Development and Evaluation of Building Energy Efficiency Through the Design and Implementation of Automation and Control Systems in Mozambique

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Objectives

The study aims to investigate the impact of automation and control systems on enhancing building energy efficiency in Mozambique. It seeks to assess potential improvements in energy consumption and operational costs by designing and implementing these systems. The research also intends to provide insights and recommendations for integrating such technologies to promote sustainable building practices in Mozambique.

Introduction

The importance of energy efficiency in the built environment has become a crucial issue worldwide, especially in Mozambique due to increasing urbanization and economic expansion leading to high energy consumption. As the nation strives to balance progress with sustainability, the integration of advanced automation and control systems into the fabric of building design and construction presents a promising solution [1].

Results

The collected data shows stakeholders in Mozambique are willing to work with the government to propose energy conservation strategies. Traditional building methods are still prevalent due to a need for more skilled labour and higher initial costs. Academics and engineers suggested using programmable thermostats, LED lighting, and smart control sensors to reduce energy consumption. Additionally, strategies for building orientation and insulation systems were proposed, resulting in a 14.7% to 34.5% reduction in power consumption for a two-bedroom apartment over a year.

Table 1: Total monthly electrical energy consumption
In kWh and cost for 2022 without proposed modification

Month	Price	kWh
January	19.83	351
February	17.52	324
March	15.38	300
April	15.65	303
May	14.42	241
June	20.4	315
July	25.87	306
August	28.13	448
September	26.47	429
October	17.28	322
November	19.29	345
December	20.62	361

Table 2: Total monthly electrical energy consumption in kWh and cost for 2023 with the proposed modification

Month	Price	kWh
January	26.65	431
February	26.74	432
March	23.19	390
April	21.16	367
May	20.46	315
June	27.49	319
July	31.42	495
August	36.79	536
September	33.2	505
October	24.88	410
November	22.62	384
December	25.23	414

Methodology

The study utilized the Delphi method to collect input from stakeholders with over 10 years of experience in building design. This involved repeated feedback cycles, face-to-face interviews, and online workshops. Smart active building management was employed to assess smart home building technologies, integrating hardware and software to establish an intelligent, dynamic environment system.

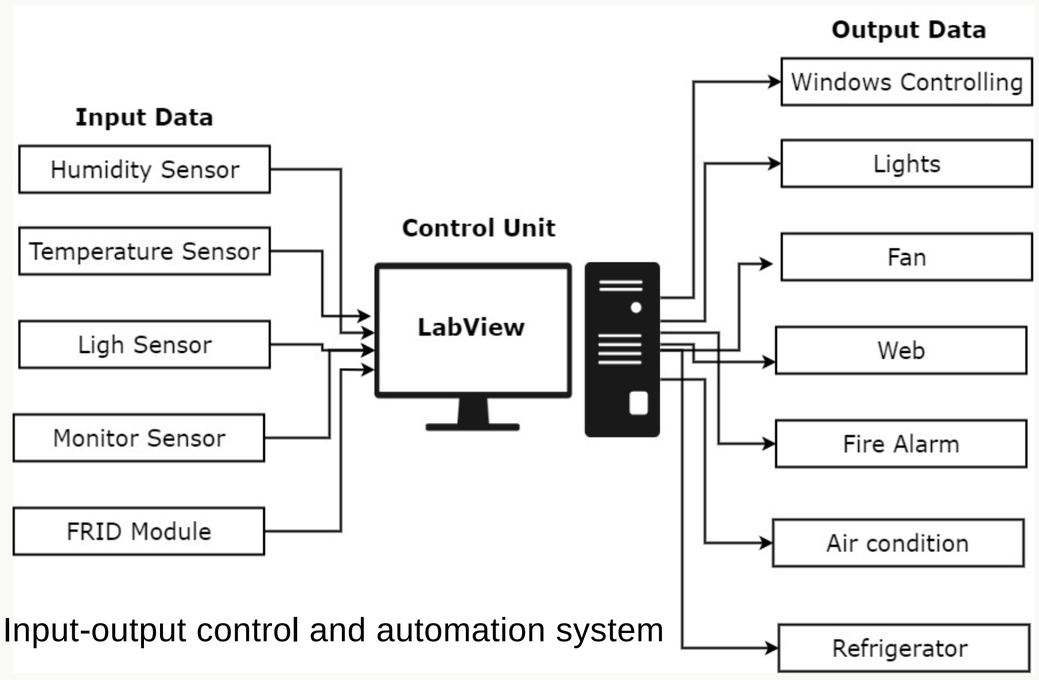


Figure 1. Input-output control and automation system

Building Energy Efficiency Project Setup

The algorithm for data collection and decision-making, utilises a finite state machine for systematic logic application, ensuring actions are based on a series of complex rules [2]. The key to this approach was the temperature and lighting control, which considers internal and external temperatures and motion detection to optimize energy use, detailed in our flow charts and state machine diagram.

Figure 2. Smart house structure and sensing elements

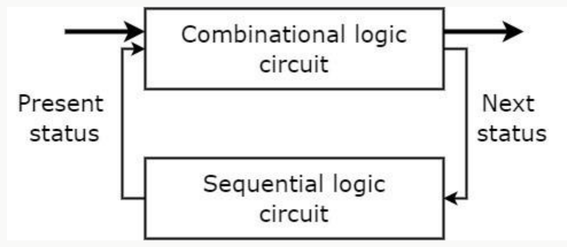
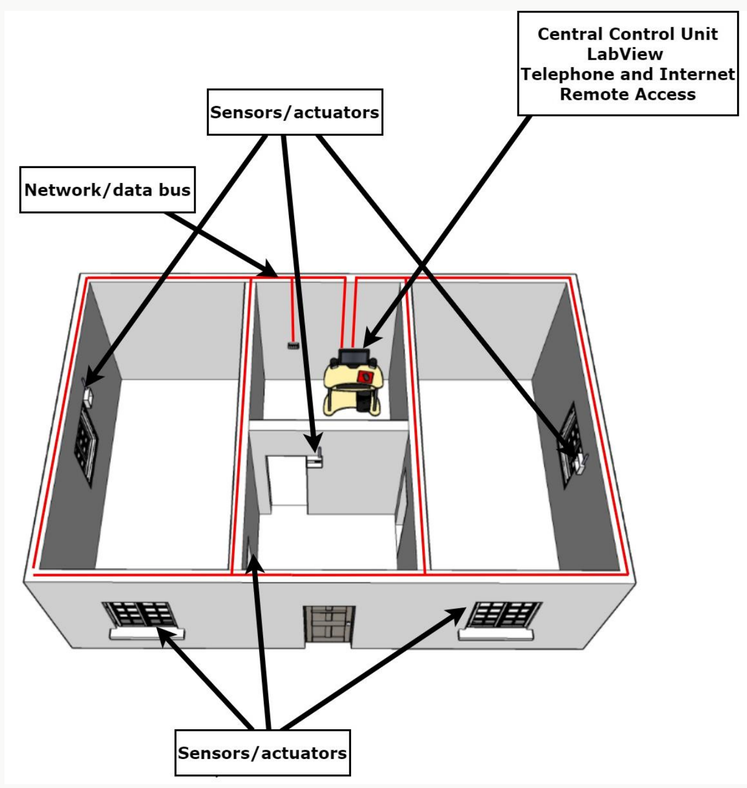


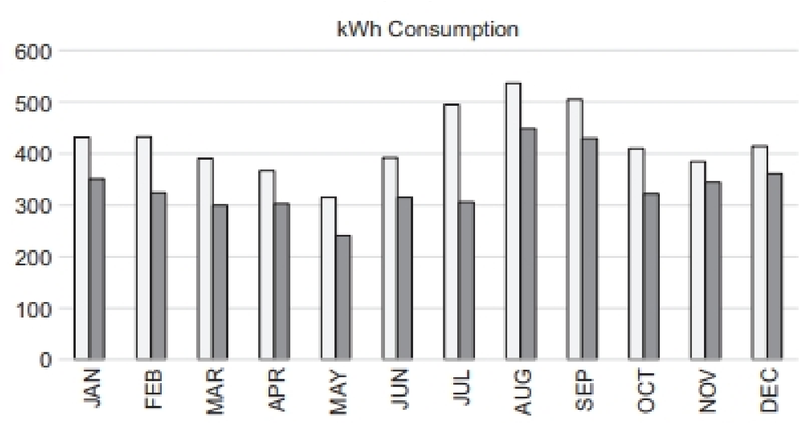
Figure 3. System state machine diagram



- The building management system enhances comfort and energy efficiency through automation and control systems.
- By integrating LED lighting, motion, and light sensors with LabView control, the system dynamically adjusts lighting based on occupancy and natural light levels, conserving energy without sacrificing comfort.
- A network of thermostats, heat sensors, and actuators, coordinated through LabView, optimally manages heating, cooling, and blinds, further reducing energy use and protecting against UV exposure.

This project aimed at reducing energy consumption and lowering utility bills in a 110m² two-bedroom apartment by integrating smart home technologies and passive methods in LabView.

Table 3: Electrical energy saving between 2022 and 2023 due to the proposed modification



Key Findings

- Automation systems play a crucial role in regulating energy-consuming components, leading to a significant reduction in overall energy consumption within buildings.
- These systems have the unique ability to swiftly detect and address faults in energy systems, ensuring efficient repairs, which is especially beneficial in areas with unstable energy supply and complex maintenance.
- Case studies and experimental results demonstrate the tangible benefits of integrating these technologies into building infrastructures, showing the potential to significantly reduce energy usage.

References

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【2】R., Zainaldain, A. (2011), Smart home gateway for smart grid. International Conference on Innovations in Information Technology, 2011, 90-93. Al-Hindi, I., Al-Sallami.