

The Study of Motivation in Energy Conservation Participation: Case Study of Sheet Metal Forming Factory

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Abstract

The most important factor affecting energy conservation is people knowing the importance and adapt their behavior in energy consumption. This research focuses on studying motivation towards participation in energy conservation which was separated into two parts, including 1) setting policies for energy conservation by mainly focusing on changing or modifying machineries and equipments to reduce energy consumption in manufacturing area; 2) study the motivation towards participation of employees in manufacturing company about energy conservation. This phase was distributed into 2 main procedures including, 1) employees' training related to energy conservation and how can they reduce energy consumption; and 2) policies for every employee to follow to reduce energy consumption in organization. Thus, each procedure took 3 months for observation and evaluation. In the second procedure, there was a reward for the department that could reduce highest amount of energy consumption. The participation of employees concerning about energy conservation helped reducing energy consumption in the organization. Rewards are the main motivation increasing employees' participation to follow energy conservation policies. In the last month before reward had announced, the amount of Energy Use Index was 0.009906 MJ/Baht which was the lowest number throughout the research time, however; the number of sales were higher than the average of production with the percentage of 17.24. This showed that a reward for participation in energy conservation is an efficient motivation for employees.

Keywords: *Energy Conservation, Motivation, Participation, Energy Use Index.*

1. Introduction

In each year, everywhere in the world has policies related to energy conservation. Mostly, organizations use technologies as the solution for energy conservation. However, it might not be effective enough as humans

behavior are still the same in terms of energy consumption. Therefore, if humans or employees in organization has not changed or adapted themselves to help reducing energy consumption, there would be no way to increase the efficiency of energy conservation in the organization. Therefore, Siam Industry and Manufacturing Company Limited considered procedures for increasing energy conservation as well as reducing energy consumption in terms of electricity, for example, setting the machineries to have high efficiency, setting variable speed drive to motor or VSD, and decrease wind pressure in high air pressure area in order to have high efficiency of energy consumption in manufacturing area. The decrement of electricity cost can be changed into oil energy cost (ktoe) in order to decrease amount of oil imports, decrease energy costs, and decrease the loss of faults of energy consumptions. Also, to study the motivation of reducing energy consumption in organization so the employees concern about energy conservation and adapting their behavior towards energy consumption in daily lives, home, offices, and others.

2. Research Background

There are many procedures for energy conservation and regulations for reducing energy consumption in factories, for example, regulations of using machineries and equipments for highest performance, and regulations for changing equipments for higher efficiency in order to use energy efficiently for both machineries and equipments in factories which leads to reducing energy cost and energy loss. Therefore, to build up motivation for increasing energy conservation in factory is another factor to change human's behavior towards energy consumption, so people

will consider more when using any electricity, no matter at homes, offices, or others.

There are two principles related to motivation including:

- 1) Hebb's Concepts[1] focused on biological theories of humans where they would like to search for attractions which can be environmental factors around them. This should cause motivation within those people.
- 2) Zajonce's Concepts[2] stated that people with ambition and behave to reach their ambitions, beliefs, thoughts, and self-value

The sample manufacturer used for case study was introduced in the year 1970. This manufacturer produces sheet metals forming. There are 190 employees in manufacturing area with 3 shifts a day. The electrical energy used was 825,000.00 kWh/year [3] which leads to high cost of electricity. Therefore, Siam Industry and Manufacturing Company Limited searched for procedures for energy conservation and reducing energy consumption in manufacturing area in order to increase efficiency of electricity usage in the organization, including machineries and equipments, as well as reducing cost of electricity. Moreover, the organization had a plan to build motivation towards participating in energy conservation, so employees can follow the instructions and help reducing electrical usage in the organization.

3. Experimental Procedure

In order to analyze problem and find solutions for reducing electricity usage in Siam Industry and Manufacturing Company Limited, the researcher had observed and analyzed the daily electricity usage in the organization by considering last 12 months usage from the company's records. These records stated the amount of electricity used and energy cost as well as efficiency in process improvement. Also, the researcher looked through the information related to building motivation for employees to reduce energy consumption in the offices.

For the first part of the research, the observation of machineries and production methods in the manufacturing area to record the ratio of energy used. However, air compressor system and producing machineries used high energy consumption. There are two air compressor machines; the second air compressor had the ratio of energy consumption of 31.30 percent. The stabilizer had ratio of using energy consumption of 23.06 percent. The reduction of energy use can be modified or processed to reduce the energy consumption for production. Therefore, the research focused on air compressor which had the highest ratio of energy consumption. However, stabilizer

cannot be used in the research as it would affect the production. So, the researcher came up with 6 principles for energy conservation including:

- 1) Use air compressor in highest efficiency mode
- 2) Setting the temperature in injection room appropriately (increase the temperature at the air conditioning in the room)
- 3) Use blower instead of air form compressor and paint sprayer
- 4) Change air compressor in laser cutting machine to be inverter air compressor
- 5) Change fluorescent bulb (FL) to LED bulb
- 6) Setting Variable Speed Drive (VSD) to control the pump

The process in the second part of the research is to study the factor affecting motivation towards participation in energy conservation. Therefore, Siam Industry and Manufacturing Company Limited chose to give rewards to the department that use less energy consumption. The first process was to organize training to every level of employees in the organization so they have knowledge about energy conservation and how to easily reduce energy consumption in the organization. The first three months of the experiment, there was no announcement about the reward, but the organization already organized the training to all employees in order to see whether they have any motivation to reduce energy consumption or not. After three months, the research recorded the amount of energy consumption in each department to see the results of whether employees had any participation in energy conservation or not. After that, the organization announced about the rewards for the department with the lowest amount of energy consumption within three months in order to see whether the rewards can motivate employees to get participated in energy conservation or not. After three months, the research measured the energy consumption and calculated to "energy use index" in order to compare with the first three months whether there is any change in using energy or not.



Fig. 1 Timeline of the study of motivation in energy conservation.

4. Results and Discussions

In the first part of the research, the observation for the basic information related to machineries and equipments in

the manufacturing areas to calculate the ratio of using electricity. It showed that air compressor and production machines used high amount of electrical energy. The air compressor used the energy with the ratio of 31.30 percent, whereas the stabilizer used the energy with the ratio of 23.06 percent. For the research, air compressor had been focused as stabilizer could affect the production. After the experiment, the results showed that after following 6 procedures for energy conservation, the energy consumption reduced to 10.674 toe/year, after calculating, the company could save 470,982.53 Baht per year for energy cost, with the investment of 538,480 Baht, with 1.14 year payback. However, the sales in each month is not constant and affected to the energy use in manufacturing process. So, the energy use index would be used as indicator to ignore the sales and production rate effects with the rational between Energy use and Sales (MJ/THB).

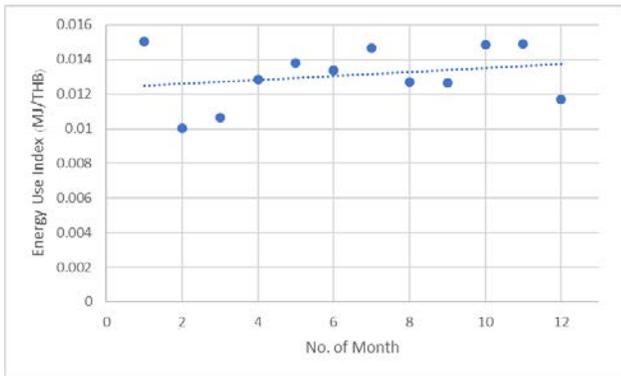


Fig. 2 Energy used for 12 months before energy conservation.

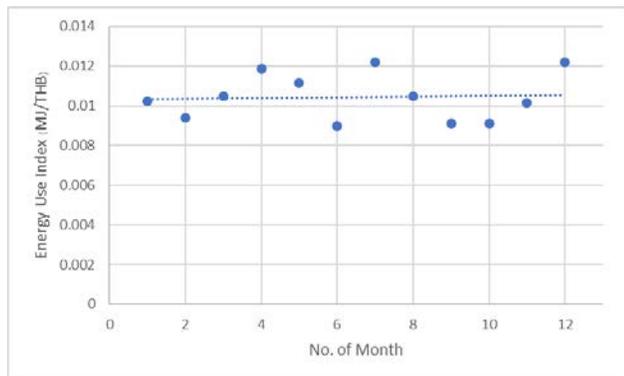


Fig. 3 Energy used for 12 months after energy conservation.

In the second phase of the research was to study the motivation towards participating in energy conservation. In this phase, the research had objective to let the employees in the organization concerned about energy conservation in the manufacturing area as well as participating in helping to reduce energy consumption. This phase was separated into two parts; 1) to organize training and procedures for participating in energy conservation as well as giving

rewards to the department with lowest amount of energy consumption. For analysis, measure the general use of electricity within the organization and calculated the energy use index to see the effects of productivity. Each department had different usage in energy. This made different departments had different procedures for energy conservation. After general training, the organization organized the specific training for each department for the researcher to train specifically for each department as they had different usage within three months (April-June or B region). After measuring the first three months after training, the organization announced the reward for the department with lowest amount of energy consumption within three months. The researcher use energy use index to be the factor for the competition. In those three months (July-September or C region), the researcher studied employees' behavior and motivation with rewards. The results showed that three months were too short to motivate the employees even with rewards. Therefore, the researcher continued observing the employees' behavior for another three months (October-December or D region) without any reward announcement.

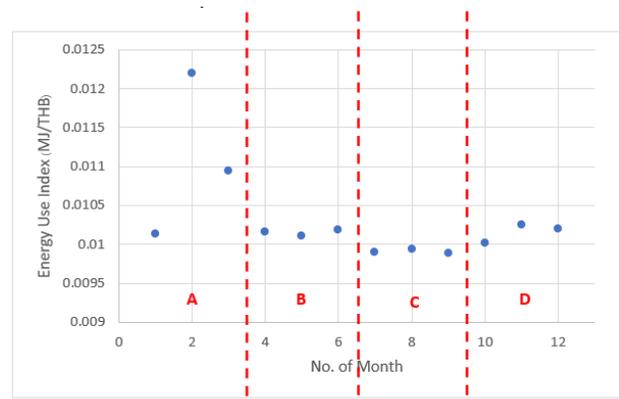


Fig. 4 Energy used after study the motivation in participation.

Considering the results in the first three months before the experiment and nine months in the experiment, the results showed that in the first months, the energy use index was really high. However, nine months after training, the results showed that the participation of employees concerned about energy conservation could reduce the energy use index which leads to reducing cost of electricity in the organization. Therefore, this can be concluded that not only machineries and equipments in production affects the energy consumption, but also employees' behavior affected electricity use.

After the training and announcing regulations for energy conservation, most of the employees had participation towards energy conservation with the mean of energy use index of 0.010152 MJ/Baht. However, after three months,

there were some employees had no participation in energy conservation, therefore, the energy index use was getting higher. Therefore, having rewards and providing the correct knowledge about energy conservation could help the organization to reduce electricity cost as employees were giving participation towards reducing energy consumption in the organization with the mean of energy use index of 0.009906 MJ/Baht. In the last month before announcing the winner led to the lowest energy use index with higher amount of sales with 17.24 percent. This showed that rewards are the motivation that could increase employees' participation towards energy conservation.

In the last part of the research after the reward had been given, the researcher continued doing observation for another three months and found out that the mean of energy use index was 0.010157 MJ/Baht which was similar to the amount before training.

5. Conclusions

In the study of motivation towards participation in energy conservation could be separated into two phases. The first phase was changing and replacing parts of machines and equipments in the manufacturing area in order to reduce the energy consumption in general. The results showed that by changing and replacing parts of machineries and equipment, the energy use index could be reduced for 12 percent and constantly reducing for 20 percent. For the second phase, the research was to study the motivation towards participating in energy conservation which also separated into two parts. The first part was the employee's training about energy conservation and how can they help to reduce energy consumption in the organization. After that, the reward was announced to motivate the employee's to participate and reduce energy consumption in the organization. After three months, it showed that reward helped the employees to be participated in the energy conservation. With the rewards, the energy index use was reduced 0.009906 MJ/Baht. This can be concluded that in order to increase the employees' participation towards energy conservation in the organization, reward is the important factor to support and motivate them.

Acknowledgments

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