ISSN (Online) 2582-9327

IJARSCMT

International Journal of Advanced Research in Science, Commerce, Management and Technology

Impact Factor: 5.731 Volume 1, Issue 1, April 2021

Increasing Performance of Thermal Processes In Healthcare Units Under HVAC Systems For Energy Saving: A Critical Review

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Abstract: *Healthcare units consume outsized amount of energy, in the present day scenario. Within developed countries, the energy utilization of healthcare units may reach up to 16% of the overall energy usage in profitable sectors. In this study the maximum energy consumers in South African healthcare units are well-known and approximate energy-efficacy initiatives are proposed, in terms of performance, operation and technology .Two thermal energy systems are identified heating, ventilation and air conditioning and water-heating systems .At each level, energy-efficacy initiatives are introduced based on potential energy savings and the effort required to achieve these savings. In addition, model predictive control approaches are discussed and reviewed as part of the further improvement section. Average may possibly energy savings ranged from 46%–65% at the base level, while energy savings of 16%–31% may possibly be expected for energy-efficacy initiatives at the active level. Energy efficacy activities at the technical level and the further improvement level may result in savings of 45%–70% and 6%–12%, respectively.*

Keywords: Energy saving, Efficiency, thermal process, Energy management, renewable energy

I. INTRODUCTION

Pérez-Lombard, L et.al studied that [1,2], the energy consumption of commercial buildings in developed countries ranges from 8%–18%, Healthcare units are the fifth highest energy consumer in the commercial sector, in terms of energy consumption. Additionally, it was observed that the energy consumption of healthcare units ranges from approximately 43–92 kWh/bed/day. Eberhard, A et.al stated that [3]. In order to reduce the impact that electricity costs have on healthcare expenses, energy-intensive systems need to be effectively managed in terms of energy efficacy. A huge body of research with the explicit objective to enhance energy efficiency of particular systems in buildings has been conducted, particularly in the past two decades . Amowine, N et.al observed that [4,5]. However, a comprehensive review of scientific articles on energy-efficiency initiatives in healthcare units are currently lacking, substantiating the need for such a review. Therefore, the aim of this research is to conduct a review using a well-established energy-management systems Javied, T et al [6]. The first stage incorporates energy policy and planning with the aim of obtaining an initial energy baseline, energy performance indicators, strategic and operative energy objectives and action plans. Prashar, A et.al [7]. Explored that the Plan do check act (PDCA) model has beneficiary of being a powerful, to resolve new and recurring issues in any industry.

Van Heerden, et.al [8]observed that, another major drawback, similarly as a consequence of the circular paradigm and the step-by-step process, is the limitation placed on radical innovation. Therefore, the PDCA model has its focus on correcting mistakes rather than preventing it. Consequently, the time required to implement a program with the best possible outcome, in this case, maximized energy efficiency , is increased substantially

II. ENERGY EFFECTIVENESS BASED ON THE RECITAL, OPERATION, EQUIPMENT AND EXPERTISE STRUCTURED WORK

Hoexter, M.F et.al studied that [9] The sustainability of an energy-management program for the improvement of energy efficiency may be evaluated by considering the three aspects; organizational structure, compatibility of performance indices and engineering support A well-designed organizational structure supports the sustainability of an energy-management program. Yong, J. et. al focused [10] In order to effectively stimulate the performance, operation, equipment and technology efficiency activities and in turn the sustainability of an energy-management program, certain external mechanisms such as energy policies, regulations, incentives and penalties are necessary. Engineering support plays a crucial role in evaluating the technical feasibility of a system.

In hindsight, support entails energy analysis, system modelling and the implementation of relevant optimization techniques. Suitable engineering support will improve the reliability of energy solutions, while ensuring sustainability.

III. METHOD

Zhang, S et.al [11] In hindsight, evaluating the available literature subjected to the above stated search strategy in conjunction with the performance, operation, equipment and technology perspective orders a clear advantage over the traditional PDCA method in that every avenue of the broad category of energy efficiency is consulted .Hatch, M.J et.al [12] described that the contribution of this study is a comprehensive assessment of the potential energy and associated cost savings that may result if appropriate sustainable energy- efficiency measures were to be implemented. Additionally, the presented data with respect to the ranged average payback periods or economic feasibility of the initiatives at each level may provide valuable insight to energy managers during the planning phase of energy-efficiency projects. The drawback of the POET perspective presents itself when energy-efficiency initiatives are evaluated and categorized within the hierarchy of the framework.

3.1 Technology Efficiency

EE Publishers [13] Energy consumption data of healthcare institutions may be analyzed, in order to obtain the typical energy usage spectrum. From the chart, it is evident that heating, ventilation and air-conditioning (HVAC) systems are the single largest energy-intensive processes in healthcare institutions, contributing to 46% of the overall energy consumption. Lighting consumes approximately 16% of the total energy in healthcare institutions and is the second largest consumer of energy. At this stage, obsolete equipment has been replaced with higher efficiency equipment available on the market. However, limited energy-management activities have been applied, increasing the equipment efficiency at the conceptual level. Therefore, in this section, basic energy management through the implementation of additional equipment is considered.

Recently developed HVAC systems, operating at higher efficiencies , have been purchased and installed. Nevertheless, external HVAC equipment efficiency improvement activities have not been considered. Hence, the following may be considered at the active level to enhance HVAC equipment efficiency

3.2. Operational Efficiency

The operational efficiency may be improved by applying effective control techniques in conjunction with the newly acquired equipment .Therefore, human intervention will be discussed in terms of implementing effective control techniques to improve the operational efficiency. Operational efficiency of HVAC equipment is improved by reducing VSD operating speeds.

In Dezfouli et al. [14] noted a maximum energy saving of 82% when motor speeds were reduced by62%, while a minimum saving of 23% was obtained at a speed reduction of 10%, in terms of energy consumed by motors (fans) in air-handling units (AHUs).

IV. IMPORTANT FINDINGS FROM LITERATURE

The performance operation equipment and Technology energy-management framework is an effective tool for evaluating and improving a building or large-scale system's energy efficiency. Potential energy-efficiency improvements were proposed, based on the four performance operation equipment and Technology energy-management levels. These levels were discussed throughout the previous sections of this paper, and are: the conceptual, active, technical and further improvement level. systematic review was conducted, from a performance operation equipment and Technology perspective, to which three research questions were raised. The research questions and the motivation behind the questions are presented in the method section of this paper. The first research question was introduced to evaluate the existing evidence base regarding potential energy and cost savings of energy-efficiency initiatives applied to healthcare institutions. This prompted an extensive search of available literature. A large body of scholarly articles was available on energy-efficiency initiatives with regard to HVAC and water-heating systems. However, studies were limited for the specific cases of healthcare institutions. It was further necessary to obtain regional data to assess the environmental influence on particular case studies. For these instances, research was similarly lacking. Therefore, with the available data from scholarly articles, approximations were made to attain average energy savings for each energy-efficiency initiative.

V. Conclusion

- The energy usage intensity of healthcare institutions, particularly in South Africa are nearly three times that of typical commercial buildings.
- The two main thermal energy consumers in South African hospitals were identified as HVAC and water-heating systems. These consumers account for approximately 59% of the total energy consumed in the evaluated buildings.
- Energy efficiency initiatives and associated potential energy savings where identified at each level, which included; the conceptual level, active level, technical level and further improvement.
- Energy efficiency activities at the technical level and the further improvement level may result in savings of 48%–68 % and 5%–10%, respectively. These savings may not be attainable in some instances, due to economic barriers.

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