A Critical Review on Value Engineering Applications to Enhance Building Energy Performance of Auditorium

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Abstract: Value engineering is a proven management technique, originated during World War-II. This technique is widely used to eliminate the high cost areas in a system by targeting unnecessary cost, while still satisfying the required function or purpose. As Value Engineering is a life cycle approach and applicable during any phase of a project it can be best used to analyze existing building's energy consumption. Value Engineering is the best evaluating method to reduce excess energy consumption by best combination of building components and HVAC system.

IndexTerms **- Value Engineering, unnecessary cost, energy consumption, HVAC system**

INTRODUCTION

Almost 50% of the energy demand is used to support indoor thermal comfort conditions in commercial building (3). This energy demand can be reduced, if the building is designed in such a way that heat gained by the building is least and escape of cool air is controlled. Thermal insulation for building should be wisely selected and should be given due consideration while designing HVAC system. In existing building, the energy consumption can be reduced by proper selection of insulation material, changing the mode of operation of HVAC system, using more efficient lighting fixtures, analysing the function of the areas within the building and providing the optimum energy. Value engineering can provide best solution for the selection of alternatives to be adopted for dropping energy consumption of building without affecting function of the building.

VALUE ENGINEERING

a. HISTORY OF VALUE ENGINEERING

Value Engineering was a result of a material shortage problem during World War-II. Lawrence D. Miles, was an electrical engineer and was assigned to the purchasing department of General Electrical Company. He noticed that plants were faced with regular material shortage. Therefore he started to analyze the material, which were short in supply and understood that products were purchased for what they can do – either through the work they perform or the pleasing aesthetic qualities they provide (SAVE standards). Miles invented an innovative process and devised function analysis concept which later termed as Value Analysis. The success of his method adopted gradually and was applied to construction field during late 1960's or early 1970's.

b. OBJECTIVES OF VALUE ENGINEERING

According to IS 11810:2003 the objectives of VE are to increase

i. Profitability
ii. Competitiveness
iii. Resource utilization
iv. Customer satisfaction
v. Job satisfaction
vi. Value delivered by the use of product/service/system

These can be achieved by

i. Finding out necessary functions and their costs.
ii. Classifying function into basic function, primary function, secondary function etc.
iii. Identifying high cost functions
iv. Eliminating unnecessary functions
v. Helping to establish alternative ways of providing the needed function by creative techniques
vi. Selecting the most valuable alternative for implementation

c. AREAS OF APPLICATION

Value engineering can be applied during any stage of project's development phase, as it is a life cycle oriented. Some of the example where VE is mostly used are

i. Construction projects
ii. Manufacturing projects
iii. Business systems and processes
iv. Service organization
v. Management decisions
vi. As a problem solving technique

ENERGY EFFICIENCY IN BUILDING

a. FACTORS AFFECTING ENERGY CONSUMPTION OF BUILDING

i. Orientation of building
ii. Building configuration
iii. Building envelope
iv. Fenestrations
v. Lighting
vi. Heating, Ventilating and Air Conditioning (HVAC)
vii. Temperature control
viii. Function of building
ix. Type of control
x. Energy distribution
xi. Hours of operation
xii. Ventilation and Thermal quality

b. ENERGY CONSUMPTION BY HVAC SYSTEM

Heat Ventilation and Air Conditioning (HVAC) systems plays an important role in ensuring the thermal comfort of the building occupants. In India, air conditioning systems accounts around 32% of electricity consumption of a building (1). Almost 70% of electricity is generated by thermal power, which leaves negative footprint on the environment. Due to the tropical climate in India, electricity consumption increased in the months of summer to support thermal comfort. In recent years, different control and optimization strategies have been used to improve the energy consumption rate of HVAC systems (2). Due expensive and complexity of these strategies, their implementation is difficult. HVAC loads can be reduced by designing and modifying the building systems, which allows minimum heat entry in the building or minimum loss of cool air from the building.

c. HEAT EXCHANGE PROCESS IN A BUILDING

The heat exchange in a building takes place by conduction, effect of solar radiation, movement of hot air within building, internal heat gain, introduction heat or removal of heat and evaporation. The equation for calculating the required air conditioning capacity is $Qi + Qs \pm Qc \pm Qv - Qe = Qm$, where,

Qi = internal heat gain
Qs = effect of solar radiation
Qc = conduction heat flow rate
Qv = convection heat flow rate
Qe = cooling effect due to evaporation
Qm = required air conditioning capacity

Conductance: - conductance of heat occurs due to the transfer of heat on outer face or inner face of the body. Heat is transferred due to molecular movement and depends on thickness of the body and thermal properties of the material.

Effect of solar radiation: - when the radiation from the Sun falls on the surfaces it heats the surface. This effect, on opaque surface can be included in conductance by using sol-air temperature concept. While on transparent surface solar heat gain must be considered separately.

Internal heat gain: - This is the result of heat emitting bodies, which are within the building. This includes human bodies, mechanical devices, equipment, lighting facilities etc.

Convection: - in convection, heat is carried by the bodily movement of a carrying medium, usually gas or a liquid. This is occurs due to internal movement of the hot air and depends on the volume of the inside air and number of air change per hours.

Cooling effect due to evaporation: - if evaporation takes place on the surface of the building or within the building and the vapours are removed, this will produce a cooling effect.

CONCLUSION

To optimize the building energy consumption, elements like windows, walls, insulation material, lighting fixtures, equipment enclosed in building, use of natural curtains, use of renewable energy etc. would be decisive factors. The application of value engineering to existing building would result in bringing down the HVAC loads and thereby electricity consumption and lots of savings. Value engineering analyses the alternatives and gives the best alternatives which are economic in life cycle time of the building. Understanding the source of heat in a building is important while designing HVAC system and heat gain by the building should minimized by altering the building components or insulation materials.

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REFERENCES

1. Energy Conversation Building Code (ECBC). Bureau of Energy Efficiency, Ministry of Power, Government of India; 2007.
2. Energy statistics 2017, Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India.
3. Enteria N, Mizutani K. The role of the thermally activated desiccant cooling technologies in the issue of energy and environment. Renew Sustain Energy Rev 2011;15:20 p.95–122.
4. Indian Standard: Guidelines to Establish a Value Engineering Activity, 2003 (IS 11810 : 2003)
5. Indian Standard: Life Cycle Costing, Part 2- Methodology, 1994 (IS 13174 – 2)
6. Larry W. Zimmerman, Glen D. Hart, "Value Engineering: A practical approach for owners, designers and contractors", CBS Publishers & Distributors Pvt. Ltd.
7. Luis Perez-Lombarda, Jose Ortizb, Juan F. Coronela, Ismael R. Maestrec "A review of HVAC systems requirements in building energy regulations", Energy and Buildings, Vol. 43, p. 255-268, 2011
8. Ma Z, Wang S, Xu X, Xiao F. A supervisory control strategy for building cooling water systems for practical and real time applications. Energy Convers Manage 2008;49: 23 p. 24–36.
9. O. H. KOENIGSBERGER, T. G. INGERSOLL, ALAN MAYHEW, S. V. SZOKOLAY (1975). Manual of Tropical Housing and Building. E-Edition (2013). University Press
10. SAVE International Value Standard, 2007 edition

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