CHAPTER 1

INTRODUCTION

In the realm of modern logistics, ensuring the freshness and quality of products during transit is paramount. From perishable goods to sensitive materials, maintaining optimal conditions throughout the supply chain journey is essential for meeting customer expectations and preserving product integrity. Recognizing this critical need, the Cloud Integrated Cargo Management System emerges as a pioneering solution, poised to revolutionize how businesses manage and monitor their cargo operations. At its core, this innovative project aims to seamlessly integrate cloud technology with cargo management processes, ushering in a new era of efficiency, transparency, and reliability. By harnessing the power of the cloud, businesses can now leverage advanced data processing capabilities to monitor and control various factors influencing product freshness, even in the most challenging transport conditions.

Central to the system's functionality is the deployment of state-of-the-art sensors within cargo vehicles. These sensors, meticulously designed to capture crucial data points such as temperature, humidity, and air quality, serve as the frontline guardians of product integrity. As goods traverse from source to destination, these sensors continuously monitor environmental conditions, providing real-time insights into the freshness scale of the cargo.

To facilitate seamless data transmission and decision-making, an intuitive mobile application is intricately woven into the system's framework. Through Bluetooth communication, this application acts as a central hub for receiving, analyzing, and visualizing data collected by the onboard sensors. With user-friendly interfaces and robust functionalities, stakeholders can effortlessly access vital information, empowering them to make informed decisions on the fly.

In essence, the Cloud Integrated Cargo Management System represents a holistic approach to modern logistics, where technology converges with industry expertise to safeguard product freshness and optimize supply chain efficiency. By embracing cloud integration, businesses can not only mitigate risks associated with cargo management but also unlock new avenues for innovation and growth in an increasingly competitive marketplace. As the project unfolds, its transformative impact promises to reshape the landscape of cargo logistics, setting new standards for reliability, sustainability, and customer satisfaction.

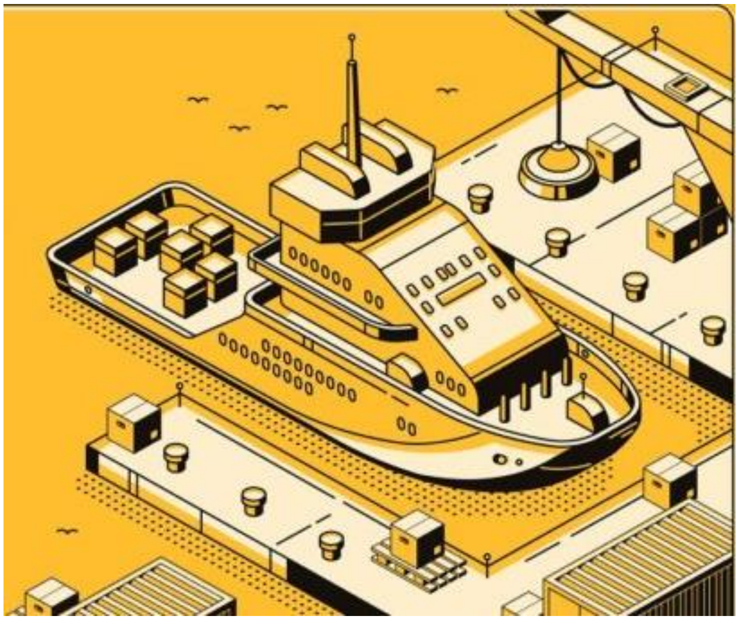

Fig 1.1: Cargo management system

1.1: Problem Statement:

Despite advancements in logistics technology, ensuring the freshness and quality of products during transportation remains a significant challenge for businesses. The lack of real-time monitoring and control mechanisms often leads to incidents of spoilage, degradation, and loss, resulting in financial losses and customer dissatisfaction. To address this critical issue, there is a pressing need for an integrated solution that leverages cloud technology to monitor environmental conditions within cargo vehicles and optimize supply chain processes accordingly.

Incidence of Spoilage and Losses: According to a report by the Food and Agriculture Organization (FAO), approximately one-third of the food produced for human consumption globally is lost or wasted annually. A significant portion of these losses occurs during transportation due to inadequate monitoring of temperature, humidity, and other environmental factors.

Impact on Financial Performance: A study conducted by the World Bank found that inefficiencies in the logistics and supply chain management processes result in an estimated 4-5% loss in overall revenue for businesses. This includes direct costs associated with spoilage, as well as indirect costs related to customer refunds, reputation damage, and lost opportunities.

Customer Satisfaction and Retention: Research published in the International Journal of Logistics Management indicates that product quality and freshness are among the primary factors influencing customer satisfaction and repurchase intentions in the retail sector. Instances of receiving spoiled or damaged goods during online or offline purchases can significantly erode customer trust and loyalty.

Regulatory Compliance and Liability: Regulatory bodies such as the Food and Drug Administration (FDA) impose strict guidelines and standards for the transportation and storage of perishable goods, particularly in the food and pharmaceutical industries. Failure to comply with these regulations can result in hefty fines, legal penalties, and damage to brand reputation.

Opportunity Cost of Inefficiencies: An analysis by McKinsey & Company suggests that optimizing supply chain processes can yield cost savings of up to 20% and lead to a 10-40% increase in operational efficiency. However, without real-time visibility and control over cargo conditions, businesses miss out on opportunities to streamline operations, reduce waste, and improve overall profitability.

In light of these statistical proofs, it is evident that the lack of an effective monitoring and management system for cargo transportation poses significant challenges for businesses across various industries. The development and implementation of a Cloud Integrated Cargo Management System offers a promising solution to mitigate these challenges, improve product freshness, and enhance supply chain performance.

1.2: Problem Scope:

Identification of Critical Factors: Determine the key natural and physical conditions that significantly impact the freshness of products during transportation. This includes factors such as temperature fluctuations, humidity levels, air quality, and other environmental variables that may affect product integrity.

Sensor Deployment Strategy: Develop a comprehensive plan for deploying sensors inside cargo vehicles to monitor the identified critical factors. Consider factors such as sensor placement, type of sensors required, data collection frequency, and integration with the existing vehicle infrastructure.

Data Collection and Processing: Establish efficient mechanisms for collecting, storing, and processing data generated by the onboard sensors. Define protocols for real-time data transmission from the sensors to a centralized database or cloud platform for analysis and decision-making.

Algorithm Development: Design algorithms and analytical models to interpret the collected data and assess the freshness scale of the products in transit. Incorporate machine learning techniques to identify patterns, anomalies, and potential risks to product quality based on the sensor data.

App Development and Integration: Develop a user-friendly mobile application for receiving, visualizing, and analyzing the parameters monitored by the onboard sensors. Ensure seamless integration with the Bluetooth communication protocol to enable real-time data transmission from the sensors to the application interface.

1.3: Advantages of using Cloud integrated Cargo management system

- Scalability: Easily scale resources to accommodate changing demands.
- Real-time Accessibility:Access cargo data anytime, anywhere with internet access
- Collaboration: Facilitates collaboration & communication among stakeholders.
- Security: Robust security measures ensure data protection and compliance.
- Cost-effectiveness: Eliminates investments and reduces maintenance costs.
- Automation: Automates routine tasks, enhancing operational efficiency.
- Analytics: Provides valuable insights for data-driven decision-making.
- Disaster Recovery: Recovery capabilities ensure business continuity.
- Global Connectivity: Easily connects with global partners and logistics providers.

- Innovation: Advanced features and technologies ensures the system updated.

1.4 Proposed Solution:

The proposed solution for a Cloud Integrated Cargo Management System encompasses a comprehensive approach to ensure the freshness and quality of goods during transportation from source to destination. It involves leveraging cloud-based technologies and data processing capabilities to monitor, analyze, and manage various factors that influence the freshness scale of the products.

Firstly, the system incorporates sensors deployed inside the truck to continuously monitor crucial parameters such as temperature, humidity, and air quality. These sensors collect real-time data throughout the transportation journey, providing insights into the environmental conditions experienced by the goods.

Secondly, the collected data is efficiently processed and analyzed using cloud computing resources. Advanced analytics algorithms are employed to interpret the sensor data and assess the freshness level of the products. This analysis takes into account factors such as temperature fluctuations, humidity levels, and air quality variations, correlating them with the expected freshness standards for the specific type of goods being transported.

Thirdly, an intuitive mobile application is designed to receive and display all the parameters monitored by the sensors. Utilizing Bluetooth communication, the app seamlessly connects to the sensors inside the truck, providing users with real-time updates on the freshness status of the products. Users can view detailed insights, track historical data trends, and receive alerts in case of any deviations from the desired freshness conditions.

Additionally, the cloud-based platform offers several advantages such as scalability, reliability, and accessibility. It enables seamless integration with other systems and applications, allowing for enhanced collaboration and communication among stakeholders involved in the cargo management process. Furthermore, the cloud infrastructure provides robust security measures to protect sensitive data, ensuring compliance with regulatory requirements and safeguarding against potential threats.

Overall, the proposed Cloud Integrated Cargo Management System offers a comprehensive solution for monitoring and managing the freshness of goods during transportation. By leveraging advanced sensor technology, cloud computing capabilities, and intuitive mobile applications, the system empowers stakeholders to make informed decisions and ensure the quality and integrity of the transported products throughout the supply chain journey.

1.5 Aim and Objectives

Aim:

The project aim for the Cloud Integrated Cargo Management System is to revolutionize the transportation of goods by ensuring the freshness and quality of products throughout their journey from the source to the destination. Recognizing the critical influence of natural and physical conditions on the freshness scale of goods, the primary objective is to deploy advanced sensor technology inside trucks to monitor key parameters such as temperature, humidity, and air quality. By collecting real-time data on these crucial factors, the system aims to provide insights into the environmental conditions experienced by the cargo during transportation. Furthermore, the project focuses on efficiently processing the collected data to enable stakeholders to make informed decisions in real-time. This involves the development of sophisticated analytics algorithms capable of interpreting sensor data and assessing the freshness level of the products accurately. Additionally, the project aims to enhance communication and accessibility by designing a user-friendly mobile application. The application, enabled with Bluetooth communication, acts as a central hub for receiving and displaying all monitored parameters, allowing users to track the freshness status of the cargo remotely. Overall, the project aims to optimize the transportation process by leveraging cloud-based technologies to monitor and manage the freshness of goods effectively, thereby ensuring customer satisfaction and reducing waste throughout the supply chain.

Objectives:

Real-time Monitoring: Implement sensors inside the truck to continuously monitor parameters such as temperature, humidity, and air quality, ensuring real-time visibility into environmental conditions during transportation.

Data Collection and Processing: Collect data efficiently and process it in real-time to gain insights into the freshness scale of the products. Develop algorithms for analyzing collected data to make informed decisions regarding product freshness.

Efficient Decision-making: Enable stakeholders to make timely and accurate decisions based on the analyzed data, ensuring the quality and integrity of the transported goods throughout the supply chain journey.

Enhanced Communication: Develop a user-friendly mobile application that acts as a central hub for receiving and displaying all monitored parameters. Utilize Bluetooth communication to enable seamless data transmission between the sensors inside the truck and the mobile application.

Optimization of Transportation Process: Use insights from monitored parameters to optimize the transportation process, ensuring that goods are transported under optimal environmental conditions to maintain freshness and quality.

Customer Satisfaction: Ultimately, aim to enhance customer satisfaction by ensuring that goods arrive at their destination in the best possible condition, meeting freshness standards and minimizing waste.

Compliance and Regulation: Ensure compliance with relevant regulations and standards governing the transportation of perishable goods, incorporating necessary measures to meet regulatory requirements and maintain product integrity.

Scalability and Adaptability: Design the system to be scalable and adaptable to accommodate varying transportation needs and evolving technological advancements in the field of cargo management and sensor technology.

CHAPTER 2

LITERATURE SURVEY

A thorough literature survey on Cloud Integrated Cargo Management Systems, based on published papers, offers a comprehensive understanding of the landscape surrounding the optimization of goods transportation. These papers delve into the myriad factors influencing the transportation of perishable goods, emphasizing the critical importance of monitoring natural and physical conditions to ensure product freshness from source to destination. Research highlights the necessity of efficiently processing collected data to facilitate informed decision-making in the logistics chain. A significant focus lies in the deployment of sensors within trucks to monitor various parameters crucial for maintaining product freshness, such as temperature, humidity, and air quality. The integration of cloud-based technologies plays a pivotal role in this process, enabling real-time monitoring and data transmission to enhance cargo management efficiency. Moreover, the development of mobile applications equipped with Bluetooth communication further streamlines the monitoring process, allowing stakeholders to receive and analyze data remotely. These applications serve as central hubs for accessing and interpreting monitored parameters, providing invaluable insights into cargo conditions. Additionally, literature explores the integration of emerging technologies like artificial intelligence and machine learning to optimize cargo management processes further. These technologies aid in predictive analytics, risk assessment, and route optimization, ultimately contributing to improved operational efficiency and cost-effectiveness. Furthermore, the survey encompasses discussions on the challenges and opportunities associated with regulatory compliance, security, and sustainability in cloud integrated cargo management systems. Overall, the literature underscores the transformative potential of cloud integration in revolutionizing cargo management practices, offering valuable insights into the development and implementation of efficient and sustainable logistics solutions.The literature survey on Cloud Integrated Cargo Management Systems further explores several critical aspects shaping the landscape of modern logistics. One prominent area of focus is the optimization of supply chain visibility and transparency facilitated by cloud integration. Papers delve into how real-time access to cargo data enables stakeholders to proactively respond to disruptions, minimize delays, and enhance overall supply chain resilience. Moreover, discussions revolve around the integration of advanced technologies such as the Internet of Things (IoT) and blockchain to enhance cargo tracking, tracing, and authentication capabilities. These technologies enable seamless data sharing, transparent transactions, and immutable record-keeping, thereby fostering trust and accountability across the supply chain. Additionally, research highlights the growing importance of sustainability in cargo management practices, with studies exploring strategies for reducing carbon emissions, minimizing environmental impact, and promoting sustainable transportation practices. This includes initiatives such as modal shift analysis, route optimization, and the adoption of alternative fuels and energy-efficient vehicles. Furthermore, the literature survey addresses the role of collaborative platforms and ecosystems in fostering innovation and collaboration within the logistics industry. Collaborative platforms facilitate information sharing, resource pooling, and collaborative decision-making among stakeholders, ultimately driving efficiency and competitiveness in the global marketplace. Overall, the literature survey provides valuable insights into the multifaceted nature of cloud integrated cargo management systems, emphasizing the importance of technological innovation, regulatory compliance, and sustainability in shaping the future of logistics.

CHAPTER 3
METHODOLOGY

In the methodology for implementing a Cloud Integrated Cargo Management System using NodeMCU temperature sensor, humidity sensor, and pressure sensor, the first step involves the deployment of sensors inside the truck to monitor crucial parameters influencing the freshness scale of the transported goods. NodeMCU, a popular microcontroller board based on the ESP8266 Wi-Fi module, is utilized for its versatility and compatibility with various sensors. The NodeMCU is programmed to interface with temperature, humidity, and pressure sensors, collecting real-time data on environmental conditions inside the truck. The temperature sensor measures ambient temperature, while the humidity sensor monitors moisture levels, and the pressure sensor gauges air pressure. These sensors provide continuous data streams, which are processed by the NodeMCU microcontroller.Next, the collected sensor data is transmitted to the cloud platform for further analysis and decision-making. The cloud-based cargo management application is designed to receive and process the sensor data, providing real-time insights into the environmental conditions inside the truck. An intuitive user interface allows stakeholders to visualize temperature, humidity, and pressure readings, track historical data trends, and set threshold values for alert notifications. Additionally, the application incorporates advanced analytics algorithms to analyze sensor data, predict potential issues or deviations from freshness standards, and generate actionable insights for decision-making.

Furthermore, Bluetooth communication is implemented to enable seamless integration with a mobile application, allowing users to remotely monitor cargo conditions and receive alerts on their smartphones or tablets. The mobile application serves as a centralized dashboard for accessing real-time sensor data, receiving notifications, and communicating with other stakeholders involved in cargo management.

Overall, the methodology leverages NodeMCU temperature, humidity, and pressure sensors, along with cloud-based data processing and mobile application integration, to create a robust and efficient Cloud Integrated Cargo Management System. By continuously monitoring environmental conditions inside the truck and providing real-time insights to stakeholders, the system ensures the freshness and quality of transported goods throughout the supply chain journey.

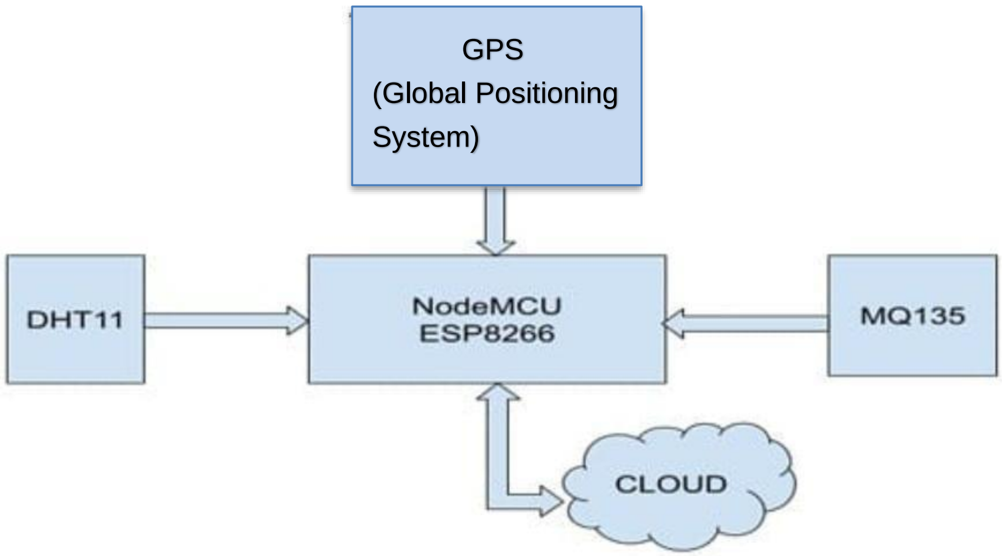

Fig 3.1.Block diagram for Cloud integrated Cargo Management System

3.1 NodeMCU (ESP8266)

The NodeMCU ESP8266 is a powerful and versatile platform designed for Internet of Things (IoT) development. The ESP8266 is a cost-effective Wi-Fi microchip known for its capability to enable wireless communication in IoT applications. NodeMCU, on the other hand, is an open-source firmware and development kit that simplifies the process of prototyping and programming the ESP8266. With built-in Wi-Fi connectivity, the NodeMCU ESP8266 allows devices to connect to the internet wirelessly, making it suitable for a wide range of IoT projects. One notable feature is its support for the Lua scripting language, providing a high-level programming environment for developers. Additionally, it is compatible with the Arduino IDE, allowing those familiar with Arduino to use the NodeMCU platform. Equipped with General Purpose Input/Output (GPIO) pins, the ESP8266 facilitates interfacing with various electronic components, making it ideal for applications such as home automation and sensor networks. The NodeMCU ESP8266 has garnered significant community support, resulting in an extensive collection of libraries and documentation, making it a popular choice for rapid IoT prototyping and development.

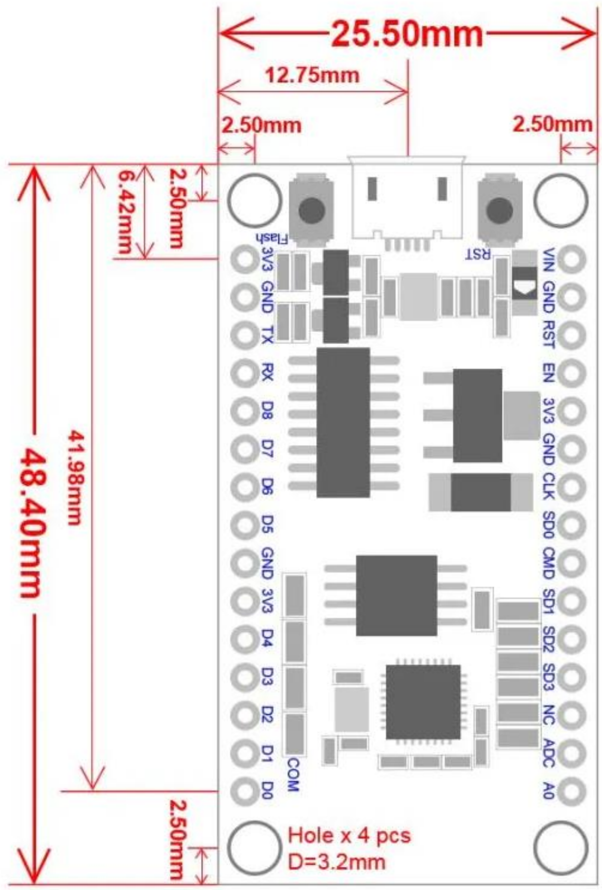

Figure 3.2 NodeMCU 2D View

NodeMCU Specification:

The NodeMCU development board is based on the ESP8266 microcontroller, and different versions of NodeMCU boards may have slight variations in specifications.

As of my knowledge cutoff in January 2022, here are the general specifications for t
he NodeMCU ESP8266 development board:

1. Microcontroller: ESP8266 Wi-Fi microcontroller with 32-bit architecture.

2. Processor: Tensilica L106 32-bit microcontroller.

3. Clock Frequency: Typically operates at 80 MHz.

4. Flash Memory:

- Built-in Flash memory for program storage.
- Common configurations include 4MB or 16MB of Flash memory.

5. RAM: Typically equipped with 80 KB of RAM.

6. Wireless Connectivity:

- Integrated Wi-Fi (802.11 b/g/n) for wireless communication.
- Supports Station, SoftAP, and SoftAP + Station modes.

7. GPIO Pins: Multiple General Purpose Input/Output (GPIO) pins for interfacing with sensors, actuators, and other electronic components.

8. Analog Pins: Analog-to-digital converter (ADC) pins for reading analog sensor values.

9. USB-to-Serial Converter: Built-in USB-to-Serial converter for programming and debugging.

10. Operating Voltage: Typically operates at 3.3V (Note: It is crucial to connect external components accordingly to avoid damage).

11. Programming Interface: Programmable using the Arduino IDE, Lua scripting language, or other compatible frameworks.

12. Voltage Regulator: Onboard voltage regulator for stable operation.

13. Reset Button: Reset button for restarting the board.

14. Dimensions: Standard NodeMCU boards often have dimensions 49mm x 24mm.

15. Power Consumption: Low power consumption, making it suitable for battery-operated applications.

16. Community Support: Active community support with extensive documentation and libraries.

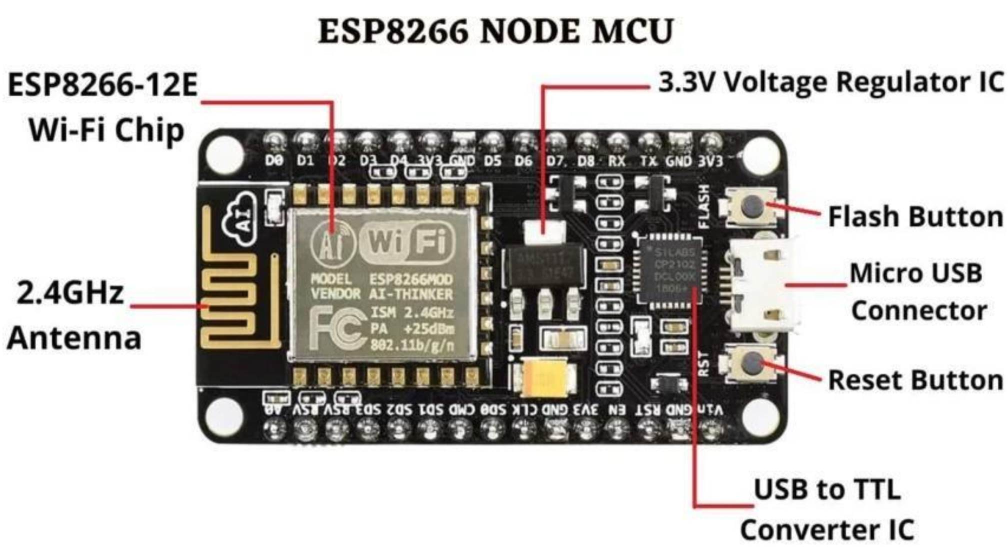

Figure 3.3: NodeMCU Parts

The NodeMCU ESP8266 development board typically has GPIO (General Purpose Input/Output) pins that can be used for various purposes, including interfacing with sensors, actuators, and other electronic components. Below is a common pinout configuration for the NodeMCU development board.

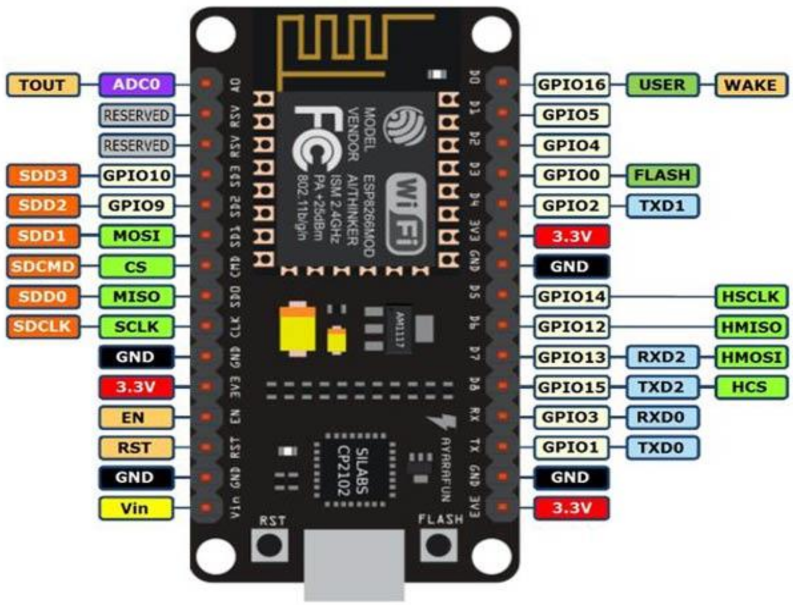

Figure 3.4: NodeMCU ESP8266 Pinout

ADC	A0	GPIO16
EN	Enable	GPIO14
D0	GPIO16	GPIO12
D1	GPIO5	GPIO13
D2	GPIO4	GPIO15
D3	GPIO0	GPIO2
D4	GPIO2	GPIO9
D5	GPIO14	GPIO10
D6	GPIO12	GPIO3
D7	GPIO13	GPIO1
D8	GPIO15	TX (GPIO1)
D9	GPIO3 (RX)	RX (GPIO3)
D10	GPIO1 (TX)	D11 (MOSI)
D11	MOSI	D12 (MISO)

D12 | MISO | D13 (SCK)

ADC: Analog-to-Digital Converter pin for reading analog sensor values.
EN (Enable): Enable pin.
D0-D8: Digital GPIO pins.
D9 (RX) and D10 (TX): Serial communication pins for programming and debugging.
D11 (MOSI), D12 (MISO), D13 (SCK): Pins used for SPI communication.
D14 (SDA) and D15 (SCL): Pins used for I2C communication.

It's important to note that GPIO pins labeled as "D" (Digital) are typically used for general-purpose digital input/output. Additionally, GPIO pins labeled as "A" (Analog) can be used as analog inputs with the ADC. GPIO pins 6, 7, 8, 9, 10, and 11 have additional functions, so it's advised to refer to the specific NodeMCU documentation for detailed information on pin functionality and capabilities.

3.2 MQ-135 Gas sensor:

The **MQ-135 Gas sensor** can detect gases like Ammonia (NH3), sulfur (S), Benzene (C6H6), CO2, and other harmful gases and smoke. Similar to other MQ series gas sensors, this sensor also has a digital and analog output pin. When the level of these gases go beyond a threshold limit in the air the digital pin goes high. This threshold value can be set by using the on-board potentiometer. The analog output pin, outputs an analog voltage which can be used to approximate the level of these gases in the atmosphere.

The MQ135 air quality sensor module operates at 5V and consumes around 150mA. It requires some preheating before it could actually give accurate results.

Details of MQ135 Sensor

The MQ135 is one of the popular gas sensors from the MQ series of sensors that are commonly used in air quality control equipment. It operates from 2.5V to 5.0V and can provide both digital and analog output. The pinouts and important components on an MQ135 Module is marked below

Note that all MQ sensors have to be powered up for a pre-heat duration for the sensor to warm up before it can start working. This preheat time is normally between 30 seconds to a couple of minutes. When you power up the module the power LED will turn on, leaving the module in this state till the pre-heat duration is completed.

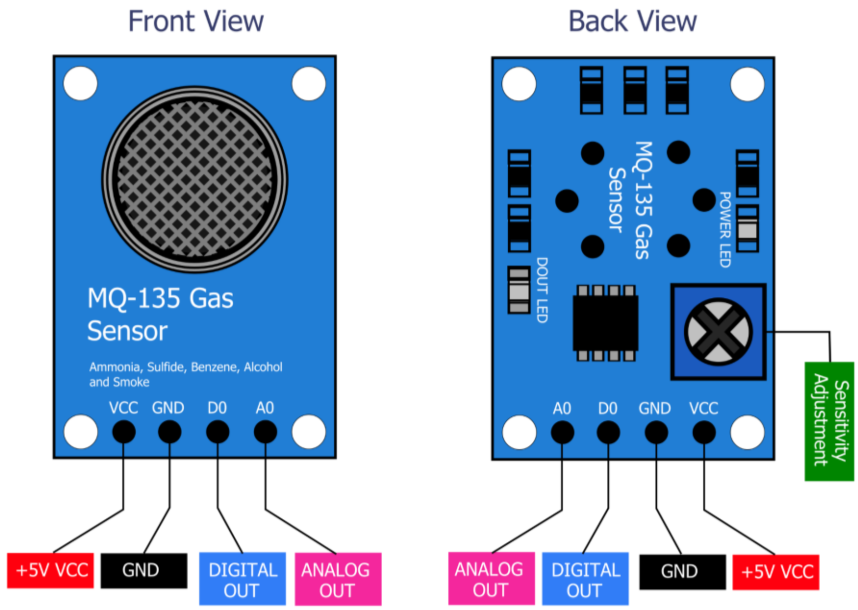

Figure 3.5: MQ135 Gas Sensor

Technical Specifications of MQ135 Gas Sensor

- Operating Voltage: 2.5V to 5.0V
- Power consumption: 150mA
- Detect/Measure: NH_3, Nox, CO_2, Alcohol, Benzene, Smoke
- Typical operating Voltage: 5V
- Digital Output: 0V to 5V (TTL Logic) @ 5V Vcc
- Analog Output: 0-5V @ 5V Vcc

Detect Harmful Gasses using Digital Pin:

The digital output pin of the sensor can be used to detect harmful gasses in the environment. The sensitivity of the digital pin can be controlled by using the 10k potentiometer. If the gas is detected the indicator LED D0 will turn on and the digital pin will go from logic high to logic low (0V). The LM393 Op-Amp Comparator IC is used to compare the actual gas value with the value set using the potentiometer. If the actual gas value increases than the set value then the digital output pin gets low.

Because of the onboard LM393 comparator IC the MQ135 Gas sensor module can also be used without the need of an external microcontroller. Simply power up the module and set the sensitivity of the digital pin using the potentiometer, then when the module detects the gas the digital pin will go low. This digital pin can directly be used to drive a buzzer or LED with the help of simple transistors.

Measure PPM Value using Analog Pin:

The Analog output pin of the sensor can be used to measure the PPM value of the required gas. To do this we need to use an external microcontroller like Arduino. The microcontroller will measure the value of analog voltage and perform some calculations to find the value of Rs/Ro where Rs is the sensor resistance when gas is present and Ro is sensor resistance at clean air. Once we find this ratio of Rs/Ro we can use it to calculate the PPM value of required gas using the graph below which is taken from the datasheet of MQ135 Sensor.

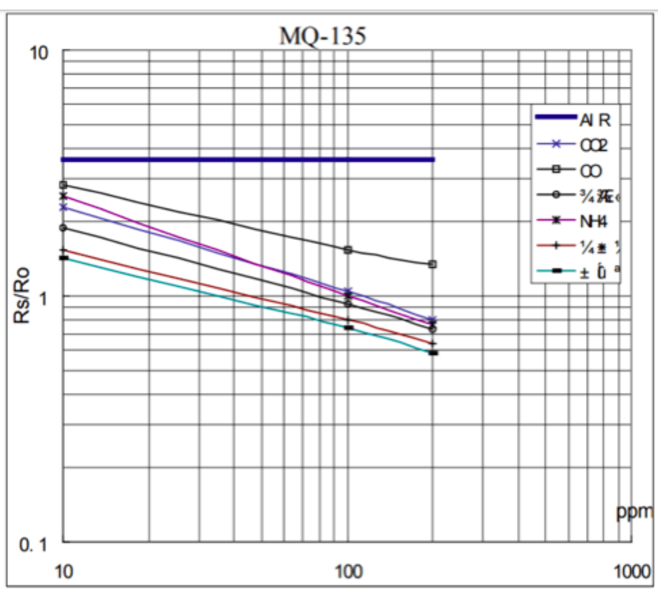

Figure 3.6: MQ135 Measurement of Smoke values

If you are just detecting the gas and not measuring the PPM then the module need not be calibrated or pre-heated and hence it is extremely simple to use. You can find these MQ Gas sensors commonly used in Gas/Smoke detectors and Air Quality Monitors. The dimensions of the MQ135 Gas sensor module is given below

Further Resources:

- Datasheet of MQ135
- MQ-135 Arduino Library

3.3 Temperature and Humidity Sensor:

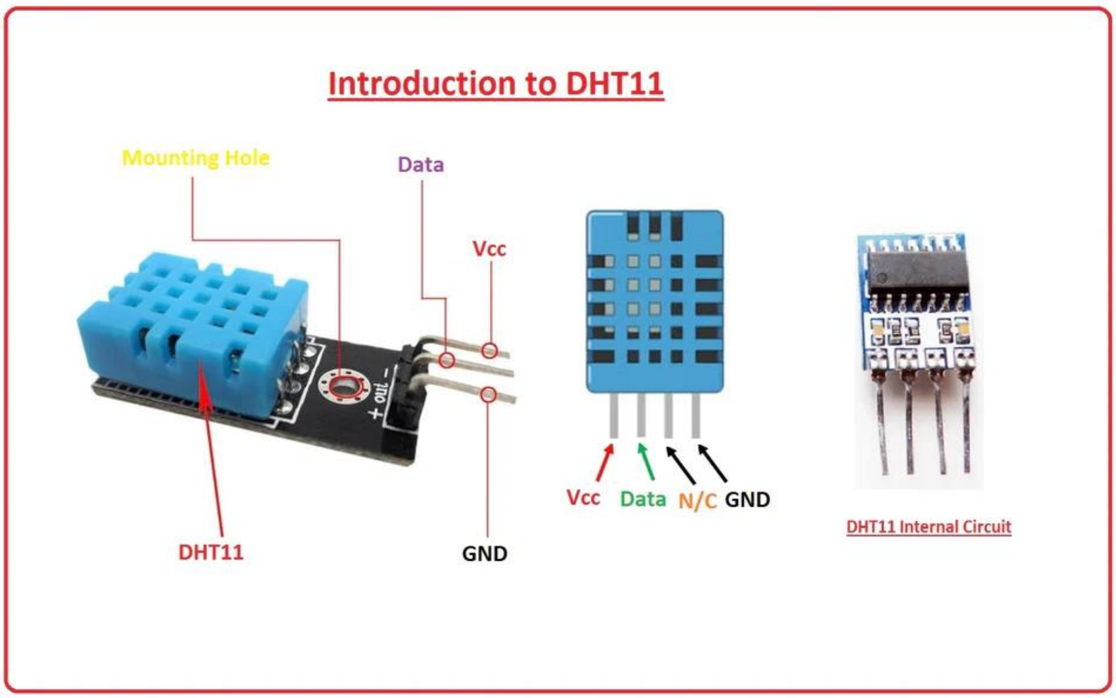

Figure 3.7 DHT 11 sensor

Temperature and Humidity Sensor

A temperature sensor is a device that measures the temperature of its surroundings or a specific object and converts that temperature into an electrical signal. Temperature sensors are used in a wide range of applications, including industrial processes, environmental monitoring, consumer electronics, medical devices, and more.

Features of Temperature Sensors:

1. **Accuracy:** Temperature sensors should provide accurate readings to ensure precise temperature measurements.
2. **Range:** They should be able to measure temperatures within a specific range, which can vary from sensor to sensor.
3. **Response Time:** The time it takes for a sensor to detect and report a change in temperature.
4. **Resolution:** The smallest temperature difference that a sensor can detect and report.
5. **Stability:** Consistency of readings over time and in various conditions.
6. **Calibration:** Some temperature sensors might need periodic calibration to maintain accuracy.
7. **Output Type:** Temperature sensors can provide analog or digital outputs, depending on the type of sensor.

Sensitivity Adjustments:

Sensitivity adjustment in a temperature sensor refers to the ability to fine-tune the sensor's response to temperature changes. Some sensors offer the option to adjust sensitivity to match specific requirements or to compensate for external factors that might affect accuracy.

Principle of Temperature Measurement:

Different types of temperature sensors work based on various principles. Some common principles include

Thermocouples: These sensors use the Seebeck effect, where two different metals connected at two junctions produce a voltage proportional to the temperature difference between the junctions. The voltage generated is used to determine the temperature.

RTDs (Resistance Temperature Detectors): RTDs are based on the principle that the electrical resistance of a material changes with temperature. They use materials with a predictable resistance-temperature relationship, such as platinum, to measure temperature.

Thermistors: Thermistors are temperature-sensitive resistors that have a resistance that changes significantly with temperature. They can be either Negative Temperature Coefficient (NTC) or Positive Temperature Coefficient (PTC) thermistors.

Bimetallic Strips: Bimetallic strips consist of two different metals with different coefficients of thermal expansion bonded together. As the temperature changes, the strip bends due to the differential expansion, and this bending can be used to measure temperature.

Semiconductor Temperature Sensors: These sensors use the temperature-dependent properties of semiconductors, such as diodes or transistors, to measure temperature.

3.4 GPS:

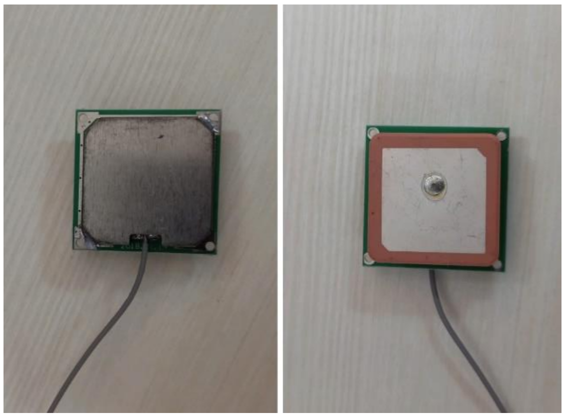

Figure 3.8 GPS

Features of GPS:

Real-time Tracking: GPS allows companies to track the exact location of their cargo at any point during the journey, ensuring better visibility and control.

Route Optimization: It helps in optimizing routes by providing real-time traffic updates, reducing delays and improving delivery times.

Loss Prevention: By continuously monitoring the location of the cargo, companies can detect and prevent theft or misplacement of goods.

Efficient Fleet Management: GPS enables fleet managers to monitor the movement and performance of multiple vehicles, helping with scheduling, fuel management, and maintenance.

CHAPTER 4

DESIGN AND CODING

The circuit connections were initially designed and tested in Tinkercad for simulation. Following successful execution, the real connections were assembled, and the system was tested using Arduino IDE. This approach ensured the proper functioning of sensors and microcontroller, confirming the reliability of the cargo management system.

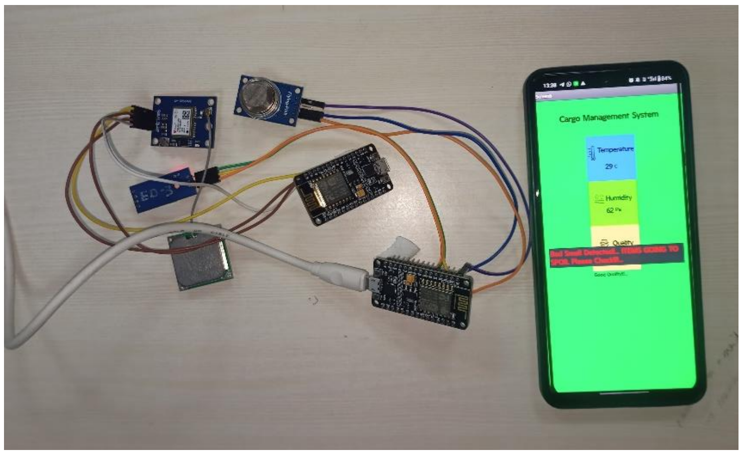

Figure 3.9 Circuit Diagram

This is the system we developed for the Cloud Integrated Cargo Management System

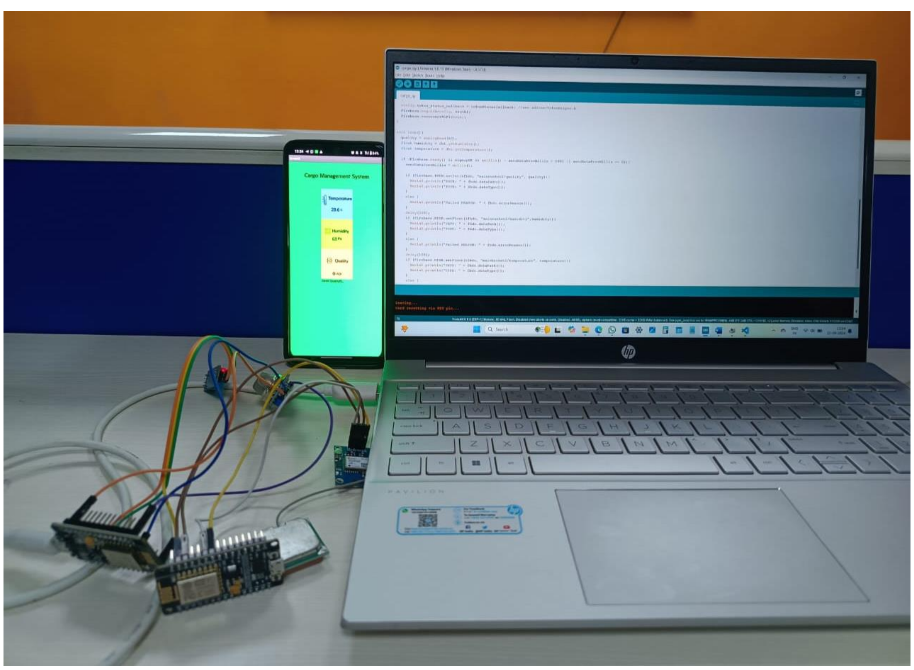

Figure 3.10 Cloud Integrated Cargo Management System

In our cargo management project, we successfully established connections to streamline operations and improve efficiency. Using MIT App Inventor, we developed a mobile application **WEIGHT ALERT** designed to manage and monitor food quality during transportation. The app enables users to input and track quality metrics, ensuring that only food items with a quality rating of 90 or below are accepted for shipment. By integrating real-time data and quality checks, the app helps to maintain high standards, reducing waste and ensuring customer satisfaction. This system simplifies the cargo management process, ensuring efficient handling and delivery of high-quality food products.

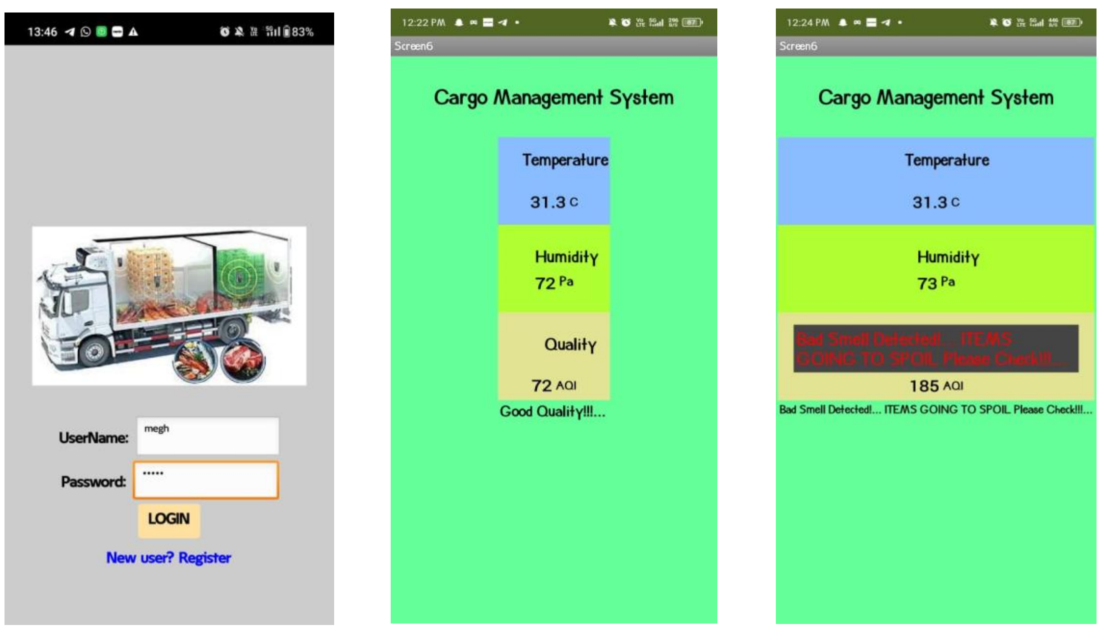

Figure 3.11 Application Results

CODE:

```
#include <ESP8266WiFi.h>
#include <Firebase_ESP_Client.h>
#include "addons/TokenHelper.h"
#include "addons/RTDBHelper.h"
#include "DHTesp.h"

#define WIFI_SSID "123456789"
```

```
#define WIFI_PASSWORD "123456789"
#define API_KEY "AIzaSyC0BOfLql-CshMoTrCVnvLKdqktzzYxdqc"
#define DATABASE_URL "https://gnits-7819a-default-rtdb.firebaseio.com/"

FirebaseData fbdo;
FirebaseAuth auth;
FirebaseConfig config;
DHTesp dht;

unsigned long sendDataPrevMillis = 0;
bool signupOK = false;
int quality = 0;
String intValue;

void setup(){
   dht.setup(D0, DHTesp::DHT11);
  Serial.begin(115200);
  WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  Serial.print("Connecting to Wi-Fi");
  while (WiFi.status() != WL_CONNECTED){
    Serial.print(".");
    delay(300);
  }
  Serial.println();
  Serial.print("Connected with IP: ");
  Serial.println(WiFi.localIP());
  Serial.println();
  config.api_key = API_KEY;
  config.database_url = DATABASE_URL;
  if (Firebase.signUp(&config, &auth, "", "")){
    Serial.println("ok");
```

```
    signupOK = true;
  }
  else{
    Serial.printf("%s\n", config.signer.signupError.message.c_str());
  }
  config.token_status_callback = tokenStatusCallback; //see addons/TokenHelper.h
  Firebase.begin(&config, &auth);
  Firebase.reconnectWiFi(true);
}

void loop(){
  quality = analogRead(A0);
  float humidity = dht.getHumidity();
  float temperature = dht.getTemperature();

  if (Firebase.ready() && signupOK && (millis() - sendDataPrevMillis > 1000 ||
sendDataPrevMillis == 0)){
    sendDataPrevMillis = millis();

    if (Firebase.RTDB.setInt(&fbdo, "mainbucket2/quality", quality)){
      Serial.println("PATH: " + fbdo.dataPath());
      Serial.println("TYPE: " + fbdo.dataType());
    }
    else {
      Serial.println("Failed REASON: " + fbdo.errorReason());
    }
    delay(100);
    if (Firebase.RTDB.setFloat(&fbdo, "mainbucket2/humidity",humidity)){
      Serial.println("PATH: " + fbdo.dataPath());
      Serial.println("TYPE: " + fbdo.dataType());
    }
```

```
    else {
      Serial.println("Failed REASON: " + fbdo.errorReason());
    }
    delay(100);
    if (Firebase.RTDB.setFloat(&fbdo, "mainbucket2/temperature", temperature)){
      Serial.println("PATH: " + fbdo.dataPath());
      Serial.println("TYPE: " + fbdo.dataType());
    }
    else {
      Serial.println("Failed REASON: " + fbdo.errorReason());
    }
    delay(1000);

  }
}
```

This is the code written for simulation of Cloud Integrated Cargo Management System using Arduino IDE.

CHAPTER 5

CONCLUSION

The *Cloud Integrated Cargo Management System* successfully addresses the critical need for real-time monitoring and management of environmental conditions during cargo transportation, particularly for perishable goods. By leveraging advanced sensor technologies and cloud computing, the system ensures continuous monitoring of crucial factors such as temperature, humidity, and air quality, thereby safeguarding product freshness and integrity throughout the supply chain.

The integration of a mobile application further enhances the system's functionality, providing stakeholders with instant access to live data and alerts, enabling informed decision-making on the go. This not only reduces instances of spoilage and financial loss but also enhances operational efficiency, regulatory compliance, and customer satisfaction.

The system's scalability, cost-effectiveness, and data-driven insights offer a sustainable solution for optimizing logistics processes, promising significant improvements in both supply chain visibility and product quality. As the system evolves, its potential to incorporate emerging technologies like machine learning and blockchain could further enhance cargo management, setting new standards for reliability and innovation in the logistics industry.