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A Study into Utilization Building Automation System (BAS) In Energy Efficiency of HVAC system at Government Hospital in Kuala Lumpur

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Abstract: Building automation systems (BAS) help to optimise building performance, energy efficiency, comfort, and overall operational effectiveness.Over the previous few decades, the rate of global population expansion has accelerated the rate of world energy consumption. The focus of building energy management was on HVAC, which accounted for 50% of total energy usage. Defective actuators, valves, and dampers are the principal source of the building automation system in HVAC energy efficiency. The study's goal is to identify the types of Building Automation System (BAS) utilised at Pusat Perubatan Universiti Malaya (PPUM), to estimate energy efficiency utilising BAS in HVAC energy performance at PPUM, and to assess energy use using real BAS data. As a result, data gathering methods such as site visits, interviews, and data collection utilising real BAS data of each factor temperature, humidity, and ventilation within a building to be adjusted depending on occupancy, time schedules, and environmental variables were used. As a consequence, the energy consumption for OT room 1 is 22775.9 kW. The recommendation to examine present BAS integration may be taken into consideration for future research in order to better the future study. Investigate new BAS and HVAC trends and technologies that may increase hospital energy efficiency. Examine several BAS optimisation techniques that may increase energy efficiency in HVAC systems.

Keywords: BAS System, Energy Efficiency, HVAC, PPUM, Energy Performance

1 Introduction

Energy efficiency initiatives in all sectors are crucial for slowing the rapid growth in energy consumption, which may indirectly delay the depletion of fossil fuel reserves and the worsening of global climate conditions. The building sector, which has become increasingly complicated over the years, is critical to energy efficiency initiatives. Healthcare facilities were

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the second most energy-intensive construction sector in the United States, trailing only the food service industry, with an annual energy consumption of USD8.8 billion [1]. Furthermore, 58% of healthcare facility decision makers rated energy management as very critical to their organizations [2]. Naturally, the focus of building energy management was on Heating, Ventilation, and air conditioning (HVAC) which contributed 50% of building energy consumption [3]. Automation is the only way to increase the energy efficiency of complex buildings while balancing other demands.

Energy efficiency is frequently associated with using as little energy as possible to complete certain tasks, which can increase savings opportunities and avoid waste.Naturally, the focus of building energy management was on HVAC which contributed 50% of building energy consumption [3]. Healthcare institutions have high demands on HVAC systems to maintain a careful balance between infection control, indoor air quality, optimum management, and energy economy [4]. Additionally, defective actuators, valves, and dampers are the primary source of the building automation system in energy efficiency of HVAC system.

The Objective of this study is to identify the type of Building Automation System (BAS) used in *Pusat Perubatan Universiti Malaya* (PPUM), to determine energy efficiency using BAS in HVAC energy performance at PPUM and to analyze energy usage from real BAS data. This study focuses on the overall energy usage of the building and uses a calibrated energy model simulation to control a few key variables. This research will only look at HVAC factors that a BAS can monitor and manage. The purpose of this study is to evaluate the operation of Building Automation Systems to achieve energy efficiency. It is conducted both during the day and at night. This is because the hospital operates continuously. Data for this study will be collected every day at 10am for a month. The data analyse is only on AHU OT Room 1.This case study will focus on how much energy is used by HVAC systems; with the goal of measuring how much energy is used by PPUM buildings; Menara Utama. To achieve the objectives Project of this study, data will be taken through an energy performance on real BAS data to achieve the energy efficiency.

3 Methodology

A flow chart is formed as an infographic for the sequence of processes or parts involved in a system or activity. In this study, to determine the pattern of the situation, quantitative approaches were used. Therefore, the research methods and process of the study might be illustrated more clearly and understandably using this flow chart, as shown in Figure 3.1. To determine energy efficiency using BAS in HVAC energy performance at PPUM.

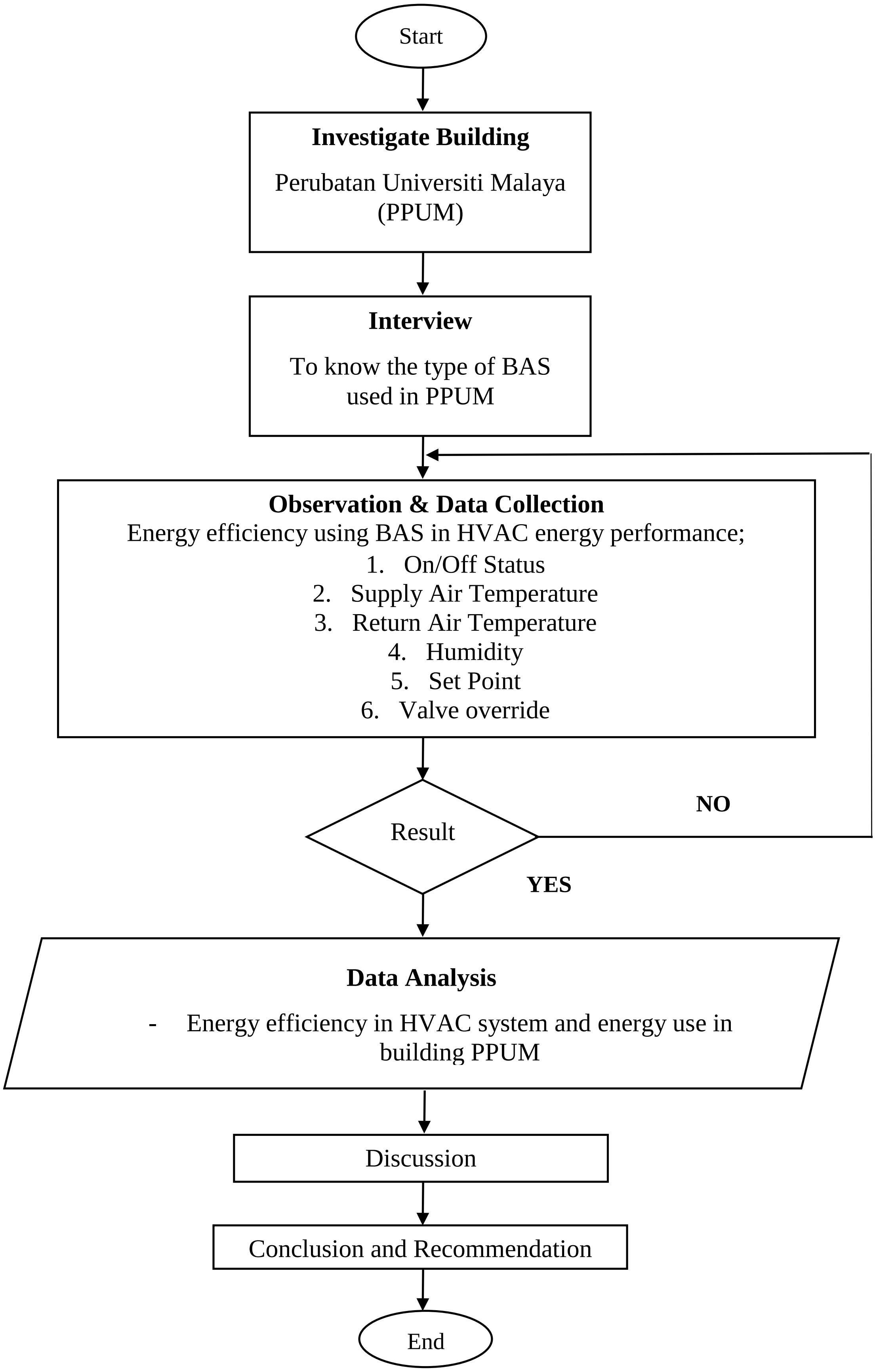

Figure 3.1: Flow chart for the sequence of this research

4 Results and Discussion

4.1 Questionnaire Analysis

This study contains three (3) aims and two (2) data gathering techniques, namely interviewing, observing, and collecting data. The sort of bus system employed at the University of Malaya Medical Centre (UMMC) was investigated using interviews. The following technique is to monitor and gather data using actual BAS data to assess energy efficiency in HVAC energy performance at PPUM using BAS. Following that, data analysis uses the same procedure for analyzing energy usage from real BAS data.

4.1.1 Type of BAS system

Pusat Perubatan Universiti Malaya (PPUM) building uses Modbus protocol for Building Automation System to meet the first aim of this study. Modbus is a serial communications protocol developed by Modicon for use with their Programmable Logic Controllers (PLCs) in 1979. It has now become one of the industry's de facto standard communications protocols, and it is the most widely accessible way of linking industrial electrical equipment. Modbus enables communication between several devices linked to the same network. For example, a system that measures temperature and humidity sends the data to a computer. . In Supervisory Control and Data Acquisition (SCADA) systems, Modbus is frequently used to connect a supervisory computer to a Remote Terminal Unit (RTU). Many data types get their names from their use in operating relays, such as a single-bit physical output being termed a coil and a single-bit physical input being called a discrete input or a contact.

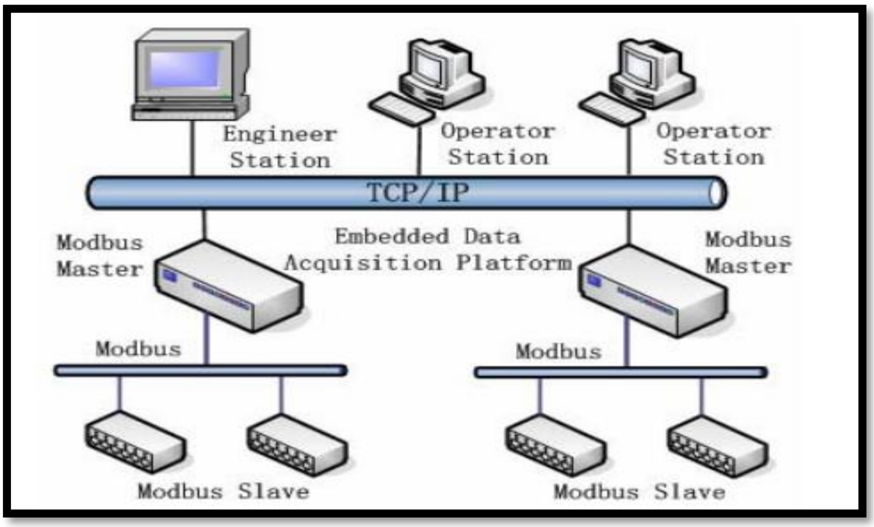

Figure 4.1: Architecture of the Modbus Protocol

According to Peng et al, (2008), It is the overall structure chart of the embedded data acquisition system, as illustrated in Figure 4.1. The integrated data acquisition platform is the foundation of this system, and data from the controlled plant connects with it via the Modbus protocol via all types of Modbus slave. Therefore, data gathering, data processing, and data transfer to the monitoring center's operator and engineer stations through TCP/IP are accomplished.

4.1.2 HVAC energy performance

Building automation system (BAS) data is frequently used in energy efficiency and optimization to find chances for savings in buildings. BAS data may be used to identify areas where energy usage can be optimized and offers insightful information about how building systems operate. . The term "real BAS data" refers to the actual data gathered and monitored by a building's BAS. Depending on the building's automation system and the sensors and meters installed within it, the specific data points and characteristics might vary. Data related to heating, ventilation, and air conditioning (HVAC) systems. This includes information such as temperature readings, humidity levels, setpoints, equipment operating modes, and runtime data for HVAC equipment like chillers, boilers, air handlers, and pumps

1) Scheduling

Figure 4.2 displays a graph in Operation Theater (OT)1 between Return Air Temperature (RA) and Modulating Valve (MV). The BAS system evaluates the temperature of the return air against a predetermined setpoint. If the return air temperature is greater than the setpoint, as in the first bar graph, where the RA is 21.9 °C higher than the setpoint of 18 °C and the valve is 100% open, the room or zone is warmer than planned. To cool the space, the BAS system can then tell the valves to increase the flow of supplied water. If the return air temperature is lower than the set point, the BAS system can adjust the valves to lower the supply air flow or the heating system to maintain the required temperature, as shown in the fifth bar chart (RA 18.6 °C, set point 22°C, and valve open 74.80%).Valves in the BAS system is equipped with actuators that can modify their locations based on BAS control inputs. If the return air temperature deviates from the setpoint, the BAS system can adjust the valve positions to manage the flow of supply air. This modulation enables precise control of the heating or cooling capacity given to the room, assisting in maintaining the optimum temperature and improving energy efficiency.

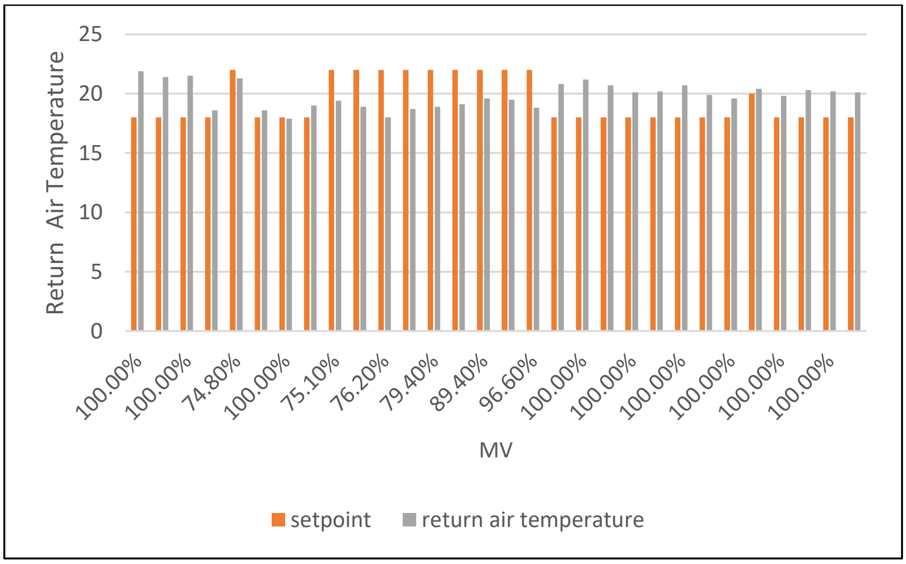

Figure 4.2: Graph between Return Air Temperature with Modulating Valve

2) Economizer

Figure 4.3 shows the air supply temperature and Air return temperature reacting with the set point that has been set in the operation room. The supply air temperature, return air temperature, and set point are all interrelated variables in a Building Automation System (BAS) that play a part in maintaining the ideal conditions within a controlled environment. The BAS continuously compares the return air temperature with the set point. If the return air temperature is higher or lower than the set point, the BAS adjusts the HVAC system's operation to bring the temperature back to the desired level. For example, if the return air temperature is higher than the set point, the system may increase cooling or decrease heating to lower the temperature. Conversely, if the return air temperature is lower than the set point, the system may increase heating or decrease cooling.

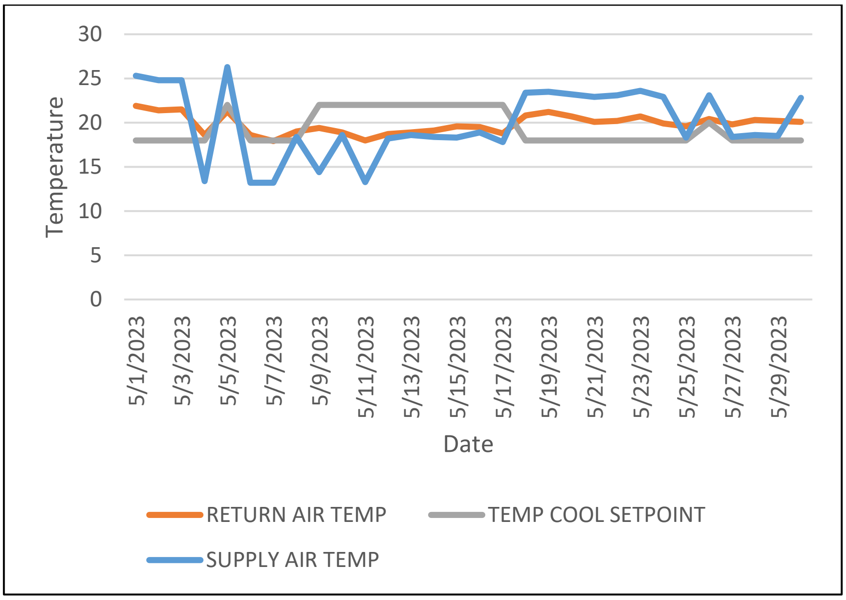

Figure 4.3: Graph of air temperature

3) Optimization

According to figure 4.4, the humidity for AHU 1 - OT2-duty is displayed. The room humidity is less than the overall humidity setpoint of 55.00%RH from May 1 to May 3, 2023. Then, from the setpoint value, the room's humidity increased by 55.5%RH on May 4, 2023. The rating of the room humidity fell slightly on May 5 and May 6, 2023. Additionally, on May 8, 2023, the room humidity value climbed by 58.9% RH. Finally, between May 5 and May 30, the room humidity value fell just a little short of the set point value that had been established for the operating theatre room. The BAS system offers energy-efficient humidity management in the OT. By connecting with HVAC systems and employing advanced control algorithms, BAS can optimize humidity management while minimizing energy use. The humidity set point may be adjusted by BAS based on occupancy, surgical operations, and external circumstances, establishing an optimal balance between humidity management and energy economy.

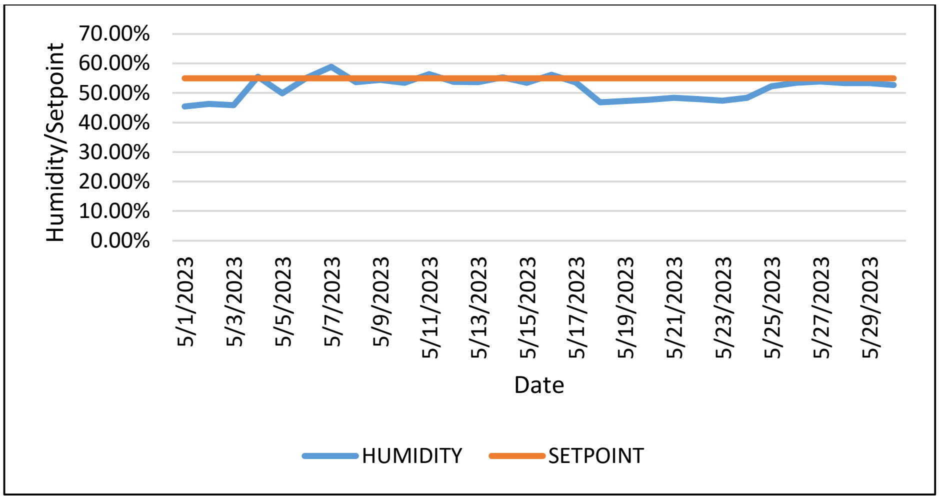

Figure 4.4: Graph between humidity and setpoint

4) Delta T

Figure 4.5 shows the graph of delta T In a Building Automation System (BAS), "delta T high" usually refers to a large temperature differential in an HVAC system. BAS systems are used to monitor and regulate various building systems, such as heating, ventilation, and air conditioning. In this application, "delta T high" denotes a considerable temperature difference between the supply and return sides of an HVAC system. The "delta T" is derived by subtracting the supply air temperature from the return air temperature.

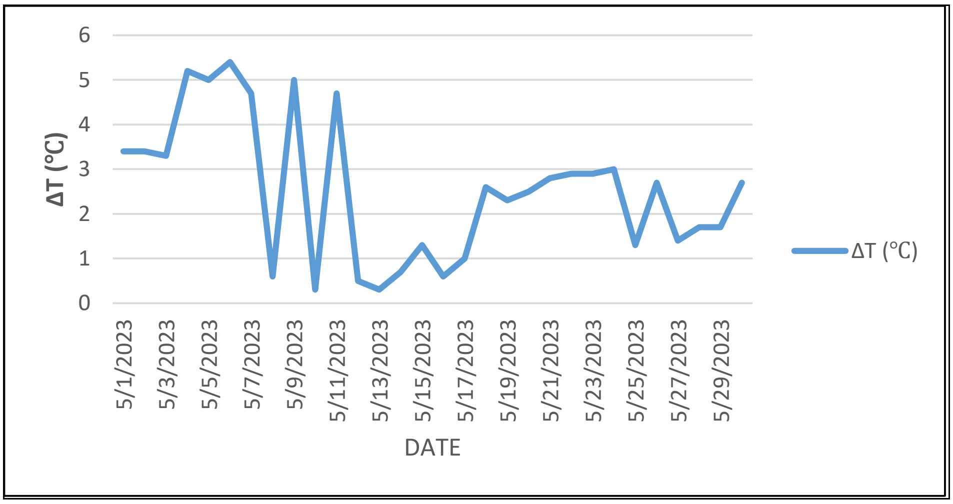

Figure 4.5: Graph of delta T

5) Energy usage

Figure 4.6 depicts a graph of the cooling load in the Ot room during a one-month period, with the cooling load exceeding 1000kw from May 1 to May 7. However, on May 8, the cooling load was just 191.4kW. On May 9, the cooling load increased by 1595.0kW, but decreased down to 159.5kW on May 10. Furthermore, the cooling load value is less than 1000kW from May 11 to May 30, 2023. The cooling load for an Air Handling Unit (AHU) in an Operating Theater (OT) within a Building Automation System (BAS) is determined by the specific requirements of the OT environment, which demands precise temperature and humidity control for maintaining a sterile and comfortable space. Hence, total of energy using from real BAS data for AHU OT1 is 22775.9 kW.

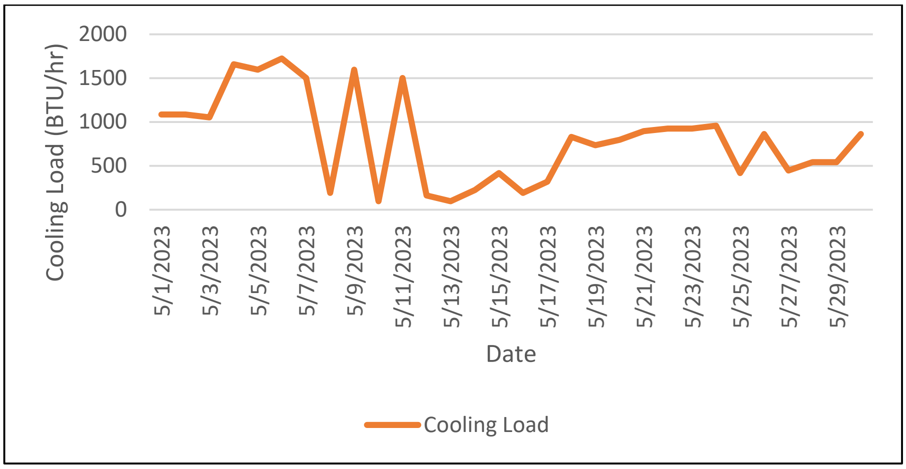

Figure 4.6: Graph of cooling load

5 Conclusion

In conclusion, the three objectives that have been proposed at the beginning of the research were achieved through quantitative and qualitative gathering techniques, namely interviewing, observing, and collecting data. In addition, the feedback of respondent for the first objective, The Modbus communication protocol is widely used and has even become the industrial standard. It is utilized as a communication standard between huge industrial equipment such as DCS, PLC, RTU, intelligent instruments, and so on. The high-performance embedded microprocessor is at the heart of the current generation of industrial automation data acquisition monitoring systems.

Next for the second objective, to determine energy efficiency using BAS in HVAC energy performance at PPUM. The use of a Building Automation System (BAS) may greatly enhance energy performance in HVAC systems. BAS is a centralized control system that combines multiple components of the HVAC system, allowing for optimal operation and energy optimization. These are the benefits and considerations of using BAS for energy performance in HVAC systems is improved control and automation. BAS offers sophisticated control features that make it possible to precisely monitor and modify HVAC system parameters including temperature, humidity, ventilation, and airflow.

Subsequently, the third objective of the study is to analyza energy usage from real BAS data, The energy usage for an Air Handling Unit (AHU) within a Building Automation System (BAS) depends on several factors, including the size of the AHU, its efficiency, the load it serves, and the control strategies implemented within the BAS. These are among the factors that affect the use of AHU energy in the BAS system are Size and Capacity of the AHU. The AHU's size and capacity, which are commonly expressed in terms of airflow volume (measured in cubic feet per minute, or CFM), directly affect how much energy is used. A big AHU could use more energy than necessary, while an undersized AHU might have trouble keeping up with cooling needs and use more energy as a result.

Finally, the researchers hope that this research can benefit all users of Pusat Perubatan Universiti Malaya (PPUM). The results obtained from interview and collected data, as well as any parties involved to increase energy efficiency in hospital HVAC systems..

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