EEE 416 – Microprocessor and Embedded Systems Laboratory
Jan 2025 Level-4 Term-1 Section B1

Final Project Presentation

IOT-BASED SYSTEM FOR REAL-TIME MONITORING AND CONTROL OF FRUIT STORAGE CONDITIONS

SUBMITTED BY – GROUP 6

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Outline

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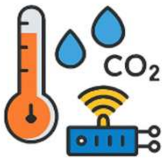
1. Abstract

This project aims to -

- ❑ Designed an IoT-based system to monitor crop storage conditions in real-time.
- ❑Uses sensors to track temperature, humidity, and air quality.
- ❑Automates misting, cooling, and ventilation using threshold-based logic.
- ❑Displays live data on an LCD screen.
- ❑Aims to reduce spoilage and improve storage efficiency.

2.Introduction

• **Post-harvest losses are high** due to improper storage conditions like humidity, heat, and pests.



• **Manual monitoring is slow and ineffective**, especially in large storage facilities.

• **IoT systems enable real-time, automated monitoring**, helping prevent spoilage and reduce crop loss.

3.1.1 Identification of Scope

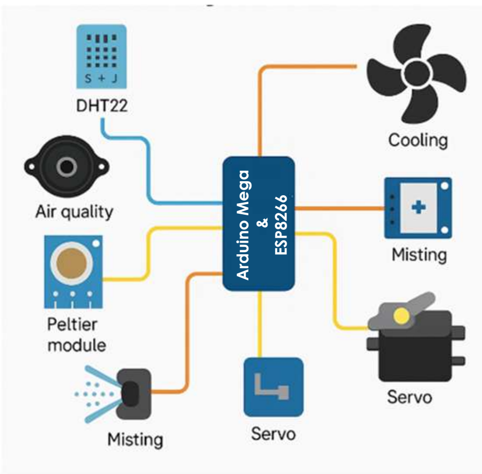
- **Problem:** No automated way to ensure proper crop storage conditions. Manual monitoring is slow, inconsistent, and not scalable.
- **Scope:** Real-time monitoring of temperature, humidity, and gas levels.
- **Goal:** Prevent spoilage by maintaining optimal storage environment using IoT.

3.1.2 Literature Review

- **Ansari et al**. (2023) and **Hema et al**. (2020) demonstrated the use of IoT with sensors like DHT22 for real-time monitoring of grain storage, reducing spoilage through automated alerts and control.
- **Gupta et al**. (2021) highlighted an energy-efficient system using air quality sensors and Peltier modules, proving the potential of low-cost IoT setups for maintaining optimal storage conditions.

3.1.3 Analysis

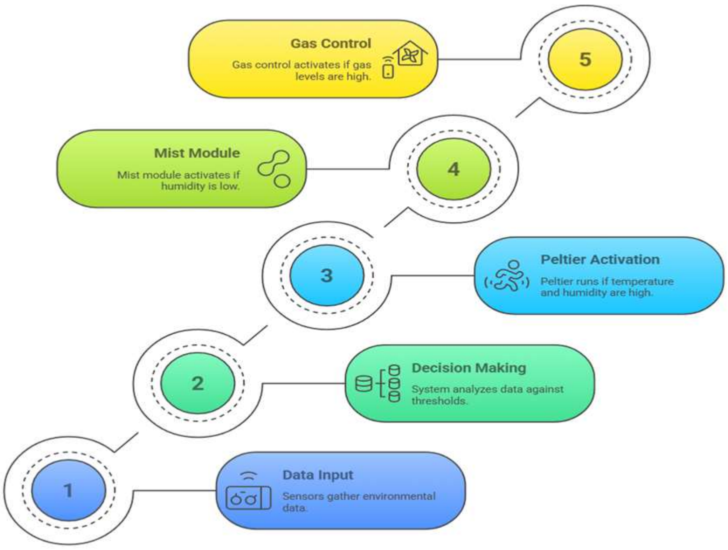
- Key factors: temperature, humidity, and air quality directly affect crop storage.
- DHT22 and MQ-135 sensors provide real-time environmental data.



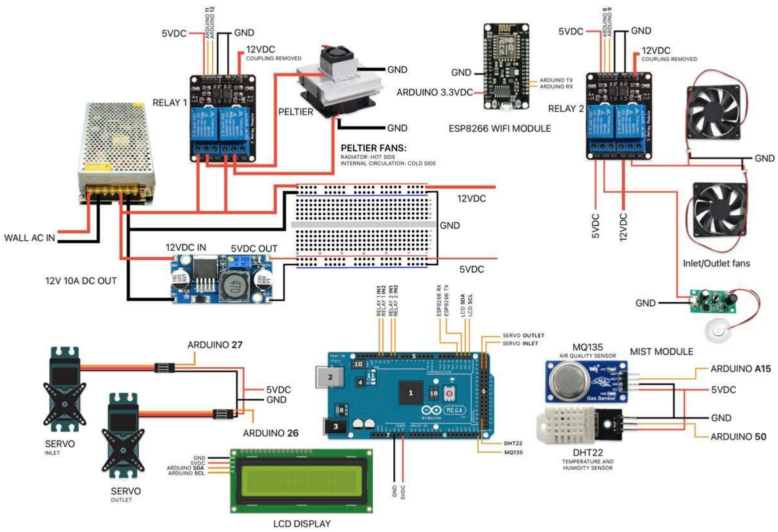
3.1.3 Analysis

- Automated climate control using Arduino Mega to manage misting, cooling, and ventilation based on preset threshold values.
- Relay modules and servos automate the system's physical responses.
- Low-cost, scalable design with ESP8266 enabling remote monitoring and future IoT integration.

3.2 Methodology (PO(a))

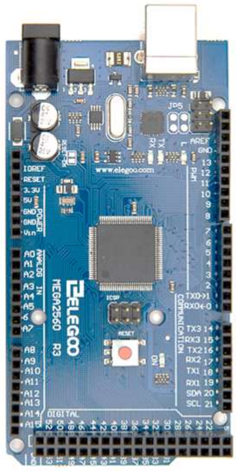


3.3 Design: Circuit Diagram



4. Implementation: Sensor Integration

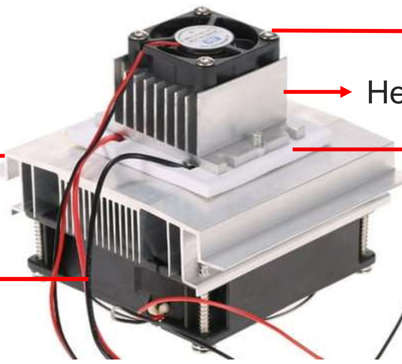
DHT-22



Arduino Mega

MQ-135

4. Implementation: Cooling & Dehumidifying



Peltier Fan(Cold Side)

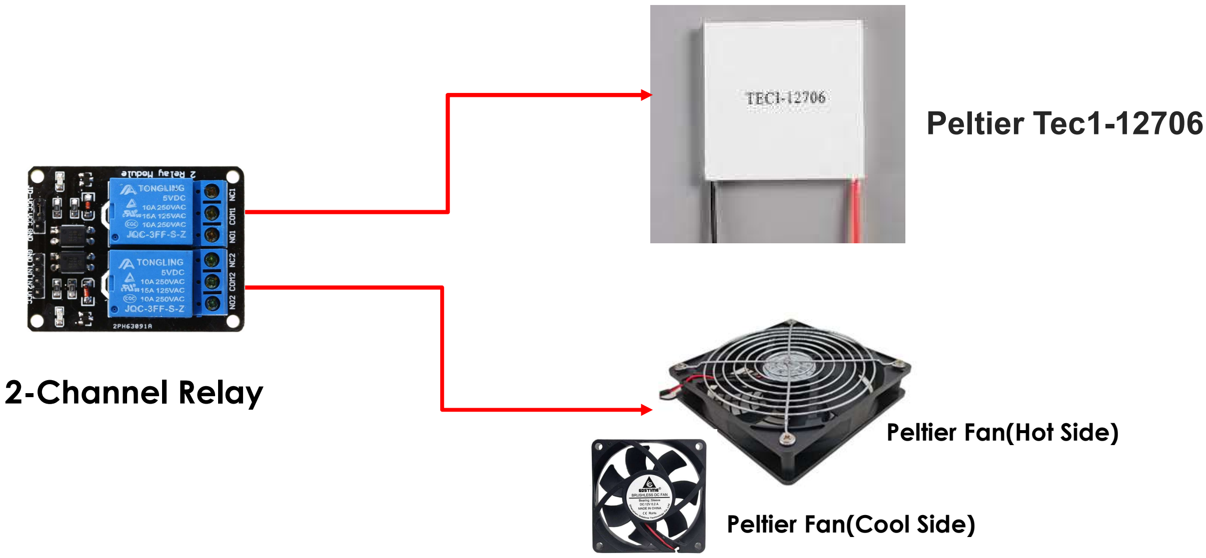
Heat Sink(attached to cold side)

Heat Sink(attached to hot side)

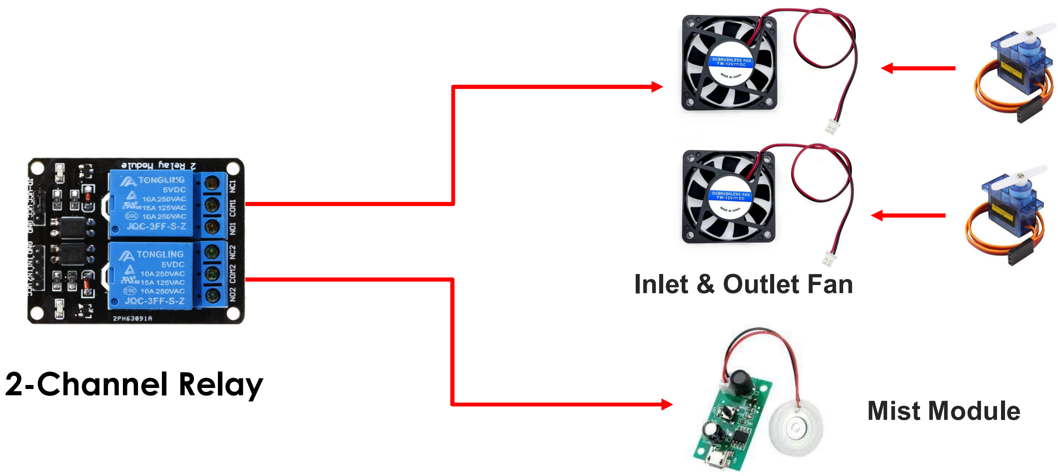
Peltier Fan(Hot Side)

Peltier Tec1-12706

4. Implementation: Control Mechanism



4. Implementation: Control Mechanism



4. Implementation: Power Source

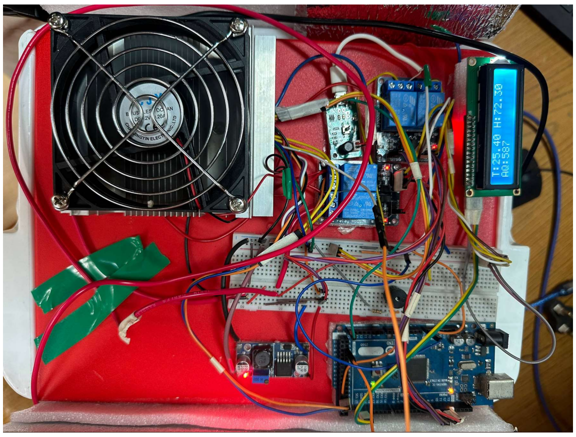
Peltier Tec1-12706
Peltier Fan
Inlet & Outlet Fan

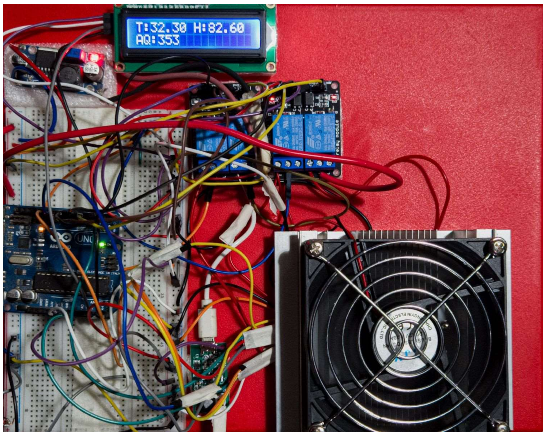
12V 10A SMPS

Buck Converter (5V O/P)

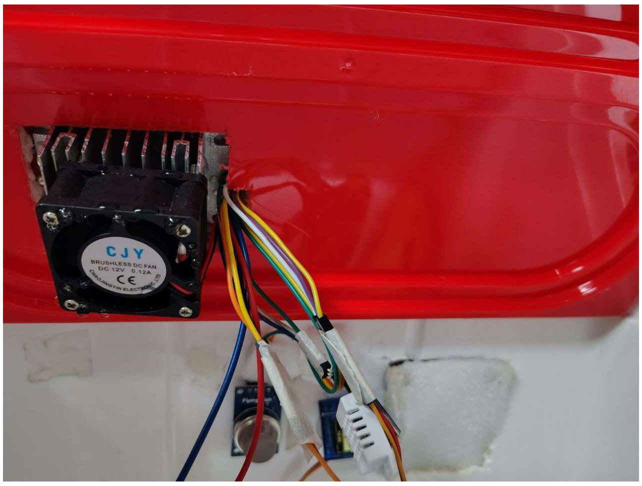
DHT22
MQ135
Relay
Arduino Mega
ESP8266
Servo

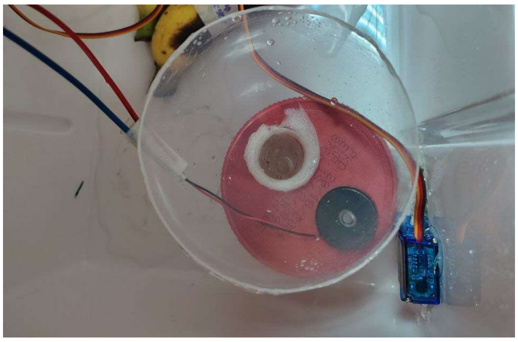
4. Implementation: Demonstration



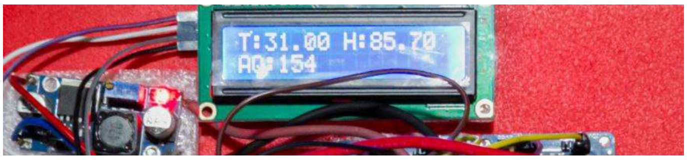


4.1 Implementation: Photo Gallery





4.2 Implementation: Demonstration



Saturday, 26th JULY 06:50pm

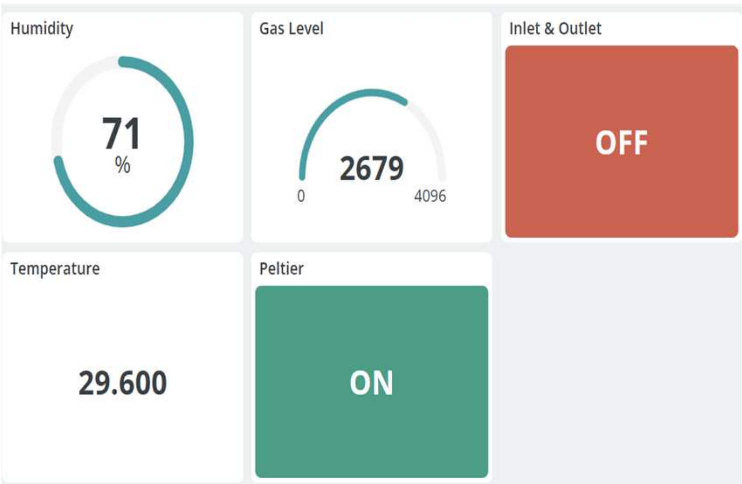
Saturday, 26th JULY 11:00pm;

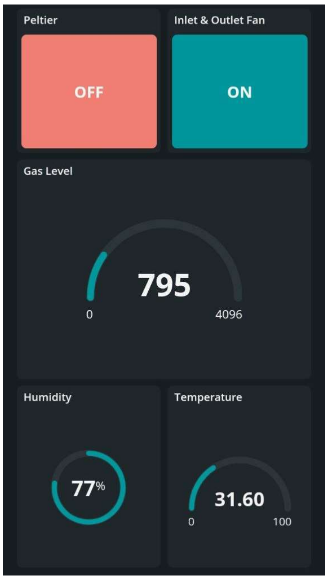
4. Implementation: Final Result

Experiment Started:
Saturday, 26th JULY
06:50pm

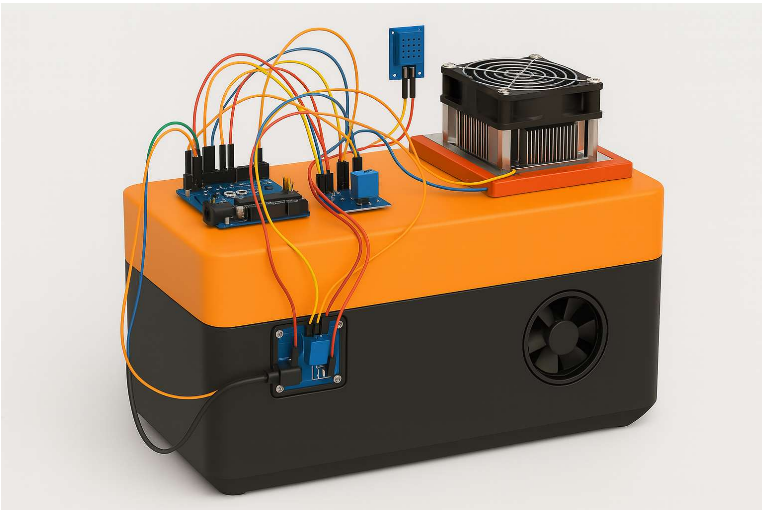
Experiment Ended:
Monday, 28th JULY
09:10AM

Software Implementation





Expected Protype:



5. Design Analysis and Evaluation

- 5.1 Novelty
- 5.2 Design Considerations (PO(c))
- 5.3 Investigations (PO(d))
- 5.4 Limitations of Tools (PO(e))
- 5.5 Impact Assessment (PO(f))
- 5.6 Sustainability and Environmental Impact Evaluation (PO(g))
- 5.7 Ethical Issues (PO(h))

5.1 Novelty

- Combines cooling, humidifying, and gas detection in one box
- Auto-controls environment based on sensor thresholds
- Uses Peltier for dual cooling and dehumidification
- Gas-triggered venting with servo control
- Compact and low-cost design for home use

5.2 Design Considerations (PO(c))

- **5.2.1 Considerations to public health and safety:**

  Prevents consumption of spoiled fruit by maintaining safe storage conditions.
- **5.2.2 Considerations to environment:**

  Reduces fruit waste and uses energy-efficient components.
- **5.2.3 Considerations to cultural and societal needs:**

  Supports safe storage of local fruits and reduces post-harvest loss.

5.3 Investigations (PO(d))

- ❑ Tested gas sensor readings against overripe fruit to validate spoilage detection.
- ❑ Measured temperature/humidity variations to optimize energy use and reduce waste.
- ❑ Analyzed fruit storage practices to adapt the design for local household and vendor needs.

5.4 Limitations of Tools (PO(e))

- **MQ135** needs calibration for accuracy
- **DHT22** has limited precision under fluctuation
- **Peltier** draws high current, slow to stabilize
- **Relay** lacks variable control, only supports switching
- **Mist module** can overshoot humidity
- **Open wiring** may cause signal noise

5.5 Impact Assessment (PO(f))

- **5.5.1 Assessment of Societal and Cultural Issues:**
  Promotes better fruit preservation, supporting food security and reducing waste in local communities.
- **5.5.2 Assessment of Health and Safety Issues:**
  Prevents health risks by detecting spoilage gases and maintaining safe storage.
- **5.5.3 Assessment of Legal Issues:**
  No significant legal risks; operates within general safety guidelines.

5.6 Sustainability Evaluation (PO(g))

- ❑ Encourages sustainable fruit storage practices in local households and markets.
- ❑ Improves long-term food safety by preventing early spoilage and contamination.
- ❑ System design supports sustainability goals without conflicting with any existing safety or electrical standards.

5.7 Ethical Evaluation (PO(h))

- ❑ We ensured safety in design by using proper insulation and isolating high-current paths to prevent electrical hazards.
- ❑ All components were selected keeping in mind ethical sourcing and safety ratings.
- ❑ No data privacy concerns exist, but if extended to IoT cloud storage, ethical handling of data would be considered.

6.1 Individual Contribution of Each Member

Team Member	Responsibility
87,88	Sensor selection & calibration
88, 89	Testing & validation; documentation
89, 90	Cloud setup & dashboard development
87, 90	Microcontroller coding & integration
88, 89, 90	Wiring and Set-up complete

6.2 Logbook of Project

Date	Activity	Key Decision / Observation
Week 1	Formed project group and received initial instructions	Group members finalized; received guidance on project expectations, scope, and timeline from course instructor.
Week 2-3	Explored project topics and reviewed references	Explored project ideas by reviewing course content and relevant papers; finalized the topic after team discussion.
Week 4	Shortlisted project ideas for presentation	Selected 3 potential projects and planned to present them in the following week for feedback and final decision.
Week 5	Finalized project topic and goals	Was instructed to focus on smart fruit storage using sensors
Week 6	Component selection and sourcing, Sensor testing (DHT22, MQ135)	Chose ESP32, DHT22, MQ135, Peltier module, Verified basic readings; observed slight DHT delay
Week 7	Relay control setup	Decided on 2 relays: one for cooling, one for mist

6.2 Logbook of Project

Mid-break	Optional cloud integration and code refinement	Explored cloud-based UI options and optimized control logic for smoother sensor-actuator response.
Week 8	Peltier + fan integration	Cooling confirmed; cold side causes condensation
Week 9	Mist module and humidity threshold testing	Overshoot noted when humidity very low
Week 10	Vent + servo control based on gas levels	Servo works well; adjusted position for airflow
Week 11	Full system integration	All modules respond to thresholds as expected
Week12	Box setup and internal layout optimization	Airflow and wiring adjusted for better reliability
Week 13	Live test with stored fruit	System maintained stable temperature and humidity; vent triggered after mild gas rise; fruit stayed visibly fresh over 48 hours
Week 14	Final packaging and report preparation	Minor wiring cleanup needed; logbook and cost table done

7 Communication to External Stakeholders (PO(j))

1. **GitHub Link**

https://github.com/mohammad-al-hosan/IOT_Fruit_Storage_System.git

2. **YouTube Link**

https://youtu.be/SsQY30of0jE

8. Project Management and Cost Analysis (PO(k))

8.1 Bill of Materials

8.2 Calculation of Per Unit Cost of Prototype

8.3 Calculation of Per Unit Cost of Mass-Produced Unit

8.4 Timeline of Project Implementation

8.1 Bill of Materials (PO(k))

Component	Qty	Unit Cost (BDT)	Total Cost (BDT)
DHT22	3	220	660
MQ-135	2	120	240
ESP32	2	400	800
Peltier Tec1-12706	1	200	200
Buck Converter	2	60	120
Mist Module	1	120	120
Relay Module	3	80	240
Cooling Fan (12V)	2	90	180
Alarm Buzzer Module	2	50	100
Servo motor	2	200	400
Arduino UNO	1	900	900
Arduino MEGA	1	1790	1790
Lipo charger(	1	300	300
Enclosure & Cabling	1	500	500

8.1 Bill of Materials (PO(k))

Component	Qty	Unit Cost (BDT)	Total Cost (BDT)
12V 10A SMPS	1	700	700
USB micro B	1	60	60
CPU Cooler	1	400	400
funnel	1	30	30
insulating foil	1	100	100
Heat sink (large)	1	300	300
Heat sink (small)	1	100	100
Peltier Fan (large)	1	400	400
Peltier Fan (small)	1	150	150
Mounting Screw and Drilling	1	100	100
Ice Box 8L	1	920	920
Motor Driver	1	350	350
LCD	1	350	350
Magnets	1	150	150
Total			**10,660**

8.2 Calculation of Per Unit Cost of Prototype (PO(k))

Component	Qty	Unit Cost (BDT)	Total Cost (BDT)
12V 10A SMPS	1	700	700
funnel	1	30	30
Heat sink (large)	1	300	300
Heat sink (small)	1	100	100
Peltier Fan (large)	1	400	400
Peltier Fan (small)	1	150	150
Ice Box 8L	1	920	920
LCD	1	350	350
Magnets	1	150	150
Servo motor	1	200	200
Arduino MEGA	1	1790	1790

Component	Qty	Unit Cost (BDT)	Total Cost (BDT)
DHT22	1	220	220
MQ-135	1	120	120
Peltier Tec1-12706	1	200	200
Buck Converter	1	60	60
Mist Module	1	120	120
Relay Module	2	80	160
Cooling Fan (12V)	2	90	180
Alarm Buzzer Module	1	50	50
Enclosure & Cabling	1	300	300
Total			**6,500**

8.3 Calculation of Per Unit Cost of Mass-Produced Unit (100 unit) (PO(k))

Component	Qty	Unit Cost (BDT)	Total Cost (BDT)
12V 10A SMPS	100	650	65000
Funnel	100	15	1500
Heat sink (large)	100	300	30000
Heat sink (small)	100	100	10000
Peltier Fan (large)	100	350	35000
Peltier Fan (small)	100	120	12000
Ice Box 8L	100	750	75000
LCD	100	250	25000
Magnets	100	100	10000
Servo motor	100	180	18000
ESP32	100	380	38000

Component	Qty	Unit Cost (BDT)	Total Cost (BDT)
DHT22	100	190	19000
MQ-135	100	110	11000
Peltier Tec1-12706	100	180	18000
Buck Converter	100	50	5000
Mist Module	100	120	12000
Relay Module	200	70	14000
Cooling Fan (12V)	200	70	14000
Alarm Buzzer Module	100	40	4000
Enclosure & Cabling	100	180	18000
Total			**434,500**
Per Unit Cost			**4,345**

Comparison with Similar Products

- MQ135 vs MQ2/MQ3→ MQ135 detects NH_3, CO_2, CH_2O, and other VOCs released during fruit spoilage, while MQ2 targets combustible gases and MQ3 focuses on alcohol — less relevant in sealed fruit storage.
- Relay vs MOSFET→ Relay is simpler for binary control; PWM not needed.
- Ice Box vs Custom Enclosure→ Ice box is pre-insulated, cheaper, and ready to use.
- Locally Available Modules vs Specialized Imports→ Chose modules readily available in local markets to reduce cost and ensure replacements.

8.4 Timeline of Project Implementation (PO(k))

- Week 6: Finalize components and plan circuit design
- Week 7: Interface sensors and test basic hardware functions
- Mid-break: Optional work on cloud UI and code optimization
- Week 8-10: Perform testing, debugging, and edge case handling
- Week 11-12: Assemble final setup with enclosure and safety
- Week 12-13: Final testing and documentation
- Week 14: Project Presentation and demonstration

9. Future Work (PO(I))

• Create a mobile app for easier remote access.

• Use AI to predict spoilage early.

• Power the system with solar for remote areas.

• Expand system to monitor multiple storage sites.

References

1.Ansari et al., "IoT-Enabled Smart Storage System," Security and Privacy, 2023.

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