KEMENTERIAN PENGAJIAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

POLITEKNIK MALAYSIA
TUANKU SYED SIRAJUDDIN

National Conference on TVET for Undergraduate Students

e-Proceedings NCTS 2022

NATIONAL CONFERENCE ON TVET FOR UNDERGRADUATE STUDENTS

E-PROSIDING
NATIONAL CONFERENCE
ON TVET UNDERGRADUATE STUDENTS
2022

This book contains information submitted by the author based on his knowledge, experience and expertise in the field of teaching cost accounting. In addition, this book also contains some information obtained from other parties whose original source is stated through reference.

However, since this book only covers topics related to element costs then readers are encouraged to refer to the contents of other related books to gain a detailed understanding in cost accounting.

Published by:
Politeknik Tuanku Syed Sirajudddin (PTSS)
Pauh Putra, 02600 Arau, Perlis
Tel No. : 04-988 6200
Fax No. : 04-988 6300
www.ptss.edu.my

e ISBN 978-967-2258-97-1

9 7 8 9 6 7 2 2 5 8 9 7 1

e-Proceedings NCTS 2022

THE IMPACT OF HVAC SYSTEM TOWARDS ELECTRICITY CONSUMPTION IN TERM OF ENERGY SAVING

Nur Farahin Mazelan[1], and Dr.Sr. Fadhilah Mohd Noor[2]
[4] Civil Department, Polytechnic Sultan
Salahuddin Abdul Aziz Shah, Selangor
farahin_mazelan@yahoo.com
fadhilah@psa.edu.my

Abstract

The HVAC system has evolved into a valuable asset that affects a building's performance in terms of the services it provides. A building fault can be defined in a variety of ways. Based on personal experience and observation, a building flaw was linked to energy waste, which resulted in unsatisfactory living conditions. There are a lot of reasons for this, including faulty control programming, design defects, mechanical degradation, and occupant behaviour, and etc. This research study intends to recommend the best practices to reduce the electricity consumption on HVAC system. The factors that impact on HVAC system is; the technology or system of hvac, users and cost that involve during operation and maintenance activities. The respondent's information was gathered using a descriptive survey technique. The target population, there were 60 respondents who represented all management levels, including facility managers, energy managers, and mechanical teams. The sample size was 57 respondents. A combination of qualitative and quantitative approaches will be used in this study in the form of graphs. The findings suggest that, the Variable Speed Drive (VSDs) controller was able to reduce electricity consumption, provide maximum comfort, ensure good HVAC equipment conservation and, most importantly, can save more than 34% of energy consumption.

Keywords: HVAC system, electricity consumption, energy saving and Variable speed drive (VSDs).

1. Introduction

Today's attempts to reach the objective of Near Zero Energy Building Conditions have resulted in high levels of thermal insulation for building envelopes and high-efficiency HVAC systems for both hot and cold production (Paoletti et al., 2017). Although electricity is utilised to assist in the movement of HVAC components such as fans and pumps, the proportion of energy quota is particularly important in achieving the environmentally friendly according to the building occupants' need, which is previously discussed in term of improvements.

The household and business sectors consume the majority of energy. Heating, ventilation, and air-conditioning (HVAC) energy demand accounted for 30% of commercial building primary energy consumption and 39% of residential building primary energy consumption in 2018 (Chen et al., 2018).The implications are on energy usage and occupant quality of life, and one of the key goals of this study is to reduce energy use while maintaining thermal comfort. (2016, Isa et al.) The goal of this study is to enhance energy efficiency in HVAC systems, which is an important goal in the facility management (FM) business, by using Building Management Systems (BMSs) to control HVAC operations as well as other assets in the building.

Except in HVAC systems, a fundamental present to energy savings can be gained by installing a device that can adjust the motor speed based on the real requirement and building demand based on the size of the HVAC system. Variable speed drives (VSDs) are used to modify the rotational speed of electric motors and, as a result, the equipment that is powered by the motor (fans, pumps etc.). Apart from that, the VSD technology allowed the components to run in parallel and independently using Building Management Systems (BMSs), confirming the capacity to ensure quality. Variable speed motors, such as fans, pumps, and compressors, have components that perform differently depending on their speed changes.

Furthermore, the BMSs can be used to save data that is needed to assess the performance of the building-plant system, particularly the status of all operative systems and the resulting energy consumption. All of these data are used to model the likely results of several alternative operation procedures, with relevant comparisons and improvements has been made.

Finally, in the field of HVAC system service, a comfortable aspect was a basic element of energy conservation, environmental friendliness, the use of natural energy, lower the energy load, and should be the direction of future architectural design. The main purpose of this study is to attain zero energy consumption through reducing building energy consumption, as well as to create and promote new energy as a future resource replacement (Pang et al., n.d.)

2. Literature Review

In the past years, the researchers have examined studies on the impact of HVAC system towards electricity consumprion in term of energy saving. Figure 1 shows the conceptual framework that influence the electricity consumption on HVAC system in building facility.

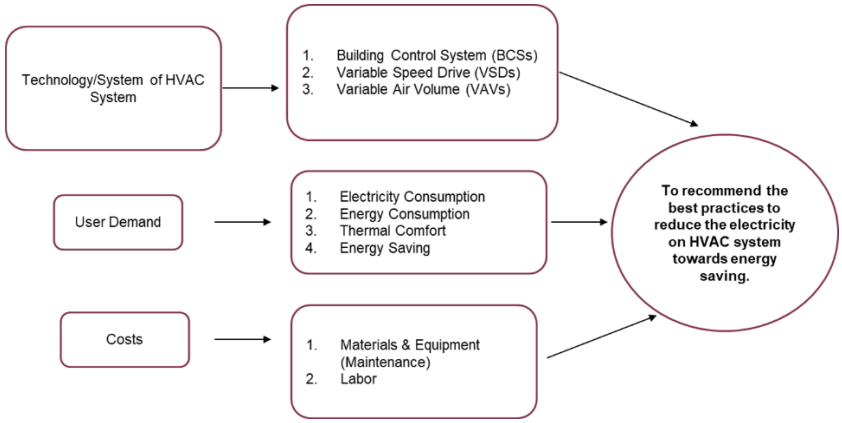

Figure 1: Conceptual Framework

2.1 Description of Technology/ HVAC system

Nowadays, due to rising costs for fossil fuel and reduction of resources, producing electrical energy from renewable sources and lowering the electrical usage in the government building become a huge topic addressing in the globe.

A building management system (BMS) is a complete platform that are currently installed to monitor and control a building's mechanical and electrical systems; it is used to manage loads and improve efficiency, reducing the amount of energy required to light, heat, cool, and air a structure (HVAC). The electric motors consume a significant amount of energy on a daily basis because most motors are used in HVAC (Heating, Ventilation, and Air Conditioning) systems as Air Handling Units (AHU) or Fan Coil Units (FCU) to provide comfort environment for their occupant. AHU is a huge metal box with blowers, motor, filter, cooling coil, heating coil, damper, and ductwork. It is responsible for supplying air to various regions of structures. But, the structure and the quantity of AHU components such as fans, ducts, and dampers should be designed based on the cooling load and zone capacity of the building.

The outside air can mix with return air from a room in the duct before being filtered. The air is then sucked into the heating or cooling coil by a fan or blower. Different zones of cool or hot air in the supply air duct might be created. FCUs are likewise part of an HVAC system and perform the same functions as AHUs. However, FCUs are often positioned in rooms and do not have ducts, whereas supply air from an AHU is delivered to rooms by ducts. Because the AHU system is more comprehensive and larger than the FCU system, the blower motor power (hp) in the AHU is substantially higher than in the FCU. To provide a comfortable environment for structures. The high energy consumption of the blower, dehumidification, and fresh air utilisation all contribute to the enormous amount of energy used.

The HVAC systems are powered by hot or cold water generated by heat exchangers in the building and are found in practically in government buildings, with mechanical space heating and cooling systems accounting for over 90% of floor space (Ru et al., 2018). By the exception of thermally triggered systems that use natural gas or district heating for space cooling system is driven by electricity (in the form of steam or hot water). The activities of the facility, building size, layout, climate, geographic region, existing equipment or distribution system, and other factors are influence the type of HVAC equipment utilised in a building.

The air flow rate of the AHU provides enough ventilation in the rooms. The CO2 sensor system is present. Each room has its own supply and return air ducts, allowing for independent ventilation control depending on CO2 concentrations detected by a CO2 probe installed in the return air duct of each room. Air dampers were installed in the supply and return air ducts immediately attached to the AHU. Static pressure sensors are installed downstream of the supply fan and upstream of the return fan, and linked to the fan speed controller (VSD) to maintain a constant air pressure in those areas. As a result, the control relies on the inverter devices that controlled the AHU's fans. A conventional PID algorithm controls synchronised movement of the air dampers and the fan speed controller. The performance of the system (VSD's) significant reduction in energy consumption. Many efforts have been made to develop the best practices for controlling HVAC systems in order to cut energy costs. This study has been conducted on small-scale for HVAC control issues (Dezfouli et al., n.d.).

2.2 User Demand

One of the biggest causes of uncertainty in simulation systems' predictions of building energy usage is user which is the occupant behaviour. Building operation and, consequently, energy usage are strongly influenced by how occupants establish the comfort requirements (including thermal, visual, and acoustic), interact with building energy and services systems, and react to uncomfortable environmental conditions.

By opening and closing windows, dimming lights, turning on and off office equipment, operating HVAC systems, and establishing interior thermal, auditory, and visual comfort standards, occupant behaviour directly and indirectly influences the building's energy usage. Even amongst buildings serving the same purpose and situated in similar climes, measured energy usage of structures revealed significant variations. Behavioral studies that encourage changes in occupant behaviour resulted in energy savings of 5 to 30 percent.

Daily electricity consumption profiles from smart meters are explored as proxies of active behaviour regarding space heating and cooling. The influence of the environment air temperature on electricity consumption (Rahman et al., 2018).

2.3 Costs

The total investment costs of an HVAC system include both direct and indirect costs associated with transforming material and equipment design ideas into operational projects. The cost of all HVAC equipment, as well as the materials and labour needed in the actual installation of HVAC systems, account for the majority of direct costs. Indirect costs are associated with the support of direct construction required for a project's timely completion. Many design aspects influence investment cost, including an HVAC price index, HVAC technology, building type, building quality, and building regionality. Buildings that are constructed to satisfy the same or similar needs often necessitate varying costs due to design differences.

Cost modelling, according to (Cho et al., 2018), is a current methodology for estimating the projected cost of a proposed building project. Cost modelling, according to Ferry and Brandon, is a symbolic representation of a system that communicates the contents of that system in terms of factors that determine its costs. Clients will influence business decisions in anticipation of reliable projections at the early stage of construction projects, and investment cost is a key measure of the project's success.

Because of the rising importance and complexity of modern structures, which have a substantial impact on the relative costs to the total cost of building projects, effective cost management of HVAC systems in buildings is highly desirable for industry stakeholders. The demand for specialised quantity surveyors, who are responsible for cost control of HVAC systems, has increased as a result of the rising complexity and cost sensitivity of HVAC systems.

2.4 The Conclusion

Based on the article, the independent variables are shown that the HVAC system is the main factor that influence on reducing the electricity consumption for HVAC system in term of energy saving. In the field of air conditioning, comfortable and become a basic subject in today's architecture and design of energy conservation, environmental protection, use of natural energy, reduce the energy load, become the direction of the future architectural design. Reduce building energy consumption has also been a HVAC researchers goal, strive to achieve zero energy consumption, and also has a lot of scholars have made great contributions in this area. At the same time, we should also actively develop new energy, and promote new energy such as solar energy, geothermal energy, and atomic energy.

3.0 Research Methodology

3.1 Research Design

This research used a mixed method approach (quantitative & qualitative) in combination to provides a better understanding for research problems. The mixed method study uses for the research design is to analyze the impact of HVAC System on electricity consumption in terms of energy saving.

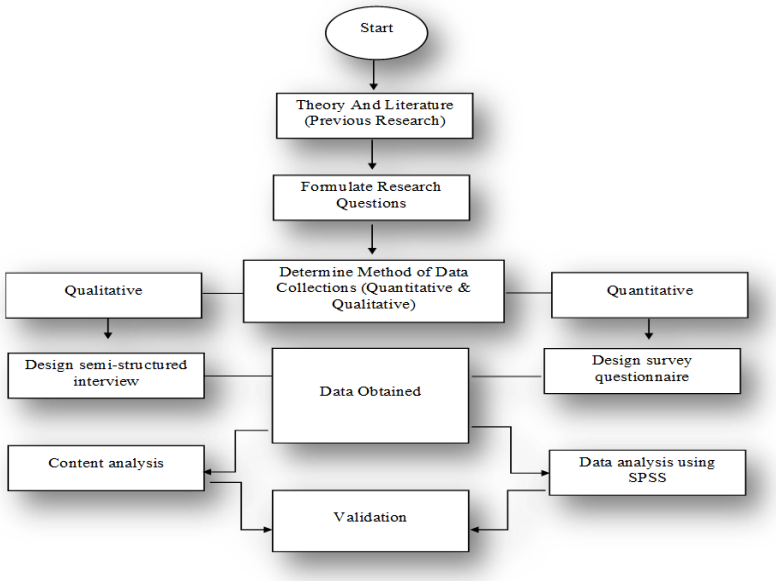

Figure 2: Research Design

3.2 Research Instrument

The research instrument used to recommend the best practices to reduce the electricity consumption on HVAC system by conducting the questionnaire and interview survey to the respondent for each building that was selected.

4.0 Findings and Discussion

Table 1: Target Population

Building	Total Population	Total Respondent
Menara Usahawan (MU)	**15**	**14**
Kementerian Perumahan dan kerajaan tempatan (KPKT)	**10**	**9**
Kementerian Pengajian Tinggi (KPT)	**15**	**14**
Kementerian Pelancongan dan Kebudayaan (MOTAC)	**10**	**10**
Kementerian Wilayah dan Persekutuan (KWP)	**10**	**10**
Total	**60**	**57**

This research involved 5 buildings, it includes, Menara Usahawan, Kementerian Pengajian Tinggi, Kementerian Perumahan dan Kerajaan Tempatan, Kementerian Pelancongan dan Kebudayaan and Kementerian Wilayah dan Persekutuan. Out of 57 from 60 participants answered this survey.

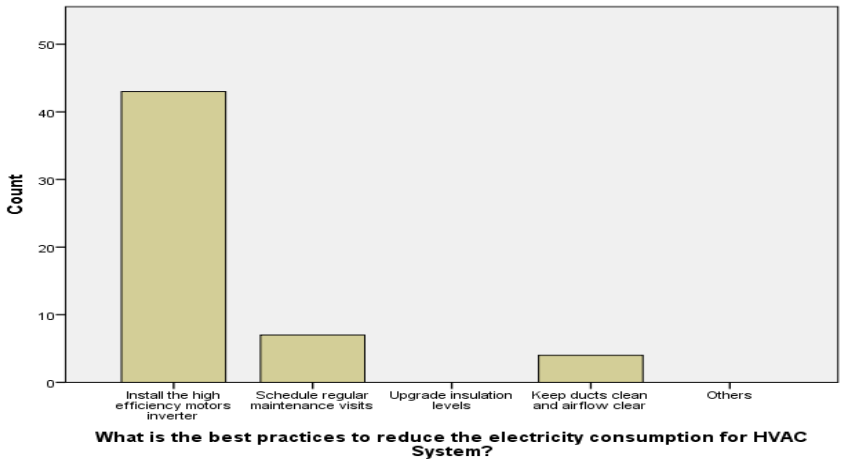

Figure: What is the best practices to reduce the electricity consumption for HVAC system.

From the diagram, it shows more than 40 respondent agree that install the high efficiency motor inverter are the best practices to reduce the electricity consumption for HVAC system for each building involve.

Besides that, less than 10 respondent chose schedule regular maintenance visits could reduce the electricity consumption on HVAC system due to Indoor air quality (IAQ) factor that requires regular maintenance in order to remain the HVAC system in good operating order.

Apart from that, About 5 respondents believe that keeping ducts clean and airflow clear will minimise the electricity usage. It's because a clear ducting allows for unrestricted ventilation and improves air quality for consumers and preventing from sick building syndrome occurred in the building.

The inference that can be drawn from finding is that variable speed drive (VSDs) is importance to reduce the electricity consumption on HVAC system because the VSDs allows to control motor speed which promote for energy saving. The implication of the

result is most of the respondent was agreed that the variable speed drive use to reduce the bills of electricity for HVAC system. Therefore, it is recommended that essential for the building to installed the variable speed drive to other equipment that use electricity to power on. Besides that, VSDs also may enhance the efficiency of equipment and its life expectancy.

5.0 Conclusions

In conclusion, the striking variables in results obtained that most of respondents agreed with the level of thermal comfort, the amount of power used, and the efficiency of VSDs to meet the user comfort. Additionally, it reduces the building owner's monthly power bill expenses. Besides that, from respondents' opinions and responses, the study concluded that the respondents perceive the impact of HVAC systems on power usage to reach the energy saving requirement. These results demonstrate that the respondents' level of awareness for energy saving and environmental-friendly is good according to the positive feedback from respondent in this survey question.

The author discovered that studies of the impact of HVAC system towards electricity consumption in term of energy saving have been efficiently explored. This study's purpose was achieved. This has been demonstrated through data analysis obtained.

6.0 References

Website:

Miu, Y. (2017, May 13). Analysis of HVAC Energy Saving Technology. Atlantis Press. https://www.atlantis-press.com/proceedings/icmeit-17/25876617.

Pang, Z., Chen, Y., Zhang, J., O'Neill, Z., Cheng, H., & Dong, B. (2020). Nationwide HVAC energy-saving potential quantification for office buildings with occupant-centric controls in various climates. Applied Energy, 279, 115727. https://doi.org/10.1016/j.apenergy.2020.115727.

Paoletti, G., Pascual Pascuas, R., Pernetti, R., & Lollini, R. (2017). Nearly Zero Energy Buildings: An Overview of the Main Construction Features across Europe. Buildings, 7(4), 43. https://doi.org/10.3390/buildings7020043.

Rahman, A., Srikumar, V., & Smith, A. D. (2018). Predicting electricity consumption for commercial and residential buildings using deep recurrent neural networks. Applied Energy, 212, 372–385. https://doi.org/10.1016/j.apenergy.2017.12.051.

Schibuola, L., Scarpa, M., & Tambani, C. (2018b). Variable speed drive (VSD) technology applied to HVAC systems for energy saving: an experimental investigation. Energy Procedia, 148, 806–813. https://doi.org/10.1016/j.egypro.2018.08.117.

Shi, W., Jin, X., & Wang, Y. (2019). Evaluation of energy saving potential of HVAC system by operation data with uncertainties. Energy and Buildings, 204, 109513. https://doi.org/10.1016/j.enbuild.2019.109513.

Watcharapongvinij, A., & Therdyothin, A. (2017). Energy cost saving evaluation of VSD installation in compressor rack of refrigeration system for the retail and wholesale building. Energy Procedia, 138, 8–13. https://doi.org/10.1016/j.egypro.2017.10.036.