A Data-Driven Approach to Performance Improvement in University Dormitory Management Based on Internet of Things Technology

Yihao Ning[1*], Huibing Lai[2], Jinjia Zhuang[3]

[1]School of Converged Media Center, Hainan Vocational University of Science and Technology, Haikou, 571126, China
[2]School of Accounting, Hainan Vocational University of Science and Technology, Haikou, 571137, China
[3]School of Accounting, Hainan Vocational University of Science and Technology, Haikou, 571137, China
[*]Corresponding author: I24027287@student.newinti.edu.my

Abstract: *In the course of developing smart campuses and digitising the management of university logistics, the traditional dormitory management system has many problems, such as information lag, passive control, slow response times, resource waste and subjectivism, and has failed to achieve good governance. A Data-driven Dormitory Management Framework Based on the Internet of Things (IoT) for Perception, Intelligent Application and Performance Evaluation is Proposed in This Paper. Based on the above analysis, the general idea is to add real-time environmental monitoring and automatic control to the dormitory management system with Raspberry Pi 3B+ and DHT11. Based on the experimental results, the system can operate normally, automatically adjust the air conditioning according to the preset limit, and thus improve management efficiency and enhance the living environment for the students. Therefore, it can be concluded that the development of Internet of Things technology will help to promote the construction of an early warning and data-driven management system in university logistics and advance the digitalisation of the system.*

Keywords: *Internet of Things, Data-driven Management, university dormitory, performance improvement*

Introduction

The school should properly manage the university dormitories to ensure the safety of the students living there and maintain the good name of the university. With the development of higher education and changes in the demands of students, many deficiencies have appeared in the traditional model of dormitory management, such as low operational efficiency of manual labour, late detection of risks, poor energy use, lack of environmental control, slow service response, and no quantitative performance evaluation.

The development of Internet of Things (IoT) technology has been going well recently, and some problems have now been solved. Raspberry Pi 3B+ will be used as the embedded computer for the intelligent dormitory management system in this paper, and a DHT11 temperature-humidity sensor will be employed to obtain the present environmental data. According to the preset threshold control strategy, the air conditioner in the dormitory will be automatically turned on or off according to changes in temperature.

Continuously collect all kinds of related operating data on the environment and energy-use conditions, and thus, the first step of data-driven management has been achieved by means of IoT technology. Based on the above, this paper will build a data-driven performance-improvement system for university dormitory management and verify the feasibility of this system through development and function tests of the system. The purpose of this paper is to provide some technical support and practical ideas for improving the efficiency and intelligence of dormitory management.

1. Theoretical Basis and Technical System

1.1 IoT Technology Foundations

The four general stages of an Internet of Things system are Perception, Network, Platform and Application. Sensors, RFID, Bluetooth, Wi-Fi and other technologies have been used to connect the real world with information.

Raspberry Pi 3B+ is the small computer used in this paper, and a DHT11 sensor is employed to obtain environmental data. Real-time sensing and local processing can help to improve the living environment and safety of the people in the dormitories[1].

1.2 Data-driven Management Theory

At any time during the course of the management, data will be collected, organised, analysed, applied to make decisions and fed back. Management used to be based on tradition, but now we can identify problems and allocate resources more reasonably to improve the company's performance.

1.3 Performance Dimensions of Dormitory Management

Generally speaking, the main contents of the performance of dormitory management include safety supervision, staff administration, resource utilisation, service response, etc. The old mode of assessment is subjective and does not provide data. Be able to obtain outside data on how the company's performance has changed over time.

2. Problems and Performance Bottlenecks in Traditional Dormitory Management

2.1 Delayed Safety Management

The old way of managing dormitory safety is manual inspection, and it is not all-encompassing or timely. Therefore, many potential safety hazards, such as the use of electrical equipment and an unhealthy working environment, may go unnoticed until there is an accident; at that time, management will only be able to address the problem reactively rather than taking timely corrective action.

Without live supervision and intelligent operation, a considerable amount of energy will be wasted in the dormitories. One is that the electrical equipment has not been monitored for a long time, and thus there is energy waste and no data-driven energy management.

2.2 Passive Service Response

Service management in the old dormitories is relatively passive, and there is no manual reporting process with good transparency or tracking. Therefore, there will be late responses, poor organisation of work, low-quality services and dissatisfaction among students.

2.3 Lack of Quantitative Data

Most of the traditional dormitory management performance appraisals are subjective, and there is no basis in facts. Therefore, the reasons for the operating problems have not been found and continuous improvement cannot be carried out.

3. IoT-based Data-driven Framework for Dormitory Management Performance Improvement

There are some deficiencies in the current dormitory management system; thus, an Internet of Things (IoT) data-driven framework that covers all links in the data collection and analysis, application and feedback cycle is proposed in this paper. The framework is closed-loop; that is to say, it has been sensing, analysing, controlling and improving in a cycle to enhance the efficiency of management and the quality of service.

3.1 Data Collection and Integration Mechanism

At the bottom of the above framework is the collection of real-time data in the dormitory area. The main control unit in this paper is a Raspberry Pi 3B+, and one of the GPIO pins is connected to the DHT11 temperature and humidity sensor. Therefore, the environment will continue to be monitored and the collected data will be accurate and current.

Collect the data, and then send it to the central office for organisation and use. Gather all the data from various places, then normalise it to solve the problem of scattered data and build a complete data foundation for analysis and decision-making.

3.2 Data Analysis and Intelligent Application Mechanism

Based on the above data, the framework can offer all sorts of references for management. These are changes in the environment, abnormalities in the data, energy-use data, etc.; all of them can help improve the safety management and optimise resources.

Therefore, the direct intelligent control will be based on the analysis above. Automatically set the temperature of the air conditioner to a certain level and adjust the environment accordingly. First, we should actively deal with any problems in the course of operation to improve efficiency and service quality.

3.3 Analysis Layer: Data Processing

Based on the data in the performance appraisal system, keep doing so. Performance indicators can be obtained from real-time data, such as the current condition of safety and energy efficiency, service speed, etc., and are all objective.

Based on the results of the evaluation, adjustments will be made to the management plan; thus, the entire process will be in a continuous improvement cycle, and the efficiency of dormitory management will gradually increase over time[3].

4. System Construction and Functional Testing

4.1 System Architecture and Implementation

The intelligent dormitory management system proposed in this paper is based on the Raspberry Pi 3B+ embedded platform, and it will be used to collect and process data from all over the place. Connect the DHT11 temperature and humidity sensor to a GPIO pin of the Raspberry Pi, and then obtain the present environment information in the dormitory. Python will be used to obtain the data from the sensor, process the data, and execute the control algorithm in this system.

The Structure of the hardware and software in this system is relatively simple, and the three parts mentioned above are the sensing module, the control module and the execution module. Continuously collect the environmental data in the Sensing Module, and then, according to the rules in the Control Module, carry out some operations. The execution module will carry out the control decision and switch the air conditioner on or off. It will be more convenient to add new modules in the future.

Periodically collect the environmental data, send it to the embedded controller, and then the controller will filter and compare the data with a threshold. Then the processed data will be used to start the corresponding control action or saved for later analysis. Regularly collect and analyse the above data to find any problems in time and use this information to improve the company's management.

It will have a small investment and will be relatively simple to build and run stably. Based on a Raspberry Pi and low-power sensors, a prototype will be constructed, and then this prototype will be deployed in the real dormitory. The first goal of the new building will be to build an Internet of Things dormitory management system.

4.2 Control Mechanism and Operating Process

Due to the change in the environment at that time, the system will automatically adjust or regulate it in the dormitory. At this time, the environment data obtained from the DHT11 sensor will be regularly

read and then sent to the Raspberry Pi for real-time processing and application. At the top of this paper, an introduction to the system architecture will be given.

There is an upper and a lower temperature threshold for the control of the air conditioning device. If the measured temperature exceeds the upper bound of the high-temperature range, then a control signal will be issued to start cooling. If the temperature is lower than the lower bound, then this way will automatically turn off the device. To improve the stability of operation and reduce frequent switching, hysteresis is employed in the control circuit so that small changes in the sensor reading do not lead to fluctuations in the control.

At some times, the four steps of the system are to collect data, process the obtained data, set a threshold, and then output a control signal. The above steps will help us learn about the changes in the environment in recent years. Continue to run in this loop to respond promptly and reduce the amount of manual labour in the management process.

It is fully automatic and will be altered according to changes in the environment. It is relatively simple to operate and stable, so many people are also satisfied with this way. In brief, the control scheme put forward above will be employed to regulate the environment of the intelligent dormitory in an Internet of Things (IoT) manner.

4.3 Experimental Verification and Performance Analysis

To know how good the new system is, a small-scale test will be carried out in the dormitory at different temperatures. The three purposes of the experiment are to determine the accuracy of data collection, the speed of the control response and the stability of operation. Raise the temperature of the test gradually and observe the condition of the system in different environments.

Based on the above data, the system will be able to collect the environment data and work normally in a good environment. Sensor readings are in line with changes in the environment, have good measurement accuracy and are practical[4], and the system can respond quickly to changes; that is to say, it will generally adjust within a few seconds of reaching the set upper or lower temperature.

The system has been operating normally for a long time, is not slow or unstable, and there have been no data transmission errors. Set the threshold in the control and then stably obtain and process the data to ensure the normal operation of the system. Therefore, it can be concluded that the system will work normally in the dormitory under normal conditions.

The Aim and Result of the Proposed System are to automatically observe the environment and control intelligent devices. It can deal with the problems more promptly now and does not need to be done manually. Based on the above results, it can be concluded that the technical foundation for building the system is relatively strong, and the IoT-based data-driven framework put forward in this paper can be realised.

5. Data-driven Performance Improvement Strategies

Based on the IoT framework and system introduced in the previous section, the following three data-driven ways to improve dormitory management will be presented in this paper. The above ways can help to improve the safety of life, protect the environment and increase management efficiency.

5.1 Proactive Safety and Service Management

Most of the old dormitory management systems are reactive; people only learn about a problem after it has happened and then deal with it manually, so they cannot prevent risks in time. At the same time, an early warning safety management system can also be established based on the Internet of Things. Monitor changes in the temperature and operating environment of the equipment; if there are any abnormal situations, send an early warning notice so that the problem can be dealt with in time and not worsen.

It will be able to conduct the company's business normally in the future. Collect and analyse the data regularly to find any problems in the operation or maintenance early, and then deal with them before they become serious. Based on the above data, the service life will be short, and the process will be more open to the public.

Now that there is real-time supervision and automatic correction, the type of management has changed from passive to active. According to the data collected by IoT sensors, early warnings and countermeasures can be taken in time to prevent risks and improve the living environment for the people in the dormitories; thus, an efficient and intelligent dormitory management system will be built.

5.2 Adjustable Environment and Energy Management

Based on the actual data obtained from the DHT11 temperature and humidity sensor, the proposed system can change the environment, and thus it is based on data for joint regulation of the environment and energy. Constantly observe the environment in the dormitory, and according to changes in the environment, adjust the operation of devices to keep them in good health.

A Threshold-Based Control Method is Used for the Air Conditioner. If it is too hot or too cold outside, then turn on the air conditioner or heater. To improve the stability of operation and reduce the frequency of device switching, the control mechanism will be within the tolerance range and only be activated by substantial changes in the environment.

Help reduce the amount of electricity that needs to be used. According to the actual circumstances of the environment, the system will run more reasonably and have lower power consumption by not being idle. Based on the above data, we can distribute the energy resources more reasonably and make people more comfortable.

Environmental Sensing and Intelligent Control should be combined to promote the construction of green dormitories. The new way is better for the environment and more energy-efficient than the old way; it has been shown that IoT technology can help people obtain what they need with lower energy consumption.

5.3 Data-driven Decision-making and Performance Improvement

According to the data collected by IoT, some decisions will be made in the dormitory. Continuously collect and store the data of the environment and operation to obtain all-encompassing information on the dormitory's conditions, such as environmental conditions, use of devices and systems, etc. The above data will be used in the analysis stage to inform the company's management.

Based on the above data, all sorts of analysis can be carried out to find trends, identify abnormal circumstances and compare performance. The above analysis can help the managers know about any problems or risks in time and make more precise and effective decisions[5]. It is more objective and reliable than the old way of management based on experience.

Therefore, it was decided to build a quantitative performance appraisal system. According to the actual circumstances, some indices can be obtained to show the state of management at all levels. Based on the above evaluation results, the management will be strengthened and improved continuously in the coming days.

The above Optimisations will enhance the efficiency of daily dormitory management and gradually improve the overall living conditions for the students. In short, the above method shows that by analysing Internet of Things data in dormitory management, it is possible to build intelligent, data-driven dormitory management systems.

6. Support Measures

To guarantee the good operation and long-term development of the proposed IoT-based dormitory management system, full support will be provided in terms of technology, institution and operation in this paper. The above will help guarantee the stability of the system and the security of the data in the long run.

6.1 Technical and Data Support Mechanism

The first is that there is no good, stable and reliable Internet of Things network. A Raspberry Pi 3B+ and a DHT11 sensor are used in this paper to obtain some environmental data at different times. A safe and convenient way will be chosen to carry out the data transfer, and there will be no damage or loss during the transfer.

Only one Data Management System will be used to store, process and utilise all the data. General rules for the handling of data have been released to improve the quality and availability of data for future analysis and decision-making. The above measures will help to keep the stability and progress of the system in the actual dormitories.

6.2 Technical and Data Support Mechanism

An Organisation will be established to promote the standardisation of system operation. It will also set up data governance rules for the collection, use and storage of dormitory data. Some rules will be introduced to regulate the use of data reasonably.

At the same time, there is also the problem of privacy protection in IoT applications. Therefore, we have only collected the necessary data in this paper to reduce the amount of information. According to the roles of the users, some parts of the data will be unavailable or restricted for certain users to protect the privacy of students.

6.3 Operation and Resource Support Mechanism

The first two are a sufficient number of people and funds. At the same time, we will also hold training for staff on the operation of IoT devices and data platforms to improve their skills. A Technical Support Team will be set up to address any problems with the system and offer support.

At the same time, there are also considerable funds required for the construction, operation and development of the system. The funds will be used to purchase equipment, run the platform and carry out technological updates. By adding the human, financial and organisational resources of the system, it will have a stable operation and good performance in the long run.

7. Conclusion

Based on the Internet of Things (IoT) technology, a Data-Driven Dormitory Management Model will be introduced in this paper, and its actual application and experimental results will be verified. An embedded system based on the Raspberry Pi 3B+ and DHT11 has been used to obtain environmental data in real time and make automatic adjustments. Based on the above results, it can be concluded that the system will improve the efficiency of management and enhance the quality of service by building a closed-loop mechanism for data collection, analysis, decision-making and feedback; thus, the mode of management will be changed from reactive to proactive. Strengthen the implementation of the improvement plan, provide full support from the sides of technology, operation and institution, add them to the model for practical application and long-term development. In short, this paper has found that IoT technology can be applied to dormitory management, and it has offered a practical and extendable way to promote the digital transformation and intelligent governance of university residential areas.

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