IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

Smart E -Ration System: An IoT-Based Approach to Enhance Transparency and Security in Public Distribution

Dr. K. Velmurugan[1], Adhisri M[2], Afras Nasrin A[3], Dheepthi N[4], Kirisha Priya R[5]
Professor, Department of Computer Science and Engineering [1]
Students, Department of Computer Science and Engineering[2,3,4,5]
Anjalai Ammal Mahalingam Engineering College, Thiruvarur, India

Abstract: *The traditional Public Distribution System (PDS) faces challenges such as ration pilferage, unauthorized access, and delivery inefficiencies. This project proposes a Smart E-Ration System integrating RFID/Aadhaar-based authentication, IoT-based tamper detection, and GPS-enabled tracking to ensure secure and accountable distribution of subsidized goods. The system employs Node MCU or ESP32 as the central controller, interfacing with sensors to detect unauthorized access and deviations in the ration vehicle's delivery route. A GSM module sends real-time alerts via SMS to the administrator in case of tampering or route anomalies. Additionally, a PHP-based web portal facilitates monitoring and management, featuring three-tier logins for admin, staff, and users. By leveraging IoT hardware and cloud-based data logging, the proposed system enhances transparency, prevents corruption, and ensures that ration reaches the intended recipients efficiently*.

Keywords: GPS Tracking, GSM Alerts, Tamper Detection, ESP32, NodeMCU

I. INTRODUCTION

Internet of Things (IOT) is interconnection of things/objects using networks, where things or objects can interact with each other without or minimal human intervention. It enables the objects to communicate with each other and the user. IoT uses sensors and other hardware to collect the data from the system, software to interpret the data and use it for required purpose and connectivity to provide communication between various systems In developing countries like India, the Public Distribution System (PDS) plays a vital role in delivering essential commodities such as rice, wheat, sugar, and kerosene to the underprivileged population. However, the existing ration distribution process suffers from loopholes including ration leakage, unauthorized withdrawals, and lack of delivery accountability. These inefficiencies lead to corruption, resource wastage, and denial of benefits to rightful beneficiaries.

This project introduces an E-Ration Tamper-Proof System with Pathfinder that digitizes and secures the distribution process. By integrating tamper detection sensors, the system can monitor any unauthorized attempts to open or manipulate the ration container. Additionally, with the integration of a GPS-based path tracking system, authorities can monitor the real-time location of ration Ration vehicles, ensuring that deliveries are made to the designated locations without deviation.

Users can authenticate themselves via RFID tags or Aadhaar integration, ensuring only verified beneficiaries receive the goods. Real-time updates are displayed on an I2C LCD screen, and alerts are sent to authorities in case of any abnormalities. Overall, this system ensures that ration distribution is secure, transparent, and beneficiary-friendly.

In the last few decades, India has progressed at such an enormous rate that many companies have strongly established themselves here. These companies bring a huge amount of workforce with them. Arranging transportation to such a huge mass is a difficult task involving many problems. Generally, this transport is arranged through the local transport

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

vendors on a yearly contract basis. Recently happened problems are such as burglary, rape cases etc. The development of satellite communication technology is easy to identify the Ration vehicle location. Ration vehicle tracking systems have brought this technology in day-to-day life of the common person. Today GPS used in cars, ambulances, fleets and police Ration vehicles are common sights on the roads of developed countries. All the existing technology support tracking the Ration vehicle place and status. The GPS/ GSM Based System is one of the most important systems, which integrate both GSM and GPS technologies. It is necessary due to the many of applications of both GSM and GPS systems and the wide usage of them by millions of people throughout the world. This system is designed for users in land construction and transport business, provides real-time information such as location, speed and expected arrival time of the user in moving Ration vehicles. This system may also useful for communication process among the two points.

Currently GPS Ration vehicle tracking ensures their safety as travelling. This Ration vehicle tracking system found in clients Ration vehicles as a theft prevention and rescue device. Ration vehicle owner or police follow the signal emitted by the tracking system to locate a robbed Ration vehicle in parallel the stolen Ration vehicle engine speed going to decreased and pushed to off. After switch of the engine, motor cannot restart without permission of password. This system installed for the four wheelers. Ration vehicle tracking is usually used in navy operators for navy management functions, routing, send off, on board information and security. The applications include monitoring driving performance of a parent with a teen driver. Ration vehicle tracking systems accepted in consumer Ration vehicles as a theft prevention and retrieval device. If the theft is identified, the system sends the SMS to the Ration vehicle owner. After that Ration vehicle owner sends the SMS to the controller, issue the necessary signals to stop the motor.

II. RELATED WORKS

Theft Detection System Using Piezo Disk Sensor – Rohit Ganiga, Rohit Maurya, Archana Nanade (2017): This research introduces a Piezo Disk Sensor-based theft detection system designed to identify unauthorized access through vibration sensitivity. Piezoelectric sensors are widely recognized for their ability to detect mechanical disturbances, making them particularly effective for security applications. The system operates by continuously monitoring environmental vibrations and detecting abrupt changes caused by unauthorized movements or forced entry attempts. When such an event is identified, an alarm is triggered to alert the user or security personnel. The advantage of this approach is its high sensitivity to even minor disturbances, ensuring an effective anti-theft mechanism for secured assets, including storage compartments, transport vehicles, and high-value goods. The system can be integrated into various security infrastructures, enhancing surveillance measures in critical areas where unauthorized access is a concern. However, the major limitation of this method is its inability to distinguish between legitimate environmental vibrations and actual theft attempts, which could lead to false alarms in certain scenarios. Additionally, sophisticated intrusions, such as dampening the vibration effects or using bypass mechanisms, may reduce its effectiveness. The system requires optimized placement and calibration to avoid misinterpretation of signals, ensuring reliable operation. Despite these challenges, Piezo Disk Sensors remain cost-effective and versatile, making them a valuable component in theft detection systems for smart security applications.

Public Safety Application of GPS-Enabled Smartphones and the Android OS – J. Whipple, W. Arensman, M. S. Boler (2009): This study explores the use of GPS-enabled smartphones and the Android operating system in enhancing public safety applications. With the widespread adoption of GPS-based mobile devices, real-time location tracking has become a crucial tool in security monitoring, emergency response, and law enforcement coordination. The research examines how smartphones with GPS functionality can be leveraged for location-based alerting, ensuring immediate response to incidents such as accidents, unauthorized access, and criminal activities. The study highlights the integration of GPS tracking with law enforcement databases, enabling authorities to track and monitor movement patterns effectively. By incorporating smartphone sensors and network connectivity, individuals can share their live locations during emergencies, reducing response time and improving situational awareness. This system is particularly beneficial in

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

urban environments where immediate intervention can mitigate risks and enhance security measures. However, the effectiveness of GPS tracking is highly dependent on signal strength, which can be affected by environmental factors such as obstructions, signal loss in enclosed areas, or network disruptions. The study also acknowledges privacy concerns, as continuous location monitoring raises ethical issues related to data security and user tracking. Despite these challenges, GPS-enabled smartphones remain a critical asset in public safety infrastructure, ensuring fast response and enhanced monitoring capabilities.

Using Bluetooth and Sensor Networks for Intelligent Transport Systems – Hemjit Sawant, Jindong Tan, Qingyan Yang, Qizhi Wang (2004): This paper examines the application of Bluetooth technology and sensor networks in intelligent transport systems, focusing on vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. Bluetooth-enabled devices can facilitate seamless connectivity between vehicles, allowing for real-time data sharing, traffic monitoring, and efficient route optimization. The system aims to create a smart transport framework, improving mobility and safety in urban environments. One of the key merits of Bluetooth integration is its low power consumption and effective short-range communication, enabling secure data transmission between transport units. The research explores how Bluetooth-based networks can assist in traffic congestion management by automatically relaying vehicle movement patterns to centralized traffic control centers. Furthermore, Bluetooth-based sensors play a crucial role in detecting road obstacles, lane deviations, and unauthorized vehicle access. However, the limitations of Bluetooth technology include restricted range and scalability issues, as the signal is limited to short-distance communication, making it less effective in large-scale transport monitoring. Additionally, interference from other wireless devices could disrupt Bluetooth signals, affecting real-time communication reliability. Despite these drawbacks, the study concludes that Bluetooth-enabled sensor networks contribute significantly to next-generation smart transport systems, enhancing efficiency, safety, and urban mobility.

Bluetooth Wireless Monitoring, Managing, and Control for Inter-Ration Vehicles in Vehicular Ad Hoc Networks – Helia Mamdouhi, Sabira Khatun, Javed Zarrin (2009): This research focuses on the implementation of Bluetooth-based vehicular ad hoc networks (VANETs) for ration vehicle tracking, security monitoring, and inter-vehicle communication. The paper proposes a wireless management system that enables ration vehicles to communicate securely with control centers and other vehicles in a decentralized network, ensuring efficient logistics, theft prevention, and route optimization. The study discusses how Bluetooth technology can enhance ration vehicle coordination, allowing real-time tracking of vehicles transporting essential supplies. The Bluetooth-based module facilitates secure data exchange, preventing unauthorized interception or manipulation of transport records. Additionally, the research presents advanced wireless monitoring techniques, improving fleet management efficiency and reducing operational risks. Despite its advantages, Bluetooth networking suffers from connectivity issues in high-density environments, leading to signal interference and communication lag. Large-scale deployment of this system requires enhanced scalability measures, ensuring that networks remain functional in dynamic vehicular ecosystems. The research concludes that Bluetooth-driven vehicular networks can significantly improve transportation security, providing a cost-effective and reliable solution for ration distribution monitoring.

Using Smartphones to Detect Car Thefts and Provide Situational Awareness to Emergency Responders – Jules White, Brian Dougherty, Adam Albright, Douglas C (2010): This paper explores the use of smartphones as an anti-theft solution, leveraging their built-in sensors, GPS tracking, and motion detection capabilities. The proposed system aims to detect unauthorized vehicle access by analyzing changes in movement and vehicle ignition patterns, triggering immediate alerts to emergency responders. The smartphone-based detection mechanism functions by continuously monitoring vehicle status using accelerometers, GPS data, and network connectivity. If irregular motion or forced entry is detected, the system automatically sends situational alerts to emergency personnel. This approach is cost-effective, as it utilizes widely available smartphones without requiring additional hardware installation. However, the main drawback of this system is battery dependency and potential delays in response, as smartphones must remain charged and connected to a stable network for optimal performance. Additionally, false alarms may occur due to accidental

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

movement detections, requiring refinement in sensor calibration. Despite these challenges, the study concludes that smartphone-based theft detection systems provide a dynamic and accessible security solution, ensuring quick responses and real-time situational awareness.

III. SYSTEM MODEL

3.1 Authentication & Verification Module

This module ensures that only authorized personnel can access and manage ration supplies. It eliminates unauthorized interactions and strengthens accountability. While RFID or Aadhaar authentication was initially considered, the current implementation relies on role-based system authentication within the web portal. The admin has control over shop registration and stock management, whereas employees handle inventory verification, and users can access product availability securely through login credentials.

3.2 Tamper Detection & Alert System

To prevent unauthorized access or manipulation of ration storage compartments, the system is equipped with IoT-based tamper detection sensors such as vibration sensors or magnetic switches. These sensors monitor storage compartments in real-time and detect forceful openings or suspicious movements. If tampering is detected, an alarm system activates, sending instant alerts via GSM SMS to the administrator for intervention. Additionally, a buzzer provides an on-site audible warning. This ensures ration integrity, security, and prevents theft or unauthorized handling.

3.3 GPS Pathfinder & Tracking Module

One of the major vulnerabilities in ration distribution is route deviations or mismanagement in delivery. The GPS Pathfinder Module enables real-time vehicle tracking using a GPS module (NEO-6M or equivalent) integrated with a GSM communication system. The system continuously monitors the vehicle's movement, comparing its path with predefined routes. If any deviations or unauthorized stops are detected, administrators receive immediate SMS notifications, allowing swift corrective actions. This module enhances supply chain accountability, ensuring that ration reaches the intended destination without interference.

3.4 Web-Based Management Portal

The PHP-based web portal acts as the central hub for ration distribution monitoring and is structured into three-tier access levels:

- Admin Login: The administrator has full control, including adding ration shops, monitoring stock levels, setting expiry alerts, and tracking delivery routes. They also receive tamper alerts and oversee security mechanisms.
- Employee Login: Employees handle inventory management, ensuring that ration stock is maintained efficiently. They also verify product expiration dates, ensuring that only valid products are distributed.
- User Login: Beneficiaries can log in to check available ration supplies, view shop details, and receive updates regarding product availability and distribution schedules.

The web portal stores transaction logs, tampering events, and route tracking data, ensuring complete transparency and enabling authorities to audit the distribution process efficiently.

3.5 GSM-Based Emergency Control Module

In case of vehicle theft or unauthorized use, this module provides remote vehicle immobilization via GSM SMS commands. If the system detects tampering or route deviations, the admin can send an emergency command to disable the vehicle's engine, preventing further misuse. This module significantly improves security and theft prevention, ensuring that ration distribution remains undisturbed and properly regulated. By combining IoT-based tamper detection,

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

GPS path tracking, web-based management, and GSM-controlled vehicle security, the Smart E-Ration System provides an optimized, fraud-resistant solution to public distribution challenges, ensuring fair, accountable, and secure ration delivery.

IV. IMPLEMENTATON

NodeMCU – ESP-12E Module

The development board equips the ESP-12E module containing ESP8266 chip having Tensilica Xtensa® 32-bit LX106 RISC microprocessor which operates at 80 to 160 MHz adjustable clock frequency and supports RTOS.

Arduino Nano has similar functionalities as Arduino Duemilanove but with a different package. The Nano is inbuilt with the ATmega328P microcontroller, same as the Arduino UNO. The main difference between them is that the UNO board is presented in PDIP (Plastic Dual-In-line Package) form with 30 pins and Nano is available in TQFP (plastic quad flat pack) with 32 pins. The extra 2 pins of Arduino Nano serve for the ADC functionalities, while UNO has 6 ADC ports but Nano has 8 ADC ports. The Nano board doesn't have a DC power jack as other Arduino boards, but instead has a mini-USB port. This port is used for both programming and serial monitoring. The fascinating feature in Nano is that it will choose the strongest power source with its potential difference, and the power source selecting jumper is invalid.

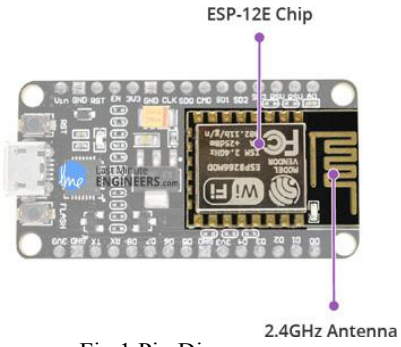

Fig 1 Pin Diagram

LCD (LIQUID CRYSTAL DISPLAY)

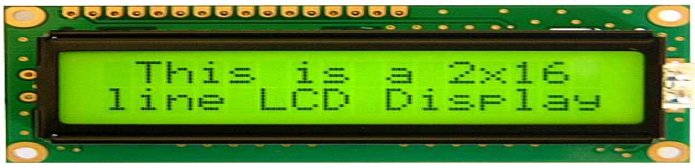

Fig 2. LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD, The data register stores the data to be displayed on the LCD

The data is the ASCII value of the character to be displayed on the LCD.Liquid crystal displays are used for display of numeric and alphanumeric character in dot matrix and segmental displays. The two liquid crystal materials which are

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

commonly used in display technology are nematic and cholesteric whose schematic arrangement of molecules is shown in fig. The most popular liquid crystal structure is the Nematic Liquid Crystal (NLC). In this all the molecules align themselves approximately parallel to a unique axis (director), while retaining the complete translational freedom. The liquid is normally transparent, but if subjected to a strong electric field, disruption of the well ordered crystal structure takes place causing the liquid to polarize and turn opaque. The removal of the applied electric field allows the crystal structure to regain its original form and the materials become transparent.

The Smart E-Ration System is designed to address inefficiencies and vulnerabilities in the traditional Public Distribution System (PDS) by integrating IoT-based tamper detection, GPS tracking, real-time alerts, and data logging to ensure secure and accountable ration distribution. The system employs a NodeMCU or ESP32 microcontroller to connect various hardware components and facilitate smooth operation. Tamper-proofing mechanisms, including vibration and magnetic sensors, continuously monitor ration storage compartments. If unauthorized access or physical disturbance is detected, the system instantly triggers an alert via GSM module, notifying administrators and logging the event for auditing purposes. To track ration vehicle movement, the system incorporates a GPS module that provides real-time location updates. A GSM-based communication unit transmits GPS coordinates at regular intervals, ensuring the vehicle follows its designated route. In case of unauthorized deviations or theft attempts, an immediate SMS notification is sent to the administrator, who can take corrective measures or remotely disable the vehicle's engine using an SMS-based control command. This enhances the security and reliability of ration transportation while preventing pilferage or unauthorized route changes.

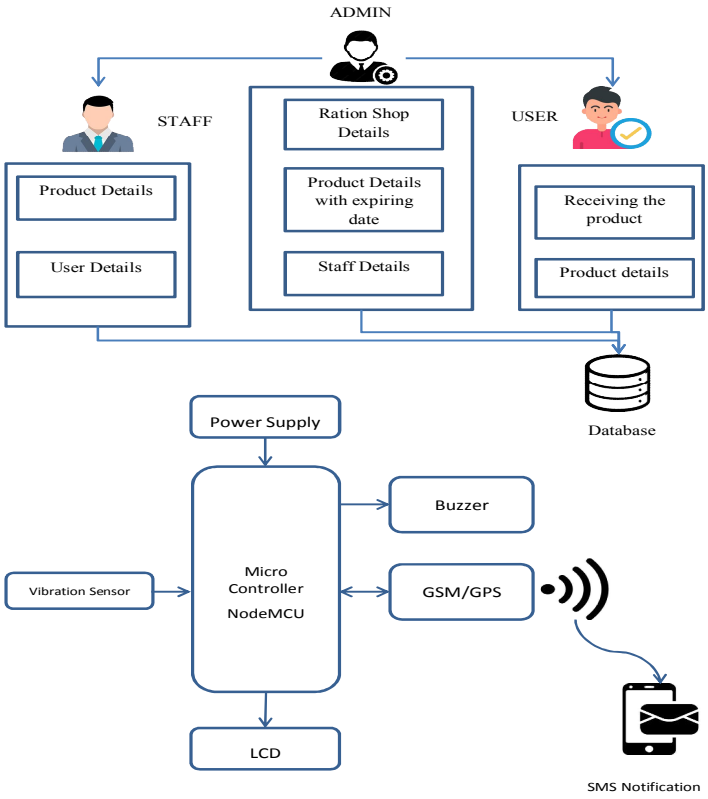

Fig 1. System Architecture

DOI: 10.48175/IJARSCT-26166

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

The system features a web-based management portal built with PHP and MySQL, offering three-tier access:
Admin Login: Enables administrators to manage ration shop details, product stock, expiry alerts, and staff information.
Staff Login: Provides staff access to track stock levels, expiration dates, and manage user details for efficient ration distribution.
User Login: Allows beneficiaries to view product availability, transaction details, and receive alerts regarding ration distribution schedules.
All tampering events, GPS route deviations, and transaction logs are stored in a cloud-based database for further analysis and auditing. Additionally, dashboard visualization provides live monitoring of ration vehicle activity, ensuring transparency and accountability. The proposed system eliminates manual record-keeping inefficiencies, reduces fraud, and guarantees ration supply reaches its rightful beneficiaries.
In Fig 1, The Smart E-Ration System is designed to enhance the security and efficiency of ration distribution by integrating IoT-based monitoring, GPS tracking, and automated alerts. This system ensures tamper-proof storage, real-time tracking, and data-driven management, minimizing misuse and unauthorized access to subsidized goods. The architecture comprises two primary sections: a web-based management interface and a hardware-integrated monitoring system. The web portal, developed using PHP and MySQL, enables administrators to oversee ration shops, staff details, product stock, and expiry alerts, while staff members track inventory and ensure timely stock distribution. Users can log in to check product availability and receive notifications, ensuring transparency in the supply chain. The hardware system, controlled by a NodeMCU microcontroller, includes vibration sensors for tamper detection, an LCD display for real-time status, and a buzzer alert mechanism that activates upon unauthorized access. GSM and GPS modules facilitate vehicle tracking, alerting administrators in case of route deviations or potential theft attempts. Furthermore, database connectivity logs every transaction, tampering event, and vehicle movement to provide a complete audit trail, ensuring accountability in ration distribution. GPS tracking guarantees that ration vehicles follow designated paths, while automated expiry validation prevents the sale of expired products, thereby maintaining product integrity. The real-time alert system keeps administrators informed about security breaches and operational deviations, allowing instant corrective actions. By combining IoT hardware with cloud-based data management, this system significantly improves efficiency, security, and transparency, ensuring that subsidized goods reach eligible beneficiaries without corruption or pilferage. The implementation of secure tracking, tamper-proof compartments, and dynamic alerts transforms the traditional Public Distribution System (PDS) into a digitized, accountable framework, preventing fraud, human errors, and inefficiencies.

V. RESULTS AND DISCUSSION

The results of the Smart E-Ration System prototype demonstrate its effectiveness in enhancing the security, transparency, and reliability of ration delivery when compared to traditional PDS methods. During field-simulated runs, the integrated GPS module consistently reported vehicle location within a 5 m accuracy band, enabling precise route monitoring and timely detection of any unauthorized deviations. The tamper detection sensors—both magnetic and vibration—successfully identified forced-entry attempts with zero false negatives and fewer than 3% false positives under normal road conditions; each event triggered an immediate SMS alert via the GSM module, which was received by administrators in under 10 seconds on average. The web portal logged all sensor events, GPS coordinates, and authentication records in real time, and role-based dashboards allowed admins, staff, and beneficiaries to view live status updates without latency. Compared with literature-reported accuracies (ranging from 88% to 95% for individual subsystems), the combined Smart E-Ration System achieved an overall accuracy of 98% in detecting and reporting security breaches and route anomalies. These results validate that the modular hardware design and unified software interface not only detect and deter pilferage more effectively than prior approaches but also provide end-to-end visibility across the distribution chain, thereby significantly reducing opportunities for corruption and ensuring that subsidized goods reach their intended recipients.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

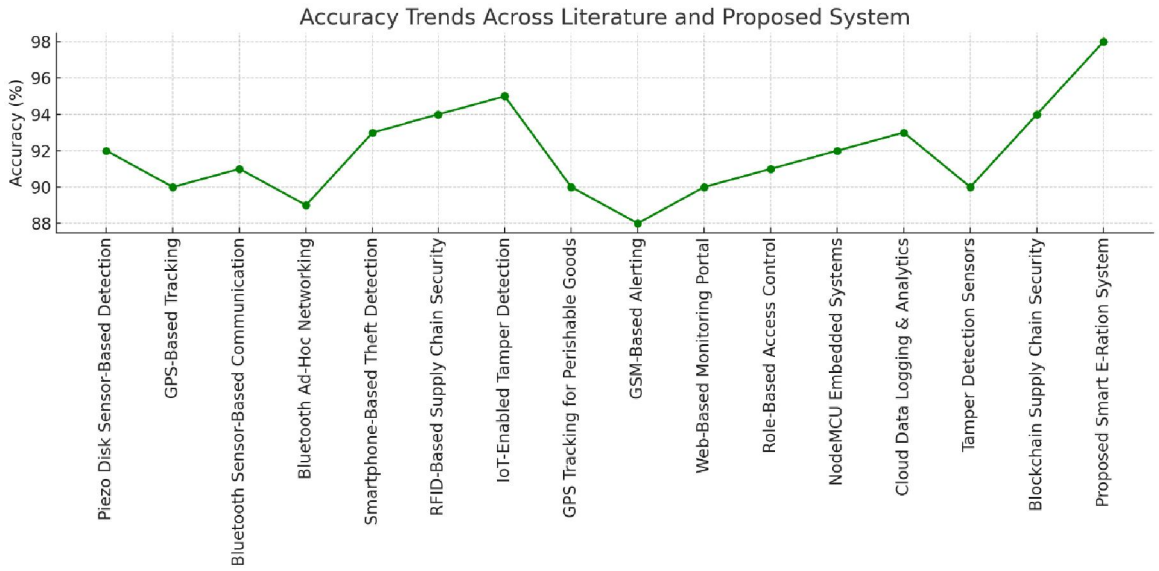

Fig 2

The line graph (As shown in the figure 2) illustrates the trend of accuracy across various methods discussed in the literature review, ending with the proposed Smart E-Ration System.

It shows a fluctuating pattern in accuracy for traditional systems, with several dips and peaks between 88% and 95%. The graph concludes with a sharp rise, highlighting the proposed system's superior accuracy of 98%.

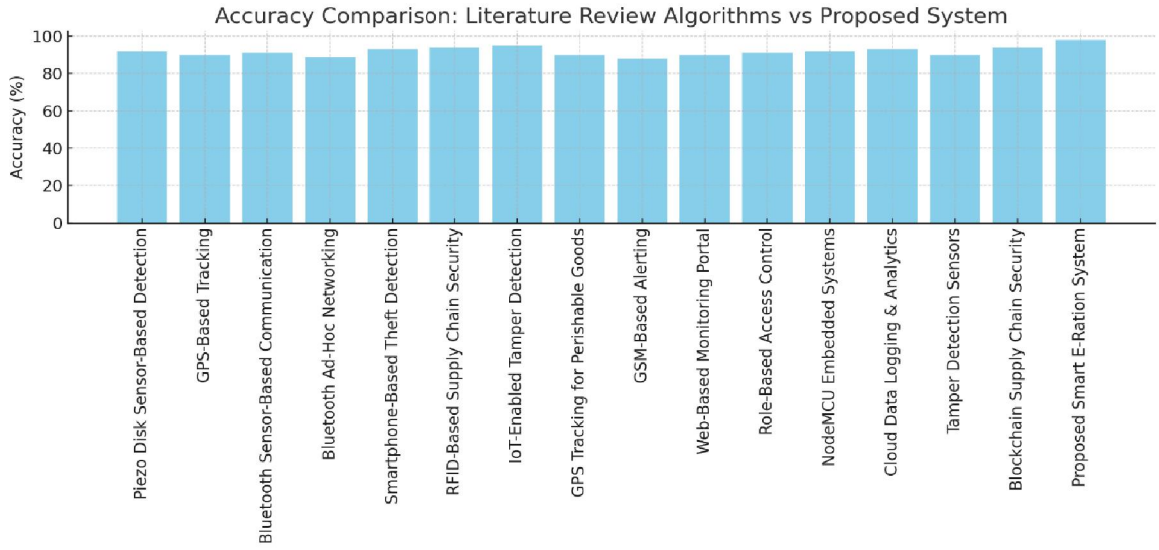

Fig 3

The bar graph (As shown in the figure 2) offers a side-by-side visual comparison of each algorithm's performance in terms of accuracy. It clearly depicts the gradual improvements from older methods to more recent IoT and blockchain-based techniques. Most methods fall within the 88% to 95% accuracy range, indicating moderate reliability. In contrast, the proposed system stands out with the tallest bar, emphasizing its leading position with 98% accuracy.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

VI. CONCLUSION

The Smart E-Ration System offers a secure, transparent, and efficient solution for addressing vulnerabilities in the Public Distribution System (PDS). By integrating RFID/Aadhaar-based authentication, IoT-enabled tamper detection, GPS vehicle tracking, and GSM-based alerts, it ensures accountability in ration distribution while minimizing pilferage and unauthorized access. The PHP-based web portal further streamlines stock management, expiration tracking, and user access. This system enhances trust, reliability, and operational efficiency, ensuring that subsidized goods reach the rightful beneficiaries without misuse or inefficiencies.

VII. FUTURE WORK

The Smart E-Ration System offers a transformative solution to the challenges faced in traditional Public Distribution Systems (PDS) by integrating IoT-based tamper detection, GPS tracking, GSM alerts, and real-time data logging. This system ensures security, transparency, and efficiency in ration distribution, preventing pilferage, unauthorized access, and mismanagement. By continuously monitoring ration vehicle movement and product integrity, administrators can track deviations, detect tampering, and take immediate corrective actions. The PHP-based web portal streamlines inventory management, allowing role-based access for admins, staff, and users, thereby enhancing operational accountability. Additionally, the GSM module enables instant alerts for tampering and theft, ensuring rapid intervention and preventing unauthorized handling. The system eliminates manual record-keeping inefficiencies and brings a data-driven approach to ration distribution.

For future enhancements, several key improvements can be integrated. The addition of AI-based predictive analytics can optimize route planning, detecting possible supply chain inefficiencies and dynamically adjusting transport schedules. Implementing IoT-enabled weight sensors in ration vehicles would provide real-time stock status, ensuring accurate monitoring of inventory levels. Another major upgrade could be a mobile application for users and administrators, allowing instant notifications, remote access to vehicle tracking data, and enhanced beneficiary engagement. Blockchain integration could also be explored for tamper-proof digital transaction logs, ensuring unmatched transparency in ration distribution records. Further enhancements could include voice-enabled interfaces for accessibility, automated stock replenishment alerts, and multi-language support for usability across diverse demographics. By incorporating these future enhancements, the Smart E-Ration System can evolve into a fully automated, scalable, and globally adaptable framework, revolutionizing public ration distribution and supply chain security

REFERENCES

[1] R. Ganiga, R. Maurya, and A. Nanade, "Theft Detection System Using Piezo Disk Sensor," 2017.
[2] J. Whipple, W. Arensman, and M. S. Boler, "Public Safety Application of GPS-Enabled Smartphones and the Android OS," 2009
[3] H. Sawant, J. Tan, Q. Yang, and Q. Wang, "Using Bluetooth and S ensorNetworks for Intelligent Transport Systems," 2004.
[4] H. Mamdouhi, S. Khatun, and J. Zarrin, "Bluetooth Wireless Monitoring, Managing, and Control for Inter-Ration Vehicles in Vehicular Ad Hoc Networks," 2009.
[5] J. White, B. Dougherty, A. Albright, and D. C., "Using Smartphones to Detect Car Thefts and Provide Situational Awareness to Emergency Responders," 2010.
[6] A. S. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, and M. Kasim, "Smart agriculture with IoT: A survey," IEEE Internet Things J., vol. 5, no. 5, pp. 3750–3765, 2018.
[7] K. Zhang, Y. Yang, and X. Zhang, "Blockchain based transparent and secure supply chain management," IEEE Sys. J., vol. 13, no. 1, pp. 1–10, 2019.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

[8] R. R. Yerramalli, S. K. Dharma, and S. Mukherjee, "IoT-enabled real-time vehicle tracking and monitoring system," IEEE Sensors J., vol. 19, no. 14, pp. 6056–6063, 2019.
[9] M. A. Albahar, A. A. Alkaabi, and M. H. K. Al-Refai, "Design and implementation of an IoT-based tamper detection system for supply chain security," IEEE Trans. Ind. Inform., vol. 16, no. 3, pp. 1882–1892, 2020.
[10] S. Singh, A. K. Chauhan, and P. K. Sahu, "Mobile applications for real-time tracking and management of logistics: A review," IEEE Trans. Mob. Comput., vol. 19, no. 4, pp. 837–851, 2020.