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# Accident Prevention of BOXN Wagon Train

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ABSTRACT

The safety and efficiency of railway freight transportation are critical to the functioning of many national economies, and India is no exception. BOXN wagons, widely used in the Indian railway system for transporting heavy goods such as coal, minerals, and other bulk materials, are essential for supporting industries across the country. However, due to their size, weight, and the volume of cargo they carry, these wagons are prone to accidents if not properly managed. Accidents involving BOXN trains can result in severe consequences, including loss of life, damage to property, and environmental degradation. One of the biggest and most significant industries in the world is the Indian goods railway sector. It is essential for the transportation of materials and goods across the nation. Indian Railways seeks to shorten commute times by boosting the average freight train speed efficiently from 22 mph to 50 mph. The adoption of new technologies is anticipated to have positive effects on the Indian goods railway sector as well. Smart Innovations, for instance, smart goods cars and digital signaling can contribute to reducing train accidents and help to increase railroad productivity using smart mobility.

**Keywords :** BOXN wagons, Railway, Transport, Safety, Awareness, Infrastructure

## I. INTRODUCTION

The Indian railway freight system plays a vital role in the nation's economy by facilitating the transport of goods and materials across vast distances. As one of the largest and most significant sectors in the world, it serves as a backbone for industries, agriculture, and commerce. The system is constantly evolving to meet growing demands, and with advancements in technology, it is poised to become even more efficient and reliable. Enhancing the speed and safety of freight operations remains a key objective for Indian Railways, given the increasing need for faster delivery and minimal disruptions.

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Preventing accidents in BOXN wagon trains is necessary for the safe cargo supply of the railway freight system. This includes deformation and collisions due to the size and weight of the wagons. Doors of wagons are not fixed regularly due to negligence. So it collides with electric mast i.e. OHE mast. That's when a large number of accidents occur. Mostly it is found on railway bends. We are developing a wireless electronic communication model to solve this problem. In which transmission and reception signals will remain.

The implementation, of advanced technologies such as smart goods cars and digital signaling systems, holds significant potential for the Indian railway freight sector. These innovations not only enhance the safety of operations by reducing accidents but also contribute to high efficiency, allowing for higher speeds and improved logistics management. As Indian Railways continues to adopt smart mobility solutions, the industry can expect enhanced productivity, reduced delays, and a positive impact on the overall economy, paving the way for a more reliable and sustainable freight transport system.


## II. LITERATURE SURVEY

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## III. OBJECTIVES

The objectives of the proposed work are as follows:
Regular maintenance and inspections:- Regular and thorough inspections of freight wagons are critical for maintaining safety and preventing accidents in railway operations. Thus, inspecting wagons frequently and thoroughly is very important for

reducing the risk of equipment failure during transit. So, it implements a rigorous and frequent inspection schedule, rail operators can ensure that each wagon is in optimal condition before it embarks on its journey. This proactive approach significantly reduces the chances of accidents, equipment failure, and delays, ultimately contributing to the safe and efficient operation of the railway freight system.

Training and Awareness: The model ensures providing, good training to the staff. Effective training equips personnel with the necessary skills to follow safety protocols, handle emergency situations, and maintain wagons and equipment properly. By fostering a safety-conscious workforce, rail companies can significantly reduce the risk of accidents, equipment failures, and operational disruptions. They provide safety protocols, and emergency work procedures to all personnel involved in the operation, maintenance, and handling of wagons. To keep up with the evolving railway technologies and regulations, it is essential to provide continuous learning opportunities to staff. Refresher courses should be held regularly to reinforce key safety protocols.

Reduce the frequency and severity of accidents: Minimize the number of accidents involving BOXN trains and reduce their impact on human life, property, and the environment. Providing extensive training to staff on safety protocols is essential. Personnel should be well-versed in standard operating procedures, including pre-departure checks, routine inspections, and emergency response actions. It ensures the staff is equipped with knowledge and skills to handle emergencies effectively. Staff should be equipped with knowledge and skills to handle emergencies effectively. These efforts not only enhance the safety and efficiency of railway operations but also protect human life, property, and the environment, contributing to a more reliable and sustainable freight transport system.

Improve safety standards and protocols:- Enhance security measures and protocol for the BOXN wagon train. It helps prevent and mitigate accidents and minimize risk. This includes securing access to railway facilities with restricted zones and surveillance, conducting thorough pre-departure inspections and routine maintenance, and adopting advanced technologies such as real-time tracking and sensor systems. Additionally, integrating digital signaling for improved communication and developing detailed standard operating procedures (SOPs) are crucial.

Reduce the frequency and severity of accidents: Minimize the number of accidents involving BOXN trains and reduce their impact on human life, property, and the environment

## IV. INTRODUCTION OF STM32 NUCLEO U575ZI-Q BOARD

**Fig 2.** Introduction of STM32 Nucleo-U575ZI-Q Board

The STM32-U575ZIQ is a microcontroller development board from STM Microelectronics that, is part of the STM32U5 series. This series focuses on ultra-low-power microcontrollers with advanced features. Below is a detailed overview:

**Key Specifications:**

**1. Core:**

32-bit Arm® Cortex®-M33 CPU with Trust Zone® technology for security. Operating frequency up to 160 MHz

**2. Memory:**

Up to 2 MB of Flash memory. 786 KB of SRAM (split into multiple banks for optimization). Optional external memory support via QSPI, Octo-SPI, and FMC interfaces.

**3. Power Efficiency:**

Advanced power management features (Ultra-low-power series). Multiple low-power modes, including Stop, Standby, and Shutdown modes. Low power consumption down to a few microamperes in standby mode.

**4. Security Features:**

Integrated cryptographic hardware accelerators. Trust Zone® security with isolation between secure and non-secure regions. Secure Boot and firmware update (SFU). Hardware random number generator (RNG).

**5. Connectivity:**

1x USB 2.0 Full-Speed with integrated PHY. Multiple serial interfaces: UART, I2C, SPI. CAN, SDMMC (SDIO for SD cards), and Quad-SPI for external memory.

**6. Analog Peripherals:**

2x 12-bit ADCs (Analog to Digital Converters). 1x 12-bit DAC (Digital to Analog Converter). Integrated temperature sensor.

**7. Timers:**

Advanced control timers for motor control (PWM, dead-time generation). Multiple general-purpose timers. Low-power timers and watchdog timers.

**8. Digital Peripherals:**

Up to 8 USART, 6 I2C, 4 SPI, and 2 CAN-FD. Up to 165 GPIO pins. Dual-mode Quad-SPI interface for external memory.

**9. Development Environment:**

Compatible with ST's STM32CubeMX software for pin configuration, clock tree, and peripheral setup. Integrated support in STM32CubeIDE (Eclipse-based IDE with GCC and GDB). Extensive middleware support including USB, file systems, networking, and more.

**10. Operating Range:**

Operating voltage range: 1.71 V to 3.6 V. Temperature range: -40°C to +85°C or +105°C, depending on the package variant.

**11. Package:**

Available in various packages (including the 144-pin LQFP or WLCSP) depending on specific requirements like pin count and physical size.

## V. PROPOSED METHODOLOGY

The block diagram for the railway disaster prevention model describes the 12 steps involved in monitoring BOXN wagon doors and sending real-time alerts to the control room if a door is detected to be open. The steps are:

- Power supply: Provides electricity to the system.
- Start sensing: Initiates sensor monitoring of BOXN wagon doors.
- Train engine: Represents the train's movement or condition, influencing sensor activation timing.
- Wait for the train: Pauses the system until the train reaches a certain point or the engine is in motion.
- Main sensor (Ultrasonic sensor): Detects open doors and sends information to the processing unit.
- STM32 Nucleo (U575ZI-Q): Processes sensor data, determines if the door is open, and controls communication modules.

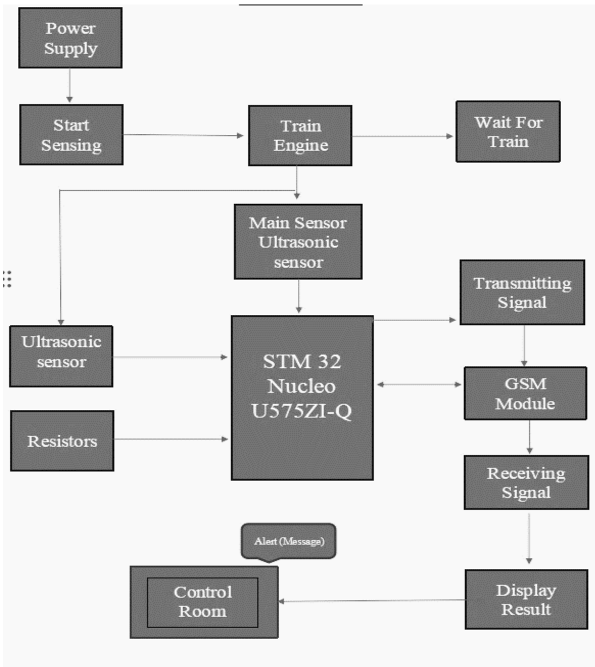


**Figure 3.** Block diagram of accident prevention of BOXN wagon train.

- Transmitting signal: Sends information to the GSM module for transmission to the control room.
- GSM module: Sends alerts over the mobile network to notify the control room of open doors.
- Receiving signal: The control room receives the transmitted signal.
- Display result: The output screen displays the door status or train condition.
- Control room: Monitors door status and can send alerts if danger is detected.

## VI. FUNCTIONAL BLOCK DIAGRAM OF MODEL

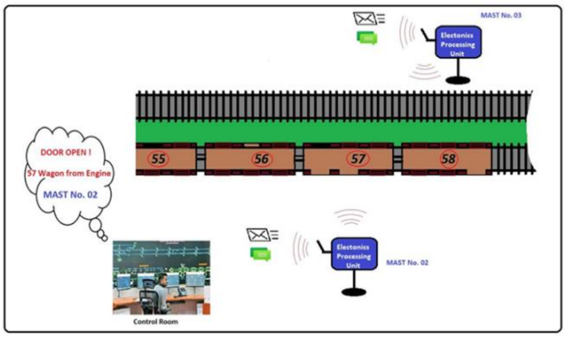


**Fig 4.** Functional Block Diagram of a model

Wireless communication (ultrasonic sensor) on the platform of the Internet of Things (IoT) is used in our model for the transmission and reception of a signal. The ultrasonic sensor provides the best result and alternative options for GSM technology as it solves the range coverage problems in communication systems.

**Mounting and positioning of our product on the OHE mast:**

We have selected the OHE mast for mounting our product for the following reasons:

- Precision for detection of open-door problems is found more accurate, as our unit will be mounted on the mast nearer to the passing train.
- Near to OHE mast, the inductive effect is also found very less, so, it is a less risky area.
- Easy to install and maintain over time.
- There is no vibrational effect on our unit if a train passes at high speed.

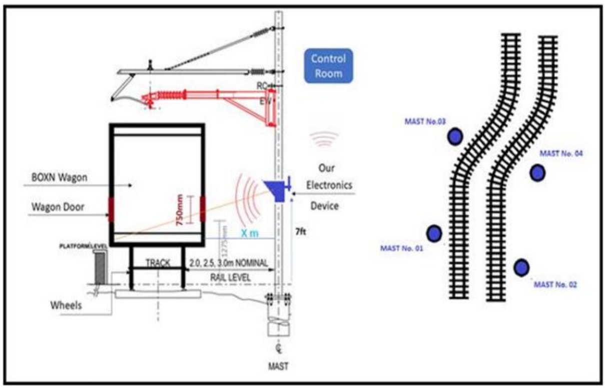


**Fig 5.** Best Place mounting of our product i.e. on the OHE mast

- As the distance between the rail track and every mast is variable, so, we can design our unit for a specific mast also.

## VII. EXPECTED RESULT

The system is installed on wagons to detect and alert if the door is open. The transmitter unit sensor will sense the train engine. By installing this detection and alert system, the railway sector can significantly enhance safety protocols, ensuring that open doors on BOXN wagons are quickly identified and addressed thereby preventing accidents and ensuring smoother operations.

The system Provides continuous, real-time monitoring of door statuses on all wagons, enhancing overall safety. The wireless communication system ensures that any open door is promptly reported to the control room, allowing swift action. It reduces the risk of accidents caused by open doors, especially during transit through areas with overhead electric masts or other infrastructure.

If it senses the open door, then the main sensor will be triggered, and check a distance wagon from the unit. If the door is open, then the information about that respective wagon from the engine will be communicated through, wireless with the receiver unit present in the control room. The receiver unit will show the open door message of a respective wagon from the engine on the screen with an alarming buzzer for further action by the control room.

## VIII. CONCLUSION AND FUTURE SCOPE

To provide continuous service and greater confidence in the railway sector, it is necessary to create safety against accidents on its assets. This paper describes general preventive measures aimed at reducing the number of accidents involving collisions with electric masts. The present discussion is done in terms of the ability, to effectively, reduce accidents, their cost implications, and their integration into the rail transport system as a whole and to minimize the impact on railway operations. By adopting a comprehensive approach to accident prevention, including advanced monitoring, infrastructure improvements, regular maintenance, and effective integration into the rail transport system, the railway sector can significantly reduce the frequency and impact of collisions with electric masts. This not only enhances safety but also provides economic benefits through lower costs and improved operational reliability.

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