

**Correlation is significant at 0.01 level (2-tailled)

Pearson's correlation coefficients show that energy analysis, employee training , measuring, facility age and environmental factors have a direct and positive relation with system survival and Because the SIG value for each correlation is less than 0.05, then this correlation is statistically meaningful. Thus all of 5 hypotheses are justified at 0.99 confidence level. That is we find that:

- Energy analysis has a positive and direct relation with efficiency.
- Employee training has a positive and direct relation with efficiency.
- Energy measuring has a positive and direct relation with efficiency.
- Age of facility have positive and direct relation with efficiency.
- Environmental factors have positive and direct relation with efficiency.

For developing regression equation for predicting efficiency score, we have used SPSS 18. The results are as table 4.

Table 2: Model summery

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.950	.902	.885	4.02306

Predictors: (Constant), environmental Factor, facility Age, measuring, training, energy Analysis

Table 3:ANOVAb

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4328.805	5	865.761	53.491	.000[a]
	Residual	469.366	29	16.185		
	Total	4798.171	34			

a. Predictors: (Constant), environmental Factor, facility Age, measuring, training, energy Analysis
b. dependent Variable: efficiency

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Table 4: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	31.384	2.935		10.695	.000
	Energy Analysis	.754	.958	.092	.787	.438
	training	1.359	.868	.153	1.565	.128
	measuring	3.568	.892	.384	4.001	.000
	Facility Age	2.531	.869	.249	2.913	.007
	Environmental Factor	2.745	1.225	.227	2.241	.033
a. Dependent Variable: efficiency						

Regarding significance level of independent variables show that all variables can be included in regression model because their SIG is less than 0.05. Energy analysis, employee training, measuring, facility age and environmental factor have direct and positive impact on organizational efficiency because their B-coefficient are positive.

Efficiency = 31.384 + 0.754 energy analysis + 1.359 training + 3.568 measuring + 2.531 facility age + 2.745 environmental factor

This equation shows that albeit correlation between energy analysis and efficiency and also between training and efficiency is significant, but their effect on efficiency is not significant when all variables are considered altogether.

Conclusion:

EN 16001 is a useful tool for managers to have more control on specific parameters that can have direct reflex on efficiency in different fields. In this research 5 effective factors on system survival and efficiency are energy analysis, employee training, measuring, facility age and environmental factors.

These factors were studied Pearson's correlation coefficients show that energy analysis, employee training, measuring, facility age and environmental

factors have a direct and positive relation with system survival. Finally, a regression model developed for forecasting efficiency and system survival. For future studies it is recommended that consider ISO 50001 implementation in organization.

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