AN INTELLIGENT CONSULTING SYSTEM FOR DEVELOPING BUILDINGS IN EDUCATIONAL INSTITUTIONS

By

Elgamal, A.F.
Prof. of Computer Science,
Faculty of Specific Education,
Mansoura University, Egypt

Elsaid, W. K.
Assistant of Prof. of Computer Science,
Faculty of Specific Education,
Mansoura University, Egypt

Mohamed, A. E.
Department of Computer Science,
Faculty of Specific Education,
Mansoura University, Egypt

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*Elgamal, A.F. *Elsaid, W. K. * Mohamed, A. E.

Abstract

The educational years at educational institutions are regarded as some of the most significant for students because they assist students in developing their personalities, abilities, and creative potential. Also, it will assist students develop into young adults who can make important contributions to society. Unfortunately, these days, educational facilities often suffer from various shortcomings that negatively impact the overall quality of education.

The paper proposes an intelligent advisory system for educational buildings. This intelligent advisory system aims to tackle several significant issues that arise during the construction of educational facilities. These issues include ensuring that rules and standards for education are followed, implementing energy- efficient and sustainable design concepts, and meeting the changing demands of contemporary teaching methods. By proactively addressing problems and reducing operational disruptions, this data-driven approach improves students' and staff's general safety and well-being. It adds to the longevity and sustainability of school buildings. Continuous data collection on temperature, humidity, and occupancy is possible using sensors in AI-driven school building assessments. In addition to facilitating predictive maintenance, which helps spot possible problems before they become serious, these sensors also improve energy efficiency by adjusting lighting, ventilation, and heating systems in real time. The combination of sensor data and AI algorithms improves the overall efficacy of infrastructure management in educational settings.

To determine the quality of the proposed system, it was evaluated on two levels: expert satisfaction and system accuracy. The obtained results showed that, a team of expert specialists confirmed the proposed system's

* Department of Computer Science Faculty of Specific Education Mansoura, Egypt

potential for widespread implementation in real educational settings. The obtained results showed that, a team of software experts confirmed the proposed system's potential for widespread implementation in real educational settings. Furthermore, the results showed that the proposed system achieved a high level of accuracy, reaching 93.1%, in identifying and resolving problems in the tested educational institutions.

Keywords: Educational Institutions, Artificial Intelligence, Advisory System, Expert Satisfaction Test, Accuracy Test.

1. INTRODUCTION

Technology's rapid development has drastically changed several industries, including construction and education. As hubs for innovation and learning, educational institutions need functional infrastructure that supports a changing pedagogical environment. The intricacy of organizing, creating, and building such facilities calls for a methodical and astute strategy to guarantee that they satisfy the various demands of stakeholders, such as academic members, administrative staff, and students [1].

Property companies worldwide are currently concerned about the need for technology-assisted property management that is both efficient and effective. A significant part of the government's function in many nations is regulating real estate sector issues [2]. Numerous technologies, such as data acquisition, analysis, and visualization, are integrated to offer safe, reliable, affordable, and high-quality smart buildings [3]. Many researchers see opportunities to use AI-powered capabilities in many aspects of the education process [4].

Sensor integration in school building assessments allows a more detailed understanding of the surroundings. For example, occupancy sensors ensure energy efficiency by optimizing HVAC and lighting systems based on real-time usage. Environmental sensors keep an eye on temperature and air quality to create a healthier indoor environment. Predictive maintenance is made easier by structural sensors' ability to identify wear and tear early. Together with AI, this extensive sensor network turns data into insights that can be used, improving the school infrastructure's responsiveness, sustainability, and resilience [5].

Light sensors adjust “artificial lighting” following natural light levels, promote energy efficiency, and create a comfortable learning atmosphere. Heat sensors contribute to temperature control, ensuring optimal comfort and energy conservation conditions. Together, these sensors, when integrated with AI, create an innovative system that adapts to changing conditions, reducing energy consumption, and enhancing the overall efficiency of school building management [6].

Assessing school buildings with gas sensors adds to an extra degree of security. These sensors can track a variety of gases and notify authorities of any anomalies, including gas leaks. By integrating gas sensors with AI systems, schools can enhance safety protocols, respond swiftly to potential hazards, and ensure students' and staff's well-being. This proactive approach significantly creates “a secure and resilient” educational environment [7].

This study investigates the creation of an intelligent consulting system designed explicitly for educational buildings. The system provides scenario simulations, real-time feedback, and predictive analytics to make well-informed decisions throughout the project. The suggested system uses machine learning and artificial intelligence to offer data-driven insights and suggestions throughout the building development, improve decision-making, optimally allocate resources, and raise building projects' general efficacy and efficiency.

The following is the order of the remaining portions of the paper: Section 2 describes the study problem. Section 3 outlines the approach. In Section 4, the pertinent study is demonstrated. Section 5 presents the study's materials and methodology. In Section 6, the proposed system are discussed. Section 7 talks about the study's results. In the final section, the study is concluded and future work is outlined.

2. STUDY PROBLEM

With the increasing demand for smart educational infrastructure that supports modern pedagogical needs, there is a growing necessity for intelligent systems that can provide accurate, data-driven recommendations during the building development process. However, current consulting methods do not adequately integrate artificial intelligence, building information modeling (BIM), or real-time data analytics to support decision-making in the early planning and design phases. This gap highlights the need for an intelligent advisory system capable of assisting stakeholders, such as architects, engineers, and educational administrators, in designing and developing educational buildings that are safe, sustainable, and adaptable to future requirements.

This gap highlights the need for an intelligent system that can assist all stakeholders, such as architects, engineers, and educational institution administrators, in designing and constructing safe, sustainable, and adaptable educational buildings that meet future requirements. This is precisely what the current study proposes: an intelligent advisory system for the development of buildings in educational institutions.

The primary goal of this research is to develop an intelligent advisory system that supports the efficient design and development of buildings in educational institutions. The proposed intelligent advisory system uses multiple sensors to identify building deficiencies during the planning and construction phases. It then provides the manager of the educational institution with a set of recommendations supported by accurate actual data about the deficiencies and proposes solutions to address them.

3. STUDY APPROACH

This study employed a descriptive approach to review the findings of previous studies on the research topic, in order to establish a theoretical framework. It also utilized an experimental approach to evaluate the effectiveness of the proposed system in identifying shortcomings in educational institutions, and to suggest solutions to address them.

4. RELATED WORK

Because it offers a precise overview of the most recent developments made by scientists in the field at hand, a literature review is an essential part of scientific research. In the discussion that follows, the most important prior research on the topic of the current study is reviewed and arranged chronologically from oldest to newest.

A study entitled “Smart home using local area network (LAN) based Arduino Mega 2560”, which was conducted by Kusriyanto & Putra (2016), aimed to design, build, and test a prototype for a low-cost smart home automation system. The research addressed the high cost and internet-dependency of many commercial smart home solutions. The primary barrier identified was the need for an affordable and reliable system that could operate on a private Local Area Network (LAN) without requiring a constant internet connection for basic control of home appliances. The study concluded that the developed prototype was successful, demonstrating that home appliances could be effectively and reliably controlled through a web-based interface hosted on the Arduino microcontroller. Furthermore, the study found that several design choices were independent predictors of the system's successful operation. Factors such as the use of an Arduino Mega 2560 for processing, the integration of an Ethernet shield for stable network connectivity, and the proper implementation of relay modules for appliance control were identified as the key technical factors ensuring the system's functionality [8].

A study entitled “Determination of environmental parameters based on Arduino-based low-cost sensors”, which was conducted by Mobaraki et al. (2020), aimed to design and develop a portable, low-cost environmental monitoring system using an Arduino microcontroller. The research addressed the prohibitive cost and lack of accessibility of professional-grade environmental monitoring equipment. The primary barrier identified was the financial and technical difficulty for educational institutions or citizen scientists to obtain real-time environmental data for analysis and learning purposes. The study concluded that the developed prototype was capable of successfully determining and displaying various environmental parameters, such as temperature, humidity, and air quality, offering a viable and affordable alternative to commercial devices. Furthermore, the study implicitly found that several elements were independent predictors of the system's accuracy and reliability. Factors including the careful selection and calibration of sensors, the efficiency of the data-processing algorithm running on the Arduino, and the stability of the device's power source were identified as critical factors for achieving dependable environmental measurements [9].

A study entitled “Environmental monitoring system based on low-cost sensors”, which was conducted by Mobaraki et al. (2020), aimed to develop and validate a low-cost system for monitoring environmental parameters that affect the durability of building materials and components. The research addressed the significant financial barrier that prevents widespread, long-term environmental monitoring in and around buildings. The primary barrier identified was the high cost of commercial-grade monitoring stations, which limits their use in many research and practical applications related to building science and material degradation studies. The study concluded that the Arduino-based prototype could reliably measure key parameters like temperature, humidity, and airborne pollutants, presenting a cost-effective tool for assessing the service life of building materials. Furthermore, the study highlighted that the system's utility was dependent on several factors. The validation of low-cost sensor data against reference instruments, the system's capacity for long-term autonomous data logging, and the successful integration of wireless communication for remote data access were identified as independent predictors of the system's reliability and practical applicability in the field[10].

A study entitled “Evaluation of low-cost angular measuring sensors”, which was conducted by Komarizadehasl et al. (2020), aimed to evaluate the accuracy and reliability of low-cost angular sensors for use in construction and structural health monitoring. The research addressed the high cost of industrial-grade sensors, which often limits their widespread application in monitoring projects. The primary barrier identified was the lack of validated data on the performance of affordable alternatives, leading to uncertainty about their suitability for engineering applications. The study concluded that while low-cost sensors exhibit more noise and lower precision than their expensive counterparts, they can provide acceptable accuracy for many monitoring tasks when their data is properly filtered and calibrated. Furthermore, the effectiveness of the data acquisition system and the implementation of appropriate signal processing algorithms were identified as independent predictors of the overall reliability and accuracy of the measurements obtained from these low-cost sensors [11].

A study entitled “Intelligent systems for functional improvement of buildings”, which was conducted by Omar (2020), aimed to review and analyze the application of intelligent systems in enhancing the functionality, efficiency, and sustainability of modern buildings. The research addressed the growing need to optimize building performance in response to environmental and economic pressures. The primary barrier identified was the complexity of integrating diverse intelligent technologies (such as IoT, AI, and automation) into a cohesive and interoperable building management system. The study concluded that intelligent systems offer significant potential to improve energy consumption, user comfort, and operational management, transforming buildings into responsive and adaptive environments. Furthermore, the successful implementation of these systems was found to be dependent on several factors. The establishment of open communication protocols, the development of advanced data analytics capabilities, and a focus on user-centric design were identified as independent predictors for achieving the full functional and economic benefits of intelligent buildings [12].

A study entitled “Assessing the energy resilience of office buildings: Development and testing of a simplified metric for real estate stakeholders”, which was conducted by Mathew et al. (2021), aimed to develop and test a simplified, actionable metric for evaluating the energy resilience of commercial office buildings. The research addressed the lack of practical tools for real estate stakeholders to assess this critical attribute. The primary barrier identified was that existing resilience assessment methods are often too complex and data-intensive for non-technical decision-makers, making it difficult to incorporate resilience into investment and management decisions. The study concluded that the proposed metric, based on a three-part framework, effectively quantifies a building's resilience and allows for easy comparison across a portfolio of properties. Furthermore, the study established three core capabilities as independent predictors of overall energy resilience: Robustness (the ability to withstand disruptions), Resourcefulness (the availability of backup power and resources), and Recovery (the speed at which normal operations can be restored). The metric provides a clear pathway for stakeholders to invest in measures that directly improve these factors [13].

A study entitled “Generative AI in business consulting: Redefining strategic insights”, which was conducted by Malaga et al. (2023), aimed to explore the transformative impact of Generative AI on the business consulting industry and how it can redefine the generation of strategic insights. The research addressed how consulting firms can leverage these new technologies to enhance their services. The primary barrier identified was the risk of over-reliance on AI without critical human oversight, which could lead to generic, biased, or contextually inappropriate strategies, alongside significant ethical and data privacy concerns. The study concluded that Generative AI is not a replacement for human consultants but a powerful augmentation tool that can automate data analysis and accelerate idea generation. Furthermore, the study found that the successful integration of Generative AI into consulting workflows depends on several key factors. The organization's ability to develop robust ethical guidelines, cultivate a culture of human-AI collaboration, and invest in training consultants to critically evaluate AI outputs were identified as independent predictors of achieving superior strategic insights and maintaining client trust [14].

A study entitled “The future role of artificial intelligence (AI) design's integration into architectural and interior design education to improve efficiency, sustainability, and creativity”, which was conducted by Almaz et al. (2024), aimed to examine and propose a framework for the integration of Artificial Intelligence into the curriculum for architecture and interior design students. The research addressed the slow pace of adaptation in traditional design education to rapid technological change. The primary barrier identified was the significant gap between the advanced capabilities of AI tools used in professional practice and the lack of structured pedagogical approaches to teach these technologies in academia. The study concluded that incorporating AI into design education is critical for preparing students for the future of the industry, positioning AI as a collaborative partner that enhances human creativity and analytical skills. Furthermore, the study asserted that several institutional and pedagogical shifts are independent predictors of a successful integration. Factors such as comprehensive curriculum reform, dedicated faculty training programs, ensuring student access to cutting-edge AI tools, and a strong emphasis on the ethical application of AI were identified as crucial for effectively improving student efficiency, creativity, and focus on sustainability [15].

5. MATERIALS and METHODS

The materials and methods of the current study include the following:

5.1 Study Design and Ethical Approval

The study was conducted at the beginning of the 2025-2026 academic year in several schools in Dakahlia Governorate, with the aim of identifying their shortcomings and developing appropriate solutions. Although this study does not involve sensitive human data, ethical approval will be obtained for expert interviews. All participants will provide informed consent, and their responses will remain confidential and anonymous. Data used for simulations will be non-identifiable and solely for research purposes.

5.2 Study Sample

The study was conducted using a random sample of schools in the Dakahlia Governorate, Egypt. The number of schools participating in the study was 50, distributed in approximately equal proportions among the various educational administrations in Dakahlia Governorate.

5.3 Study Instruments

The following methods were used to collect the required data from the study sample:

- The first method was used to measure the ease of use of the proposed system, by designing a questionnaire with multiple questions covering various aspects of software system evaluation.

- The second method was used to measure the effectiveness of the proposed system in identifying deficiencies in educational buildings and proposing solutions, through a practical experiment.

In this context, it is important to emphasize the methods used to ensure the validity and reliability of the study tools.

5.3.1 Validity of Questionnaire

To get expert opinions on the validity of the proposed questionnaire in measuring what it was designed to measure, the current study used the "Degree of Agreement Method". In order to use this approach, a group of subject-matter experts were shown the proposed questionnaire, and their responses were noted. According to the obtained results, 93.1% of the experts agreed that the proposed questionnaire is an acceptable tool for measuring the usability of the proposed system.

5.3.2 Reliability of Questionnaire

To ascertain whether or not the proposed questionnaire could produce the same findings when utilized again under comparable circumstances, the current study employed the "Test-Retest" method. In order to implement this approach, the proposed questionnaire was conducted on 10% of the study sample, and the findings were noted. Three weeks later, another 15% of the study sample underwent the same procedures, and the results were recorded again. The obtained results demonstrated that the reliability score of the proposed questionnaire was 0.92, which is considered a high level in different published scientific research papers.

5.4 Data Analysis

Data analysis is defined as the process of analyzing study data using statistical methods to obtain the necessary information. This study employed a descriptive analysis approach, and the data were analyzed using IBM SPSS software.

6. PROPOSED SYSTEM

To facilitate understanding of the proposed system, it will be divided into separate sections. Each of these sections will be explained in detail below:

6.1 System Overview

The purpose of the proposed intelligent advisory system is to assist with the planning and construction of educational facilities by continuously tracking and evaluating important environmental parameters like lighting, noise, humidity, temperature, and air quality. The proposed system uses information gathered from sensors both inside and outside the building, processes it via an ESP32 microcontroller, and then transmits it to an expert application on a personal computer. The data is assessed, adverse conditions are identified, and recommendations are made in real time to improve the learning environment and guide future building upgrades. A more efficient, student-centered educational infrastructure is guaranteed by the system's integration of environmental consciousness with wise decision- making.

To design an ideal educational institution building, the researcher takes into account the following two points:

A) School Building Specifications:

The design of a school building should possess several key characteristics, as shown in Figure 1. These include:

1. It should be simple and clear.
2. It should have aesthetic appeal, such as the use of attractive and visually pleasing colors.
3. It should be suitable for the educational process and the number of students.
4. It should provide infrastructure needs, such as electricity, sanitation, and water.
5. It should be compatible with the climate and weather fluctuations in terms of ventilation and lighting
6. It should provide public services, such as sports, social, medical, and

cultural services.

7. It should be compatible with safety requirements, such that it must be away from sources of danger, such as fires and accidents.
8. It should be away from humidity and sources of pollution.

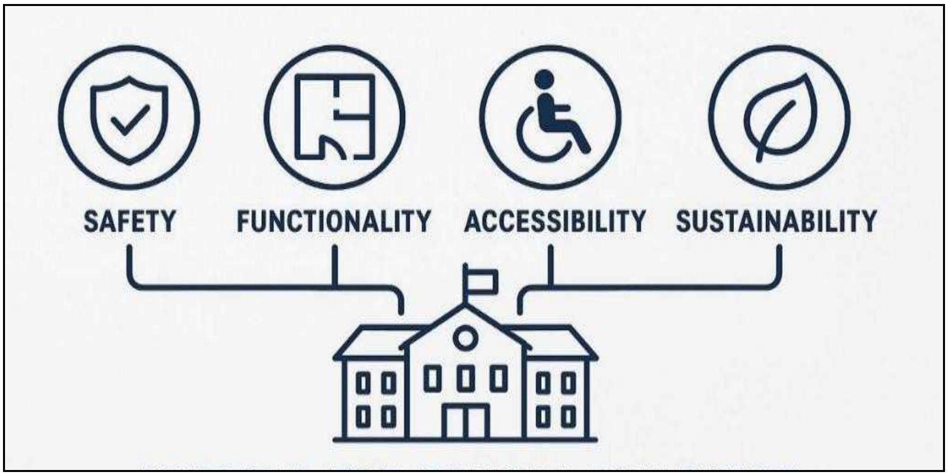

Figure 1: The major criteria for school buildings

B) Impact of Environmental Factors on the Educational Process:

It is well known that key environmental factors, such as temperature, humidity, air quality, noise, and lighting, directly affect concentration, comfort, and cognitive function. Poor air quality and excessively high or low temperatures can cause fatigue and negatively impact mental performance, while excessive noise and inadequate lighting can impair concentration and comprehension. Therefore, providing an optimal learning environment in schools and universities can enhance student engagement and improve learning outcomes, contributing to a healthier and more effective educational environment, as illustrated in Figure 2.

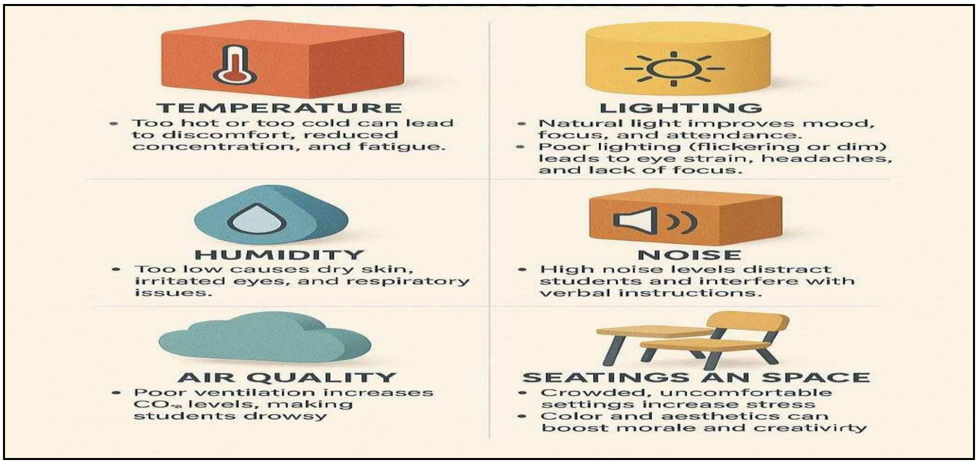

Figure 2: The impact of environmental factors on the educational process

6.2 System Flowchart:

The proposed system monitors the educational institution in real time, continuously gathering data from both internal and external sources to identify any shortcomings and provide recommendations for addressing them. This, in turn, contributes to improving the overall learning and teaching environment. A flowchart for the main operations involved in the proposed system is shown in Figure 3.

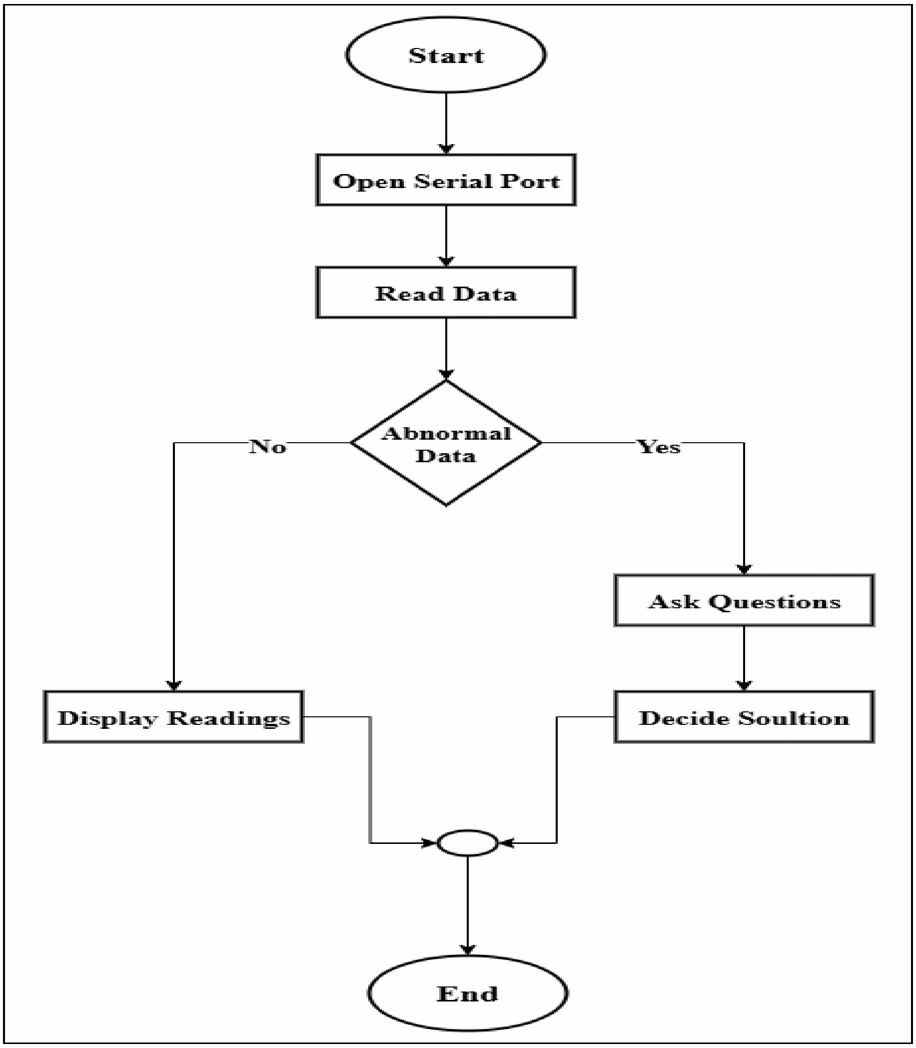

Figure 3: The steps of the proposed system

6.3 System Methodology

The methodology of the proposed system include the following procedures:

6.3.1 Data Collection:

- Gather architectural designs, construction data, environmental impact reports, and cost analyses from existing educational building projects.
- Collect user requirements and feedback from stakeholders

(administrators, teachers, students).

6.3.2 System Design:

- Define the architecture of the intelligent consulting system.
- Develop AI models for predicting costs, suggesting sustainable materials, optimizing space usage, and ensuring compliance with educational standards.

6.3.3 Implementation:

- Integrate AI models into a unified consulting system.
- Develop a user-friendly interface for interaction with the system.

6.3.4 Testing and Evaluation:

- Gather feedback from software experts about the usability of the proposed system.
- Performing practical tests to evaluate the system performance.
- Presenting the results and making recommendations.

6.4 System Components

Many components were used in building the system. These components can be classified into two categories: hardware components and software components. These components are described below:

6.4.1 Hardware Components:

It is used to sense the conditions of the surrounding environment and consist of the indoor unit and the outdoor unit. In addition, it is to measure the conditions inside and outside the building, as shown in Figure 4, and to simulate the process of measuring and containing components, as shown in Figure 5. This unit consists of the following elements:

10.4.1.1 ESP32

10.4.1.2 Gas Sensor

10.4.1.3 Light Sensor

10.4.1.4 An Infrared Sensor

10.4.1.5 Temperature and Humidity Sensor

10.4.1.6 Contact Temperature

10.4.1.7 Led Sensors

10.4.1.8 Sound Sensor

10.4.1.9 Power Supply

10.4.1.10 Some Connections

10.4.1.11 Test Board

10.4.1.12 Maquette Room

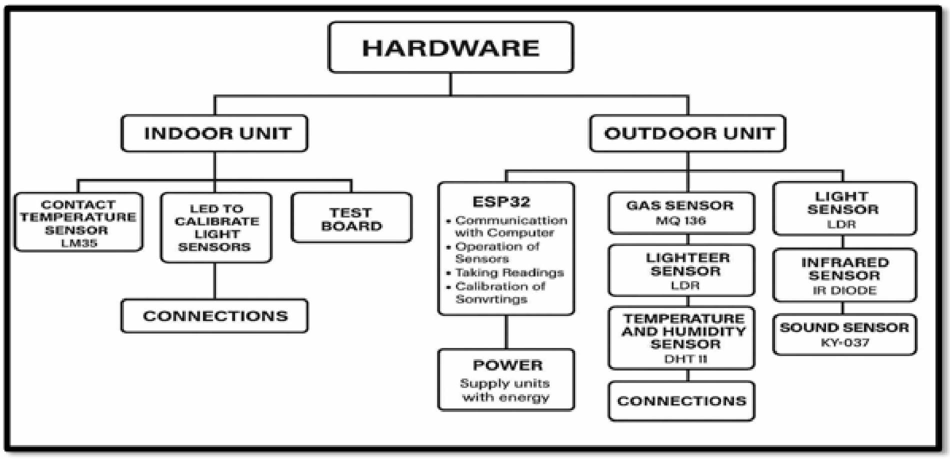

Figure 4: The components of the proposed system hardware

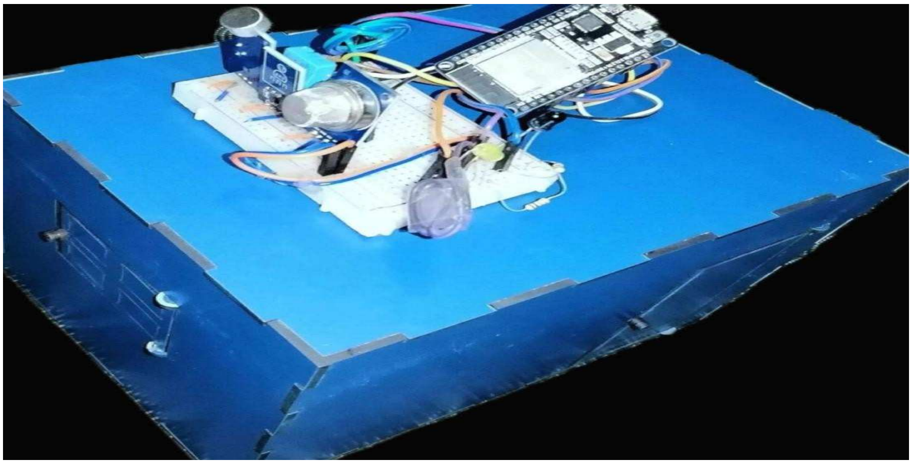

Figure 5: The Maquette room of the proposed system hardware

6.4.2 Software Components:

It is used to program the hardware components and ensure their efficient operations, and it is includes the following element:

6.4.2.1 Arduino Software:

It is a free and open-source programming environment. With a community-driven system and simple interface, the program makes it easier to code websites and applications. This software does not require advanced technical skills or experience, making it suitable for both beginners and professionals.

6.5 System Implementation

The proposed system is designed to run on PCs running Windows 8 and above operating systems, using Visual Studio with C# and the WPF interface.

In practice, the proposed system includes a number of graphical screens.A sample of the proposed system implementation's screens is presented in the following:

6.5.1 The Settings Screen:

The settings screen of the proposed system shown in Figure 6 is used to enter the basic data of the target school.

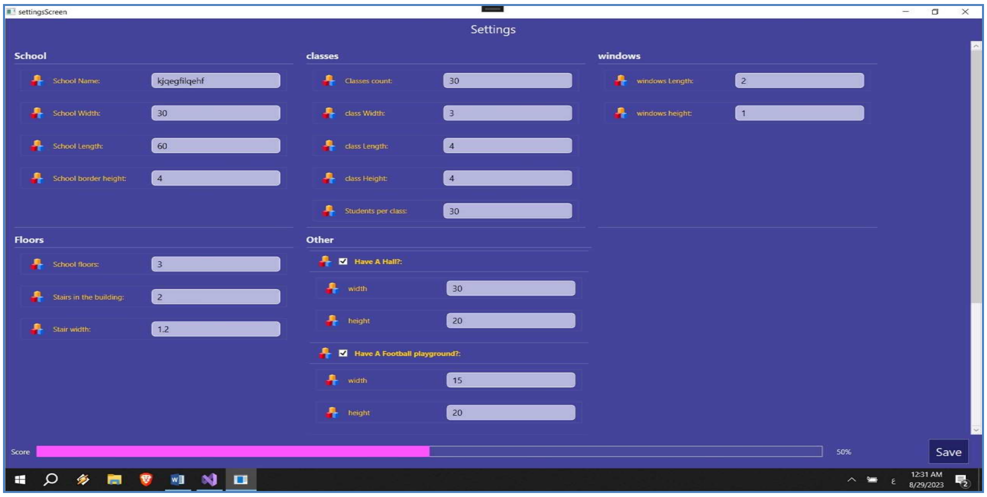

Figure 6: The setting screen of the proposed system

6.5.2

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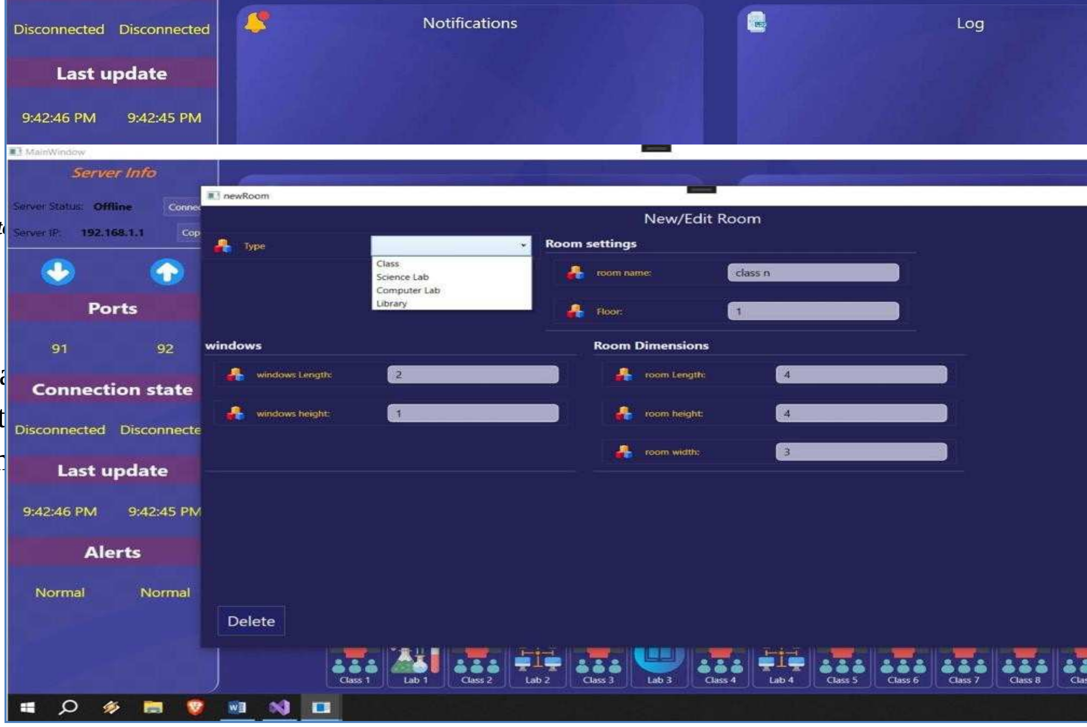

The modifications screen of the proposed system shown in Figure 8 is used to edit (add, delete, modify) elements of the school, such as classrooms, laboratories, library, etc.

Figure 8: The modifications screen of the proposed system

6.5.4 The Monitoring Screen:

The monitoring screen of the proposed system shown in Figure 9 is used to continuously monitor the school's status.

Figure 9: The monitoring screen of the proposed system

6.5.5 The Expert screen:

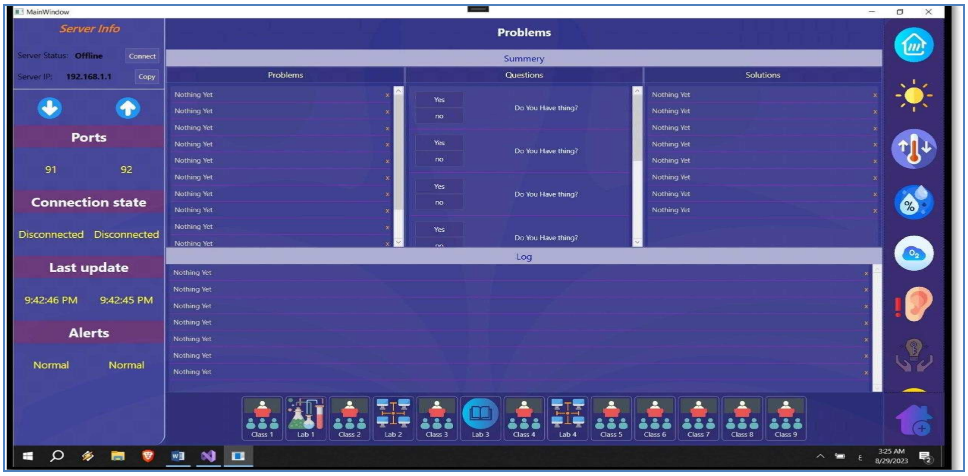

Figure 10: The expert screen of the proposed system

The expert screen of the proposed system shown in Figure 10 is used to identify the problems existing in the school and to propose solutions for them.

7. Study Results

To evaluate the proposed system, it will undergo two tests as follows:

7.1 Validity Test

In order to get precise expert feedback on the proposed system, the suggested usability questionnaire was divided into four main dimensions, most notably operational efficiency, system response time, analysis accuracy, and user ease of use.

The usability evaluation questionnaires were collected from the evaluators, and any invalid, incomplete, or damaged questionnaires were excluded. A descriptive statistical analysis was then performed on the completed questionnaires, and the results are presented in Table 1.

Table 1: Results of the proposed system usability

Expert 1	Expert 2	Expert 3	Expert …. N	AVG
99	90	95	95	99
80	95	85	98	80
90	85	95	90	90
90	85	99	80	90
98	90	95	90	98
90	90	98	90	90
80	90	99	99	80
95	90	95	90	95
99	99	99	99	99
95	90	99	85	95
90	95	90	90	90
99	99	99	95	99
90	80	95	95	90
99	99	99	95	99
98	95	90	95	98
99	90	95	95	99
Overall Expert Satisfaction Level			**93.1%**	

The above results demonstrated that the average scores are calculated for each row, culminating in an overall system evaluation score of 93.1%. It indicates a high level of performance and consistency across the various aspects assessed by the experts. In addition, according to the data shown in Table1, the experts' evaluations “ranged between 80% and 99%, with an overall average of 93.1%, indicating a high level of satisfaction and positive consensus regarding the quality of the system's performance”.

7.2 Efficiency Test

In order to verify the efficiency of the system, it was tested in several schools in Dakahlia Governorate, with the aim of identifying their shortcomings and developing appropriate solutions.

The sensors were installed to detect environmental changes occurred in the school such as lighting, humidity, temperature, noise, and air quality.Then, the proposed system collected this data in real time, processed it, and issued immediate recommendations for improving the classroom environment.

The accuracy of the proposed system for identifying shortcomings in schools was calculated, and the results are documented in the Table 2.

Table 2: Results of the proposed system accuracy

Light	IR Light	Amb Temp	Ceiling Temp	Humidity	Air Quality	Noise	Windows State	Solution
H/M	H/L	26/24	24	50	H/H	M/L	Closed	Open windows
M/M	H/M	22/20	19	61	H/H	M/M	Open	Increase light
H/M	H/M	29/31	33	63	H/H	L/L	Open	Needs thermal insulation
M/H	M/L	24/25	24	66	H/M	L/H	Closed	Decrease crowdedness
M/H	M/M	25/25	25	56	H/H	H/H	Closed	Needs sound insulation
H/H	H/H	30/29	29	57	H/H	M/L	Open	Needs fan
H/H	H/M	34/34	35	70	M/M	L/L	Open	Needs ac (cold)
M/H	M/L	19/24	21	52	H/L	M/L	Closed	Needs an air puffier
M/H	M/M	12/14	11	61	H/H	L/L	Closed	Needs ac (hot)
H/M	H/L	26/24	24	50	L/M	M/L	Open	Close the windows, it needs air vent with filters
H/H	H/H	22/20	19	51	M/H	M/M	Closed	Needs curtains
H/H	H/L	40/38	37	68	H/M	L/L	Open	Needs ac (cold)
M/H	M/L	24/25	24	46	H/H	L/L	Open	Needs an air moisturizer
H/H	H/M	37/35	35	36	H/H	H/H	Open	Needs an evaporative cooler
L/H	L/L	20/21	20	59	H/H	L/H	Open	Close windows

The above results demonstrated that examples of these real-life cases, which include current environmental conditions and the proposed recommendations for each case. Each row represents a distinct snapshot where the system has ingested sensor data and then prescribed a control intervention (ventilation, lighting adjustment, thermal or sound insulation, etc.) to bring conditions into a more desirable range. The abbreviation (H) stands for (High), M for Medium, and (L) for Low.

In each cell, there are two abbreviations (M/L): the right-side one represents the interior condition, and the left-side one represents the exterior condition. For example, when the indoor temperature rose and the air quality deteriorated, the system recommended opening the windows and turning on a cooling fan. In other cases, it recommended thermal insulation, installing air conditioners, or reducing the number of students to reduce noise.

These results also demonstrated that the system's ability to provide accurate and practical solutions that can be applied based on the incoming data. They also demonstrate their ability to distinguish between different environmental conditions and customize recommendations based on the nature of each situation. This highlights the system's intelligence and its ability to adapt to the actual context, rather than simply working according to a fixed program.

8. CONCLUSION And FUTURE WORK

The study conclusion and future work will be presented in detail in two separate sections below:

8.1 CONCLUSION

The Internet of Things (IoT) technology has become a significant issue in the education sector, with estimates indicating its widespread adoption in many modern schools for developing smart buildings. Therefore, this study presented an intelligent advisory system for improving buildings in educational institutions.

The proposed system continuously monitored the indoor and outdoor conditions of a classroom using ESP32 devices that were outfitted with a range of sensors. By monitoring critical environmental parameters like temperature, light intensity, and humidity, the system was able to spot irregularities and recommend solutions. Assessing school buildings with sensors enables a more thorough comprehension of the environment. When paired with artificial intelligence, this vast sensor network transforms data into insightful knowledge that enhances the resilience, sustainability, and responsiveness of school infrastructure. For instance, if the classroom's temperature rose too high or the lighting was inadequate, the system offered specific suggestions for enhancement, like changing the lighting or the thermostat.

The evaluation plan focused on testing two aspects: the suitability of the proposed system for practical use, and its accuracy in detecting and addressing shortcomings in educational institutions. Analysis of the study results showed that most experts agreed on the suitability of the proposed system for use in real-world educational environments. The testing procedures also demonstrated the system's effectiveness in detecting and addressing shortcomings in the participating schools.

The research recommendations concluded the need to expand the use of the proposed system to detect and address shortcomings in educational facilities.

8.2 FUTURE WORK

This study contributes to sustainable and adaptable learning environments and is a step toward smarter, more effective building management in educational settings. Research can expand the system's capabilities by integrating additional sensors or utilizing advanced AI algorithms to predict potential issues before they arise.

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نظام استشارى ذكي لتطوير الأبنية في المؤسسات التعليمية

اماني فوزي الجمل – وسام كمال السعيد – امل السعيد جاد محمد*

الملخص العربي

يهدف هذا النظام الاستشاري الذكي إلى معالجة العديد من القضايا المهمة التي تواجهها عملية بناء المنشآت التعليمية.

تشمل هذه القضايا ضمان اتباع قواعد ومعايير التعليم، وتطبيق مفاهيم تصميم مُستدامة ومُوفّرة للطاقة، وتلبية المتطلبات المُتغيّرة لأساليب التدريس المُعاصرة. من خلال مُعالجة المُشكلات بشكل استباقي والحدّ من الانقطاعات التشغيلية، يُحسّن هذا النهج القائم على البيانات السلامة العامة والرفاهية للطلاب والموظفين. كما يُساهم في إطالة عُمر المباني المدرسية واستدامتها. يُمكن جمع البيانات المُستمرة حول درجة الحرارة والرطوبة والإشغال باستخدام أجهزة الاستشعار في تقييمات المباني المدرسية القائمة على الذكاء الاصطناعي. بالإضافة إلى تسهيل الصيانة التنبؤية، مما يساعد على اكتشاف المشكلات المحتملة قبل أن تصبح خطيرة، تعمل هذه المستشعرات أيضًا على تحسين كفاءة الطاقة من خلال ضبط أنظمة الإضاءة والتهوية والتدفئة في الوقت الفعلي. ويحسن الجمع بين بيانات المستشعر وخوارزميات الذكاء الاصطناعي من الفعالية الشاملة لإدارة البنية التحتية في البيئات التعليمية.

ولتحديد جودة النظام المقترح، تم تقييمه على مستويين: رضا الخبراء ودقة النظام. وأظهرت النتائج التي تم الحصول عليها أن فريقاً من المتخصصين الخبراء أكدوا إمكانية تطبيق النظام المقترح على نطاق واسع في البيئات التعليمية الحقيقية. كما أظهرت النتائج التي تم الحصول عليها أن فريقاً من خبراء البرمجيات أكدوا إمكانية تطبيق النظام المقترح على نطاق واسع في البيئات التعليمية الحقيقية.

علاوة على ذلك، أظهرت النتائج أن النظام المقترح حقق مستوى عالٍ من الدقة، وصل إلى ٩٣٫١٪، في تحديد المشكلات وحلها في المؤسسات التعليمية المختبرة .

الكلمات المفتاحية: المؤسسات التعليمية – الذكاء الاصطناعي – النظام الاستشاري – اختبار رضا الخبراء – اختبار الدقة

* قسم الحاسب الألي، كلية التربية النوعية، جامعة المنصورة، مصر