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ENERGY MANAGEMENT THROUGH SIX SIGMA: A CASE STUDY

PARDEEP GAHLOT

Assistant Professor, Mechanical Engineering Department, University Institute Of Engineering And Technology, Maharishi Dayanand University, Rohtak, Harayana

pardeepgahlot@gmail.com

ABSTRACT: *Small and micro industries often exist in the form of clusters and act as an important component of Indian economy. Energy being an indispensable input, enhancing its utilization efficiency not only helps in improving competitiveness of MSMEs through cost reduction but also aids in alleviating energy linked environmental pollution. Level of energy efficiency in small industries depends not only on the production technology adopted but also on other non-technology factors. This paper analyzes such factors in energy intensive cluster of textile industries located at Panipat in Haryana. The outcome of the study underlines the need to involve non-technology factors in the prevailing technology-centered energy initiatives in the MSMEs for discernible improvements in the long run.*

Key Words: Energy Management, MSMEs, Non-Technology Factors. Technology Factors.

INTRODUCTION

The Micro Small and Medium Enterprises (MSMEs) play a crucial role in the overall industrial economy of the country [1]. In current years the MSME sector has constantly registered superior growth rate compared to the overall industrial sector[1]. The major benefit of the sector is its employment probable at low capital cost[1]. With its quickness and dynamism, the sector has shown venerable innovativeness and flexibility to survive the recent economic worsening and recession's per obtainable statistics (4^{th} Census of MSME Sector), this sector employs an estimated 59.7 million persons spread over 26.1 million enterprises[2]. It is estimated that in terms of value, MSME sector accounts for about 45% of the manufacturing output and around 40% of the total export of the country[2]. Cost of energy consumption in MSMEs is still high and there is a significant scope of improving efficiency of energy consumption in these industries by properly analyzing various involved factors[3]. This paper analyzes such factors including technical and non technical factors, in the context of an energy intensive MSME cluster. India is a Developing nation. Its per capita Energy Consumption is very low [3]. To achieve Economic Growth, we need to & have to use more & more energy to increase the pace of development [3]. We need to increase the manufacturing of good in Quality & Volume [5]. It is estimated that Industrial energy use in developing countries constitutes about 45-50 % of the total commercial energy consumption [5]. Much of this energy is converted from imported oil, the price of which has increased tremendously so much so that most of developing countries spent more than 50 % of their foreign exchange earnings[6]. With existing constraints developing countries need to expand its industrial base like us if it has to generate the resources to improve the quality of life of its people[6]. The expansion of industrial base does require more and more additional energy inputs[6].

Generation of power needs resources[7]. Resources available on earth are of diminishing nature. It is getting depleted very fast with time as use is increasing exponentially[7]. There are some resources, which are Renewable e.g. Solar Power, Wind Power and Geothermal Power[7]. Technology is also being developed to harness these Renewable Resources to generate Power[7]. The capital investment requirement for renewable resources is very high as compared to normally available resources[8]. It can be quoted here that with the available technology, we could hardly generate 5% of total power generation as on date from renewable resources[8]. Hence it is must to restrict the use or increase the life of diminishing type of resources[10]. Thus the need to conserve energy, particularly in industry and commerce is strongly felt as the energy cost takes up substantial share in the overall cost structure of the operation. Hence it calls for management of energy[10].

In this paper a model has been proposed to do the analysis of empirical data from textile industry units located in Panipat (Haryana) of north India. In this we will use Six Sigma approach to improve energy consumption efficiency and establish the significance of various technological and non technological factors and identify the key variables in achieving energy efficiency. Multiple regression analysis is used for assessing the significance of four identified

factors, Economic Factor (EF), Technical Factor (TF), Human Resource Factor (HRF) and Organizational Behavioural Factor (OBF), in explaining the variation in energy efficiency levels within a given cluster. Further, the key variables affecting energy efficiency are identified using ANOVA (sequential sum of squares method) models.

ENERGY MANAGEMENT

The term "Energy Management" means the judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions. Another definition states that energy management is the strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems. Energy management is the process of monitoring, controlling, and conserving energy in a building or organization**.** Energy management is not by chance / incident / accident. It is a Mission with a Target. It can't be done single headedly or by sitting on a table but needs coordinated effort by team of energy conscious people with a milestone to be established. Very concerted efforts in a planned manner to established Energy Management. Strategy needs to be established based on the Target of Energy Conservation.

Various objectives of the research are to minimize energy cost/waste without affecting production and quality. Other objective was to minimize environment effects. Typically this involves following steps:

1. Metering your energy consumption and collecting the data.
2. Finding opportunities to save energy and determining scope for each opportunity.
3. Taking action to target opportunities to save energy.
4. Tracking your progress by analyzing your meter data.

Energy management is the key to saving energy in an organization. Much of the importance of energy saving stems from the global need to save energy - this global need affects energy prices, emissions targets, and legislation, all of which lead to several compelling reasons. Energy management is the means to controlling and reducing organization's energy consumption and this is important because it enables you to:

1. Reduce costs – this is becoming increasingly important as energy costs rise.
2. Reduce carbon emissions and the environmental damage that they cause - as well as the cost-related implications of carbon taxes and the like, your organization may be keen to reduce its carbon footprint to promote a green, sustainable image. Not least because promoting such an image is often good for the bottom line.
3. Reduce risk – the more energy you consume, the greater the risk that energy price increases or supply shortages could seriously affect your profitability, or even make it impossible for your business/organization to continue. With energy management you can reduce this risk by reducing your demand for energy and by controlling it so as to make it more predictable.

LITRETURE REVIEW

Earlier energy efficiency had been a technical aspect of designing equipment, systems, and buildings. In 1973, efficiency metamorphosed into "Energy Management," which emerged as a distinct field of interest, rather than continuing to be a subsidiary engineering issue. Energy management became a single freestanding issue, independent of the many technical areas to which efficiency applies specifically. This single-issue nature of energy management became a dominant factor in information about energy management from that time until the present.

A different concept for simulating energy intensive production was introduced (Petter Solding, 2005) and using specially built simulation models helps companies take more than the time aspect into consideration when planning their production. Marcel Didden (2005) showed that replacing conventional motors by Variable Speed Drives compressors is good but it needs some improvements in some cases. In these cases, the savings are decreased or even entirely eliminated by process outages due to VSD-tripping on voltage dips because of short circuits in the grid. According to Weber (1997), energy consumption belongs to the realm of technology but energy conservation to the realm of society. Another study conducted by Kiel University (UK, 1998) on Small and Medium-sized Enterprises (SME) of certain European countries stresses organizational and behavioural aspects of SMEs in achieving energy efficiency. Das Gupta (1999), after analyzing some initiatives of energy efficiency and environmental improvements in Indian MSMEs, is of the opinion that a technocratic top-down approach for energy efficiency improvement is not comprehensive. Ramachandra and Subramanian (1993) proposed a case study on grain mill which is based on a sample survey of several mills spread over Karnataka. Initially Specific Energy Consumption (SEC) was computed for all industries so as to compare their efficiencies of energy use. Bala and Balachandra (2002, 2003) have analyzed energy consumption and environmental pollution of a few MSME clusters in Karnataka from a managerial perspective. They have identified labour skill levels, owner qualifications, and technology levels as the important factors in explaining the energy use and environmental

pollution. Further, they advocated the promotion of energy efficiency in MSMEs through a 'cost cutting' or 'profit maximizing' strategy. D. P. Mukherjee (2010) focused the major barriers towards cleaner production with an aim to define the strategies to overcome the eco-friendly casting production.

Based on the available literature, it appears that energy and environment related aspects of MSMEs in India have not attracted the researchers and policy makers in the past to the desired extent. Though there are a few studies on MSMEs coming under "grain-mills", "foundries", "brick/tile units" etc., it is found that most of these studies and initiatives to improve energy efficiency or environmental performance in MSMEs have adopted a technocratic approach, predominantly. Such initiatives lacked a holistic perspective necessary for comprehensively addressing the problem (Dasgupta, 1999). Further, there are not many energy efficiency related studies in literature involving non-technical factors in the analysis of energy use in foundry industry cluster. It is crucial to note that the level of energy efficiency in a MSME unit depends not only on production technology adopted but also on a whole lot of non-technology factors, including quality of human resources and entrepreneurship. In this backdrop the current research work analyzes the various non-technology factors which affect energy efficiency in energy intensive.

STRATEGIC MODEL

Six -Sigma approach follows a rigorous pattern called the DMAIC (Define, Measure, Analyze, Improve, and Control). Six-Sigma is a meticulous, data-driven methodology proposed by Motorola, USA. It aims at generating quasi-perfect production processes that would result in no more than 3.4 defects per 1 million opportunities. By definition, Six Sigma is rooted in statistical analysis because it is data-driven and is a strict approach that drives process improvements through statistical measurements and analyses.

In the proposed model, overall environment of textile industries in Panipat has been studied in terms of various identified technical and non technical factors and then create awareness about effective utilisation of energy among the management and workers.

Some of the technical factors are:

1. Age of plant and machines used
2. Quality of energy used
3. Process specific variables

Despite almost similar energy use technology within the cluster under study, there were still differences in terms of age of plant & machinery, quality of energy used, and certain process specific variables. They are mostly connected directly or indirectly with the technology of manufacturing the product, and hence are grouped under Technical Factor. Age of plant and machinery is an important variable, as generally the efficiency level tends to get worse with the age. The energy efficiency also tends to be higher with better quality of energy used, e.g. usage of electricity leads to better utilization efficiency than fossil fuels such as coal or oil in a process. The type of manufacturing process used determines the material and energy consumption level, due to usage of different machines and techniques.

Some of economic factors are:

1. Plant capacity utilisation
2. Efficiency level of resources used
3. Total volume of production

The role of Economic Factors in achieving efficiencies in production is well established. We try to capture the effect of this factor in energy use through variables such as capacity utilization, resource (other than energy) use efficiency, and production volume. There are evidences in literature showing higher capacity utilizations leading to better energy efficiency. The efficiency of utilizing other material resources causes variation in energy required in further processing these resources thus affecting energy efficiency. For example, more scrap/rejection/rework is going to have negative effect on energy efficiency due to wastage of energy consumed during their production. With the large production volume it is possible to realize "economies of scale" which indirectly contribute positively to energy efficiency.

Some of the Human Resource Factors are:

1. Owner experience and education level
2. Supervisor education level
3. Labour skill level

MSMEs generally depend on the entrepreneurial ability for its survival and growth, the Human Resource Factor is of prime importance. Besides, as SSIs are mostly labour-intensive the skill level of employed labour also merits due attention. The Human Resource Factor consists of variables such as quality of labour, managerial and technical ability, and business experience of the owner. Highly skilled labour force can reduce wastage and effectively perform the job in the best possible manner. It is believed that higher the educational level of owners/ managers/supervisors, higher will be their capabilities in terms of planning, decision-making, implementing, innovating, etc, with respect to overall operation of the unit. This again affects the overall efficiency of operation including energy. The owner's business experience does count a lot in energy efficiency, especially in MSMEs in view of their critical role in taking long term and technology oriented decisions.

Some of the Organizational and Behavioural Factors are:

1. Work practices, Layout and House keeping
2. Importance attached to Energy
3. External interaction level

Organizational & Behavioural Factor includes variables like work practices, layout & housekeeping,

importance attached to energy related issues, and the external interaction level of the organization. This factor is expected to capture the variation in attitudes and organizational aspects among MSMEs within a given cluster. The best work practices, neat layout and good housekeeping such as proper insulation for heat loss, regular overhaul and maintenance, etc., will positively contribute towards energy efficiency improvement. The attitude of MSMEs entrepreneurs/supervisors/ workers towards energy in terms of importance they attach to energy related issues in day-to-day functioning is seemingly important for efficiency improvement. A progressive entrepreneur with positive attitude and social accountability may use the government policies, regulations and programmes to improve the overall performance, especially related to energy and environment, of his firm. The general interaction level of MSMEs firms with other units within or outside the cluster, industry associations, R&D institutions, participation in seminars/conferences etc., help the SSIs in upgrading the knowledge and skill of their manpower thus resulting in an improved energy efficiency among other benefits.

Then in 'Measure Phase', collecting data by estimating sample size from the cluster is involved and then in 'Analyze Phase', analysis of significance of factors by Multiple Regression and ANOVA models is done. By this important factors are identified, which can improved in 'Improve Phase', where in improving efficiency of energy consumption by improving significant factors is carried out. In 'Control Phase', controlling and improving of factors to have efficient energy consumption in future is documented.

CONCLUSIONS

Energy consumption trend in Indian MSME clusters has wide variations and this is true even in the present study, though energy use technology adopted in a given cluster remained almost similar. This means, the variation in energy efficiency in the cluster cannot be attributed to production technology. This motivated to interpret the efficiency variation through non-technology factors. It is hypothesized that the variation in specific energy consumption may be understood by a combination of different factors. Technical factor covers factors such as difference in term of age of plant and machinery, quality of energy used, and different process specific variables. These are mostly connected with directly or indirectly with the technology of manufacturing the product, still adopted mostly homogeneous energy use technology within the cluster. Under Economic Factors the study tries to capture the effect of this factor in energy use through three sub variables such as capacity utilization, resource use efficiency and production volume. The contribution of Human Resource Factors in achieving better efficiency needs no emphasis. Particularly in MSMEs, which generally depend on the entrepreneurial ability for its survival and growth, the HRF is of prime importance. Besides, as MSMEs are mostly labour-intensive the skill level of employed labour also merits due attention. The fourth factor, viz. Organizational and Behavioural Factors, encompasses variables like work practices, layout and housekeeping, importance attached to energy related issues, and the external interaction level of the organization. This factor is expected to capture the variation in attitudes and organizational aspects among MSMEs within a given cluster. The general interaction level of MSME firms with other units within or outside the cluster, industry associations, R&D institutions, participation in seminars/conferences etc., help the MSMEs in upgrading the Knowledge and skill of their manpower thus resulting in an improved energy efficiency among other benefits.

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