FACULTY OF ENGINEERING TECHNOLOGY

COMPUTER SCIENCE DEPARTMENT

ECON3372, Engineering project management

Automated Classroom Energy Management System Project

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Section: 2

Date: 19/June/2025

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1. Project Initiation

Project Scope Statement

Project Title: Automated Classroom Energy Management System

Date Prepared: 15/6/2025

Project Manager: Layan Salem

Project Scope Description

The system employs multiple sensor technologies and smart controls to automatically manage classroom electricity usage based on occupancy detection. The automated system allows educational institutions to reduce energy waste by controlling lights, HVAC systems, and non-essential electrical equipment when classrooms are unoccupied, while improving cost efficiency and environmental sustainability. The system's sensors monitor occupancy status in real-time and reduce the need for manual switching and human intervention. As well, the system reduces operational costs significantly.

Project Deliverables

- Create an automated system that manages classroom energy consumption efficiently.
- Find an alternative for manual energy management.
- Decrease the operational energy costs.

Project Acceptance Criteria

- Successfully differentiate between occupied and unoccupied classrooms.
- Successfully control energy systems without affecting educational activities.
- Reduce the operational energy costs by 25-40%.

Project Restriction and constraints

- Budget limitations.
- Time/resources/personnel limitations.
- Building infrastructure compatibility.
- Noise when installing sensors while there’s ongoing classes around work area.

Milestones

Milestone	Deadline	Status

Project Approved	2025-06-01	Done
System Requirements Defined	2025-06-03	Done
Design Phase Completed	2025-06-10	In Progress
Hardware Components Ordered	2025-06-12	In Progress
Installation Completed	2025-06-20	Not started
Software Integrated	2025-06-25	Not started
System Testing Completed	2025-06-30	Not started
Final Report Submitted	2025-07-13	Not started

Project charter

Contact information

Project Title	Automated Classroom Energy Management System
Project Sponsor	Department of Electrical and Computer Engineering, Birzeit University
Project Manager	Layan Salem
Project Start Date	June 01, 2025
Project Finish Date	July 13, 2025
Project Description	The system uses AI and smart sensors to optimize classroom energy consumption by detecting occupancy in real-time. This minimizes waste, lowers costs, and enhances sustainability with minimal human intervention.
Scope	Develop an AI-powered system that uses sensors to automatically control classroom energy use, reducing waste and improving efficiency.
Constraints	- Budget and time limitations - Must comply with university safety and installation policies
Major Deliverables	- Functional automated control system - User interface for scheduling and manual control - Energy usage reports - Final project report and presentation
Stakeholders	- Project team - Faculty advisors - University administration - Students and instructors using classrooms
Acceptance Criteria	-Successfully differentiate between occupied and unoccupied classrooms. -Successfully control energy systems without affecting educational activities. -Reduce the operational energy costs by 25-40%.
Approval	Sponsor Signature: _____

	Project Manager Signature: _____

General information

Manual energy management has increased energy waste in educational facilities, created unnecessary operational expenses, contributed to environmental impact, and reduced cost efficiency. Automated classroom energy management systems offer educational institutions an effective, economical, and environmentally friendly energy control solution. The Educational Technology Stores will carry the product.

Project overview

The Automated Classroom Energy Management System uses artificial intelligence (AI) and IoT sensors to distinguish between occupied and unoccupied states as it monitors classroom occupancy to identify, target, and control energy consumption. Energy waste can now be eliminated using smart sensor technology since we are concerned about cost efficiency and environmental impact. The system has multiple sensor types so that it could accurately detect occupancy through various methods.

Project Objectives

Automated Classroom Energy Management System will be very useful for educational institutions that have multiple classrooms and high energy costs.

Acceptance criteria

It relies on environmentally friendly energy management practices and does not produce unnecessary energy consumption.

Cost estimates

Budget to complete this project is $15,000 per classroom installation.

Constraints

1. **Timeline** - Implementing energy control with lowest cost, effective way, minimum time, and less impact on educational activities.
2. **Budget** - High upfront capital investment requirements.
3. **Resources** - Integration with existing electrical infrastructure.

Assumptions

The overall cost of day-to-day operations will decrease significantly after implementation.

Project organization

Resources and funding

Resources	Source of fund	Percent of fund
Executive support	Institutional	100%
Project team and staff	Sponsors/investments	30% / 70%
Software development	Professional services	15%
Hardware(sensors/controllers)	Institutional/grant funded	35%

Signature

Position	Signature	Date
Responsible executive		2025-06-01
Hardware supplier		2025-06-01
Project manager		2025-06-01
Stakeholders' representative		2025-06-01

Stakeholder register

Position	Name	Contact
Quality Manager	Eng. Layan Salem	layan@gmail.com
Hardware Design	Eng. Shahd Shwekeyeh	shahd@gmail.com
Testing Manager	Eng. Mohammad Awwad	mohammad@gmail.com
Software Design	Eng. Mohammad Shamasneh	mohammadsh@gmail.com
Hardware supplier	Tech4Pal Company	info@tech4pal.ps
Hardware supplier2	FutureHardware Ltd	contact@fhltd.com
Hardware supplier3	ElectroPal Suppliers	support@electropal.ps

PROJECT KICKOFF MEETING

Agenda
KICKOFF MEETING: AUTOMATED CLASSROOM ENERGY MANAGEMENT SYSTEM PROJECT

Date: June 1, 2025 — 9:00 AM, 5th Floor Conference Room
Project Manager: Layan Salem

1. Welcome by Layan Salem
2. Introductions of team members
3. Distribution and discussion of the project charter:
   a. Project overview
   b. Assumptions
   c. Project scope with milestones and deliverables
   d. Authority and responsibility
   e. Project organization
   f. Roles and responsibilities
   g. Disaster recovery
   h. Resources and funding
4. Stakeholder register
   a. Known stakeholders
   b. Hidden stakeholders
5. Next steps
6. Around the room:
   a. Questions
   b. Concerns

2. Project Planning

System Design

This is an approximate image of what the sensor would look like in a classroom (worked with AI)

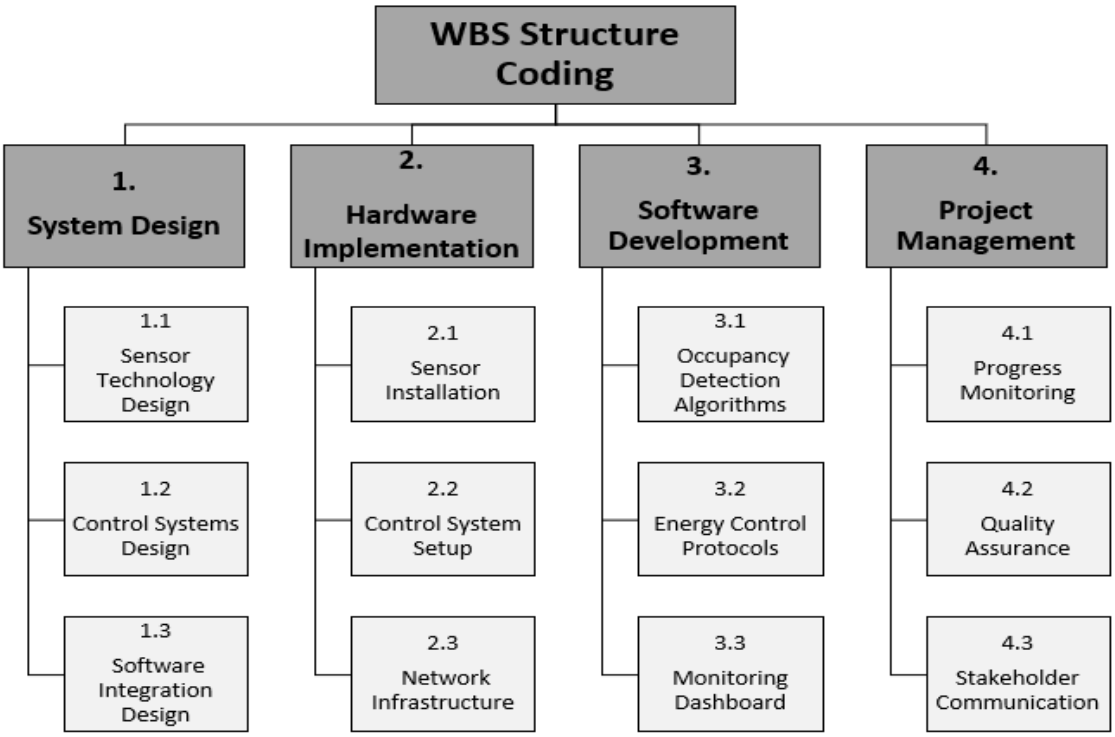
The sensor is linked to lighting and related devices such as air conditioning and ceiling-mounted projectors. It is positioned above the whiteboard to ensure full coverage of the classroom. Using artificial intelligence, the system can accurately detect student presence and distinguish between actual occupancy and irrelevant movements. If the classroom remains unoccupied for a set period, the system automatically shuts down connected devices to conserve energy.

This smart system works by continuously monitoring the environment using a Passive Infrared (PIR) motion sensor. Once movement is detected—such as students entering the room—the system activates connected devices like lights and HVAC (Heating, Ventilation, and Air Conditioning). If no movement is detected for a pre-defined duration (e.g., 10 minutes), the system interprets the room as empty and powers down the devices.

Moreover, the system can be customized to adjust sensitivity levels, delay times, and the types of devices it controls. This makes it adaptable for different classroom sizes and schedules. The use of AI allows for smarter decision-making—for example, ignoring false positives such as shadows or slight temperature changes—making the system both energy-efficient and reliable.

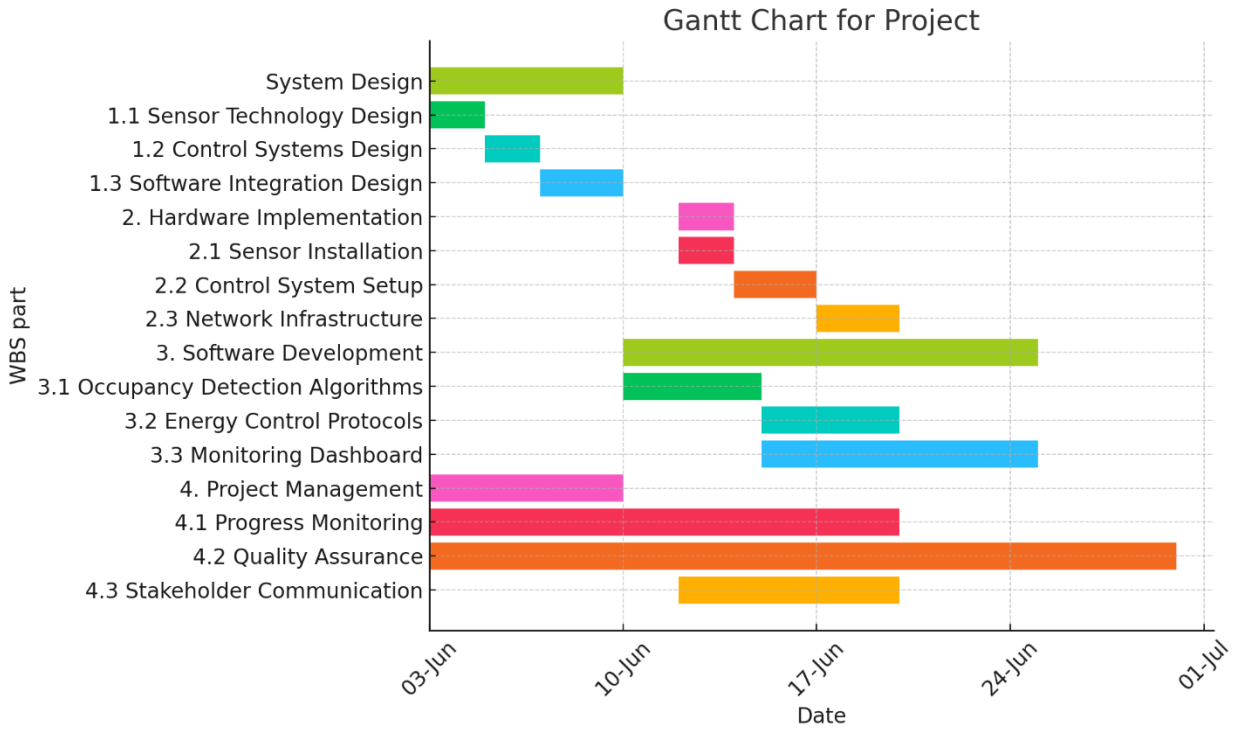
WBS structure coding

The following figure shows the WBS structure graph:

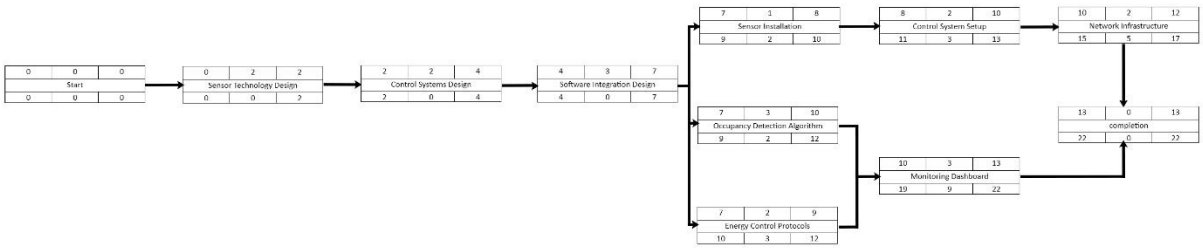


Project schedule

1. System Design	**2025-6-3**	**2025-6-10**	**7**
1.1 Sensor Technology Design	2025-6-3	2025-6-5	2
1.2 Control Systems Design	2025-6-5	2025-6-7	2
1.3 Software Integration Design	2025-6-7	2025-6-10	3
2. Hardware Implementation	**2025-6-10**	**2025-6-20**	**5**
2.1 Sensor Installation	2025-6-10	2025-6-13	1
2.2 Control System Setup	2025-6-13	2025-6-16	2
2.3 Network Infrastructure	2025-6-16	2025-6-20	2
3. Software Development 3.1 Occupancy Detection Algorithms	**2025-6-10** 2025-6-10	**2025-6-25** 2025-6-15	**6** 3
3.2 Energy Control Protocols	2025-6-10	2025-6-15	2
3.3 Monitoring Dashboard	2025-6-15	2025-6-25	3
4. Project Management	**2025-6-3**	**2025-6-30**	**As long as project in progress**
4.1 Progress Monitoring	2025-6-3	2025-6-25	As long as project in progress
4.2 Quality Assurance	2025-6-3	2025-6-30	As long as project in progress
4.3 Stakeholder Communication	2025-6-12	2025-6-20	As long as project in progress



CPM Network Diagram:



Developing and cost estimation budget

Project Name: Automated Classroom Energy Management System
Project Manager: Layan Salem

Project Task	Labor Hours	Labor Cost ($)	Material Cost ($)	Other Cost ($)	Total per Task
1 Design					
1.1 Hardware Design	60	35	0	0	95
1.2 Software Design					
1.2.1 Occupancy Detection Algorithm	15	35	0	0	50
1.2.2 Energy Control Protocol	20	35	0	0	55
1.2.3 Dashboard Development	25	35	0	0	60
1.2.4 Integration Testing	30	35	0	0	65
1.3 System Testing	15	35	0	0	50
Subtotal	**165**	**210**	**0**	**0**	**375**
2 Hardware Implementation					
2.1 PIR Motion Sensors	0	0	800	0	800
2.2 Door Sensors	0	0	400	0	400
2.3 Smart Relay Switches	0	0	1200	0	1200
2.4 HVAC Control Integration	0	0	1500	0	1500
2.5 Control Hub/Gateway	0	0	600	0	600
2.6 Installation and Wiring	40	35	300	200	575
Subtotal	**40**	**35**	**4800**	**200**	**5075**
3 Software Integration					
3.1 System Software	50	35	2000	0	2075
3.2 Mobile App Development	35	35	1000	0	1035
3.3 Database Setup	20	35	500	0	535
Subtotal	105	105	3500	0	3645
4 Project Management					
4.1 Progress Meetings/Reports	45	35	100	150	330
4.2 Quality Assurance	25	35	0	100	135
4.3 Documentation	20	35	50	50	135
Subtotal	**90**	**105**	**150**	**300**	**600**
5 Other Costs	30	35	200	300	565
Sub-totals:	**430**	**490**	**8650**	**800**	**10260**
(Contingency):	50	50	1000	200	1300
TOTAL (scheduled):	**480**	**540**	**9650**	**1000**	**11560**

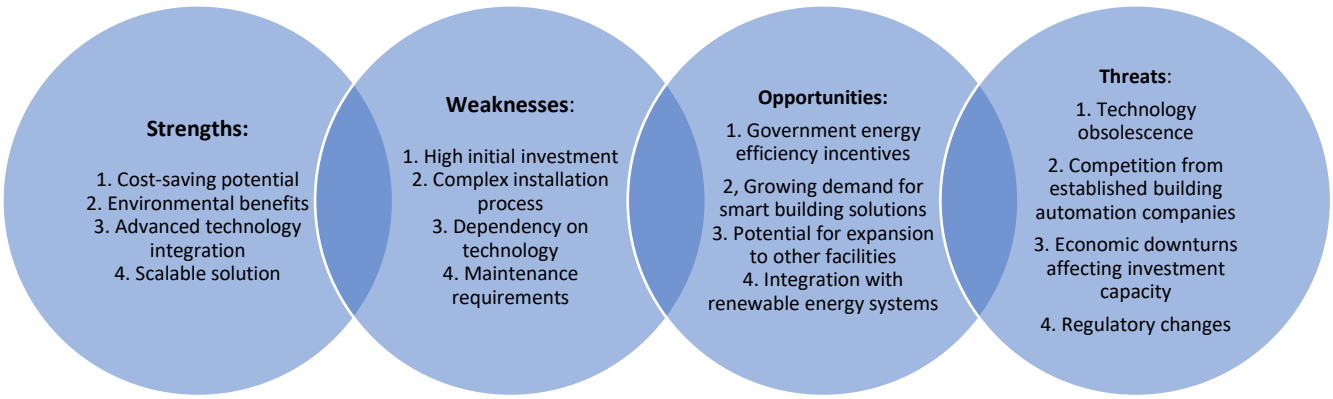
Risk management plan

Risk register

Risk	Likelihood (Low/Med/High)	Impact (Low/Med/ High)	Mitigation Strategies
Integration with existing electrical	Med	High	Conduct thorough electrical assessment before installation
Sensor accuracy and false readings	Med	Med	Implement multiple sensor types for redundancy
Budget overruns due to installation complexity	High	Med	Detailed cost estimation and contingency planning
User resistance to automated systems	Low	Med	Comprehensive training and gradual implementation
Network connectivity issues	Low	High	Implement backup communication methods
Regulatory compliance challenges	Med	High	Early consultation with building codes and safety standards

Risk management tool (SWOT Analysis)

A SWOT analysis was used to identify key strengths, weaknesses, opportunities, and threats that may affect the success of the project. This helps guide strategic planning and risk mitigation efforts.



Risk breakdown structure

To further enhance risk management, a Risk Breakdown Structure (RBS) is developed to categorize potential risks into major domains based on their nature and source.

1. *Technical Risks*
    - **Sensor failure :** Use high-quality, tested sensors and maintain spare units for quick replacement.
    - **Integration issues :** Conduct a full compatibility assessment and pilot testing before full-scale integration.
    - **Software bugs :** Perform comprehensive code reviews, unit testing, and debugging before use.

2. *Financial Risks*
    - **Budget overruns :** Prepare a detailed budget plan with a contingency reserve .
    - **Unexpected component costs :** Unexpected component costs: Source multiple suppliers and update cost estimates regularly to avoid surprises.

3. *Human Resource Risks*
    - **Conflicts among team members:** Establish clear communication protocols and conflict resolution policies.
    - **Training gaps (Lack of technical expertise) :** Provide early training workshops and continuous technical support and guidance during the project.

4. *Legal and Regulatory Risks*
    - **Delays due to permits:** Agree with the university administration on working hours that ensure completion according to the timetable.

5. *Operational Risks*
    - **Network interruptions:** Implement offline fallback functionality or store essential data locally to prevent data loss during outages.
    - **Power supply instability:** Use voltage stabilizers and surge protectors for critical components.
    - **Power outages:** Design the system to safely shut down during power loss and automatically resume normal operation when power is restored.

3. Project execution

Building team

Team Authority

Project name: Automated Classroom Energy Management System

Date prepared: June 3, 2025

Team members

Role	Name
Project Sponsor	Birzeit University
Project manager	Eng. Layan Salem
Quality Manager	Eng. Layan Salem
Hardware Design	Eng. Shahd Shwekeyeh
Testing Manager	Eng. Mohammad Awwad
Software Design	Eng. Mohammad Shamasneh
Marketing	Rana Ahmad
Procurement manager	Eng. Tamer Khalil

Team Principles & Values:

ID	Value
1	There are no stupid questions, and seeking additional information is always acceptable
2	We will provide a solution for every issue
3	To address issues, we'll work together as a team, knowing that we can always seek assistance
4	We are always upfront and truthful
5	We put in a lot of effort, but we also help one another maintain a healthy work-life balance

Meeting Guidelines

ID	Guideline
1	We'll be honest about the activities we can take and promise to finish them on schedule
2	We'll arrive on time
3	We shall decline and suggest another time if we are unable to attend a meeting. We'll give project team meetings top priority
4	We will put other work on hold to attend meetings and participate actively

Communication Guidelines

ID	Guideline
1	Select the best communication channels
2	Take formal communication training into account
3	Clearly state who is responsible for each job
4	Make use of project management tools
5	Be receptive to criticism
6	Phone calls will take precedence over emails
7	We'll communicate often and early
8	Give coffee breaks a purpose
9	We shall document all choices and activities

Process of Making Decisions

Team members are allowed to decide how to do their task most effectively, but anything that affects the project's scope, duration, or cost must first be approved by the project manager. Within the project tolerances, the project manager will decide on the scope and, if necessary, refer the issue to the project sponsor.

Responsible Accountable Consulted Informed (RACI) Matrix:

RACI Chart - Automated Classroom Energy Management System Project				
Activity	**Team Member**			
	Layan Salem	Shahd Shwekeyeh	Mohammad Awwad	Mohammad Shamasneh
Hardware Design	C	R	I	A
Software Design	C	I	I	R
Quality Management	R	C	C	C
System Testing	A	I	R	I

R = Responsible, A = Accountable, C = Consult, I = Inform

Conduct Procurements

Procurement Definitions

The following procurement items or services have been determined to be essential for project completion and success.

Item/Service	**Justification**
PIR Motion Sensors	High-accuracy passive infrared sensors that detect heat signatures and movement to determine classroom occupancy status
Door Sensors	Magnetic contact sensors to monitor entry and exit points for accurate occupancy tracking
Smart Relay Switches	Programmable electrical switches that can be controlled remotely to manage lighting circuits
HVAC Control Interface	Integration module that connects to existing heating, ventilation, and air conditioning systems
Control Hub/Gateway	Central processing unit that coordinates all sensors and controls, manages data collection and system responses
System Software	Custom-developed software platform for occupancy detection algorithms, energy control protocols, and monitoring dashboard

Procurement Orders

Company name: Smart Building Solutions Ltd.

Contact name: Eng. Tamer Khalil

Date submitted: June 12, 2025

Address: Ramallah, Al-Masyoun, Building 14, 3rd Floor

Contact numbers: +970 2 298 1123 | +970 59 876 4321

Email address: tamekh@gmail.com

Orders 1:

Description	10 PIR Motion Sensors (High-accuracy occupancy detection)	
Details	**Time to be delivered**	**Cost**
	June 16, 2025	$800

Orders 2:

Description	5 Door Sensor Sets (Magnetic contact sensors for entry/exit monitoring)	
Details	**Time to be delivered**	**Cost**
	June 16, 2025	$400

Orders 3:

Description	15 Smart Relay Switches (Programmable lighting control switches)	
Details	**Time to be delivered**	**Cost**
	June 17, 2025	$1200

Orders 4:

Description	1 HVAC Control Interface (Integration module for climate control systems)	
Details	**Time to be delivered**	**Cost**
	June 18, 2025	$1500

Orders 5:

Description	1 Control Hub/Gateway (Central processing and coordination unit)	
Details	**Time to be delivered**	**Cost**
	June 18, 2025	$600

4. Project monitoring and controlling

CHANGE ORDER FORM

Project Name: Automated Classroom Energy Management System

Change Order Number: 1

Description of the Change: Add CO2 monitoring sensors to enhance occupancy detection accuracy and provide air quality monitoring capabilities.

The Contract Sum prior to this Change Order was $15,000

The Contract Sum will be increased by this Change Order in the amount of $2,500

The new Contract Sum including this Change Order will be $17,500

5. Quality Assurance

Quality Standards

The International Organization for Standardization (ISO), the Institute of Electrical and Electronics Engineers (IEEE), and Building Automation Standards (BACnet).

Quality Objectives/Metrices

Metric/Specification	Measure
Delivery to scope	The provided scope is compared to the Statement of Work, client project approval certificate and measurements taken during UAT (User Acceptance Testing)
Delivery on time	Baseline schedule plus/minus change orders in comparison to actual dates
Delivery on budget	Budget vs. actual expenses plus/minus change orders
Energy savings achievement	Actual energy consumption reduction compared to baseline measurements

Quality Roles & Responsibilities

Role	Responsibility
Quality Manager	Control of the project's quality under observation. Monitor overall quality standards
Hardware Design	Supervise and control the procurement and quality of hardware components
Testing Manager	Test every system component and supervise overall testing levels and sections
Software Design	Create, plan, and develop software applications for the energy management system
Marketing	Control company's marketing operations to create innovative, reliable brand-specific campaigns
Project manager	Schedule and control quality control procedures
Procurement manager	Ensure that the company only spends money on products and services that help reach objectives

Risk monitoring

Risk monitoring will be conducted regularly throughout the project to track identified risks, detect new ones, and evaluate the effectiveness of mitigation strategies. Updates will be discussed during project meetings, and necessary actions will be taken promptly.

6. Project Closeout

PROJECT CLOSEOUT CHECKLIST

- ✓ Verify the scope
- ✓ Close out the contract
- ✓ Close out the administrative aspects of the project
- ✓ Conduct a lessons-learned review
- ✓ Develop the project closeout report
- ✓ Recognize team members
- ✓ Complete the final step

Conclusion

The **Automated Classroom Energy Management System** project represents a significant step toward enhancing sustainability and operational efficiency within educational institutions. By integrating smart sensors and AI-driven controls, the system effectively reduces energy waste, optimizes resource usage, and ensures that energy is consumed only when classrooms are actively in use.

Throughout the project phases—from initiation and planning to execution and monitoring—the team successfully adhered to the set objectives, managed resources effectively, and applied risk mitigation strategies. The collaborative effort among all stakeholders, guided by well-defined roles and responsibilities, ensured a smooth workflow and high-quality deliverables.

This project not only addresses the immediate issue of energy inefficiency but also sets a precedent for future smart infrastructure initiatives in academic environments. With further development and broader implementation, this solution has the potential to contribute significantly to the goals of environmental sustainability, cost savings, and improved facility management.