



## An Analysis of Energy Efficiency Management Opportunities for Electrical Motor-Driven Systems Mainly from After Sales Service

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**Abstract :** With rapid increase of electrical energy consumption in India, after-sales service of electrical motors has captured attention of both end users and research scholars. By doing proper service of electrical motors, the motor losses will get reduce thereby the electrical energy consumption get reduces. In this paper, tangibles, reliability, responsiveness, empathy and assurance etc. characterize the quality of after-sale service of electrical motors in domestic sector. After sales service is an important process in many sectors, including electrical, automotive, medical electronics and retail sector as well. Other than the improving influence on brand image, it also provides competitive advantage and revenue generation. In the electrical sector, better service can result in better quality, high technical performance and also energy savings. Further, it boosts the confidence of customers with respect to zero down time and also lower maintenance charges in the upcoming years also. In this paper the authors illustrate the various opportunities for electrical energy efficiency management for electrical motor driven systems mainly due to proper after sales service.

**Keywords :** After Sales Service, Customer Satisfaction, SERVQUAL, Technical Performance.

### 1. INTRODUCTION

In the domestic sector there are now more than 100 A.C (Alternating Current) electrical appliances on the market. Fundamental components are items such as motors, lights, heaters and battery chargers etc.,

Electrical motors are used for pumping cold water and for circulating hot water in central heating system as well. Motors are also used for ventilation fans, cooking appliances like food mixers, wet grinders, oven fans, extractor hoods, washing machines, dryers, air fans, vacuum cleaners and gardening tools and appliances. In addition to that motors are used for compression purpose in refrigerators and air conditioners. Also in some places automatic gates and shutters also use electrical motors.

We use pumps for pumping raw water in irrigation requirements, drinking water in domestic requirements, sewage in municipal requirements and crude oil in industry applications. Pumps are readily available in integrated sets with different sizing in general from 0.5H.P to 5H.P for domestic usage.

We can study from the previous reports that there is a big scope for improving energy efficiency in motor driven systems in developing countries. The system optimization techniques are useful to increase the motor driven system's efficiency. The payback period for the energy efficiency equipments is less than 3 years only.

## **2. THEORY**

Over a period, the operation of the pumps is not consistent and the moving parts get deteriorate due to wear and tear. Also the efficiency of motors fall down by 10 to 15%. (ETSU etal. 2001). Depends upon the foreign material in the fluid, any solid particles presnt in the fluid and/or if the temperature is increased, the deterioration of motors will get more. The efficiency is get decreased as the working life of the motors become more.

India has a voluntary labeling scheme using the method for star rating to promote more energy efficient pumps. All these Indian test standards are IS 9079, IS 8034, IS 14220 and IS 11346. These standards were updated in 2009.

Service quality (Fazlzadeh, A., Bagherzadeh, F., & Mohamadi, P.,2011), is a critical determinant of competitiveness for establishing and sustaining satisfying relationships with customers. Service marketers have realized that competition can be well managed by differentiating the quality. A customer minded corporate culture, an excellent service-system design, and effective use of technology and information are crucial to superior service quality. Technological developments have empowered the world is providing quick and access to information and services to consumer (Christian Gronroos,2007) in all industries.

### **Construction of Induction Motor**

The following are the few key points regarding the construction, working principle and features of Electrical Motors (V.K.Mehta, 2012):

An AC motor consists of two major parts such as rotor and stator. The stator is the stationary electrical part of the motor. The rotor is the revolving part of the motor due to electromagnetism. Stator laminations are stacked together to form like a cylinder with hollow. Coils of insulated wires are formed like a coil and fixed into stator slots.

The motor enclosure consists of yoke and two bearing housings. Stator is mounted inside the enclosure. The rotor is fitted inside the stator with an air gap so that to separate from the stator. The body of the motor protects all the electrical and inner parts of the motor from ill environmental effects. The rotor rotates freely due to bearings which are mounted on the shaft. A cooling fan is used to remove the heat from the motor.

### **Principle of Operation**

Electromagnetism is the working principle for motors. The stator circuit forms as an electromagnet as the coils surround the poles. The power supply is connected to stator.

When a 3 phase voltage is given to a 3phase stator, the current will flow through all the 3 phase windings, in turn it will develop flux in the stator. The speed at which these fluxes will rotate is called as Synchronous Speed,  $n_s$ . So the flux developed and revolving is called as Rotating Magnetic Field (RMF).

Motors convert the electrical energy into mechanical energy. The motors are used as drives to rotate the mechanical equipments such as water pump, fan, mixer, grinding machine, washing machine and lifts etc., in domestic applications.

Due to many years of operation, the efficiency of motors becomes less. This is happening due to wear and tear, heat rise in windings, poor lubrication, bearing failures, excessive vibration and misalignment. Good motor-maintenance practice helps avoid unplanned downtime or postpone these problems. Avoiding after sales service will reduce motor's energy efficiency.

### **Disadvantages of Electric Motors**

- a) Brush wear: Brushes are required to connect to the rotor winding. Wear occurs at brushes which increase in low-pressure environment.
- b) There is a possibility of spark over due to sparks occur from the brushes in case of polluted environment in which the motor operates.
- c) Radio Frequency Immunity from the brushes may obstruct the quality of nearby T.V sets and/or electronic appliances etc.,

## **3. METHODS**

### **Research Objectives**

- a) To study the energy efficiency of electrical motors and customer satisfaction on the technical performance of electrical motors through after sales service quality.
- b) To ascertain the dimensions of after sales service quality which have caused customers to be satisfied or dissatisfied using the proposed conceptual model.
- c) To know the overall satisfaction level of the customers towards after sales service quality of electrical motors.
- d) To ascertain whether or not customer satisfaction affects the individual customer in any way.
- e) To provide the requisite recommendations for the improvement of electrical motor after sales service quality on the findings of the study.

## **4. LITERATURE REVIEW**

An analysis of customer satisfaction towards technical services in Malaysian automotive industries – This study was conducted by Sanmugam Annamalah and Tan Khai Ying (2016). The result of this study indicates that there is a positive relationship between satisfaction and loyalty which significantly impacts the loyalty towards the automobile industry (A. U. Haq, 2012). The quality of technical services and the quality of products promotes customer satisfaction and customer loyalty in the context of the Malaysia automotive industry. This study pointed out that by exploring in-depth investigation of the prevailing as well as innovative technologies we shall get complete picture on all the attributes contributing to customer satisfaction.

Impact of after sales service on customer satisfaction: A case review of mobile phone industry in Delhi and NCR - This study was conducted by Dr.Saloni Gupta and Rati Dhillon (2015) and reported that there is high perceived effectiveness of various dimensions of after sale service in mobile phone in-dustry in Delhi, NCR. Outcome of this study indicates that the young customers were the one who became overall satisfied by getting after sale service through the retail sellers. From their point of view it was noted that for any business or retailer to get success and to sustain in the business, it is vital that more initiatives were made to hold the existing and new customers as well as attract new buyers. Customer retention is the benefit of good service quality which ensures faithfulness, trust and long lasting relationship among the retailer and the customer. Therefore this study was concluded as that the quality of after sale service definitely impacts customer satisfaction in the mobile phone industry in Delhi and NCR.

### **Research Methodology**

A. Parasuraman (1985) proposed a model namely SERVQUAL which consists of ten dimensions to measure the satisfaction level of respondents on service quality. Further these ten dimensions were made to only five dimensions such as tangibility, reliability, responsiveness, assurance and empathy.

To study the proposed research in energy efficiency awareness of respondents in Vellore district and for data gathering, we used the modified SERVQUAL and 5 point Likert scale to evaluate electrical motors users attitude with respect to *Customer satisfaction*, where 1 is being Highly Dissatisfied and 5 is being Highly Satisfied.

### Demographics

To gain feedback on this questionnaire, the interview was conducted with 73 respondents residing in 18 villages in Arakkonam sub-district of Vellore district in Tamilnadu. Further the results of this pilot survey were studied. The subject areas of after sales service and energy conservation were discussed.

OEM service/Unauthorized service, Energy consumption and Perceived value for money are the important parameters of this study. But the study of demographic parameters is also necessary to get all results. The data collection process took 2 weeks to complete in order to ensure a maximal sample size.

### Proposed conceptual model

In this paper, the authors propose to introduce the *energy savings* as an additional independent variable which plays a vital role in evaluating the customer satisfaction. The figure 1 indicates that the inclusion of energy savings as an additional independent variable.

The proposed conceptual model will be used in such a way that in addition to the five dimensions of SERVQUAL, the respondents get satisfaction also through the energy savings achieved through the trouble free technical performance of electrical motors.

In the present scenario there is no doubt that the customer gets satisfaction through energy savings and pollution free, trouble free performance of electrical motors.

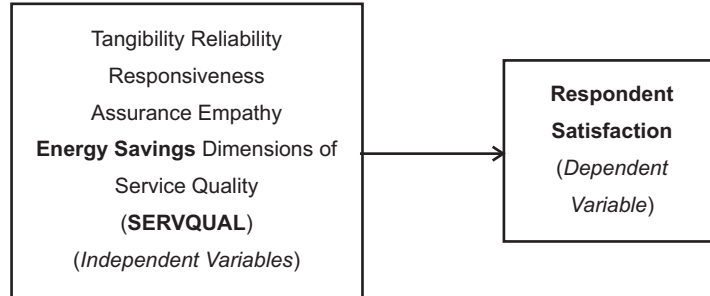


Figure 1: Proposed Conceptual Model

## 5. ANALYSIS

It is expected that after sales service can reduce the down time, pollution and thereby achieve energy savings. Electrical workshops has to deal with all end users of electrical motor driven systems in domestic sector and deliver after sales service to its customers. If the services provided by the electricians are not worth then the customers' satisfaction level is getting affected. Water pumps play an important role in the respondents' day to day life and continuous satisfied technical performance is very much essential.

Figure 1 shows the comparison between actual age of motors and their expected service life. We can see that the properly maintained motors provide more life more than the expected ones. Electrically operated water pumps consume 75% of energy. If well developed systems are used it will be possible to save at least 25% of energy consumed by motors. Therefore we have to develop and implement energy efficient policy measures to increase motor efficiency and hence it shall be in higher priority.

After Sales Service (ASS) is the heart of the process of the model which ensures that customers' asset reliability value is kept constantly. The ASS is helpful to keep life cycle of motors in healthy condition.

For example if you consider figure 2 which shows the Sharing between various motor driven systems of total electricity spent by industries. Of which we can note that the major i-e., 25% of electricity is consumed by electrical motors alone. Annual Maintenance Contract (AMC) operations is a systematic planning approach such as after sales service which results in equipment down time and hence the reliability is increased.

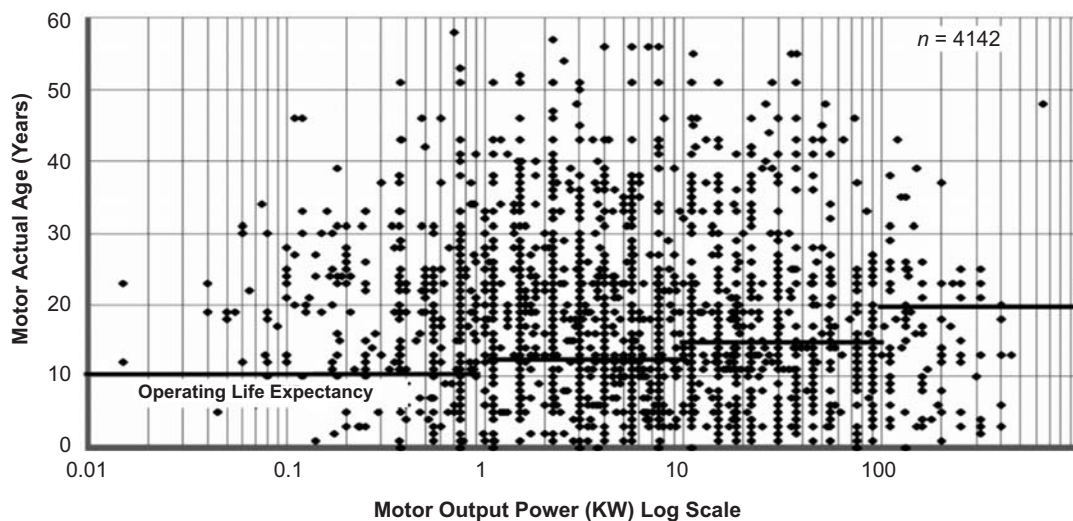
Structural Equation Modelling (SEM) is the tool was used to validate the proposed conceptual model. In practice SEM is classified into measurement model and structural model. The measurement model is used to find out the relationship between unnoticed and evident variables. The structural model tests the relationship between independent and dependent variables. The SEM measurement model is used for the present study.

From figure 3 it is seen that the variation of efficiency due to deterioration and improper maintenance of pump motors (R.C.Mishra, K.Pathak,2007), 10-15% of efficiency got reduced due to not attending the motors for preventive maintenance. Further the efficiency is going down in another few years. Finally it became necessary to replace the motor with new one.

**Methods to improve energy efficiency :**

- a) We can switch off the operation when they are not in use.
- b) If not required fast start and brakes shall be avoided.
- c) We should not overload all electrical equipments such as washing machines, refrigerators, air conditioners etc.,
- d) Periodical check-ups, preventive maintenance and after sales service to be followed.

Though our research, we have designed the “ENERSERVQUAL” in order to assess energy saving, after sales service quality and customer satisfaction in domestic sector. The “ENERSERVQUAL” scale shows good psychometric properties based on findings from reliability and validity tests, correlation and goodness to fit in services. However, there is a need to have more tests and critical analysis of model in different situations which large number of sample size so as to prove its applicability. Although this study has made an attempt to cover all dimensions of after sales service quality.



**Figure 2: Actual age of motors compared to expected service life**

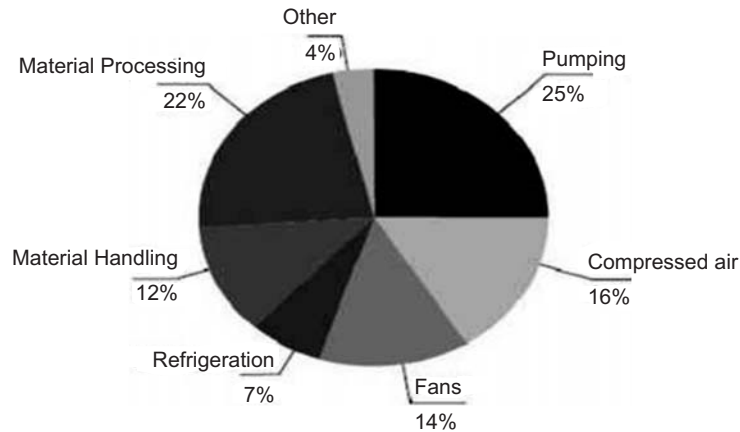


Figure 3: Sharing between various motor driven systems of total electricity spent by industries

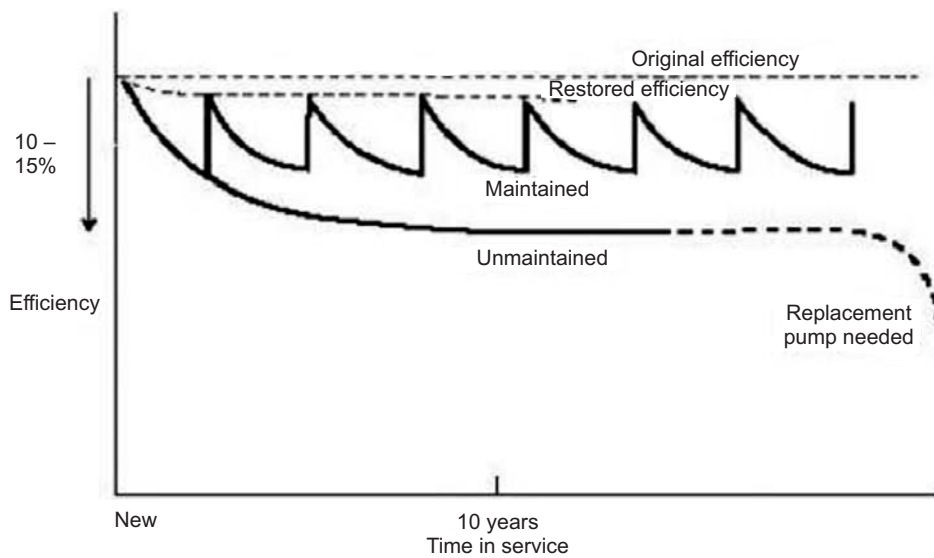


Figure 4: Variation of efficiency due to deterioration and improper maintenance of pump motors

## 6. RESULTS

In this research work, we presented a case study in order to pinpoint strengths and weaknesses as directly perceived by the electrical motor users. We used the SERVQUAL (B. Yan and P.A. McLaren, 2010), questionnaire which is typically used for collecting data for the purpose of analyzing quality of service (C.Bhattacharjee, 2008). Subsequently, we used based upon the Conceptual model to analyze data and detect the service gap. This methodology can help the administration take the necessary steps towards improving their services to the public, which intrinsically should boost their satisfaction and trust in future, energy costs.

The results indicate that customer satisfaction level increases if better after sales service is rendered (Hussain, N., Bhatti, W. A., & Jilani, A., 2011).. Using this methodology; the decision makers can not only focus on what needs improvement, but also save on what not to be modified. We realize that the yield of proper after sales service in terms of preventive maintenance is almost 32% of electric motor system energy consumption.

The SEM measurement model was tested. Average Variance Extracted (AVE), the theoretical pattern Factor Loading, and Construct Reliability (CR) were well tested using Confirmatory Factor Analysis (CFA). The size of factor loading should be equal to 0.7 or greater in testing the convergent validity. The Average Variance Extracted (AVE) will be accepted if it is 0.5 or higher. The composite reliability will be accepted if it is 0.7 or higher. In order to validate a measurement model, CFA is a right statistical technique which is used.



## Major findings

The main objective of this research is to understand that how customers get satisfaction by after sales service (Gupta, S., & Dhillon, M. R. 2016). and what are the problems they face in after sales service which impacts on their satisfaction level. Customers demand not only a good product but also after sales service also to increase its life cycle.

One of the primary objectives of this research was to gain an understanding of how customers become satisfied with after sales service and what are the problems in after sales service which adversely affects on customer satisfaction. This study is conducted to find out main determinants of customers satisfaction.

## Validity of Measurement Model

Constructs' discriminate and convergent validities were examined to confirm the proposed measurement model. Also confirmatory factor analysis (CFA) was used to assess the construct validity. There is no doubt that proper after-sales service ends up in not only customer satisfaction but also customer loyalty. After sales service is an important competitive strategy in the present business environment.

## 7. CONCLUSION

The present study was well focused on the need of after sale service of electrical motors in the domestic sector together with its effects on the customer satisfaction level in Arakkonam sub district. The study was useful to know the feelings of the customers' who utilizes the OEM services of electrical motors and also the customers' who utilizes unauthorized services of electrical motors. The results show that the efficiency of after sale service had directly proportional relationship with customers' satisfaction level.

A well planned after sales service on electrical motors must be operated properly and periodical preventive maintenance is essential to achieve energy efficiency.

This study will be helpful to draw up further maintenance guidelines for improving customer satisfaction within the industries as well as in domestic and act as a secondary data for further research.

Subsequently, recommendation was made to the motor dealers to form a team of experienced technicians with a view to develop better understanding and long term association with the customers.

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