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LOGISHIELD: SMART CARGO Monitoring System

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Abstract : *In today's transportation and logistics industry, the safe delivery of goods is a major challenge. During transportation, cargo may be exposed to various risks such as sudden temperature changes, physical impacts, excessive vibrations, unauthorized opening, and improper handling. These conditions can damage valuable products, especially food items, medicines, and other temperature-sensitive materials. Traditional transportation systems often lack continuous monitoring and real-time alerts, making it difficult to identify problems during transit. To overcome these challenges, LOGISHIELD: SMART CARGO Monitoring System is proposed as an intelligent cargo monitoring and safety system.*

The main objective of LOGISHIELD is to monitor the condition of cargo throughout transportation and provide real-time information about its safety. The system uses sensors to measure important parameters such as temperature, humidity, vibration, and physical impact. A microcontroller-based system processes the collected sensor data and continuously checks whether the measured values are within predefined safety limits. If any abnormal condition is detected, the system generates an alert to notify the concerned person. It can also record important events and sensor readings, helping users understand the conditions experienced by the cargo during transportation.

The proposed system acts like a black box for cargo by maintaining a record of important transportation conditions and detecting possible risks. For example, if the temperature of a food or medicine container exceeds the permitted limit, or if the cargo experiences a sudden impact, the system identifies the event and generates a warning. This helps in taking timely action and reducing the chances of product damage or loss.

Keywords: Smart Cargo Monitoring, Real-Time Alerts, Microcontroller, Sensor Network, Cold Chain Logistics, Anomaly Detection.

I. INTRODUCTION

The transportation of goods plays an important role in today's world. Every day, millions of products such as food items, medicines, electronic equipment, chemicals, and industrial materials are transported from one place to another using trucks, ships, trains, and airplanes. During transportation, these goods may face different environmental and physical conditions that can affect their quality and safety. Maintaining proper conditions throughout the transportation process is therefore an important part of logistics and supply chain management.

One of the major challenges in cargo transportation is the lack of continuous monitoring. In traditional transportation systems, goods are often transported without proper information about their actual condition during the journey. For example, food products and medicines may get damaged if they are exposed to high temperatures or humidity. Similarly, fragile products may be damaged due to sudden shocks, vibrations, or improper handling. In many cases, these problems are identified only after the goods reach their destination, resulting in financial losses, product wastage, and customer dissatisfaction.

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To overcome these problems, LOGISHIELD: SMART CARGO Monitoring System is proposed as an intelligent cargo monitoring and safety system. The main purpose of this project is to monitor the condition of goods during transportation and identify any abnormal conditions that may cause damage. The system works like a Monitoring System used in aircraft, which records important information about the journey. Similarly, LOGISHIELD records and monitors important cargo-related parameters throughout transportation.

The proposed system uses different sensors to collect information about the cargo environment. A temperature sensor monitors the surrounding temperature, while a humidity sensor measures moisture levels. Vibration and impact sensors detect sudden movements, shocks, or physical disturbances during transportation. These sensors are connected to a microcontroller, which acts as the main processing unit of the system. It receives the sensor readings, processes the data, and compares the values with predefined safety limits.

II. LITERATURE SURVEY

1. IoT-Based Real-Time Environmental Monitoring for Cold Chain Logistics: P. Lingeswari, B. Mohan, P. Vigneshwaran, K. Rajesh, M. R. Kumari, and S. P. Santhoshkumar proposed an IoT-based environmental monitoring system for cold-chain logistics in 2025. The study focuses on monitoring environmental conditions during the transportation of temperature-sensitive products. IoT technology helps collect and monitor environmental information in real time. This research is useful for understanding how sensors and wireless communication can be used to maintain the quality of transported goods. It provides a foundation for implementing continuous cargo monitoring in LOGISHIELD [1].

2. Real-Time Monitoring and Energy Management in Cold Chain Logistics:K. Wang and N. Du presented a study on real-time monitoring and energy consumption management in cold-chain logistics in 2025. The research focuses on using IoT technology to monitor transportation conditions and improve energy management. Proper monitoring helps maintain suitable storage conditions while reducing unnecessary energy consumption. This study highlights the importance of combining environmental monitoring with efficient system operation. It is useful for developing an energy-efficient cargo monitoring solution [2].

3. IoT Monitoring and Temperature Control in Cold Chain Transportation: N. Ren, X. Zhang, S. Liu, and N. Liu studied IoT monitoring systems and temperature control optimization methods for cold-chain transportation in 2025. The study emphasizes the importance of maintaining suitable temperature conditions during the transportation of sensitive products. Temperature monitoring and control help prevent product deterioration caused by unsuitable environmental conditions. This research provides useful information for selecting temperature sensors and defining temperature warning limits in the proposed LOGISHIELD system [3].

4. Intelligent IoT Architecture with Predictive Modeling: V. Viswanatha, S. V. Vardhini, S. M. Nithya, and V. Deeksha proposed an intelligent IoT architecture for cold-chain monitoring using LSTM predictive modeling in 2025. The study introduces the application of intelligent data processing and prediction techniques in cargo monitoring. Predictive modeling can help identify possible changes in environmental conditions before they become serious problems. This research provides an understanding of how advanced IoT and artificial intelligence technologies can improve the reliability of transportation monitoring systems [4].

5. Secure Cold Chain Shipment Monitoring Using IoT and Blockchain: S. Abishek, A. B. Varma, A. Purohit, M. Sidarth, and J. Rolant Gini presented a secure and transparent cold-chain shipment monitoring system using IoT and blockchain technology in 2025. The study focuses on improving the security and transparency of shipment-related information. Blockchain technology can help maintain reliable records of transportation activities and reduce the possibility of unauthorized data modification. This concept is useful for the LOGISHIELD project, especially for maintaining trustworthy records of cargo conditions [5].

6. IoT-Driven Cold Chain Management for Perishable Goods: A study titled "IoT-Driven Cold Chain Management for Real-Time Monitoring and Alerts for Perishable Goods" was presented in 2025. The research focuses on using IoT technology to monitor perishable goods and generate alerts when abnormal conditions occur. Real-time alerts help

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transport operators respond quickly to environmental changes that may affect product quality. This study is closely related to the proposed project because LOGISHIELD also aims to detect unsafe cargo conditions and generate immediate warnings [6].

7. IoT-Enabled Cargo Shipment Management: A study on IoT-enabled cargo shipment management was presented in 2025. It focuses on real-time tracking and optimization in global logistics. Cargo tracking and monitoring are important for improving transportation efficiency and providing better information about shipment activities. The study highlights the role of IoT technology in modern logistics management. These concepts can be used in LOGISHIELD for future integration of GPS tracking and wireless communication features [7].

8. Dynamic Shelf-Life Prediction During Cold Chain Transportation: A study on dynamic shelf-life prediction of fruits and vegetables during cold-chain transportation was presented in 2025. The research focuses on understanding how transportation conditions affect the quality and remaining shelf life of perishable products. Temperature and environmental changes can influence the freshness of food materials. This study highlights the importance of continuous environmental monitoring and provides useful knowledge for applying cargo condition monitoring to food transportation [8].

9. Industrial Cold Chain Tracking and Temperature Maintenance: A study titled "Industrial Cold Chain: A Tracking System with Temperature Maintenance" was presented in 2025. The research focuses on tracking systems and temperature maintenance in industrial cold-chain applications. Maintaining suitable temperature conditions is necessary for transporting sensitive products safely. The study provides useful ideas for combining tracking and environmental monitoring functions in a single system. It is relevant to the future development of LOGISHIELD with advanced tracking capabilities [9].

10. Solar-Powered Temperature and Humidity Monitoring: S. Mandal, P. K. Sharma, S. Chopra, and D. Dhingra proposed an IoT-enabled solar-powered temperature and relative humidity monitoring system for cold storages in 2025. The research focuses on monitoring two important environmental parameters: temperature and relative humidity. Solar power provides an alternative energy source for operating monitoring systems. This study is useful for understanding sensor-based environmental monitoring and exploring energy-efficient power solutions for LOGISHIELD [10].

11. AI-Based Monitoring and Energy Prediction in Food Transportation: A study published in the journal Sensors in 2025 focuses on an IoT-based system for real-time monitoring and AI-driven energy consumption prediction during fresh fruit and vegetable transportation. The research combines monitoring technology with artificial intelligence to improve transportation management. Such systems can help understand the relationship between transportation conditions and energy requirements. This study provides useful knowledge for future improvements involving intelligent data analysis and energy-efficient cargo monitoring [11].

12. Trustworthy IoT-Based Supply Chain Traceability: L. Li, W. Wang, X. Zhou, H. Qu, W. Ni, and A. Jamalipour proposed a trustworthy IoT-based supply-chain traceability system using semantic multichain and preblockchain data verification in 2025. The research focuses on improving the reliability and security of supply-chain information. Data verification and traceability are important for maintaining accurate records of transportation activities. This study is useful for understanding how cargo monitoring data can be stored and protected for future reference [12].

13. Logistics Data Traceability Using Mobile Sensors and Blockchain: A study published in Results in Engineering in 2025 focuses on logistics electronic data traceability using mobile sensors and blockchain technology in the context of low-carbon energy. The research highlights the importance of collecting, storing, and verifying logistics-related information. Mobile sensors can support data collection, while blockchain can improve information transparency. These concepts are useful for developing a reliable cargo monitoring and event-recording system [13].

14. SmartCargo Monitoring Using IoT and Artificial Intelligence: C. Bento proposed a SmartCargo monitoring system for cargo transportation integrated with IoT and artificial intelligence in 2024. The study is directly related to smart cargo monitoring and focuses on applying modern technologies to improve transportation management. IoT helps collect information from the cargo environment, while AI can support intelligent analysis of collected data. This research provides a useful reference for the overall concept and future development of LOGISHIELD [14].

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15. Integrated Sensing and Logging for Cold Chain Monitoring: A study titled "IoT-Based Integrated Sensing and Logging Solution for Cold Chain Monitoring Applications" was published in the IEEE Journal of Radio Frequency Identification in 2024. The research focuses on combining sensing and data-logging technologies for cold-chain monitoring. Continuous sensing helps collect environmental information, while data logging provides a record of conditions during transportation and storage. This concept is particularly important for LOGISHIELD because the proposed system is designed to work like a black box by monitoring and recording important cargo-related events [15].

III. EXISTING SYSTEM

In the present transportation and logistics industry, the safe transportation of goods is a major challenge. During transportation, cargo may be exposed to various environmental and physical conditions such as temperature fluctuations, humidity changes, excessive vibrations, and sudden impacts. These conditions can affect the quality, safety, and reliability of transported products, especially food items, medicines, electronic equipment, and other fragile materials.

Traditional cargo transportation systems mainly depend on manual inspection and basic monitoring methods. They do not always provide continuous information about the actual condition of goods during transportation. As a result, problems such as excessive temperature, high humidity, sudden shocks, and improper handling may remain undetected until the cargo reaches its destination. This can lead to product damage, financial losses, wastage of goods, and customer dissatisfaction.

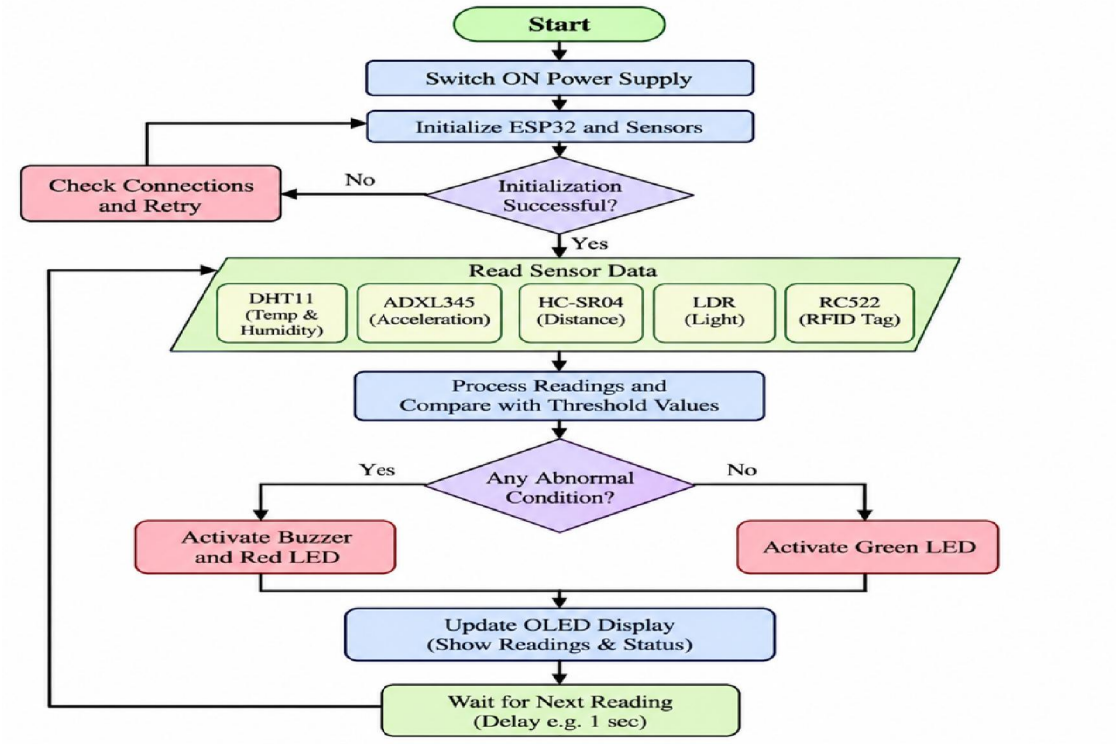


Figure 1 : Initial Work Flow Diagram for Explaining the actual working in blocks

Therefore, there is a need for a smart, compact, and cost-effective monitoring system that can continuously monitor important cargo parameters, detect abnormal conditions, and generate immediate warnings.

The problem addressed by this project is to design and develop LOGISHIELD: SMART CARGO Monitoring System, a microcontroller-based cargo monitoring system that uses sensors to measure temperature, humidity, vibration, and

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impact during transportation. The system should process sensor readings, compare them with predefined safety limits, generate alerts whenever abnormal conditions are detected, and maintain records of important events.

The proposed system aims to reduce cargo damage, improve transportation safety, and provide better monitoring of goods throughout their journey. It will work like a Monitoring System for cargo by recording important transportation conditions and helping users identify possible reasons for product damage.

IV. FUTURE ENHANCEMENT

- GPS-Based Real-Time Location Tracking
- Mobile Application Development
- Cloud-Based Data Storage
- Advanced Temperature and Humidity Sensors
- Artificial Intelligence and Data Analysis
- Improved Power Management
- Advanced Security and Tamper Detection
- Improved Wireless Communication
- Advanced Sensor Integration
- Web-Based Monitoring Dashboard
- Data Logging and Report Generation
- Compact and Industrial-Grade Design
- Multi-Cargo Monitoring
- Geo-Fencing and Route Monitoring

V. CONCLUSION

The LOGISHIELD: SMART CARGO Monitoring System presents an IoT-based approach for improving cargo safety and monitoring during transportation. The proposed system integrates an ESP32 microcontroller with different sensors, including DHT11, ADXL345, HC-SR04, LDR, and RC522 RFID, to monitor important cargo-related parameters such as temperature, humidity, movement, distance, and light intensity. The collected information is processed by the microcontroller to identify abnormal conditions and generate alerts through a buzzer and LED indicators. An OLED display provides information about the current monitoring status.

From the reviewed studies, it is understood that IoT, sensor-based monitoring, wireless communication, and intelligent data analysis play an important role in modern logistics and cargo management. However, continuous monitoring, cargo identification, timely alert generation, and reliable data collection remain important requirements. LOGISHIELD aims to address these requirements through a simple, modular, and cost-effective monitoring architecture.

The proposed system can help improve awareness of cargo conditions, reduce the chances of unnoticed transportation-related problems, and support better cargo management. Furthermore, future integration of GPS tracking, cloud storage, mobile applications, artificial intelligence, and advanced security mechanisms can enhance its functionality and practical applications.

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